N00164.AR.000638
NSWC CRANE
5090.3a

Work Plan
for
RCRA Facility Investigation, Corrective Measures Study, and Risk Assessment
at
Solid Waste Management Unit 2 - Dye Burial Grounds

Naval Surface Warfare Center Crane Division
Crane, Indiana

Volume I of II - Text and Appendices A-I

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0010

May 2001

089908/P

WORK PLAN
FOR
RCRA FACILITY INVESTIGATION, CORRECTIVE MEASURES STUDY, AND RISK ASSESSMENT
AT
SOLID WASTE MANAGEMENT UNIT 2 - DYE BURIAL GROUNDS

NAVAL SURFACE WARFARE CENTER
CRANE DIVISION
CRANE, INDIANA

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, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0010

MAY 2001

Ralph R. Basinski 5/10/01
RALPH R. BASINSKI, QEP
TASK ORDER MANAGER
TETRA TECH NUS, INC.

Debbie Wroblewski 5/10/01
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

Paul V. Frank 5-10-01
PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

Allen Debus 6/13/01
ALLEN DEBUS
QUALITY ASSURANCE COORDINATOR
U.S. EPA REGION 5

6/13/01
PETER RAMANAUSKAS
PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

Thomas J. Brent 5/23/01
TOM BRENT
SITE MANAGER
NSWC CRANE

Kathy Kreps 05/18/01
KATHY KREPS
LABORATORY DIRECTOR
LAUCKS TESTING LABORATORIES, INC.

Nancy J. Maegerlein
NANCY MAEGERLEIN
LABORATORY MANAGER
EXPLOSIVE SCIENCES BRANCH
NSWC CRANE

TABLE OF CONTENTS

SECTION **PAGE NO.**

ACRONYMS **7**

1.0 INTRODUCTION **1-1**
1.1 OBJECTIVE 1-2
1.2 SCOPE OF WORK 1-3
1.2.1 Evaluation of Historical Data 1-3
1.2.2 Field Investigation 1-4
1.2.3 Laboratory Analysis 1-4
1.2.4 Data Management 1-4
1.2.5 RFI Report 1-5
1.2.6 Risk Assessment 1-5
1.2.7 Corrective Measures Study Report 1-5
1.3 ORGANIZATION OF WORK PLAN 1-6

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES **2-1**
2.1 MANAGEMENT 2-1
2.1.1 U.S. EPA Project Manager 2-1
2.1.2 Indiana Department of Environmental Management 2-1
2.1.3 Navy Project Managers 2-1
2.1.4 Contractor Project Management 2-2
2.2 QUALITY ASSURANCE 2-5
2.2.1 U.S. EPA Region 5 Quality Assurance Coordinator 2-5
2.2.2 TtNUS Quality Assurance Manager 2-5
2.2.3 Project QA Advisor 2-6
2.2.4 Laboratory Responsibilities 2-6
2.3 FIELD INVESTIGATION 2-8
2.3.1 Field Operations Leader 2-9
2.3.2 Site QA/QC Advisor 2-9
2.3.3 Site Safety Officer 2-10
2.3.4 Field Technical Staff 2-10

3.0 FACILITY DESCRIPTION **3-1**
3.1 FACILITY LOCATION AND DESCRIPTION 3-1
3.2 FACILITY HISTORY AND ACTIVITIES 3-1
3.2.1 History of Ownership and Operation 3-1
3.2.2 History of Regulatory Actions 3-2
3.3 PHYSICAL SETTING 3-3
3.3.1 Climate 3-3
3.3.2 Physiography and Topography 3-3
3.3.3 Hydrology 3-4
3.3.4 Geology and Stratigraphy 3-4
3.3.5 Hydrogeology 3-7
3.3.6 Ecology 3-8

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

4.0 DEVELOPMENT OF PROPOSED INVESTIGATION 4-1
4.1 SWMU 2 – DYE BURIAL GROUND CONCEPTUAL SITE MODEL 4-1
4.1.1 Site Sources of Contamination 4-2
4.1.2 Contaminant Release Mechanisms and Transport Pathways 4-2
4.1.3 Exposure Routes 4-4
4.1.4 Potential Receptors 4-5
4.2 DATA QUALITY OBJECTIVES 4-8
4.2.1 Problem Definition 4-8
4.2.2 Decision Statement 4-9
4.2.3 Inputs Required for Decision Making 4-10
4.2.4 Boundaries 4-11
4.2.5 Decision Rules 4-13
4.2.6 Potential Errors Associated with the Decision Rule 4-14
4.2.7 Sampling and Analysis Design 4-16
4.3 SUMMARY 4-17

5.0 SWMU 2 – DYE BURIAL GROUNDS 5-1
5.1 BACKGROUND 5-1
5.2 PHYSICAL SETTING 5-3
5.2.1 Topography/Hydrology 5-3
5.2.2 Geology 5-3
5.2.3 Hydrogeology 5-6
5.3 PREVIOUS INVESTIGATIONS 5-7
5.4 HAZARD IDENTIFICATION 5-9
5.4.1 Organic Constituents 5-10
5.4.2 Inorganic Constituents 5-11
5.4.3 Summary of Detected Chemicals of Interest 5-12
5.5 PROPOSED INVESTIGATION 5-12
5.5.1 Conceptual Site Model 5-12
5.5.2 Proposed Sampling and Analysis 5-13

6.0 DATA MANAGEMENT 6-1
6.1 PROJECT PLANNING 6-1
6.1.1 Kick-off Meeting 6-1
6.1.2 Sample Nomenclature and Survey Data Requirements 6-1
6.1.3 Sample Tracking 6-2
6.1.4 Laboratory Electronic Deliverables 6-2
6.2 DATABASE 6-2
6.3 THE ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEM 6-2
6.4 MAPPING AND GRAPHICS 6-3
6.5 SOFTWARE 6-3
6.6 STORAGE OF DATA 6-3

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

7.0 RCRA FACILITY INVESTIGATION 7-1
7.1 OBJECTIVE 7-1
7.2 RCRA FACILITY INVESTIGATION (RFI) REPORT 7-1
7.2.1 Environmental Setting 7-2
7.2.2 Source/Waste Characterization 7-3
7.2.3 Contamination Characterization 7-3
7.2.4 Potential Receptors 7-3

8.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY 8-1
8.1 DATA EVALUATION 8-2
8.1.1 Data Usability 8-2
8.1.2 Selection of Chemicals of Potential Concern 8-3
8.1.3 COPC Summary Screening Tables 8-7
8.2 EXPOSURE ASSESSMENT 8-7
8.2.1 Conceptual Site Model 8-8
8.2.2 Central Tendency Exposure vs. Reasonable Maximum Exposure 8-8
8.2.3 Exposure Concentrations 8-9
8.2.4 Chemical Intake Estimation 8-9
8.2.5 Exposure to Lead 8-17
8.3 TOXICITY ASSESSMENT 8-18
8.3.1 Toxicity Criteria 8-19
8.3.2 Toxicity Profiles 8-20
8.4 RISK CHARACTERIZATION 8-20
8.4.1 Quantitative Analysis 8-20
8.4.2 Qualitative Analysis 8-22
8.5 UNCERTAINTY ANALYSIS 8-22
8.5.1 Uncertainty in Data Evaluation 8-22
8.5.2 Uncertainty in the Exposure Assessment 8-23
8.5.3 Uncertainty in the Toxicity Assessment 8-23
8.5.4 Uncertainty in the Risk Characterization 8-23

9.0 ECOLOGICAL RISK ASSESSMENT METHODOLOGY 9-1
9.1 PROBLEM FORMULATION 9-1
9.1.1 Ecological Setting and Potential Ecological Receptors at NSWC Crane 9-2
9.1.2 Potential Sources of Contamination and Associated Exposure Pathways 9-3
9.1.3 Ecological Effects 9-4
9.1.4 Assessment Endpoints 9-5
9.1.5 Conceptual Model 9-6
9.1.6 Measures of Effects 9-6
9.2 ANALYSIS PHASE 9-7
9.2.1 Selection of Contaminants of Potential Concern 9-7
9.2.2 Characterization of Exposure 9-8
9.2.3 Characterization of Ecological Effects 9-10
9.3 RISK CHARACTERIZATION 9-16

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

9.4 UNCERTAINTY ANALYSIS 9-17
9.4.1 Endpoints 9-17
9.4.2 Exposure Characterization 9-18
9.4.3 Ecological Effects Data 9-18
9.4.4 Risk Characterization 9-19

10.0 CORRECTIVE MEASURES STUDY WORK PLAN 10-1
10.1 PURPOSE 10-1
10.2 SCOPE 10-1
10.3 REPORTING 10-2

REFERENCES R-1

APPENDICES

A FIELD SAMPLING PLAN
B HEALTH AND SAFETY PLAN
C QUALITY ASSURANCE PROJECT PLAN
D RISK-BASED SCREENING LEVELS
E DATA MANAGEMENT CHECKLIST
F ELECTRONIC DATA DELIVERABLE FORMAT
G DATABASE STRUCTURE
H ARCVIEW GIS STRUCTURE
I INTERIM MEASURES DYE-IMPACTED SOIL EXCAVATION

TABLES

NUMBER		PAGE NO.
2-1	Contact List	2-11
3-1	USDA/SCS Soil Classifications	3-9
4-1	Summary of Potential Receptors SWMU 2	4-19
5-1	Summary of Historical Site Investigations, SWMU 2 - Dye Burial Grounds	5-19
5-2	Historical Data Summary - Ground Water, Upper Pennsylvania Aquifer, SWMU 2 - Dye Burial Grounds	5-25
5-3	Historical Data Summary - Ground Water, Lower Pennsylvania Aquifer, SWMU 2 - Dye Burial Grounds	5-31
5-4	Historical Data Summary - Ground Water, Upper Hardinsburg Aquifer, SWMU 2 - Dye Burial Grounds	5-37
5-5	Historical Data Summary - Ground Water, Golconda Aquifer, SWMU 2 - Dye Burial Grounds	5-43
5-6	Historical Data Summary - Ground Water, Beech Creek Aquifer, SWMU 2 - Dye Burial Grounds	5-49
5-7	Historical Data summary - Spring Water, SWMU 2 - Dye Burial Grounds	5-55
5-8	Summary of Objectives/Proposed Sampling, SWMU 2 - Dye Burial Grounds	5-59
8-1	Format of COPC Selection Summary Table	8-25
8-2	Exposure Routes for Quantitative Evaluation	8-26
8-3	Summary of Exposure Assumptions	8-27

FIGURES

NUMBER		PAGE NO.
2-1	Project Organization Chart	2-13
3-1	Site Location Map, SWMU 2 - Dye Burial Grounds	3-11
3-2	Surface Drainage, SWMU 2 - Dye Burial Grounds	3-13
3-3	Surficial Geology Map	3-15
3-4	Stratigraphic Column for Rock Units Encountered at the Naval Surface Warfare Center	3-17
4-1	Conceptual Site Model, SWMU 2 - Dye Burial Grounds	4-21
4-2	Decision Rule Flowchart	4-23
5-1	Site Map, SWMU 2 - Dye Burial Grounds	5-63
5-2	Site Topographic Features	5-65
5-3	Groundwater Contours in Upper Pennsylvanian Sandstone	5-67
5-4	Groundwater Contours in Lower Pennsylvanian Sandstone	5-69
5-5	Groundwater Contours in Golconda Limestone Aquifer	5-71
5-6	Groundwater Contours Beech Creek Limestone Aquifers	5-73
5-7	Historical Sample Locations, SWMU 2 - Dye Burial Grounds	5-75
5-8	Historical Soil Sample Locations, SWMU 2 - Dye Burial Grounds	5-77
5-9	Ground Water Exceedances - Human Health, Upper Pennsylvania Aquifer	5-79

FIGURES (Continued)

NUMBER		PAGE NO.
5-10	Ground Water Exceedances - Ecological, Upper Pennsylvania Aquifer	5-81
5-11	Ground Water Exceedances - Human Health, Lower Pennsylvania Aquifer	5-83
5-12	Ground Water Exceedances - Ecological, Lower Pennsylvania Aquifer	5-85
5-13	Ground Water Exceedances - Human Health, Golconda-Haney Aquifer	5-87
5-14	Ground Water Exceedances - Ecological, Goldonda-Haney Aquifer	5-89
5-15	Ground Water Exceedances - Human Health, Beech Creek Aquifer	5-91
5-16	Ground Water Exceedances - Ecological, Beech Creek Aquifer	5-93
5-17	Proposed Soil Sample Locations	5-95
5-18	Proposed Ground Water Sampling	5-97
5-19	Proposed Surface Water and Sediment Sample Locations	5-99
8-1	Summary of Human Health Risk Assessment Process	8-31
9-1	Summary of Ecological Risk Assessment Process	9-21
9-2	Ecological Conceptual Site Model	9-23

ACRONYMS

ALPEC	Ammunition Loading and Production Engineering Center
AMSL	Above Mean Sea Level
ARAR	Applicable or Relevant and Appropriate Requirement
ASL	Above Screening Level
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
B&R	Brown & Root
BAF	Bioaccumulation Factor
BGS	Below Ground Surface
BSL	Below Screening Level
BTAG	Biological Technical Assistance Team
CAAA	Crane Army Ammunition Activity
CASCO	Central Ammunition Supply Control Office
CCME	Canadian Council of Ministers of the Environment
CDI	Chronic Daily Intake
CEC	Cation Exchange Capacity
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMS	Corrective Measure Study
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CRAVE	Carcinogenic Risk Assessment Verification Endeavor
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
CTO	Contract Task Order
DOQ	Digital Ortho Quarter Quads
DQO	Data Quality Objective
EA	Environmental Assessment
EDD	Electronic Data Deliverable
EDQL	Ecological Data Quality Level
EGIS	Environmental Geographic Information System
EPD	Environmental Protection Department

ER-L	Effects Range-Low
ER-M	Effects Range-Medium
FOL	Field Operations Leader
FSP	Field Sampling Plan
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
HSM	Health and Safety Manager
HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
ICR	Incremental Cancer Risk
IDEM	Indiana Department of Environmental Management
IEUBK	Integrated Exposure Uptake Biokenetic (Model)
ILCR	Incremental Lifetime Cancer Risk
IMS	Information Management System
IRIS	Integrated Risk Information System
LAN	Local Area Network
LOAEL	Lowest Observed Adverse Effects Level
MCL	Maximum Contaminant Level
MHSPE	(Netherlands) Ministry of Housing, Spatial Planning, and Environment
NACIP	Navy Assessment and Control of Installation Pollutants
NAD	Naval Ammunition Depot
NEESA	Naval Energy and Environmental Support Agency
NOAEL	No Observed Adverse Effects Level
NSWC	Naval Surface Warfare Center
NWSCC	Naval Weapons Support Center Crane
O&M	Operation and Maintenance
OMOE	Ontario Ministry of Environment and Energy
OPPTS	Office of Prevention, Pesticides, and Toxic Substances
ORNL	Oak Ridge National Laboratory
OSHA	Occupation Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector

PM	Project Manager
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAGS	Risk Assessment Guide for Superfund
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RISC	Risk Integrated System of Closure
RL	Reporting Limit
RME	Reasonable Maximum Exposure
RPM	Remedial Project Manager
RQAC	RCRA Quality Assurance Coordinator
SCS	Soil Conservation Service
SERA	Screening-level Ecological Risk Assessment
SMC	Sample Management Coordinator
SOP	Standard Operating Procedure
SOUTHDIV	U.S. Navy Southern Division Naval Facilities Engineering Command
SQB	Sediment Quality Benchmarks
SQC	Sediment Quality Criteria
SSL	Soil Screening Level
SSO	Site Safety Officer
SSSL	Surface Soil Screening Level
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SWSL	Surface Water Screening Level
TBC	To Be Considered
TIC	Tentatively Identified Compound
TOC	Total Organic Carbon
TOM	Task Order Manager
TRV	Terrestrial Reference Value
TSD	Treatment, Storage and Disposal (Facility)

TSS	Total Suspended Solids
TSSDS	Tri-Service Spatial Data Standards
TtNUS	Tetra Tech NUS
UCL	Upper Confidence Limit
U.S. ACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
WES	Waterways Experiment Station
WQS	Water Quality Standards

1.0 INTRODUCTION

This Work Plan has been prepared for Solid Waste Management Unit (SWMU) 2 – Dye Burial Grounds at the Naval Surface Warfare Center (NSWC) Crane located in Crane, Indiana, in support of the completion of

- A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)
- A Baseline Human Health Risk Assessment
- A Screening-Level Ecological Risk Assessment
- A Corrective Measures Study (CMS).

This Work Plan was prepared by Tetra Tech NUS, Inc. (TtNUS)[1] on behalf of the U.S. Navy Southern Division Naval Facilities Engineering Command (SOUTHDIV) and NSWC Crane. The work was performed in response to Contract Task Order (CTO) Number 0010 under Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62467-94-D-0888.

In 1981 the Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) Program. This program included an investigation of designated sites at the facility. These investigations were known as the Initial Assessment Study (IAS). The Naval Energy and Environmental Support Agency (NEESA) completed the IAS in 1983 with assistance from the Ordnance Environmental Support Agency and the U.S. Army Corps of Engineers (U.S. ACE) Waterways Experiment Station (WES). The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations. Based on the conclusions of the IAS, it was determined that SWMU 2 did not represent an immediate threat to human health and the environment. However, it was recommended that further study be conducted at this SWMU to evaluate potential long-term impacts.

In 1989 NSWC Crane was issued a final RCRA Part B Permit. The permit contained corrective action requirements to be performed at its SWMUs. In response to the IAS recommendations and the requirements of the permit, RFI activities were initiated for SWMU 2.

Based on requirements of the RCRA Part B Permit, three phases of ground water assessments, a geophysical investigation, and interim measures have been conducted at SWMU 2. The Phase I Ground

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[1] Note: Brown & Root Environmental was purchased on January 1, 1998, and became Tetra Tech NUS, Inc. (TtNUS).

Water Assessment consisted of an Environmental Monitoring Report, which provided background information pertinent to the facility, contamination, and existing data gathered for the site. The objective of the Phase II Ground Water Assessment was to determine the presence or absence of contamination at the site and determine the hydrogeology at the site. Further refinement of the nature and extent of contamination and the site hydrogeology was conducted during the Phase III Ground Water Assessment.

Based on historical site information, the boundaries of burial activities (trenches) at SWMU 2 were estimated. The boundaries were further defined by a geophysical investigation, which was conducted in 1991. Based on the results of the geophysical investigation, the interim measures consisting of installing a multi-layered cap system was initiated at the site in 1996. During the vegetation clearing stage for the interim measures, dye contamination was found outside the suspected limits of the cap. Work on the cap was stopped, and further investigation of the disturbed soil areas around the burial trenches was conducted. Dye-contaminated soil from the disturbed areas was excavated and placed under the subgrade of the area to be capped. Additionally, the boundaries of the cap were extended outward to encompass a larger area of contaminated soil. The installation of the cap was completed in September 1998.

Based on the results of the ground water assessments and visual observation of dyes in the soil, chemical releases to the environment from past operations conducted at the SWMU have been identified, thereby requiring the performance of human health and ecological risk assessments. Because the nature and extent of contamination at the SWMU have not been defined, RFI activities at the site require completion. Additionally, a CMS is to be conducted to identify and evaluate cleanup alternatives for the site. The main focus of the CMS will be to determine if additional remedial actions are required at the site or if the interim measures already conducted were sufficient in controlling the migration of contaminants from the source and mitigating the potential risks to human and ecological receptors.

1.1 OBJECTIVE

The objective of this Work Plan is to outline the activities necessary to complete RFI activities, conduct a Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment, and perform a CMS at SWMU 2. Once the nature and extent of contamination are defined by the RFI and the risk assessments are completed, conclusions from the assessments will be used by risk managers to determine whether further activities (such as additional remediation, long-term monitoring, etc.) are warranted at the site. The identification and evaluation of remedial alternatives for the site will be documented in the CMS.

The RFI, risk assessments, and CMS will be conducted in accordance with the RCRA Corrective Action requirements identified in NSWC Crane's RCRA Part B Permit (issued in 1989). The RFI will also be conducted in accordance with U.S. Environmental Protection Agency (U.S. EPA) guidance in RFI Guidance, EPA 530/SW-89-031 (U.S. EPA, 1989) and Indiana Department of Environmental Management's (IDEM's) Office of Solid and Hazardous Waste Management (OSHWA) guidance in Risk Integrated System of Closure (RISC) User's Guide and Technical Resource Guidance Document (IDEM, 1999). U.S. EPA's Risk Assessment Guidance for Superfund (RAGS) (U.S. EPA, December 1989), Ecological Risk Assessment Guidance for Superfund (U.S. EPA, June 1997), and other available risk assessment guidance will be also used to complete the risk assessments. The CMS will also be conducted in accordance with IDEM guidance (IDEM, 1999).

1.2 SCOPE OF WORK

The tasks identified as being necessary to complete RFI/CMS activities and a Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment for SWMU 2 are as follows:

- Evaluation of Historical Data
- Field Investigation
- Laboratory Analysis
- Data Management
- Preparation of an RFI Report
- Conductance of Risk Assessments
- Generation of a CMS

A brief description of these tasks is provided below.

1.2.1 Evaluation of Historical Data

An evaluation of the historical data was conducted as part of the scoping effort for the proposed field investigation. These data were used to focus the proposed field investigation by assisting in the identification of chemicals of interest and spatial distribution of contamination. The historical data were compared with applicable, current risk-based screening levels for the protection of human health and the environment. Any chemicals that were reported at concentrations exceeding the screening levels were identified as detected parameters of interest. The parameters of interest were used to assist in the selection of the analytical suites for the proposed field investigations for SWMU 2.

Comparisons of historical site data to applicable, current risk-based screening criteria are presented in this Work Plan. Figures illustrating exceedances of the risk-based screening levels also are provided.

1.2.2 Field Investigation

Since the proposed field investigation is intended to collect data sufficient for the completion of RFI/CMS and risk assessment activities, a conceptual site model was developed for the SWMU. The site-specific model defines the contaminant sources, release mechanisms, migration pathways, exposure, and potential human and ecological receptors based on current and future land use. The model and information on the detected parameters of interest were then used to develop an appropriate sampling and analytical program (i.e., target analyte list, sample locations, type and depth of sampling, etc.).

The proposed field investigation for SWMU 2 is detailed in this Work Plan. The field investigation activities include surface soil sampling, surface water and sediment sampling, borehole drilling (subsurface soil sampling) and well installation, and ground water sampling. In general, proposed sample locations were identified based on exceedances of the risk-based screening levels, perceived gaps in the historical data, and receptor contact points.

1.2.3 Laboratory Analysis

Upon collection of the environmental samples identified in this Work Plan, the samples will be analyzed at a fixed-base laboratory. A specific analytical program was defined based on the detected parameters of interest. Specific laboratory quality assurance/quality control (QA/QC) requirements, as well as other project-specific QA/QC requirements, are provided in the associated Quality Assurance Project Plan (QAPP), which is contained in Appendix C.

1.2.4 Data Management

The data collected as part of the field investigation will be subjected to a formal data validation process and compiled into an Environmental Geographic Information System (EGIS) for NSWC Crane. Although various QA/QC procedures will be performed through the implementation of the associated QAPP, the analytical data will be reviewed to ensure their validity. An explanation of the data validation process and the specific procedures used to manage the data upon completion of data validation are outlined in this Work Plan.

1.2.5 RFI Report

The RFI Report will describe the environmental setting at SWMU 2 and evaluate the nature and extent of contamination present as a result of the release of hazardous substances from historical site operations. Information obtained during the field investigation will also be used to determine and/or confirm the rate, extent, and direction of the transport of contaminants from the site. Based on the results of the RFI, preliminary corrective measure technologies will be identified for further consideration. A brief description of the general procedure and methodologies to be used in the preparing the RFI Report is provided in this Work Plan.

1.2.6 Risk Assessment

Current U.S. EPA risk assessment guidance will be used to conduct the Baseline Human Health Risk Assessment and the Screening-Level Ecological Risk Assessment for SWMU 2. Because of various uncertainties associated with data quality, the historical data for the SWMU will not be used quantitatively in the risk assessments. However, the historical data will be used in a qualitative fashion to support conclusions of the risk assessments. As noted previously, the results of the risk assessments will be used for decision-making purposes by risk managers to determine whether further actions (such as additional remediation, long-term monitoring, etc.) are warranted or whether the site can be closed out with no further action. A recommendation of whether further action is needed will be provided in the conclusions of the risk assessment.

The general procedures and methodologies to be used in performing the risk assessments are identified in this Work Plan. The Baseline Human Health Risk Assessment will consist of Data Evaluation, Exposure Assessment, Toxicity Assessment, Risk Characterization, and Uncertainty Analysis. The Screening-Level Ecological Risk Assessment will include a Problem Formulation, Analysis Phase, Risk Characterization, and Uncertainty Analysis.

1.2.7 Corrective Measures Study Report

The CMS Report will identify, screen, and develop the alternative or alternatives for removal, containment, treatment, and/or remediation of the contamination based on the objectives established for the corrective action. It is assumed that the current Interim Measure cap system will be considered as the presumptive remedy for soil. A brief description of the general procedure and methodologies to be used in preparing the CMS Report is provided in this Work Plan.

1.3 ORGANIZATION OF WORK PLAN

The remainder of this section identifies the organization of this Work Plan. Section 1.0 provides this introduction. Section 2.0 describes the project organization and responsibilities. Section 3.0 consists of the facility description, which includes the location and description of the Base, the history of NSWC Crane, and the physical setting for NSWC Crane. Section 4.0 summarizes the methodologies used to develop the proposed field investigation. Section 5.0 contains the site-specific information for SWMU 2, which consists of a description of the background, physical setting, previous investigations, results of the historical data evaluation, and proposed field investigation for the site. Section 6.0 presents the system and format of the database to be compiled in support of RFI/CMS and risk assessment activities. This section also describes the overall approach for the data validation of investigation-derived data. Section 7.0 briefly summarizes the procedures to be used to develop the RFI Report. Section 8.0 contains the general methodologies to be used to conduct the Baseline Human Health Risk Assessment. Section 9.0 provides a description of the general methodologies for the performance of the Screening-Level Ecological Risk Assessment. Section 10.0 provides a description of the general methodologies to be used in development of the CMS.

Three key documents were prepared in conjunction with this Work Plan. A Field Sampling Plan (FSP) was prepared to describe the field activities that will be required for the field investigation. The relevant Standard Operating Procedures (SOPs) for the proposed field investigation are included as Attachment B in the FSP, which is presented in Appendix A. The site-specific Health and Safety Plan (HASP) outlines the health and safety procedures and guidelines to be used during the performance of the field operations and is provided in Appendix B. Attached to the HASP are the Occupational Safety and Health Administration (OSHA) Poster, Medical Data Sheet, and the Chemical Data Sheets/Hazard Lines. The QAPP, provided in Appendix C, describes the QA/QC procedures to be used to ensure that the data are usable for their intended purposes (for RFI/CMS and risk assessment activities).

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the project management and organization for the RFI/CMS and risk assessment activities to be conducted at SWMU 2. At the direction of the U.S. EPA Project Manager (PM), TtNUS, on behalf of the U.S. Navy and NSWC Crane, is responsible for the overall management, implementation of contract field activities, and preparation of the RFI, Risk Assessment, and CMS Reports. Personnel from the Navy and NSWC Crane will be actively involved and will coordinate with TtNUS personnel in a number of areas. The authorities and organizational relationship of key personnel are depicted in Figure 2-1. Corresponding addresses and telephone numbers of key personnel also are listed by organization in Table 2-1.

2.1 MANAGEMENT

Responsibilities for program management, QA, field investigation, and subcontractors are discussed in the following sections. It is intended that the individuals named will perform the designated responsibilities to the extent that the specific person is available to perform the stated activities.

2.1.1 U.S. EPA Project Manager

The U.S. EPA PM will oversee the implementation of this RFI/risk assessment/CMS investigation at NSWC Crane. The U.S. EPA PM represents the agency's interests and will provide input from this perspective as well as lend general historical and technical assistance to NSWC Crane field activities.

2.1.2 Indiana Department of Environmental Management

Although the U.S. EPA will oversee the project, the IDEM PM also will have the opportunity to review and comment on the risk assessment/CMS investigation at NSWC Crane.

2.1.3 Navy Project Managers

The Navy Remedial Project Manager (RPM) acts as the focal representative for the U.S. Navy, providing management, technical direction, and oversight for all NSWC Crane project activities performed by contractors (i.e., TtNUS) and their subcontractors. In matters such as facilitation of access, oversight, etc., the Navy RPM is assisted by the NSWC Crane Site Manager. Additional responsibilities of the RPM include the following:

- Define project objectives and develop a detailed work plan schedule.
- Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task.
- Acquire and apply technical resources (i.e., contractors) as needed to ensure performance within budget and schedule constraints.
- Review the work performed on each task to ensure its quality, responsiveness, and timeliness.
- Review and analyze overall task performance with respect to planned requirements and authorizations.
- Approve all reports (deliverables) before their submission to U.S. EPA Region 5.
- Ultimately be responsible for the preparation and quality of interim and final reports.
- Represent the project team at meetings and public hearings.

2.1.4 Contractor Project Management

Program Manager

The TtNUS Navy Southern Division CLEAN Program Manager provides operations, technical, and administrative leadership and oversees and supports quality policies. The Program Manager assigns project Task Order Managers (TOMs) and oversees their performance. The Program Manager also ensures the availability of technical and support resources for program operations and maintains consistency in procedures and projects among CTO assignments. In these matters, the Program Manager is assisted by the TOM.

Task Order Manager

The TtNUS TOM has the overall responsibility for ensuring that the project meets U.S. EPA and IDEM objectives, as well as Navy and TtNUS quality standards. The TOM is responsible for the preparation and distribution of the planning documents, at the direction of the Navy RPM, to all parties connected with the project, including any subcontractors. The TOM is also responsible for the implementation of field

activities and the preparation of the risk assessments and CMS. The TOM will report to the Navy RPM and is responsible for technical QC and project oversight. Additional responsibilities of the TOM are

- Assembling and managing the TtNUS project team.
- Ensuring timely resolution of project-related technical, quality, safety, or waste management issues.
- Functioning as primary interface with the Navy RPM and NSWC Crane Site Manager, field personnel, and subcontractor points-of-contact.
- Monitoring and evaluating subcontractor performance.
- Coordinating and overseeing work performed by field and office technical staff (including data validation, statistical evaluations, and report preparation).
- Coordinating and overseeing maintenance of all project records.
- Coordinating and overseeing review of project deliverables.
- Preparing and issuing final deliverables to the Navy.

Health and Safety Manager

The TtNUS Health and Safety Manager (HSM) is responsible for the following:

- Overseeing the development and review of the Site Security and HASP.
- Implementation of site security and HASP.
- Assigning the Site Safety Officer and supervising his or her performance.
- Conducting health and safety audits.
- Preparing health and safety reports for management.

Project Chemist

The TtNUS Project Chemist will serve as the focal point for the analytical requirements of the project and as a coordinator for sample collection, subsequent data analysis, and data reporting performed by the subcontract laboratory. This person is responsible for resolving questions the laboratory may have

regarding QAPP requirements and deliverables and coordination of sample data package deliverables received from the laboratory. The Project Chemist will report to the TOM or designee.

Project Engineer

The TtNUS Project Engineer will be responsible for completing the RFI/CMS activities in accordance with the latest U.S. EPA corrective measures guidance. This person is responsible for resolving questions that TtNUS technical staff may have regarding RFI/CMS requirements. The Project Engineer will report to the TOM or designee.

Sample Management Coordinator

The TtNUS Sample Management Coordinator will be responsible for generating sample pre-printed sample tags, tracking environmental samples as they are collected in the field, and documenting receipt and confirmation of the samples by the analytical laboratory. The Sample Management Coordinator will report to the TOM or designee.

Data Validation Coordinator

The TtNUS Data Validation Coordinator will be responsible for scheduling completion of the reduction, validation, and documentation activities related to the sample data package deliverables received from the laboratory. The Data Validation Coordinator will report to the TOM or designee.

Data Management/EGIS Leads

The TtNUS Data Management and EGIS Leads will be responsible for managing the field and analytical data generated during the project. They will be responsible for accumulation, control, and storage of the project data in accordance with the Data Management section of this Work Plan (Section 6.0) and with the QAPP (Section 9.0). These persons will report to the TOM or designee.

Risk Assessment Leads

The TtNUS Human Health and Ecological Risk Assessment Leads will be responsible for the completion of the risk assessments. They will be responsible for ensuring that the site-specific evaluations are conducted in accordance with the latest U.S. EPA risk assessment guidance. These persons will report to the TOM or designee.

2.2 QUALITY ASSURANCE

This section identifies the QA responsibilities for the field investigation at SWMU 2. Responsibilities of the U.S. EPA Region 5, TtNUS personnel, and the analytical laboratory are presented.

2.2.1 U.S. EPA Region 5 Quality Assurance Coordinator

The U.S. EPA Region 5 RCRA Quality Assurance Coordinator (RQAC) has the responsibility to review and approve the QAPP and provide overall QA support and review. Additional U.S. EPA and IDEM responsibilities may include:

- Coordinating external performance and system audits of the contracted laboratory and
- Reviewing and evaluating analytical field and laboratory procedures.

2.2.2 TtNUS Quality Assurance Manager

The TtNUS Quality Assurance Manager (QAM) is responsible for overall quality assurance for the project and reports directly to the TtNUS Program Manager. The QAM has the responsibility for the following specific activities:

- Developing, maintaining, and monitoring QA policies and procedures.
- Providing training to TtNUS staff in QA/QC policies and procedures.
- Conducting systems and performance audits to monitor compliance with environmental regulations, contractual requirements, QAPP and Work Plan requirements, and corporate policies and procedures.
- Auditing project records.
- Monitoring subcontractor quality controls and records.
- Assisting in the development of corrective action plans; ensuring correction of nonconformances reported in internal or external audits.
- Overseeing the implementation of the QAPP.

- Overseeing and reviewing the development and revision of the QAPP.
- Overseeing the responsibilities of the TtNUS Site QA/QC Advisor.
- Preparing QA reports for management.

2.2.3 Project QA Advisor

The Project QA Advisor provides support to the TOM in preparation and review of the QAPP. The QA Project Advisor communicates directly with the TOM on QA/QC matters.

2.2.4 Laboratory Responsibilities

As discussed in Section 7.0 of the attendant QAPP, Laucks Testing Laboratories, Inc., of Seattle, Washington, will perform all sample analyses for this field activity with the exception of analyses for dye constituents. Sample analyses for dyes will be the responsibility of the NSWC Crane Laboratory, who has specifically developed analytical methods for this project. The laboratories are responsible for analyzing all samples in accordance with the analytical methods and additional requirements specified in the attendant QAPP. It also will be the analytical laboratory's responsibility to properly dispose of unused sample aliquots. Responsibilities of key laboratory personnel are outlined in the following paragraphs.

Laboratory Project Manager

The Laboratory Project Manager will interface directly with the TtNUS TOM and QA Advisor and will perform the following:

- Ensure that method and project-specific requirements are properly communicated and understood by laboratory personnel.
- Ensure that all laboratory resources are available on an as-required basis.
- Monitor analytical and project QA requirements.
- Review data packages for completeness, clarity, and compliance with project requirements.
- Inform the TtNUS TOM of project status and any sample receipt or analytical problems.

Laboratory Operations Manager

Responsibilities of the Laboratory Operations Manager include the following:

- Support the QA program within the laboratory.
- Provide management overview of both production and quality-related laboratory activities.
- Maintain adequate staffing to meet project analytical and quality objectives.
- Approve all laboratory SOPs and QA documents.
- Supervise in-house chain-of-custody documentation.
- Oversee the preparation of, and approving, final analytical reports before submittal to TtNUS.

Laboratory Quality Assurance Officer (QAO)

The Laboratory QAO will report directly to the Laboratory Operations Manager. The Laboratory QAO will be independent of laboratory production management to ensure that laboratory quality performance is assessed without schedule and cost considerations. Responsibilities of the Laboratory QAO include the following:

- Define appropriate laboratory QA procedures and monitor overall laboratory QA.
- Stop work if a condition adverse to the quality of work is encountered, if QA or QC procedures are not followed, or if analytical out-of-control events are encountered that have not been corrected.
- Approve and maintain document control of all QA documents and SOPs.
- Perform and/or implement internal system and performance audits and verify completion of corrective actions cited in audits.
- Direct laboratory participation in laboratory accreditation and certification programs.

Laboratory Sample Custodian

The Laboratory Sample Custodian will report to the Laboratory Operations Manager. Responsibilities of the Laboratory Sample Custodian include the following:

- Receive and inspect the incoming sample containers.

- Record the condition of the incoming sample containers.
- Sign appropriate documents.
- Verify chain-of-custody.
- Notify Laboratory Project Manager of sample receipt and inspection.
- Assign a unique identification number and customer number, and enter each into the sample receiving log.
- With the help of the Laboratory Project Manager, initiate transfer of the samples to appropriate lab sections.
- Control and monitor access/storage of samples and extracts.

Laboratory Technical Staff

The laboratory technical staff will be responsible for sample analysis based on the analytical methods and requirements specified in the attendant QAPP.

2.3 FIELD INVESTIGATION

TtNUS will be responsible for all field activities related to this investigation. The TtNUS field team will be organized according to the activities planned. Field team members will be selected based on the type and extent of effort required. All team members will be appropriately skilled and trained for the tasks they are assigned to perform. The team will consist of a combination of the following personnel:

- Field Operations Leader (FOL)
- Site QA/QC Advisor
- Site Safety Officer
- Field Technical Staff.

2.3.1 Field Operations Leader

The FOL is responsible for coordinating all on-site personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all sampling activities and will ensure the availability and maintenance of all sampling materials/equipment. The FOL is responsible for the completion of all sampling, field and chain-of-custody documentation; will assume custody of all samples; and will ensure the proper handling and shipping of samples. The FOL is a highly experienced environmental professional who will report directly to the TtNUS TOM. Specific FOL responsibilities include the following:

- Function as a communications link between field staff members, the Site QA/QC Advisor, Site Safety Officer, the Site Manager, and the TOM.
- Oversee the mobilization and demobilization of all field equipment and subcontractors.
- Coordinate and manage the Field Technical Staff.
- Adhere to the work schedules provided by the TOM.
- Bear responsibility for maintenance of the site logbook and field record keeping.
- Initiate field task modification requests, when necessary.
- Identify and resolve problems in the field, resolve difficulties in consultation with the NSWC Crane Site Manager, implement and document corrective action procedures, and provide communication between the field team and upper management.

2.3.2 Site QA/QC Advisor

The FOL (or assistant) will act as the Site QA/QC Advisor, who is responsible for ensuring adherence to all QA/QC guidelines as defined in the FSP and QAPP. Strict adherence to these procedures is critical to the collection of acceptable and representative data. The following is a summary of the Site QA/QC Advisor's responsibilities:

- Ensure that field duplicates and field QC blanks are collected with the proper frequency.

- Ensure that additional volumes of sample are supplied to the analytical laboratory with the proper frequency to accommodate laboratory QA/QC analyses.

- Ensure that measurement and test equipment are calibrated, used, and maintained in accordance with applicable procedures.

- Act as liaison between site personnel, laboratory personnel, and the QAM.

- Manage bottleware shipments and oversee sample preservation.

2.3.3 Site Safety Officer

The FOL (or designee) will also serve as the Site Safety Officer (SSO). The duties of the SSO are detailed in the HASP. The SSO has stop-work authority, which can be executed upon the determination of an imminent safety hazard.

2.3.4 Field Technical Staff

The Field Technical Staff for this project will be drawn from TtNUS's pool of qualified personnel. All designated field team members will be experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work. Field Technical Staff are responsible for complying with field-related requirements as presented in the QAPP, as well as the requirements in this Work Plan.

TABLE 2-1

CONTACT LIST
NSWC CRANE, INDIANA
PAGE 1 OF 2

PERSON/ TITLE/ ORGANIZATION	ADDRESS	TELEPHONE
Peter Ramanauskas Project Manager U.S. EPA Region 5	U.S. EPA Region 5 77 West Jackson Blvd. Chicago, Il 60604	(312) 886-7890 FAX: (312) 353-4788
Allen Debus QA Coordinator U.S. EPA Region 5	U.S. EPA Region 5 77 West Jackson Blvd. Chicago, IL 60604	(312) 886-6186
Doug Griffin Corrective Action Section Office of Land Quality Hazardous Waste Permits IDEM	IDEM Office of Solid and Hazardous Waste Management 100 N. Senate Avenue Indianapolis, IN 46206-6015	(317) 233-2710
Bill Gates Remedial Project Manager U.S. Navy SOUTHNAVFACENGCOM	Department of Navy SOUTHNAVFACENGCOM Code 1829 2155 Eagle Drive N. Charleston, SC 29406	(843) 820-7360 FAX: (843) 820-7465
Tom Brent Environmental Site Manager NSWC Crane	NSWC Crane Code 095 B-3260 300 Highway 361 Crane, IN 47522-5009	(812) 854-6160 FAX: (812) 854-3981
Debbie Wroblewski Program Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8968 FAX: (412) 921-4040
Paul Frank Quality Assurance Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8950 FAX: (412) 921-4040
Matt Soltis Health and Safety Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8912 FAX: (412) 921-4040
Ralph Basinski Task Order Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8308 FAX: (412) 921-4040
Keith Simpson Field Operations Leader Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8131 FAX: (412) 921-4040 Field: (812) 854-0280
Matt Cochran Project Geologist Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8418 FAX: (412) 921-4040
Joseph Samchuck Data Validation Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8510 FAX: (412) 921-4040

TABLE 2-1

CONTACT LIST
NSWC CRANE, INDIANA
PAGE 2 OF 2

PERSON/ TITLE/ ORGANIZATION	ADDRESS	TELEPHONE
Andy Kendrick Data Management/EGIS Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8623 FAX: (412) 921-4040
Linda Karsonovich Project Chemist Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8729 FAX: (412) 921-4040
Jean-Luc Glorieux Project Engineer Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8568 FAX: (412) 921-4040
Tom Jackman Human Health Risk Assessor Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8724 FAX: (412) 921-4040
Aaron Bernhardt Ecological Risk Assessor Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8433 FAX: (412) 921-4040
Terrie Baranek Project QA Advisor ECT.CON Inc.	ECT.CON Inc. 3531 Fox Chase Drive Imperial, PA 15126	(724) 695-8042 FAX: (724) 695-2698
Hugh Prentice Project Manager Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491
Harry Romberg Lab QA Manager Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491
Kathy Krepps Lab Operations Manager Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491
Pam Johnson Lab Sample Custodian Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491
Nancey Maeggerlein Lab Operations Manager/ QA Manager NSWC Crane	Naval Warfare Center 300 Highway 361 Code 4052 Building 2707 Crane, IN 47522	(812) 854-5506 FAX: (812) 854-5054
Jackie Karty Lab Chemist NSWC Crane	Naval Warfare Center 300 Highway 361 Code 4052 Building 2707 Crane, IN 47522	(812) 854-3143 FAX: (812) 854-5054

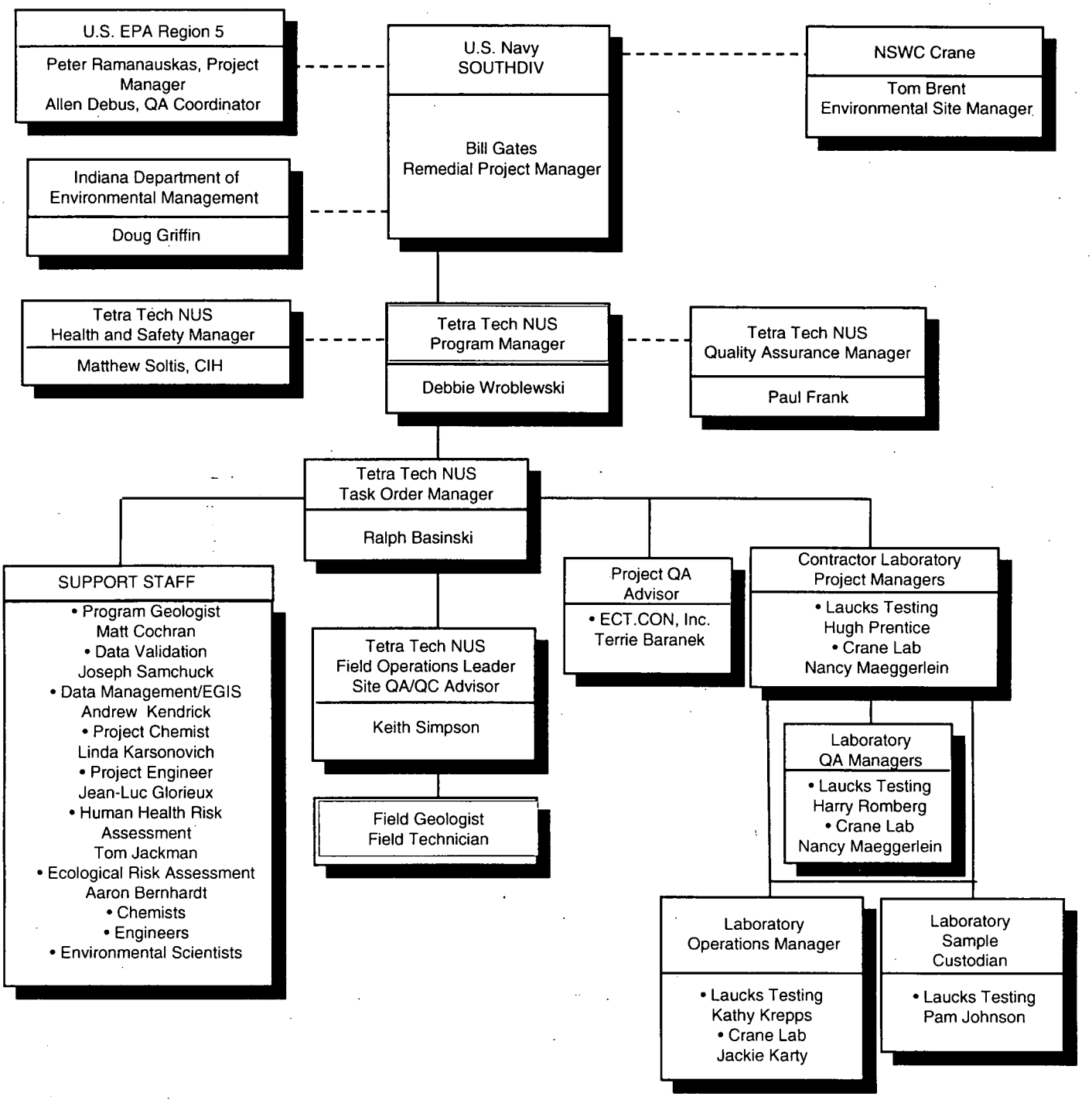


FIGURE 2-1

PROJECT ORGANIZATION CHART
NSWC CRANE, INDIANA

3.0 FACILITY DESCRIPTION

3.1 FACILITY LOCATION AND DESCRIPTION

NSWC Crane is located in the southern portion of Indiana, immediately east of Crane Village and Burns City. The facility is approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky (Figure 3-1). NSWC Crane encompasses approximately 100 square miles (62,463 acres), with the majority of the facility located in the northern portion of Martin County. Smaller portions of the facility are located in Greene, Davies, and Lawrence Counties. NSWC Crane is located in a rural, sparsely populated area. Most of the facility is forested, and the surrounding area is wooded or farmed land. NSWC Crane provides naval support for equipment, shipboard weapons systems, and ordnance. In addition, NSWC Crane supports the Crane Army Ammunition Activity (CAAA) with production and renovation of conventional ammunition and storage, shipment, demilitarization, and disposal of conventional ammunition (Murphy, 1992b). A description of SWMU 2 is provided in Section 5.0. The locations of the SWMU is shown on Figure 3-1.

3.2 FACILITY HISTORY AND ACTIVITIES

This section provides general information on the history of NSWC Crane and its activities.

3.2.1 History of Ownership and Operation

In 1940 Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana, and in late 1941 the Naval Ammunition Depot Burns City was commissioned. In 1943 NAD Burns City was renamed NAD Crane, and the Town of Crane was built to house the rapidly growing number of civil service employees. NAD Crane's overall mission was to load, prepare, renovate, receive, store, and issue ammunition to the fleet.

During World War II, NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. During the 1950s, several new departments were created, the Ammunition Loading and Production Engineering Center (ALPEC) was transferred to Crane, and the Central Ammunition Supply Control Office (CASCO) was established. NAD Crane supplied ammunition to the fleet during the Korean and Vietnam Conflicts. During the Southeast Asia crisis, the number of full-time employees at NAD Crane grew to 6,800.

In 1975 NAD Crane was designated Naval Weapons Support Center Crane (NWSCC). Its new mission was to provide support for ships, aircraft, equipment, shipboard weapons systems, and assigned ordnance items, and to perform additional functions as directed.

In 1977 the Single Manager Concept was implemented. The CAAA was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. Other functions remained Navy, and currently the Navy retains ownership of all real estate and facilities at NSWC Crane. Responsibility for overall station safety, security, and environmental protection remains with the Commanding Officer, NSWC Crane. In 1992 the facility was designated as Naval Surface Warfare Center Crane (NSWC Crane). Presently, approximately 4,000 people are employed at NSWC Crane.

3.2.2 History of Regulatory Actions

Following promulgation of the U.S. EPA RCRA hazardous waste regulatory program, NSWC Crane filed notification and application to operate as a RCRA hazardous waste treatment, storage, or disposal (TSD) facility in October 1980. Interim status was granted subject to operating requirements and applicable technical standards found in 40 CFR Part 265.

Corrective Action programs established as part of the 1984 RCRA Hazardous and Solid Waste Amendments (HSWA) required NSWC Crane to address past releases of hazardous waste or hazardous constituents at SWMUs. Accordingly, NSWC Crane submitted a Hazardous Waste Management Report to the U.S. EPA in January 1985. Following the Hazardous Waste Management Report, a RCRA Facility Assessment (A.T. Kearney, Inc., 1987) was conducted to characterize the potential for releases of hazardous waste or constituents from 100 SWMUs identified during the assessment.

On December 23, 1989, the U.S. EPA issued the Federal portion of the Final RCRA Part B Permit for NSWC Crane to the U.S. Navy. This permit established the Corrective Action requirements and compliance schedules obligating the U.S. Navy to perform RFIs at 33 SWMUs, to conduct CMSs, and to implement Corrective Measures if needed. The Corrective Action requirements identified in the RCRA Part B Permit are directed primarily at addressing the human health and ecological impacts of past waste management operations at NSWC Crane.

3.3 PHYSICAL SETTING

This section briefly describes the climate, physiography and topography, hydrology, geology and stratigraphy, hydrogeology, and ecology of NSWC Crane. More detailed descriptions for SWMU 2 are included in Section 5.2 of this Work Plan.

3.3.1 Climate

NSWC Crane is located in a temperate climatic zone displaying a wide temperature range among seasons. In general, the winters are mild with short periods of very cold weather, and the summers are warm and humid. The temperature ranges from an average minimum January temperature of 26°F to an average maximum July temperature of 89°F. Precipitation is fairly evenly distributed throughout the year, with the maximum precipitation occurring during the spring and early summer. The area receives an average of 44 inches of precipitation annually, with 42 inches of rainfall and 15 inches of snowfall (NEESA, 1983). The average humidity ranges from 40 to 90 percent in summer and 60 to 90 percent in winter. The prevailing wind is from the south-southwest (McElrath, 1988). Additional information on climatic conditions at NSWC Crane can be found in the RCRA Air Quality Assessment (B&R Environmental, 1997).

3.3.2 Physiography and Topography

NSWC Crane is located in the unglaciated area of the Crawford Uplands Physiographic Province. This region is described as a rugged, highly vegetated, dissected plateau that is bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west (U.S. ACE WES 1995). The Mitchell Plain is described as a low dissected limestone plateau characterized by sinkholes and karst topographic features. The boundary between the Crawford Upland and the Mitchell Plain is marked by the highly irregular, eastern facing Chester Escarpment. Springs, caverns, caves, and other solution weathering features can be found along this escarpment and on the eastern edge of the facility. The boundary between the Crawford Upland and the Mitchell Plain near the western boundary of NSWC Crane is gradual (U.S. ACE WES, 1995).

The terrain is predominantly rolling with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of NSWC Crane. Deciduous trees and shrubs cover most of the region. The elevations across the facility range from about 500 feet above mean sea level (AMSL) to about 850 feet AMSL. Lake Greenwood extends west to east across the northern part of the facility. Topographic relief in the Crawford Upland ranges from 100 to 350 feet. Greater relief exists in the eastern part of NSWC Crane near the Chester Escarpment (U.S. ACE WES, 1995). A topographic and surficial geologic

map of the entire facility has been compiled by Kvale (1992) and Blunck (1995) after U.S. Geological Survey 7.5 minute quadrangle maps (Indian Springs, Scotland, Koleen, Owensburg, Odon, Williams, Loogootee, and Shoals).

3.3.3 Hydrology

The surface drainage at NSWC Crane has formed a dense, dendritic pattern throughout the installation that flows generally to the south and southwest. Seven primary creeks in five drainage basins carry surface water off the installation, where it eventually drains into the East Fork of the White River and then to the Wabash River to the southwest. The seven creeks that drain NSWC Crane include Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, Indiana Creek, and Seed Tick Creek. SWMU 2 drains into Little Sulphur Creek. Figure 3-2 shows the surface drainage features and the individual drainage basins at NSWC Crane.

Drainage Basin IV consists of Boggs and Turkey Creeks, which are the primary drainageways for the installation and drain the majority of the area. The northern and northwestern sections (Basin I) are drained by Furst Creek, the eastern portion (Basin III) is drained by the Sulphur Creek complex, the extreme eastern portion (Basin II) is drained by Indiana Creek (not shown on Figure 3-2), and the southwestern section (Basin V) is drained by Seed Tick Creek.

Also located within the installation are several small ponds and Lake Greenwood, an 800-acre man-made, spring-fed lake in the northwestern portion of the installation. Lake Greenwood is the main source of water at NSWC Crane and is also used for recreation (NEESA, 1983).

3.3.4 Geology and Stratigraphy

3.3.4.1 General Geology and Stratigraphy

The geology at NSWC Crane is generally characterized by thin overburden deposits overlying bedrock. The overburden deposits generally range in depth from the surface down to 0 to 65 feet (U.S. ACE WES, 1998a) below ground surface (bgs). These deposits generally consist of two types: Quaternary-age unconsolidated deposits and unconsolidated residual soil derived from the underlying bedrock. Bedrock underlying the facility consists of sedimentary rock from the Lower Pennsylvanian-age Raccoon Creek Group and the Upper Mississippian-age Stephensport and West Baden Groups. The following subsections describe the unconsolidated deposits and bedrock at NSWC Crane in greater detail.

3.3.4.2 Unconsolidated Deposits

The Quaternary-age deposits consist of alluvial, colluvial, and glacial outwash deposits consisting of silt, sand, and gravel; lacustrine deposits consisting of clay, silt, and sand; and loess deposits consisting of clay and silt.

Residual soils at NSWC Crane were derived from the underlying sedimentary rocks of the lower Pennsylvanian Raccoon Creek Group and the upper Mississippian Stephensport and West Baden Groups. These soils consist of clay, silt, sand, and fragmented and/or partially weathered bedrock.

Using the U.S. Department of Agriculture (USDA)/Soil Conservation Service (SCS) soil classification system (McElrath, 1988), the soil association at NSWC Crane has been classified as Wellston-Berks-Gilpin. This soil association is described as deep and moderately deep, gently sloping to very steep, well-drained soils formed in loess and material weathered from sandstone, siltstone, and shale on uplands. Mapped series at the site include Zanesville soil series on the ridge tops and a complex of soils on the slopes Wellston-Berks-Gilpin. Zanesville soil series are described by a silt loam texture with a profile possessing a fragipan at 23-31 inches. A fragipan is a loamy brittle subsurface cemented horizon where water permeability is reduced and root penetration is restricted. Taxonomic classification of Zanesville soil series is fine-silty, mixed, mesic Typic Fragiudalfs. Table 3-1 shows the soil series and map units present throughout the facility and indicates which soil series are present at the SWMU.

3.3.4.3 Bedrock

Bedrock underlying NSWC Crane consists of sedimentary rock from the Lower Pennsylvanian-age and the Upper Mississippian-age bedrock. The Lower Pennsylvanian bedrock (Raccoon Creek Group) at the site primarily consists of interbedded sandstone, siltstone, shale, and coal with a total thickness varying from 0 to more than 300 feet (Fisher, 1996). The underlying Missisippian-age bedrock consists of limestone, shale, and sandstone (U.S. ACE WES, 1995; and Palmer, 1969). The relief of the unconformity between the Pennsylvanian and Mississippian bedrock has been measured to be as much as 100 feet (Kvale, 1992).

Pennsylvanian bedrock is absent in the deepest, present-day drainage channels (e.g., Sulphur Creek, Turkey Creek) primarily due to erosion. In these locations, the Mississippian-age bedrock is exposed. A large number of SWMUs are located on ridges or other topographically high areas, primarily on top of Pennsylvanian bedrock. The surficial geology illustrating the mappable geologic units at NSWC Crane is

provided as Figure 3-3. An outline of SWMU 2 is included in the figure as an illustration of the type of bedrock material underlying it.

The following paragraphs provide a brief description of the geologic formations as described by Palmer (1969), U.S. ACE WES (1995) and Kvale (1992). They are presented from youngest (first) to the oldest units. These geologic units are also illustrated on the stratigraphic column illustrated on Figure 3-4.

1. Mansfield Formation and Undifferentiated Lower Pennsylvanian, undifferentiated (Pennsylvanian Raccoon Creek Group). This unit consists of alternating beds of dark shale, sandstone, mudstone, siltstone, and discontinuous coal units.

2. Glen Dean Limestone, Hardinsburg Formation, Golconda/Haney Limestone, Indian Springs Member, undifferentiated (Mississippian Stephensport Group). This unit consists of limestone (Glen Dean Formation), soft shale and cross-bedded sandstone (Hardinsburg Formation), shaley limestone and limey shales (Golconda/Haney Formation), and dark gray shale (Indian Springs Formation). Thickness of the unit ranges from 60 to 70 feet.

3. Big Clifty Sandstone member, Big Clifty Formation (Stephensport Group). The Big Clifty Sandstone is a tan to green-gray, massive to thick-bedded, rippled, fine- to very fine-grained, well-sorted, rounded, friable sandstone with occasional shaly partings. Thickness of this unit ranges from 30 to 40 feet.

4. Beech Creek Limestone Formation (Stephensport Group). The Beech Creek Limestone consisted of fossiliferous, hard, and dense limestone. Joints in the limestone were sparse to numerous in core recovered from the 18 well borings which penetrated the unit. The Beech Creek Limestone displayed moderate to extensive solution-enlarged jointing at another site within NSWC Crane (U.S. ACE WES, 1988). Thickness of this unit ranges from 20 to 25 feet.

5. Elwren Formation, Reelsville Limestone, Upper Sample Formation, undifferentiated (West Baden Group). This unit consists of fine-grained interbedded sandstone and mudstone (Elwren Formation), a thin discontinuous limestone (Reelsville Limestone), and fine-grained sandstone (Upper Sample Formation). Thickness of this unit ranges from 65 to 75 feet.

6. Lower Sample Formation, Beaver Bend Limestone, Bethel Formation, undifferentiated (West Baden Group). This unit consists of dark greenish-gray shale (Lower Sample), fossiliferous

limestone (Beaver Bend Limestone), and a calcareous sandstone and shale (Bethel Formation). Thickness of this unit ranges from 50 to 60 feet.

7. Paoli Limestone, Ste. Genevieve, undifferentiated (Blue River). This unit consists of oolitic limestone and limestone (undifferentiated). Thickness of this unit is at least 35 feet (based on exposure in Boone Hollow at the northeastern corner of the facility).

Structurally, NSWC Crane is located on the eastern edge of the Illinois Structural Basin, where the Pennsylvanian- and Mississippian-age bedrock dips to the west-southwest and southwest at approximately 30 to 35 feet per mile (U.S. ACE WES 1982, p. 10; Kvale, 1992). Locally, however, the dip of the Mississippian bedrock can range from 0 to 15 feet/mile to as much as 100 feet/mile (Sulphur Creek; Kvale, 1992).

3.3.5 Hydrogeology

U.S. ACE WES (1988) discussed regional ground water trends pertaining to the unglaciated southwest portion of Indiana. In general, ground water is contained in joint openings of limestone and sandstone aquifers. Although unit thicknesses may vary, the distribution of bedrock units at NSWC Crane (Figure 3-4) suggests similar aquifer characteristics throughout the facility. Surficial unconsolidated aquifers are thin and have limited potential as water supplies.

Aquifers beneath NSWC Crane are considered to be vertically isolated from each other by interlayered shale beds, which act as aquitards. Ground water recharge in the unconsolidated surficial aquifers occurs from infiltration from the ground surface. Ground water recharge in the underlying bedrock units occurs where aquifer units outcrop. After entering an aquifer outcrop, ground water flows by gravity down the dip of the aquifer unit. Given that the regional dip of rock units is to the southwest, regional ground water flow in all aquifers is directed toward the southwest. Local ground water flow at SWMU 2 is consistent with the regional flow direction. The location of SWMU 2 relative to Lake Greenwood coupled with local and regional ground water flow directions indicate that ground water from the site does not discharge to Lake Greenwood.

Local variations in bedding, dip, aquifer and aquitard, thickness, the presence or absence of fractures, incision by surface drainage, and karstic conditions cause local ground water movement at NSWC Crane to differ from regional trends. Where erosion resulting from surface drainage has cut through aquifer units, springs and seeps are produced that locally complicate ground water flow. Springs and seeps are prevalent at contacts between aquitards and overlying aquifers. Ground water flowing from springs and

seeps into surface water can potentially re-enter the ground water system as recharge to a lower aquifer outcroping downstream.

In the eastern portion of NSWC Crane, U.S. ACE WES (1988) hypothesized that karstic conditions are present primarily in major drainage valleys where erosion has cut into permeable sandstones overlying easily dissolved limestone units. Rapid infiltration in the Big Clifty Sandstone units has caused dissolution and weathering of the underlying Beech Creek Limestone. The result of this occurrence has been the creation of karst and collapse conditions along major drainageways within the eastern part of NSWC Crane.

There are three distinct aquifers identified at the site. On descending order, the aquifers are the Pennsylvanian sandstone, the Golconda/Haney Limestone and the Beech Creek Limestone (including the lower part of the Big Clifty sandstone). Further site-specific details are located in Section 5.1.3.

3.3.6 Ecology

A biological characterization of NSWC Crane, including a listing of plants and animals found at the facility, is presented in the Installation Assessment (IA; U.S. Army, 1978) and the IAS; (NEESA, 1983), and is summarized in Environmental Monitoring Reports (EMR; Halliburton NUS August and November, 1992). A list of the species that may inhabit NSWC Crane and are protected under the U.S. Endangered Species Act, Indiana Department of Natural Resources Heritage Data Center, or the U.S. Fish and Wildlife Service is summarized in the RCRA Facility Permit (U.S. EPA, July 1995).

TABLE 3-1

USDA/SCS SOIL CLASSIFICATIONS[1]
NSWC CRANE, INDIANA
PAGE 1 OF 2

Soil Series	Soil Type	Present at # of SWMUs	Soil Classification[2]		Soil Classification[3]		Description	Location	Depositional Environment
			Surface Soil[4]	Subsurface Soil[5]	Surface Soil[4]	Subsurface Soil[5]			
Alluvium									
Bartle	Ba	NP	silt loam	silt loam to silty clay loam	CL, CL- ML	CL, CL- ML	0 to 2 percent slopes, gently sloping, deep, poorly drained	lowlands	Lake plains & stream terraces
Birds	Bk	2	silt loam	silt loam	CL	CL	frequently flooded, nearly level, deep, poorly drained; on broad bottom land.	lowlands	Alluvium derived from loess uplands
Bonnie	Bo	NP	silt loam	silt loam	CL	CL	0 to 2 percent slopes, gently sloping, deep, poorly drained	lowlands	Alluvium derived from loess uplands
Burnside	Bu	4	loam	loam to channery loam	ML, CL, ML-CL	ML-CL, SC, GC, SM, GM	occassionally flooded, nearly level, deep, well drained; on flood plains	flood plains	Alluvium derived from sandstone, siltstone, and shale
Haymond	Hd	3	silt loam	silt loam	ML	ML, SM	frequently flooded, nearly level, deep, well drained; on bottom land	lowlands	Silty alluvium
Pekin	PeB	NP	silt loam	silt loam to silty clay loam	CL-ML	CL-ML	2 to 6 percent slopes, deep, well drained	outwash terraces	Loess and underlying alluvium
Wakeland	Wa	4	silt loam	silt loam	ML	ML	frequently flooded, nearly level, deep, somewhat poorly drained	flood plains	Silty alluvium derived from loess uplands
Wilbur	Wr	NP	silt loam	silt loam	ML, CL-ML	ML, CL-ML	0 to 2 percent slopes, deep, poorly drained	lowlands	Alluvium derived from loess uplands
Loess/Glacial Outwash									
Hosmer	HoB	2	silt loam	silt loam to silty clay loam	ML, ML-CL, CL	ML, ML-CL, CL	2 to 6 degree slopes, gently sloping, deep, well drained	uplands and ridgetops and on loess-capped lake plains.	Loess
Camden	CaB	NP	silt loam	silt loam,clay loam, sandy loam	CL, ML-CL	ML, CL, SM, SC	1 to 5 percent slopes, deep, well drained	stream terraces	Loess and underlying outwash material
Negley	NeE	2	silt loam to loam	loam, clay loam, gravely loam	ML, ML-CL, CL	SM, ML	8 to 35 percent slopes, moderately steep to steep, deep, well drained	loess and outwash	Loess capped and underlying outwash material
Parke	PaC2	1	silt loam	silty clay loam to sandy clay loam	CL-ML	SC, CL	6 to 18 percent slopes	uplands & sideslopes	Loess capped and underlying outwash material
Pike	Pk	NP	silt loam	silt loam to silty clay loam	CL	CL, SC	2 to 6 percent slopes, deep, well drained	outwash terraces	Loess capped and underlying outwash material
Residual Soils from Bedrock (both Pennsylvanian & Mississippian)/Colluvium									
Johnsburg	Jo	NP	silt loam	silty clay loam, silt loam, to sandy loam	CL, ML-CL	ML, CL, SM, SC	0 to 2 percent slopes, deep, poorly drained	uplands	Loess and material weathered from ss, siltstone, shale.
Udorthents	UhD	1	shaly silty clay loam	shaly silty clay loam	CL-ML, CL, ML	CL-ML, CL, ML	6 to 14 percent slopes, moderately steep to steep, moderately deep to deep, well drained	uplands	Excavated areas formerly used as landfills
Udorthents-Pits complex	Up	1	gravelly sand	gravel	GM	GM	NA	uplands	Material left from sandstone quarries and sand pits
Wellston	WeB	1	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	2 to 6 percent slopes, gently sloping, deep, well drained	ridgetops	Loess and material weathered from ss, siltstone, shale.
	WeC2	5	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	6 to 12 percent slopes, eroded, moderately sloping, deep, well drained	ridgetops and sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
	WeD2	8	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	12 to 18 percent slopes, eroded, steeply sloping, deep, well drained	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
	WeD3	3	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	12 to 18 percent slopes, severely eroded, steeply sloping, deep, well drained	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.

TABLE 3-1

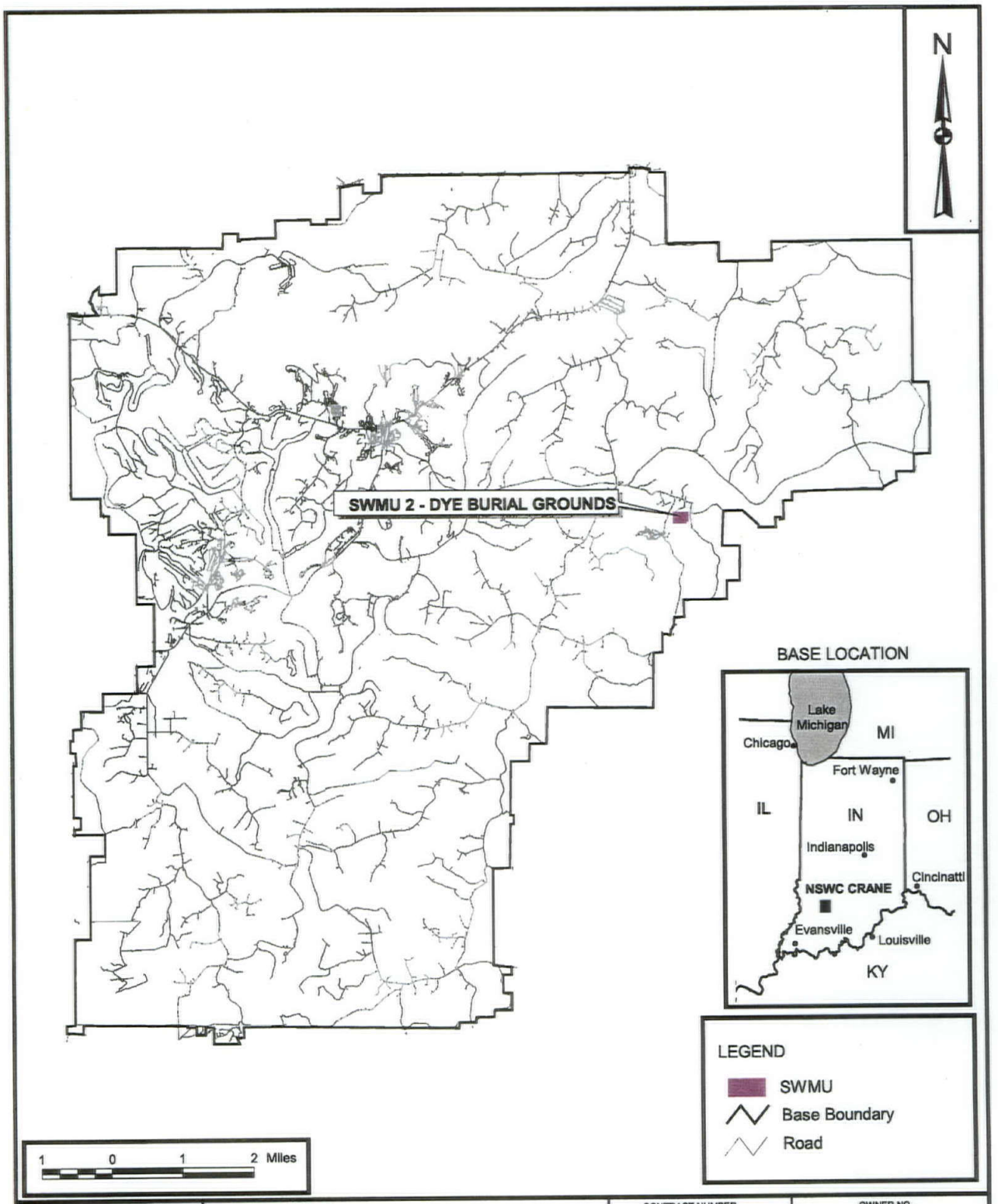
USDA/SCS SOIL CLASSIFICATIONS[1]
NSWC CRANE, INDIANA
PAGE 2 OF 2

Soil Series	Soil Type	Present at # of SWMUs	Soil Classification[2]		Soil Classification[3]		Description	Location	Depositional Environment
			Surface Soil[4]	Subsurface Soil[5]	Surface Soil[4]	Subsurface Soil[5]			
Wellston-Ebal	WID	NP	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC, CH, GC	10 to 18 percent slopes, deep, well drained	sideslopes in uplands	Loess, colluvium, and material weathered from ss, siltstone, shale.
Wellston-Berks-Gilpin complex	WgG	5	silt loam to channery silt loam	silt loam, silty clay loam, to channery loam	ML, CL, CL-ML, SC, GM, GC	CL-ML, CL, SC, SM-SC	18 to 70 percent slopes, moderately to very steep, deep, well drained	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Wellston-Gilpin complex	WnE	16	silt loam to channery silt loam	silt loam, silty clay loam, to channery loam	ML, CL, CL-ML, SC, GM, GC	CL-ML, CL, SC, SM-SC	12 to 30 percent slopes, strongly sloping to steep, moderately deep	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Wellston-Udorthents complex	WpD[6]	8	silt loam to silty clay loam	silt clay loam to channery loam	ML, CL, CL-ML	CL-ML, CL, SC, SM-SC	12 to 18 percent slopes, strongly sloping, very shallow to deep	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Zanesville	ZaB	6	silt loam to silty clay loam	silty loam, to sandy clay loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	2 to 6 percent slopes, gently sloping, deep, moderately to well drained	ridgetops in uplands	Loess and material weathered from ss, siltstone, shale.
	ZaC2	7	silt loam to silty clay loam	silty loam, to sandy clay loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	6 to 12 percent slopes, eroded, moderately sloping, deep, moderately to well drained	ridgetops and sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
	ZaC3	2	silt loam to silty clay loam	silty loam, to sandy clay loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	6 to 12 percent slopes, severally eroded, moderately sloping, deep, moderately to well drained	ridgetops and sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Zanesville-Udorthents complex	ZnB[6]	13	silt loam to silty clay loam	silt loam, silty clay loam to loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	2 to 6 percent slopes, gently sloping, moderately to well drained	ridgetops in uplands	Loess and material weathered from ss, siltstone, shale.
	ZnC[6]	17	silt loam to silty clay loam	silt loam, silty clay loam to loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	6 to 12 percent slopes, gently sloping, moderately to well drained	ridgetops in uplands	Loess and material weathered from ss, siltstone, shale.

Notes:

USDA United States Department of Agriculture
SCS Soil Conservation Service
NP - Not present at any SWMUs
SWMU - solid waste management unit
SS - Sandstone
NA - Not available

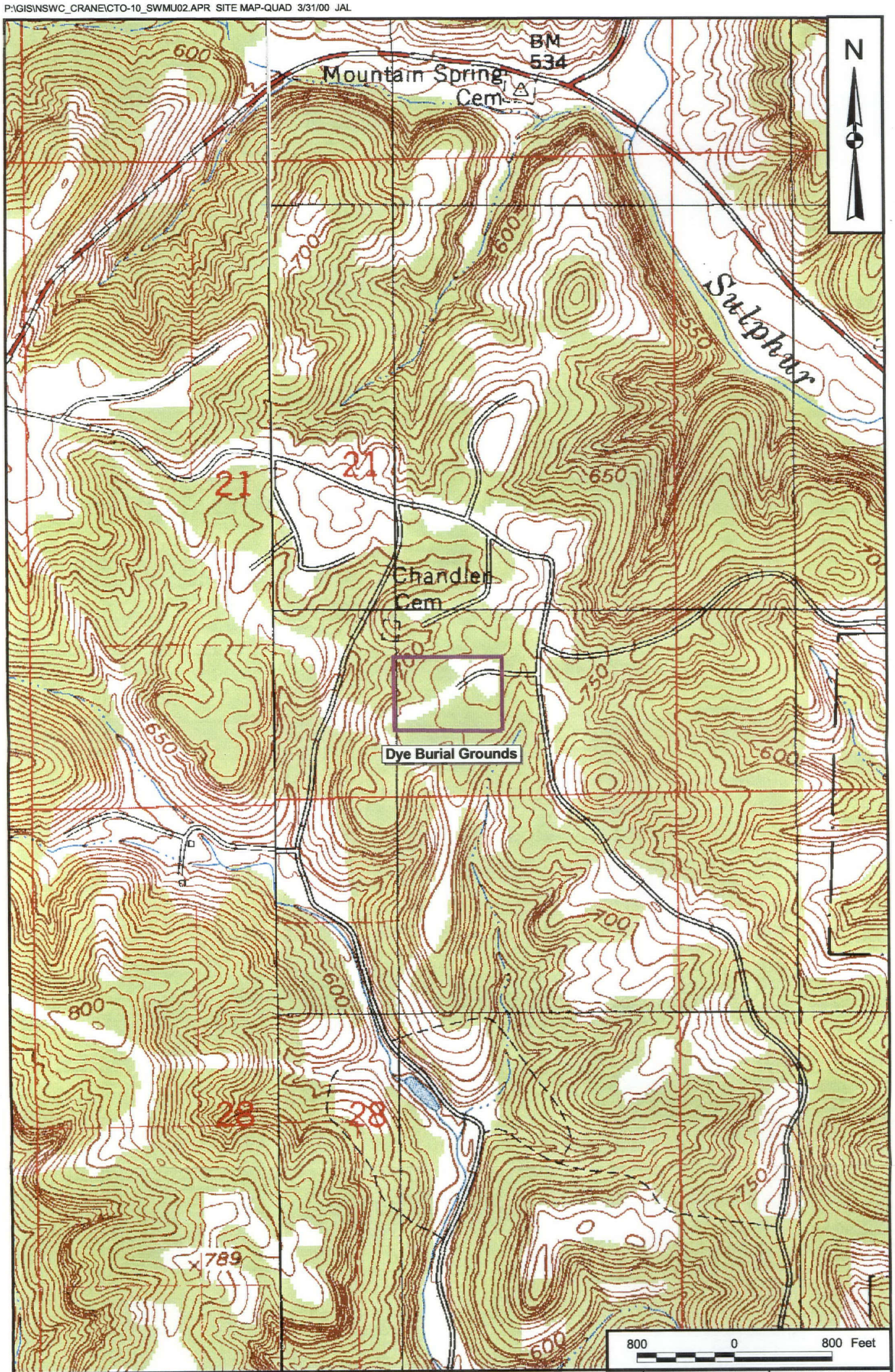
1 Information taken from McElrath, G., Jr., 1998, Soil Survey of Martin County, Indiana, Soil Conservation Service, United States Department of Agriculture.
2 United States Department of Agriculture (USDA) classification system
3 Unified Soil Classification System (USCS), abbreviations are as follows
CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
ML - Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
SC - Clayey sands, poorly graded sand-clay mixtures
SM - Silty sands, poorly graded sand-silt mixtures
GM - Silty gravels , poorly graded gravel-sand-silt mixtures
GC - Clayey gravels, poorly graded gravel-sand-clay mixtures.
4 Surface soil is from 0 to 12 inches below ground surface (bgs).
5 Subsurface soil is between 12 and 70 inches bgs or to the top of bedrock.
6 Soil at areas at the NSWC where a significant amount of construction and earth moving has removed most of the original soil, which has been deposited as fill on building sites.



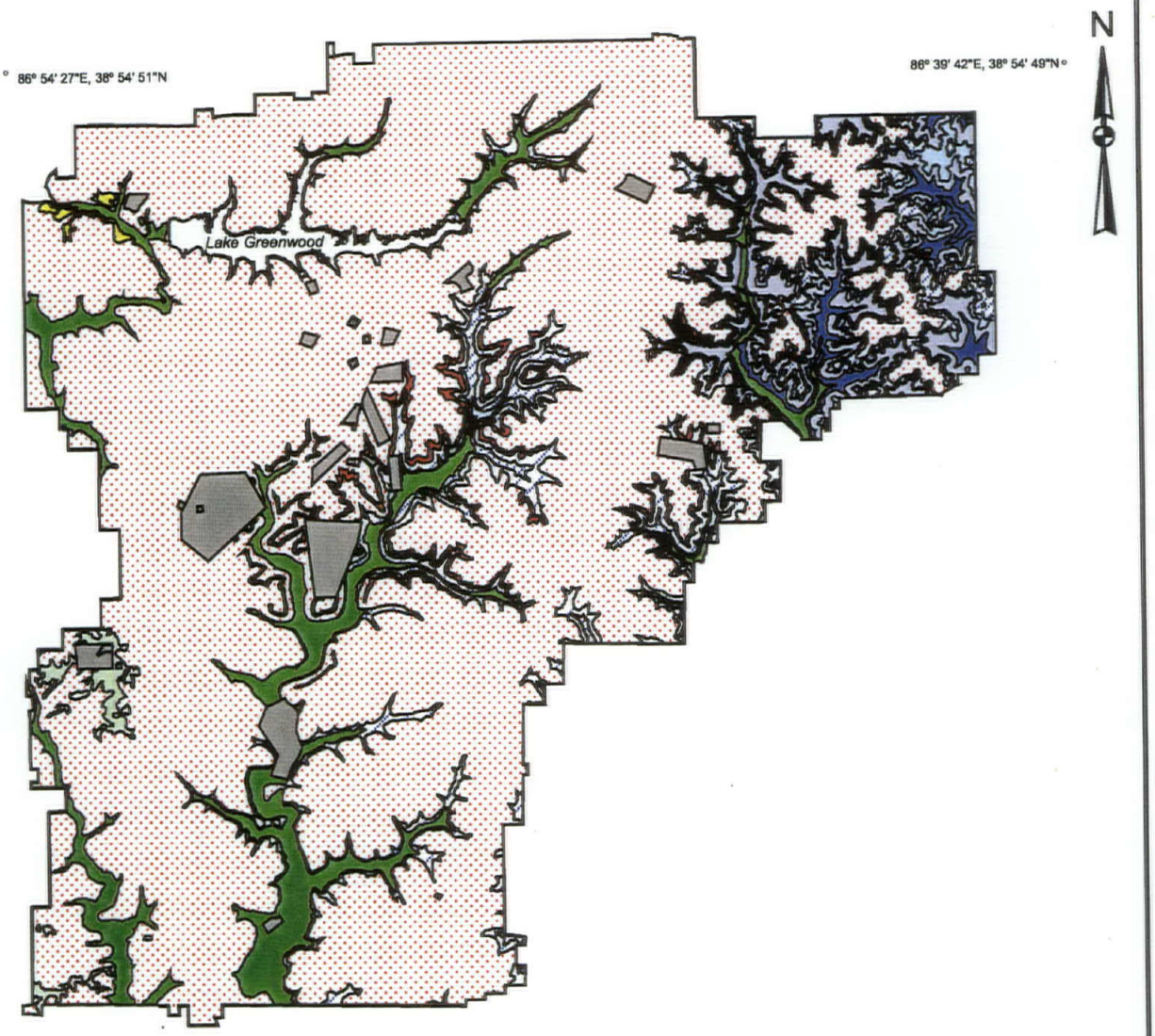
DRAWN BY J. LAMEY — DATE 8/2/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NO. 0010
CHECKED BY — DATE —	SITE LOCATION MAP SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — DATE —	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 3-1	REV —

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR 8/299 JAL SITE LOCATION LAYOUT

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR SITE MAP-QUAD 3/31/00 JAL



DRAWN BY J. LAMEY	DATE 3/24/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER 0010
CHECKED BY	DATE	SITE MAP SWMU 2 - SURFACE DRAINAGE NSWC CRANE, INDIANA	APPROVED BY / DATE
COST/SCHEDULE-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-2 / REV 0



Explanation of Geology

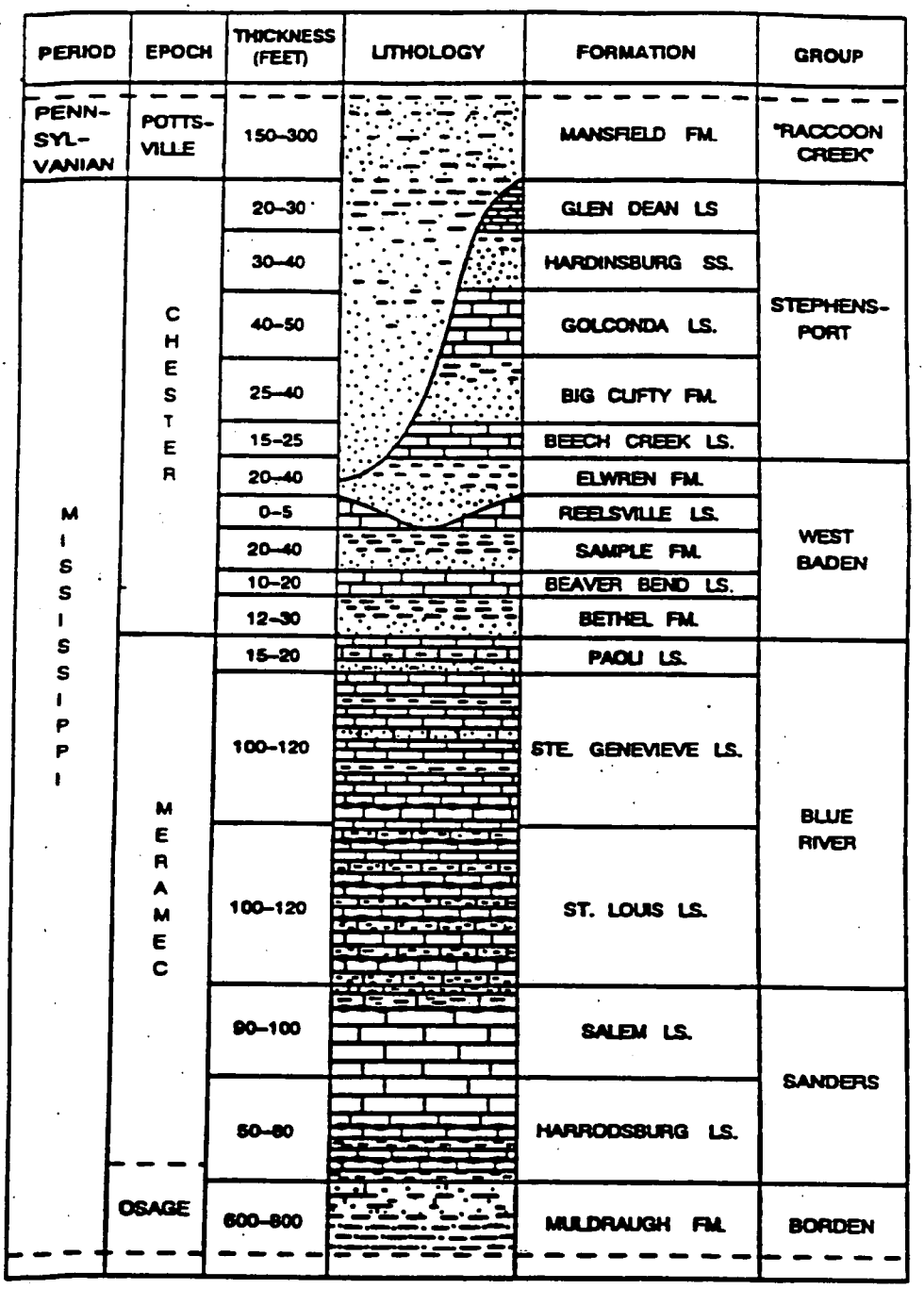
- Qal — *Alluvium*
- Ql — *Loess*
- Qo — *Glacial Outwash*
- P — *Raccoon Creek Group and undifferentiated*
- Ps — *Sandstone-dominated horizon of Lower Pennsylvanian*
- M6 — *Glenn Dean Ls, Hardinsburg Fm, Haney Ls, Indian Springs Shale Mbr, and undifferentiated*
- M5 — *Sandstone member of the Big Clifty Fm*
- M4 — *Beech Creek Ls*
- M3 — *Elwren Fm, Reelsville Ls, upper Sample Fm, and undifferentiated*
- M2 — *Lower part of Sample Fm, Beaver Bend Ls, Bethel Fm, and undifferentiated*
- M1 — *Paoli Ls, Ste Genevieve Ls, and undifferentiated*
- Select Solid Waste Management Units (SWMUs)

12000 0 12000 Feet

(Modified from Blunck, 1995)

DRAWN BY D. PERRY	DATE 15-MAR-99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NO. 0010
CHECKED BY	DATE	SURFICIAL GEOLOGY MAP NAVAL SURFACE WARFARE CENTER CRANE, INDIANA	APPROVED BY / DATE
COST/SCHEDULE-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV 0

P:\GIS\NSWC_CRANE\SWMU02_CTO0010.APR 3/29/00 JAL SURFICIAL GEOLOGY MAP LAYOUT



SOURCE: Internal Draft, RCRA Facility Investigation Phase III Groundwater Release Characterization Report, SWMU 10/15 Rockeye, U.S. Army Corps of Engineers, December 1993

DRAWN BY J. LAMEY — DATE 4/19/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NO. CTO 0083
CHECKED BY — DATE —	STRATIGRAPHIC COLUMN FOR ROCK UNITS ENCOUNTERED AT THE NAVAL SURFACE WARFARE CENTER NSWC CRANE, INDIANA	APPROVED BY — DATE 4/20/99	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 3-4	REV 0

P:\GIS\NSWC_CRANE\0087.APR 4/19/99 JAL STRATIGRAPHIC COLUMN LAYOUT

4.0 DEVELOPMENT OF PROPOSED INVESTIGATION

This section of the Work Plan presents the methodologies used to develop the proposed field investigation for SWMU 2. Because the primary objective of data collection activities for this CTO is the completion of RFI/CMS and risk assessment activities, the development of a conceptual site model (CSM) is essential for planning purposes. Section 4.1 provides general information on the preparation of the site-specific CSM. A description of the Data Quality Objectives (DQOs) developed as part of the planning process is presented in Section 4.2. The DQOs for the project were developed using U.S. EPA guidance (U.S. EPA, September 1994).

The site-specific proposed investigation for the SWMU is provided in Section 5.0.

4.1 SWMU 2 – DYE BURIAL GROUND CONCEPTUAL SITE MODEL

A site-specific CSM was used as a basis for the development of the proposed investigation for SWMU 2. The CSM, which essentially defines the nature of the environmental problem at the site, depicts the relationship among the following elements:

- Site sources of contamination
- Contaminant release mechanisms
- Transport/migration pathways
- Exposure routes
- Potential receptors

Physical site characteristics, results of previous site investigations, hazard identification (detected chemicals of interest based on the previous investigations), and current and future land use scenarios also were considered during the development of the site-specific CSM. The site-specific CSM for the SWMU, as well as details on the site background, physical setting, previous investigations, and hazard identification, are presented in this section. Figure 4-1 illustrates the CSM for SWMU 2. This figure also identifies the potential exposure pathways, which will be quantitatively evaluated in the human health and ecological risk assessments.

The elements of the CSM (contaminant source, release mechanisms, transport/migration pathways, exposure routes, and potential receptors) establish the manner and degree to which a potential receptor may be exposed to chemicals present at the site. The degree of risk incurred by a potential receptor

varies according to the means of exposure, the duration of exposure, and the specific chemical to which the receptor is exposed. An exposure, however long in duration, does not necessarily result in an "unacceptable" health or environmental risk, although risks generally increase with increased frequency and/or duration of exposure.

The elements of the CSM, including how they pertain to the SWMU, are presented in Sections 4.1.1 through 4.1.4.

4.1.1 Site Sources of Contamination

The source of contamination was identified based on a review of the previous RFI reports prepared for the site. The source of contamination for SWMU 2 is the disposal of dyes and dye-contaminated materials in open trenches or on soil surfaces. Materials buried reported included bags and boxes of dyes, magnesium, rags contaminated with dyes and open drums of dyes.

4.1.2 Contaminant Release Mechanisms and Transport Pathways

4.1.2.1 Contaminant Release Mechanisms

Past activities at the SWMU may have resulted in contaminant releases to the surrounding environment. A summary of the contaminant release mechanisms that may have occurred at SWMU 2 are as follows:

- Dyes may have spilled onto soil (subsurface and surface) during burial activities.
- Dyes could have leaked from the containers in which they were buried.
- Dye-contaminated soils may have been displaced during trench backfilling operations and/or cap construction activities.

Consequently, contaminants could have been released to the surrounding soil, drainageways, or ground water.

4.1.2.2 Transport Pathways

Previous investigations for the SWMU have documented that a release of hazardous constituents from past operational activities has occurred. Although past sampling and analytical programs did not include the analysis of dyes, color-stained surface and subsurface soil were visually observed at the SWMU. Dye-colored water, however, was not observed. Based on the physicochemical properties (e.g., solubility) of dyes that potentially could have been placed in the open trenches, the migration and

percolation (leaching) of constituents from surface soil to subsurface soil to ground water is highly possible at the site.

In general, hazardous constituents may be transported from the SWMU by a variety of mechanisms. These mechanisms include surface (storm water) runoff and subsequent erosion of surface soil, infiltration of soluble chemicals and subsequent migration through the subsurface soil to the water table where they may migrate to downgradient locations, and wind erosion of surface soil.

Storms generate surface runoff, which is directed toward drainage ways present at the sites. Initially, this water may move across the site as sheet flow, which can entrain loose soil material. This soil is moved from the site as a sediment and will be deposited where the flow velocity diminishes below that needed to carry a particular grain size. Typically, at sites in undeveloped areas, this soil/sediment is deposited in small drainage ways and migrates further downstream with each new storm, which also adds new material.

Soluble chemicals released to the ground surface may also migrate downward through the soil column with infiltrating precipitation. The migration of these chemicals may be somewhat impeded by the chemical's tendency to bind to soil organic material. Eventually, these soluble chemicals may reach the water table. Once in the ground water, they continue their migration via dispersion and advection in the downgradient direction. Eventually, these chemicals may discharge with the ground water to surface water bodies (creeks, streams, tributaries, or marsh/wet areas) and seeps near the site. Chemicals in ground water discharging at seeps or springs may sorb to surface soils/sediments at the discharge point. Impacted ground water from upper aquifers may discharge to the surface, infiltrate at recharge areas, and impact deeper aquifers.

Surface runoff (i.e., movement of constituents in surface soil to surface water and sediment) is expected to be an important transport pathway for the off-site migration of constituents detected in site media. The fact that SWMU 2 sits atop a ridge promotes this transport mechanism. The natural features of the SWMU, such as drainage ways, are indicators of surface runoff. Hydrogeologic data for the SWMU, collected during previous site investigations, suggest that a connection (i.e., discharge) exists between the ground water and surface water bodies present near the site. However, few surface water (i.e., one seep) and no sediment samples have been collected at the SWMU to characterize this transport pathway.

Chemicals adsorbed to surface soil may also be released from a site via wind erosion of loose soil material. These particulates are carried downwind and potentially off-site if the grain size is small enough and the wind velocity is great enough. Additionally, chemicals also may be released from soil via

volatilization. Volatile organic compounds (VOCs) were not typically identified as detected chemicals of interest for the soil at SWMU 2. In addition, as an interim measure, a multilayered cap system was placed over the main burial area at the SWMU, which decreases the extent of particulate generation. Consequently, particulate generation and volatile emissions are not expected to be a primary transport pathway for SWMU 2.

4.1.3 Exposure Routes

The manner in which a receptor comes into contact with contaminants is generally the result of interactions between a receptor's behavior or lifestyle and an exposure medium. Potential receptors could come into contact with potentially contaminated soil (surface and subsurface), ground water, surface water, sediment, and air.

Brief explanations of the potential routes of exposure per media are provided in this section. Details regarding how the exposure pathways will be evaluated in the risk assessments is provided in the risk assessment methodology sections of this Work Plan, Sections 8.0 (human health) and 9.0 (ecological).

4.1.3.1 Soil

Exposure to contaminated soil at the site is expected to be limited. As an interim measure, a multilayered cap system was placed over a large portion of the site, which includes the burial trenches. Additionally, dye-contaminated soil from disturbed areas outside the cap was excavated and placed in the subgrade under the capped area. Exposure to contaminated soil at the SWMU is unlikely under current and future land use because it is anticipated that the multilayered cap system has covered all dye-contaminated soils and that all contaminated soils outside the cap have been placed underneath the cap.

It is assumed that the integrity of the cap system will not be disturbed and a deed restriction will be placed on the capped area. Therefore, unless dye-contaminated soils are found outside the capped area, the soil exposure pathway will be regarded as incomplete since receptors would not come in contact with contamination left at the site (i.e., soil underneath the cap). If residual dye contaminants are found at the previously disturbed areas, a receptor may be exposed to soil via inadvertent ingestion of a small amount of soil or via dermal absorption of certain contaminants from the soil.

4.1.3.2 Ground Water

Direct exposure to ground water at the SWMU is not expected to occur under current and/or future land use. As mentioned previously, the integrity of the cap system is not expected to be disturbed and a deed

restriction will be placed on the capped area. Ecological receptors are not assumed to come into direct contact with ground water, and there are no drinking water wells located immediately downgradient of the site. However, to aid in risk management decision making, an evaluation of direct exposure to ground water (potable use) will be conducted in the Baseline Human Health Risk Assessment. Under the hypothetical residential exposure scenario, exposure routes for ground water will include ingestion and direct contact. Inhalation of chemicals in ground water is not considered to be an exposure pathway of concern because volatile compounds are not constituents of concern at the site.

Since ground water at the site discharges to surface water bodies (creeks, streams, tributaries, seeps) located near the site, indirect contact with groundwater is expected to occur. A discussion of indirect contact with ground water contaminants is provided in the following section.

4.1.3.3 Surface Water and Sediment

Receptors also may come into direct contact with surface water and sediment in the various seeps, springs, creeks, and drainage ways present at the SWMU. In most cases, because of the intermittent nature of a majority of the surface water bodies present near the SWMU, exposure to surface water and sediment is expected to be of a short duration. Individuals may be exposed primarily via dermal contact and incidental ingestion. Exposure via inhalation is expected to be insignificant because volatile compounds are not constituents of concern at the site.

4.1.3.4 Air

This exposure pathway is based on the scenario that a receptor is immersed in air that contains suspended particulates and volatile organic vapors originating from the source areas. Subsequent exposure of the receptor occurs upon inhalation (and partial subsequent ingestion) of ambient air. As noted previously, this pathway is not expected to be significant for SWMU 2. VOCs were not identified as detected parameters of interest in the surface (and subsurface) soil. Additionally, a multilayered cap system has been constructed over a large portion of the site, which eliminates the potential for particulate generation. Exposure to fugitive dust would be an applicable exposure pathway only if residual dye-contaminated soils were found outside the capped area.

4.1.4 Potential Receptors

A variety of potential receptors could be exposed to site media under current and future land use. Six general classes of receptor groups have been identified for evaluation at SWMU 2 to focus the risk assessment on potentially meaningful exposures and, in general, to streamline the risk assessment

process. These general receptors were identified by analyzing the interaction of current land use practices, potential future land use, and the identified sources of contamination. The general receptor classes include:

- Trespassers (Ages 6 to 17) – Potential receptor under current and future land use. Older children and teenagers (civilians or family of military personnel living outside the SWMU boundaries) trespassing on or near the site while exploring, playing, etc., are evaluated. This receptor could potentially be exposed to surface water and sediment. This receptor could also be exposed to surface soil (0 to 2 feet bgs) and air, if dye-contaminated soil is found outside the cap. If dye-contaminated soil is not found outside the capped area, the soil exposure pathways are incomplete and will not be addressed in the risk assessment. Direct exposure to ground water is not anticipated for this receptor.

- Maintenance Workers – Potential receptor under current or future land use, if dye-contaminated surface soils are found outside the cap. Includes adult military or civilian personnel assigned to groundskeeping activities at the SWMU. This receptor could potentially be exposed to surface soil and air. Maintenance workers are not assumed to be exposed to surface water, sediment, and ground water. If dye-contaminated soil is not found outside the capped area, there are no complete exposure pathways for this receptor, and the risks for this receptor will not be quantitatively evaluated in the risk assessment.

- Construction Workers - Potential receptor under current and future land use only if dye-contaminated soils are found outside the cap. Includes adult civilian personnel who may be involved in a short-term, one-time construction project. Extensive ground-intrusive activities are not expected to occur at the site because it is unlikely that the cap placed over a large portion of the site will be disturbed. Therefore, this receptor is not expected to come into contact with ground water. Exposure to surface water and sediment is not expected to occur. If residual dye contamination is found to be present outside the cap, the construction worker would potentially be exposed to surface and subsurface soil to an estimated maximum depth of 10 feet bgs (conservative estimate based on professional judgment) and air. If dye-contaminated soil is not found outside the capped area, there are no complete exposure pathways for this receptor, and the risks for this receptor will not be quantitatively evaluated in the risk assessment.

- Recreational Users (Adults) – Potential receptor under future land use, assuming that the facility was to close and would be developed into a state park [includes civilians involved in recreational activities (hiking, biking, hunting, etc.)]. This receptor could potentially be exposed to surface water and

sediment. This receptor could also be exposed to surface soil (0 to 2 feet bgs) and air, if dye-contaminated soil is found outside the cap. If dye-contaminated soil is not found outside the capped area, the soil exposure pathways are incomplete, and the risks for this receptor will not be addressed in the risk assessment. Direct exposure to ground water is not anticipated for this receptor. However, this pathway will be evaluated for decision-making purposes. Fishing is not considered to be applicable for the recreational user because the intermittent creeks, stream, and tributaries located near the SWMU do not support substantial fish populations.

- Residents (Adults/Children) – Potential receptor under a hypothetical future land use, assuming that the ground water at the site is used for potable purposes (i.e., drinking, bathing, washing, etc.). As discussed in Section 8.2.4.6, the inhalation of volatiles in groundwater will be addressed by the Foster and Chrostowski shower model (U.S. EPA, December 1989; Foster and Chrostowski, 1987). This model evaluates inhalation that occurs during a shower and after a shower while the receptor remains in the closed bathroom. As mentioned previously, this scenario is evaluated for decision-making purposes only. Although enlisted and officer personnel reside at the facility under current conditions, the residential scenario is not applicable for these receptors because they do not and would not be expected to reside within the boundaries of the SWMUs. Because a cap exists at the site, a deed restriction will prohibit future development of the site. Consequently, residential exposure to soil, surface water, and sediment is unlikely and is not evaluated during the risk assessment.

- Ecological Receptors (Terrestrial and Aquatic) – Because the facility is primarily a forested area, NSWC Crane supports a variety of ecological habitats. Terrestrial receptors, which may reside at the SWMU or come in contact with site media while trespassing on the site, could contact surface water and sediment. Terrestrial receptors may also come in contact with surface soil (0 to 2 feet bgs), if dye-contaminated soil is found outside the cap. If dye-contaminated soil is not found outside the capped area, the soil exposure pathways are not complete and will not be addressed in the risk assessment. Aquatic receptors present in the creeks, streams, tributaries, and marsh/wet areas at the SWMUs may come in contact with contaminants in the surface water and sediment. Ecological receptors are not assumed to have direct contact with ground water.

- Occupational workers are not identified as potential receptors under current and/or future land use. Currently, this area is not active. In addition, it is not likely that the site would be developed in the future for occupational use because of the land use limitations associated with the multi-layered cap. Therefore, occupational workers will not be addressed in the Baseline Human Health Risk Assessment.

Table 4-1 contains a matrix summary of the particular combinations of receptor groups to be evaluated for SWMU 2. Figure 4-1 graphically illustrates the applicable receptor groups.

4.2 DATA QUALITY OBJECTIVES

The U.S. EPA has developed the DQO Process (U.S. EPA, September 1994), a systematic, strategic planning tool based on a scientific method, to assist in establishing criteria for data quality and in developing sampling and analysis designs. The following seven steps comprise the DQO Process:

- Definition of the environmental concern or problem to be studied at a site.
- Identification of the decision statements on which the problem solution is based.
- Identification of inputs required to make decisions about the sites.
- Definition of temporal and spatial boundaries of the problem to be solved.
- Development of a decision rule, indicating data use for solving the problem.
- Specification of potential errors associated with data use in context of the decision rule.
- Development of an appropriate sampling and analysis plan.

The remainder of this section presents a summary of the DQO Process, as it pertains to the development of data collection activities for SWMU 2.

4.2.1 Problem Definition

From 1981 to 1983, an IAS was conducted for several sites (including SWMU 2) at NSWC Crane. The intent of the study was to identify sites posing a potential threat to human health and the environment from past hazardous materials operations. Although none of the sites were determined to represent immediate human health and environmental threats, 14 of the sites were recommended for further study to evaluate potential long-term impacts. SWMU 2 was among these 14 sites. Subsequent to this initial study, phased RFIs were conducted at SWMU 2 to characterize and delineate the nature and extent of contamination in ground water. Details regarding previous site-specific investigations are presented in Section 5.3.

Based on the results of these previous investigations, chemical releases to the environment from past operations conducted at the SWMU have been identified. As indicated by the historical data, the releases have occurred within the boundary of NSWC Crane.

The CSM described in Section 4.1 depicts the connections among constituent releases to the various site media, the migration of constituents to other media, and the potential exposure routes that could bring a receptor into contact with contaminated media.

A comparison of the historical data with current human health and ecological risk-based screening levels (i.e., hazard identification) suggests that the magnitude and persistence of these releases may pose an increased risk to current and future potential receptors. For SWMU 2, historical data are available for only ground water. The following screening criteria were used in the hazard identification for ground water:

- Federal Maximum Contaminant Levels (MCLs).
- U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water.
- Federal Ambient Water Quality Criteria (AWQC) for Freshwater (chronic values).
- Indiana Department of Environmental Management (IDEM) Tier I Default Cleanup Levels.
- U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs) for Surface Water.

Because ground water at the SWMU discharges to nearby surface water bodies (intermittent creeks, streams, etc.), comparisons of historical ground water data to surface water criteria were performed to identify a conservative list of detected chemicals of interest for the site.

A description of these criteria is presented in the risk assessment methodology sections of this Work Plan, Sections 8.0 (human health) and 9.0 (ecological). The numerical chemical-specific, risk-based criteria values are presented in Appendix D. The comparison of historical data to the human health and ecological risk-based screening levels and the identification of detected parameters of interest for SWMU 2 is presented in Section 5.0.

4.2.2 Decision Statement

The ultimate objective of this investigation is twofold: (1) determine whether hazardous constituents released into the environment by past SWMU operations pose an "unacceptable" or "acceptable" risk to potential human and/or ecological receptors. If "unacceptable" human health or ecological risks are identified for exposure to site media, a declaration of "unacceptable" risk will be issued and a recommendation for further action will be made. If "acceptable" risks are identified, no further action will be recommended for the SWMU; and (2) gather sufficient information to perform a RFI/CMS. The nature and extent of impacts from dyes will be determined during this investigation. This information when combined with risk will guide the identification and selection of corrective measure alternative.

4.2.3 Inputs Required for Decision Making

To achieve the objective stated in the previous section, a variety of inputs are required. The remainder of this Work Plan, as well as the FSP, HASP, and QAPP, provide details on the collection and interpretation of these inputs.

The primary inputs for the project are as follows:

- Constituent data that will be used to develop representative exposure point concentrations for the defined human and ecological receptors.

- Site-specific data that will be used to delineate the nature and extent of dye-impacts on site media for use in the RFI/CMS.

- Performance monitoring data that will be used to assess the integrity of the multi-layered cap. Visual checks are made of the cap to make sure that grass is growing over the site, no trees are springing upon the caps. The cap slopes are not eroding, and that there is no subsidence. Checks are also made to make sure there is no obviously "colored" water discharging from the cap.

- Pathways of migration for dyes that will be used to assess the containment of the existing cap system installed during Interim Measures activities.

- Risk-based screening levels used to determine detected parameters of interest in the planning stages and chemicals of potential concern (COPCs) during the risk assessments and CMS.

- Estimated Hazard Indices (HIs), representative of noncarcinogenic impacts (as defined in Sections 8.0 and 9.0 of this Work Plan) and derived from constituent concentration data.

- Estimated Incremental Lifetime Cancer Risks (ILCRs), representative of carcinogenic impacts (as defined in Section 8.0 of this Work Plan) and also derived from concentration data.

- Target criteria used to identify "unacceptable" risks.

These inputs directly support the project objective of evaluating risks to potential receptors and conducting a RFI/CMS.

Exposure point concentrations will be generated for the constituents identified as being present in the environmental media as a result of a release from a past operational activity. To provide the necessary data, samples of the environmental media of interest will be collected from SWMU 2 and analyzed for various chemical parameters. Quarterly monitoring of the integrity of the cap and subsidence will be collected and used to assess the ability of the Interim Measure to provide long-term containment of contaminants.

To address secondary issues of fate and transport of constituents (and ultimately the potential for risks outside SWMU boundaries) and to support the RFI/CMS, additional data will be collected for soil and ground water samples. In addition to chemical parameters, soil samples will be analyzed for bulk density, grain size distribution, cation exchange capacity (CEC), pH, and total organic carbon (TOC). Surface water samples will be analyzed for total suspended solids (TSS) and hardness. Dissolved oxygen, pH, and specific conductance are examples of water quality parameters to be measured for ground water.

The type, quality, and quantity of data must be sufficient to support the project objectives. Further details on the QA of the analytical program are provided in the QAPP, located in Appendix C. The risk-based screening criteria identified in Section 4.2.1 will be used in the QAPP to evaluate the analytical methods for the proposed investigation.

4.2.4 Boundaries

To ensure that sufficient and representative data are available to quantify risks for the general classes of potential receptors, boundaries were set for the sampling program. The boundary of the Dye Burial Grounds varies according to environmental media under investigation. Soils are not assessed much past the existing boundaries of the Interim Measures cap system. Groundwater investigations are limited to those immediately adjacent to the cap in the first round and those outermost existing wells in the second round. Valley slopes are included in the boundary of the site during surface water and sediment investigations.

Temporal boundaries are not considered for this investigation. The objective of this CTO is to evaluate potential risks to human and ecological receptors under current and future land use. This will be accomplished by evaluating the risks associated with site media under current conditions (i.e., current chemical concentrations). Past conditions will be assessed in drainageway samples of sediments.

4.2.4.1 Soil Sampling

For SWMU 2, the proposed investigation for soil will be limited to the historically disturbed soil areas outside the cap that were identified during the clearing stage of the cap installation. Soil samples will be collected at the interface of the native soil and the fill material placed in the area after excavation. It is estimated that most subsurface soils will be collected at a depth no greater than 5 feet bgs. If, however, site conditions warrant samples at depths greater then 5 ft., they will be collected. Construction in this area will not occur because of the deed restriction in place for the multi-layered cap; therefore, the necessity of obtaining information to a depth of 10 feet bgs to evaluate a construction worker scenario is not required. It is assumed that the majority of ecological receptors are not exposed to subsurface soil.

Background soil samples from locations not affected by site activities will be collected during the proposed base-wide investigation. The results of the soils background investigation will be used in the risk assessments for SWMU 2, as identified in Sections 8.0 (human health) and 9.0 (ecological). The background data will be used to identify those detected soil constituents related to historical site activities compared to those constituents attributable to natural soil conditions. Only those chemicals identified as site-related constituents will be evaluated in the risk assessments.

4.2.4.2 Ground Water Sampling

Ground water data will be collected from monitoring wells located within the SWMU boundaries, as well as locations upgradient and downgradient of the SWMU. Data from upgradient wells will be compared to data for downgradient and SWMU wells to (1) establish ground water conditions before entering the SWMU (not affected by site activities), (2) identify whether detected constituents are present as a result of historical site activities, and (3) evaluate the potential for risks outside the SWMU boundaries.

4.2.4.3 Surface Water and Sediment Sampling

Surface water and sediment sampling will be conducted. Data will be collected from locations affected by site activities. Data from Little Sulphur Creek watershed locations will be compared to data from Sulphur Creek watershed locations to (1) establish surface water and sediment conditions not affected by site activities, (2) identify whether detected constituents are present as a result of historical site activities, and (3) evaluate the potential for risks outside the SWMU boundaries.

4.2.5 Decision Rules

The decision rule is the culmination of the first four planning steps of the DQO Process. It identifies the constituents being monitored or evaluated based on historical detected chemicals of interest, the constituent-related parameters to be measured, the criterion used to determine whether an environmental problem (i.e., risk) exists, and the actions taken if a problem does or does not exist. The decision rule identifies how the data will be used when making decisions regarding the estimated risks for exposure to site media.

For this investigation, four sequential decision rules have been identified. The sequence allows for the early elimination of the SWMU if it poses minimal risks to potential receptors via a comparison of site data to risk-based screening levels. The sequence of decisions is, as follows:

1. If SWMU data collected during the historical field investigations exceed applicable, current risk-based screening levels, chemicals present at concentrations in excess of the screening levels and potentially associated with past site operations are identified as detected chemicals of interest. These chemicals are included in the sampling and analysis design. Otherwise, no chemicals of interest are identified and a comprehensive sampling and analysis design is conducted for the SWMU to confirm the absence or presence of chemicals of interest.

2. If SWMU data collected during the proposed field investigations exceed applicable, current risk-based screening levels, the SWMU is identified as having the potential to pose increased ("unacceptable") risks. Chemicals present at concentrations in excess of screening levels are identified as COPCs, and the SWMU is further evaluated in the risk assessments and CMS. Otherwise, the SWMU is eliminated from further evaluation, is identified as posing minimal ("acceptable") risks to potential human and ecological receptors and long-term performance monitoring of the cap is recommended for the site.

3. For those SWMUs carried through the risk assessment following the initial risk-based screening, if the cumulative HI for a potential receptor (or target organ) across all exposure pathways exceeds 1.0 (unity) for noncarcinogenic effects and/or if the cumulative ILCR for a receptor across all exposure pathways exceeds 1E-4 (the upper limit of the U.S. EPA's target risk level), a declaration of "unacceptable" risks for the receptor/SWMU is issued. In this instance, it will be recommended that a risk management plan be prepared for the SWMU. Corrective measure alternatives to contain the unacceptable risks, will be identified in the RFI, evaluated in the CMS, and selected in concert with stakeholders. Otherwise, the risks associated with site media will be

identified as minimal ("acceptable"). No environmental problem is considered to exist at the SWMU, and performance monitoring of the cap will be warranted.

4. If chemicals of interest are not detected in transport pathways under investigation (e.g., surface water transport into drainageways, etc.), then it will be assumed that the pathway is not complete and not viable for additional corrective measures. If pathways for migration exist, corrective measures will be identified and evaluated in the RFI/CMS.

A flowchart illustrating the decision rule sequences for the project is presented in Figure 4-2. The methodologies and techniques used to estimate the risks (HIs and ILCRs) for potential receptors are defined in the risk assessment methodology sections of this Work Plan, Sections 8.0 (human health) and 9.0 (ecological).

4.2.6 Potential Errors Associated with the Decision Rule

Potential errors associated with each of the decision rules are presented in this section.

4.2.6.1 Hazard Identification

The proposed field investigation is based in part on the identification of detected parameters of interest (i.e., hazard identification). Several uncertainties are associated with the use of the historical data, including the associated chemical-specific reporting limits and the quality of the historical data.

Reporting limits for some constituents in the historical data sets were greater than current risk-based screening criteria. If a constituent was not detected, it was assumed that the constituent was not of concern at the SWMU. However, there can be no certainty that such eliminations are valid because the data were censored at the reporting limit. Furthermore, limited QC data were available for the historical data; therefore, the validity of the data could not be confirmed. These uncertainties could result in potential constituents of interest going undetected and unidentified.

It is possible that some chemicals that were identified as detected parameters of interest are not actually present in the site media at concentrations of potential concern. For instance, various contaminants were detected in the field QC and laboratory blanks associated with the historical data. Although chemicals typically regarded as blank contaminants, such as methylene chloride and phthalates, were not identified as detected parameters of interest, other chemicals potentially attributable to blank contamination may have been identified as site-related contaminants (detected chemicals of interest). Additionally, the

background samples collected during the previous investigations were not always representative of background conditions. Consequently, the actual inorganic constituents released to the environment from past operations may not be accurately identified. Finally, constituents that are ubiquitous may have been identified as a concern at the site.

Although it is true that hazardous constituents have been detected at the SWMU, some chemicals may not be present as a result of releases from past site operations. For example, pesticides and herbicides were detected in almost every monitoring well at SWMU 2 - Dye Burial Grounds. The past operations at SWMU 2 dealt strictly with burial of dyes and dye-contaminated materials. Pesticides and herbicides, although present at the site, are not associated with dye burial activities conducted at SWMU 2. Most likely the pesticides/herbicides are a result of insect control practices that were conducted throughout the entire facility.

4.2.6.2 Reporting Limits for Proposed Investigation

Similar to issues associated with the reporting limits for the historical data, the reporting limits for some of the constituents for the proposed field investigation also exceed current risk-based screening criteria. To limit the adverse effects of data censoring, to the greatest maximum extent possible, analytical methods were selected with reporting limits (RLs) at concentrations less than or equal to the risk-based target levels. If analytical methods were selected with associated RLs in excess of risk-based screening criteria, it is only because attainment of lower limits is not practicable. Details of the efforts undertaken to establish lower RLs are provided in Section 1.4 of the QAPP.

To prevent the contamination problems previously identified with the historical data, various QA/QC measures will be taken to ensure that cross-contamination of samples and other contamination introduced during sampling and analysis do not occur. Also, all data will be independently validated to identify whether such problems have occurred. Any verifiable problems will be taken into consideration when using the data. As explained in Sections 8.0 and 9.0 of this Work Plan, the interpretation of the data for human health and ecological risk evaluations will address the potential for constituents to be present in the site media for reasons other than past site operations. These chemicals may be present because of background conditions (inorganics), as well as anthropogenic sources [pesticides, herbicides, polycyclic aromatic hydrocarbons (PAHs), etc.].

4.2.6.3 Risk Assessment

As noted in Sections 8.0 and 9.0 of this Work Plan, uncertainty in risk assessment may arise from a variety of sources (e.g., analytical data, toxicity data, exposure assumptions, etc.). These uncertainties may lead to the overestimation or underestimation of risks. These uncertainties will be explicitly identified in the risk assessments.

4.2.7 Sampling and Analysis Design

To be conservative (i.e., estimation of maximum representative risks for a SWMU) and consistent with past sampling activities, a biased, random sampling design will be used to sample those locations that are most likely to be contaminated. This will build in added conservatism in the decision-making process, providing protection against failure to identify an environmental problem (or "unacceptable" risk).

The sampling and analysis design for SWMU 2 is based on the CSM and historical data for the SWMU. In general, the historical analytical data for the SWMU consists of ground water monitoring data from approximately 1981 to 1992. At least one round of a comprehensive analytical list of constituents (e.g., Appendix IX parameters) was completed. Typically, the ground water monitoring data consisted of water quality parameters and a limited list of chemical parameters. Explosives also were included in the analytical program for SWMU 2.

As noted in Section 4.2.6.1, a potential for committing errors exists in evaluating the historical data associated with the SWMU. However, for SWMU 2, the historical data clearly defines the nature of the environmental problem; therefore, samples collected at this SWMU will be analyzed for a focused list of constituents (i.e., dyes and metals only). The specific analytical program for SWMU 2 is presented in Section 5.5.

The risks posed to human and ecological receptors from the SMWU will be calculated solely on the data collected from this field investigation. As a result of the uncertainty associated with the historical data, these data will be used to focus the field investigation and in a qualitative manner to support risk conclusions drawn from the current data. Further details on the use of the current and historical data in the human health and ecological risk assessments are presented in the risk assessment methodology sections of this Work Plan, Sections 8.0 (human health) and 9.0 (ecological).

The CMS performed for this SWMU will be based on the elimination of potential transport pathways and on performance monitoring of the cap. Further details on the use of the current and historical data in the CMS are presented in Section 10.0 of this Work Plan.

Proposed sample locations were selected in areas of known contamination to verify the nature of contamination and to better quantify the level of the constituents. It should be noted that all sampling locations are outside the perimeter of the cap. The integrity of the cap will be preserved throughout this entire sampling program. In addition, locations to be sampled were dispersed throughout the SWMU to provide adequate coverage for potential receptors (i.e., to support the calculation of a representative concentration for exposure to the entire site). Figures illustrating historical sampling locations where chemical concentrations exceeded risk-based screening levels are presented in Section 5.0.

4.3 SUMMARY

The proposed sampling and analysis design for SWMU 2 was developed based on available historical data and site-specific CSMs. U.S. EPA's DQO Process was used during the development of the proposed field investigations to ensure that the data collected are sufficient for the attainment of the objective of the project, which is the completion of a RFI/CMS and risk assessment for the SWMU.

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TABLE 4-1

SUMMARY OF POTENTIAL RECEPTORS
SWMU 2
NSWC CRANE, INDIANA

Scenario	Adolescent Trespasser	Maintenance Worker	Construction Worker	Occupational Worker	Resident (Adult/Child)	Recreational User (Adult)	Ecological Receptors[1]
Current Land Use	X[2]	X	X	--[3]	--	--	X
Future Land Use	X	X	X	--	X[4]	X	X

1 Includes terrestrial and aquatic receptors.
2 "X" indicates that the receptor will be evaluated in the human health or ecological risk assessments. Receptor may be a potential receptor under current and/or future land use.
3 "--" indicates that the receptor is not a likely potential receptor and will not be evaluated in the human health risk assessment.
4 Unlikely receptor under future land use. Evaluated for decision-making purposes only for exposure to ground water. This site is not likely to be developed because of limitations associated with the cap.

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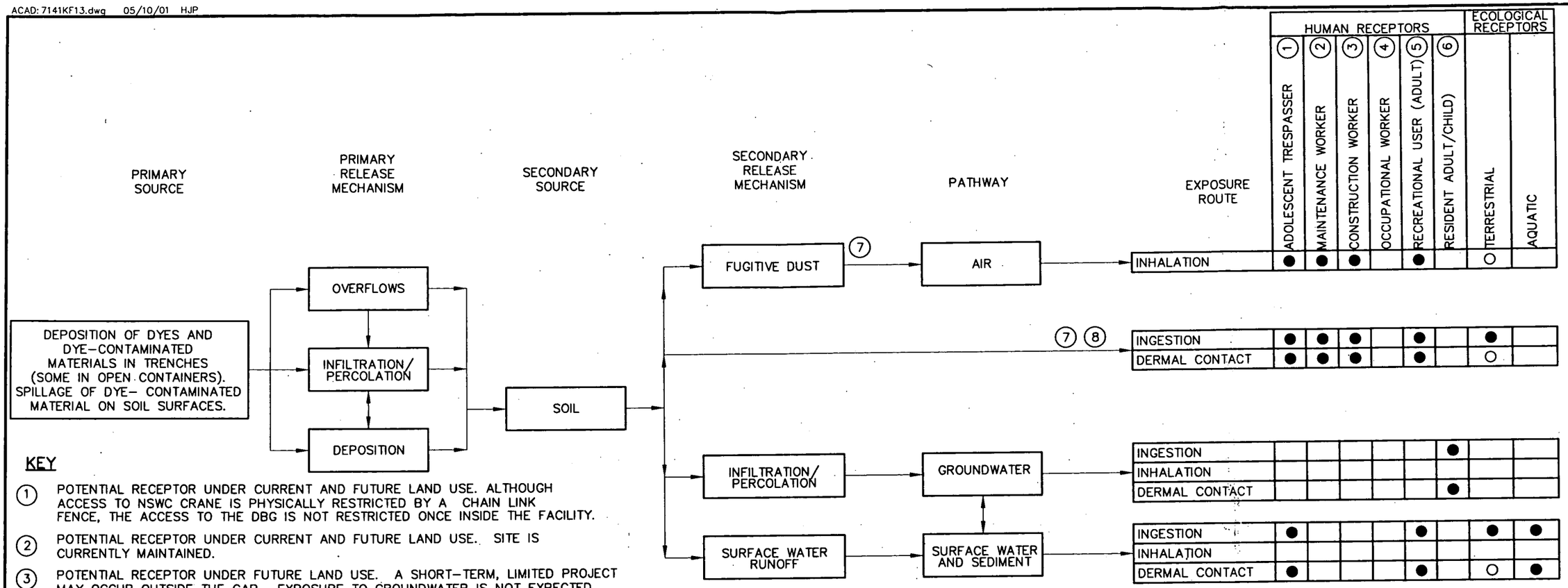

KEY

1. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. ALTHOUGH ACCESS TO NSWC CRANE IS PHYSICALLY RESTRICTED BY A CHAIN LINK FENCE, THE ACCESS TO THE DBG IS NOT RESTRICTED ONCE INSIDE THE FACILITY.
2. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. SITE IS CURRENTLY MAINTAINED.
3. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. A SHORT-TERM, LIMITED PROJECT MAY OCCUR OUTSIDE THE CAP. EXPOSURE TO GROUNDWATER IS NOT EXPECTED BECAUSE INTRUSIVE ACTIVITIES ARE EXPECTED TO BE LIMITED.
4. UNLIKELY RECEPTOR. THE SITE WILL NOT BE DEVELOPED FOR OCCUPATIONAL PURPOSES BECAUSE OF LAND USE LIMITIATIONS ASSOCIATED WITH THE CAP (i.e., DEED RESTRICTIONS, ETC).
5. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. BASE COULD CLOSE AND BE TURNED INTO A STATE PARK.
6. UNLIKELY RECEPTOR UNDER FUTURE LAND USE. EVALUATED FOR DECISION-MAKING PURPOSES ONLY FOR EXPOSURE TO GROUNDWATER. THE SITE IS NOT LIKELY TO BE DEVELOPED BECAUSE OF LIMITATIONS ASSOCIATED WITH THE CAP. DUE TO THE INTERMITTENT NATURE OF THE SURFACE WATER BODIES AT THE SITE, EXPOSURE VIA PATHWAY IS THOUGHT TO BE MINIMAL.
7. THE CAP AT THE SITE MAY ELIMINATE POTENTIAL EXPOSURE TO THIS MEDIUM. THIS EXPOSURE IS NOT EVALUATED FOR CONTAMINATED SOILS UNDERNEATH THE CAP. ONLY A COMPLETE EXPOSURE IF CONTAMINATION IS DETECTED OUTSIDE THE LIMITS OF THE CAP.
8. FOODCHAIN MODELING WILL BE CONDUCTED FOR ECOLOGICAL RECEPTORS.

● EXPOSURE PATHWAY TO BE EVALUATED IN THE RISK ASSESSMENT.

○ RELATIVELY INSIGNIFICANT POTENTIAL EXPOSURE PATHWAY COMPARED TO OTHER PATHWAYS EVALUATED IN THE RISK ASSESSMENT. RISKS NOT EVALUATED QUANTITATIVELY.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 8/12/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE NONE

CONCEPTUAL SITE MODEL
SWMU 2 – DYE BURIAL GROUNDS
NSWC CRANE, INDIANA

CONTRACT NO. 7141
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 4-1
REV. 0

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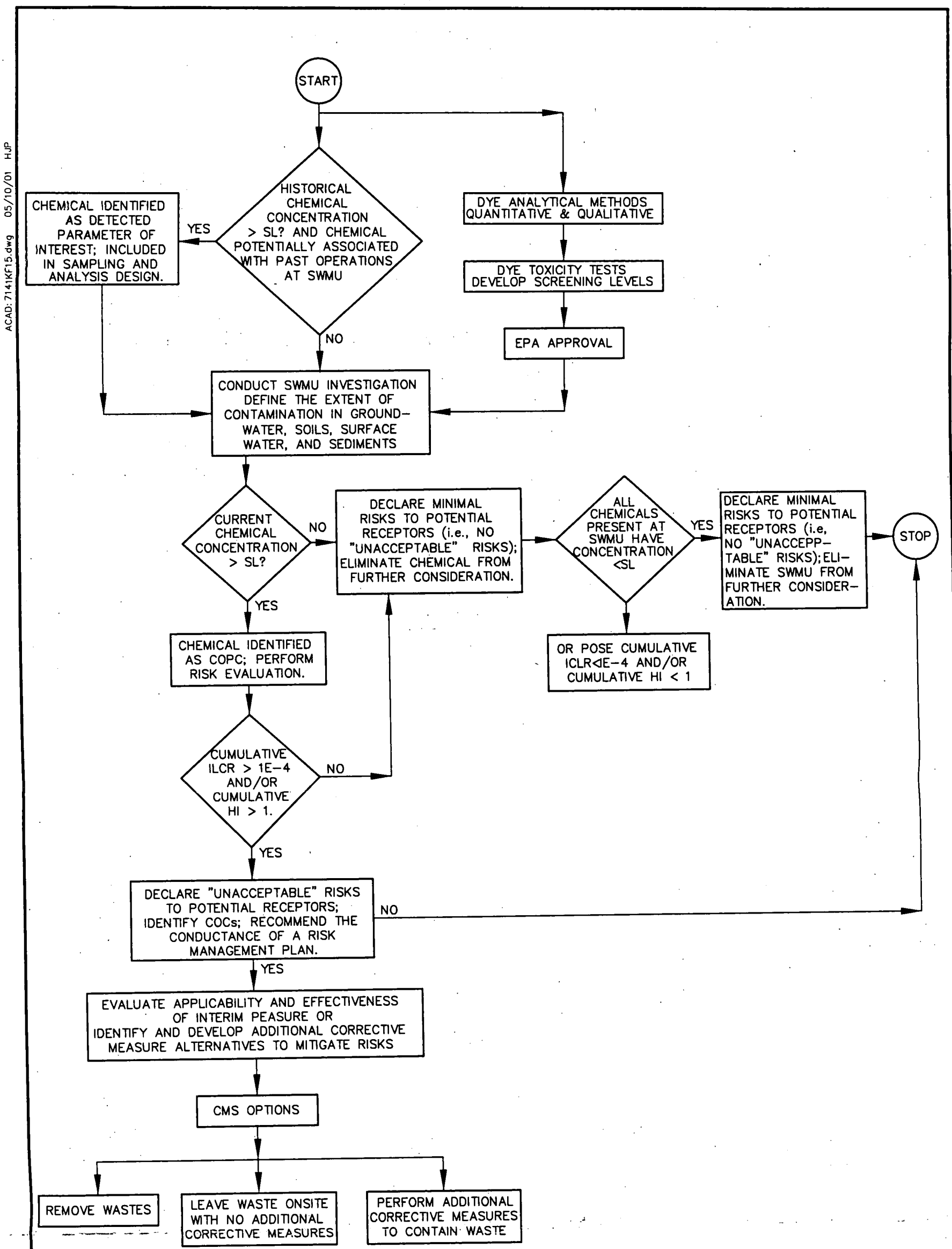

KEY

COC	CHEMICAL OF CONCERN
COPC	CHEMICAL OF POTENTIAL CONCERN
HI	HAZARD INDEX
ILCR	INCREMENTAL LIFETIME CANCER RISK
SL	SCREENING LEVEL (RISK-BASED)
SWUM	SOLID WASTE MANAGEMENT UNIT

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DRAWN BY MF	DATE 2/28/00	DECISION RULE FLOWCHART SWMU 2 – DYE BURIAL GROUNDS NSWC CRANE, INDIANA	CONTRACT NO. 7141
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4-2 REV. 0

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5.0 SWMU 2 – DYE BURIAL GROUNDS

The proposed field investigation for SWMU 2, Dye Burial Grounds, needed to fulfill the overall objectives of this CTO (i.e., the completion of RFI/CMS and risk assessment activities), is provided in this section.

Section 5.1 presents a brief background of activities, which have occurred at the site. The physical setting (geology, hydrology, topography, etc.) is contained in Section 5.2. A brief synopsis of the previous site investigations and hazard identification based on the historical site data are presented in Sections 5.3 and 5.4, respectively. Section 5.5 summarizes the proposed field investigation for the site.

5.1 BACKGROUND

Limited information is known regarding the operational history of the Dye Burial Grounds. The site map for SWMU 2 is presented as Figure 5-1. Approximate boundaries of the site are provided. Although it is known that military smoke dyes and dye-contaminated materials were disposed at the site, no records are available on the specific dyes and quantities. It is estimated that 50,000 lbs of dyes and dye-contaminated materials were deposited in open trenches from 1952 to 1964. Materials reportedly included magnesium, boxes and rags contaminated with dyes, and about 60 open-topped drums of dye. The sizes of the drums are not known.

SWMU 2 is comprised of at least four main trenches. Although three trenches were originally thought to be present at the site, additional trenches were located during historical site investigations. The original three trenches are each approximately 10 feet wide, 6 feet deep and 50 feet long. These three trenches are aligned end to end. All the trenches are situated atop a ridge. All the trenches reportedly were backfilled to the ground surface with soil in 1972, but were not permanently capped. NSWC Crane placed crushed rock along a roadway immediately north of the trench area in 1987 to facilitate access by well drilling vehicles. (USACE, 1998).

Geophysical surveys were conducted at the site in January 1991 to delineate the boundaries of the disposal activities. The results of the survey indicated that there are approximately 17 unidentified anomalies located at the site that may be attributable to site operations and may contain dye-contaminated material.

An interim measures cap design was developed for the site (Glynn, Bennett, and Stark, 1995) to minimize potential threats to human health and the environment by the mitigation of the migration of contaminants to ground water. The limits of the cap were identified using the geophysical survey information. The

construction of a multi-layered cap began in 1996. During site preparation (clearing activities), dye-contaminated materials were found outside the planned limits of the cap. An investigation of the extent of contamination outside the cap limits was performed in early July 1996. This investigation consisted of the excavation of 12 potholes approximately 24 inches deep. Dyes were visually observed in eight of the potholes.

NSWC and U.S. EPA conducted an additional investigation into contamination located outside the planned limits of the cap in early August 1996. Several additional areas/trenches containing dyes and dye-contaminated materials were found during this field investigation. Some of the disturbed areas were deeper and/or wider than the three trenches which were originally thought to comprise the site. Results of the NSWC and U.S. EPA investigation are included in the Interim Measures Completion Report (MK, 1999; Appendix D). The interim measures cap was expanded to include some of the newly identified disturbed areas; thereby delaying the construction of the cap.

In 1997, a revised Work Plan for Interim Measures Cleanup at SWMU 2 was prepared to address the residual contamination found outside the planned cap limits. Excavation of dye-contaminated soils at the disturbed areas began in November 1996. Some samples from the excavated areas were collected by NSWC Crane and are stored at the Base; these samples were not subjected to chemical analysis. In addition, no confirmatory samples were collected to verify that all residual contamination was removed from the disturbed areas.

As runoff began collecting in dye-contaminated soil excavations, surface water management became a significant issue. During the winter months, cap construction activities ceased, and dewatering of the west end of the cap excavation was required to manage surface water runoff. Dye-impacted water from the excavations was pumped to three 500-barrel frac tanks, which were located in a centralized staging area at the site.

Following a large storm, an uncontrolled release of dye-impacted surface water runoff occurred on January 22, 1997. The release occurred on the northside berm of the west (southwest) excavation extending to approximately 40 ft north of the berm. The released water was pumped into the frac tanks. Some of the released water froze on the ground. Approximately 9 cubic yards of contaminated ice and soil stuck to the ice was placed into mud boxes. At completion, a total of eight frac tanks and two mud boxes were required to minimize the waste material.

In late 1997 during the construction of the foundation fill for the cap, seeps of dye-contaminated water were observed primarily in the northeast and northwest areas within the cap limits. A seepage collection

system was constructed at the northeast area. Liquid was pumped to the frac tanks; the system was closed after construction of the foundation fill was completed. In September of 1998, the cap was completed at the Dye Burial Grounds. The NSWC Crane Laboratory analyzed samples of the dye-contaminated water collected from the frac tanks (MK, 1997). Following U.S. EPA- and IDEM-approval, the water in the frac tanks was designated as non-toxic. In September of 1998, the dye-contaminated water was disposed in the Base's wastewater treatment plant.

Complete details of the multi-layered cap system were provided in the Interim Measures Completion Report (MK, 1999).

5.2 PHYSICAL SETTING

SWMU 2, Dye Burial Grounds is located in the eastern portion of the NSWC Crane, northeast of the Ammunition Burning Grounds (SWMU 3). SWMU 2 is bounded on the west by Highway 12 and the Ammunitions Burning Grounds site; on the north by Highway 58; and on the east by Highway 274. Sulphur Creek flows on the east-northeast side of the SWMU and Little Sulphur Creek flows on the south-southwest side of the site.

5.2.1 Topography/Hydrology

The topography at Dye Burial Grounds is relatively rugged, consisting of a series of steep-sided, narrow ridges and valleys. The SWMU lies 500 to 1,000 feet southwest of the crest of a north-northwest trending ridge separating Sulphur Creek from Little Sulphur Creek. Principle surface drainage from the site is to the south and southwest into Little Sulphur Creek. Little Sulphur Creek is in contact with the Beech Creek Aquifer, therefore any contaminants carried by surface drainage may enter the aquifer (Baedke, 1998). Surface runoff from the Dye Burial Grounds is rapid, leaving the site in drainage channels that head at the edge of the ridges. The major springs at the site are located in the valleys below the Dye Burial Grounds. Another ground water seep was identified on the southwest slope of the site. This seep is located at the elevation of the projected Pennsylvanian-Mississippian unconformity, the base of the Mansfield Formation. Flow from the seep is intermittent throughout the year. Figure 5-2 is a topographic map for the area and presents drainage patterns away from the site.

5.2.2 Geology

The local geology at SWMU 2 consists of overburden residual clay or silt soil ranging in thickness from 2 to 15 feet. This layer of residual clay and soil covers the uppermost geologic unit on the ridge crests and is somewhat thinner or absent on steep slopes. The outcrop pattern present at the Dye Burial Grounds

reflects headward erosion of drainage in the area and is representative of the surface geomorphology. The geologic contacts between units are subparallel to the topographic contours and are indicative of relatively flat-lying bedding planes. Interbedded shale and sandstone from the Mansfield Formation of the Raccoon Creek Group and the Glen Dean Limestone of the Stephenson Group underlay this overburden. The primary particles that compose the sandstone are chiefly fine-grained to very fine-grained quartz sand.

The local stratigraphy of the geologic formations encountered at the site are presented below in descending order of geologic age (youngest to oldest).

In the Raccoon Creek Group (Pennsylvanian):

- *Mansfield Formation* – The Mansfield Formation caps the hills and ridges at the Dye Burial Grounds. This formation varies in thickness from 0 to 65 feet. The dye burial trenches are situated entirely within the Mansfield Formation, which consists of fine to medium grained, cross-bedded and ripple-marked, friable sandstones; interbedded shale and sandstone; dark gray, carbonaceous shale; massive claystone; siltstone; with occasional thin seams of coal. The Pennsylvanian-age rocks underlying the site are dominated by ripple-marked sandstone, dark gray shale, and lenticular bedded shale facies. Ripple-marked sandstone commonly encases thin, coarser grained cross-bedded sandstone. The sandstones at the site were probably formed in intertidal to subtidal coastal areas. The lenticular shale consists of dark gray, silty, carbonaceous shale with lenses of silty, very fine grained sandstone. The dark gray shale and lenticular shales separate two distinct sandstone units at the Dye Burial Grounds. The sandstone units form the upper two aquifers at the site. The Mansfield is covered by 5 to 15 feet of silty clay soil throughout the site. The sandstone contains numerous bedding plane joints.

In the Stephensport Group (Mississippian):

- *Hardinsburg Formation* – The Hardinsburg Formation is found immediately below the Mississippian-Pennsylvanian unconformity and is relatively uniform in thickness. The greatest thickness encountered in the Hardinsburg at the DBG was 28.6 feet. The formation consists of thick, laterally varying beds of fine-grained, friable sandstone; thinly laminated sandstone and shale; dark-gray, thinly bedded carbonaceous shale; and green shale containing dark red-brown mottling. The green shale zones are similar in appearance to the Elwren Formation. The Hardinsburg serves as an aquiclude between the Mansfield sandstone and the underlying Golconda/Haney Limestone.

- *Golconda/Haney Formation* – Several years ago the name for this formation was changed from the Golconda to the Haney. To facilitate cross-reference to earlier reports both names are used in this report. The thickness of this formation ranged from 2.9 feet in the northeast area of the site to 18.4 feet in the southwest portion of the site. The formation consists of gray-brown, medium to coarsley crystalline, fossiliferous, very hard and dense limestone in beds ranging from 2 to 14 feet thick, with interbeds or zones of dark gray shaley limestone. A 0.5 to 2 feet-thick shale bed occurs near the middle of the formation. The Golconda/Haney forms the middle aquifer of the Dye Burial Grounds.

- *Big Clifty Formation* – The Big Clifty Formation is divided into two distinctly different lithologic members. The upper member is known as the Indiana Springs shale and consists of a 20 to 24 feet-thick bed of dark gray, thinly bedded, platy to fissile, carbonaceous, locally fossiliferous shale. The lower 3 to 4 feet of shale is generally massive, olive to olive gray and tan, and oxidized in contact with the underlying sandstone. The Indian Springs serves as an aquiclude at the base of the Golconda/Haney aquifer.

  The lower member of the Big Clifty Formation consists of approximately 40 feet of yellow to olive tan, massive, rippled, very fine, well sorted, friable and permeable sandstone that is cut by numerous intersecting joints. The lower portion of the Big Clifty Sandstone and the underlying Beech Creek Limestone form the lower (deepest) aquifer at SWMU 2.

- *Beech Creek Formation* – This formation consists of fossiliferous, very hard and dense limestone that ranges from 19 to 23 feet in thickness. In the upper one-third to one-half of the formation, the limestone is light to medium gray brown, medium to coarsely crystalline, and has occasional stylolites. In the lower zone the limestone is dark gray, fine to medium crystalline and contains occasional to numerous wavy shale partings. Generally, the lower few inches of limestone contain rounded shale inclusions from the underlying Elwren Shale. The Beech Creek Limestone and the overlying sandstone in the Big Clifty Formation together represent the deeper aquifer at the site.

In the West Baden Group (Mississippian):

- *Elwren Formation* – The Elwren Formation averages 20 feet in thickness. It consists of massive to thinly bedded, dark gray-green relatively impervious shale with interzones of red-brown claystone. The Elwren serves as an effective aquiclude at the base of the Beech Creek Limestone. The base of the Beech Creek (top of the Elwren) is exposed in several places in the valleys surrounding the Dye Burial Grounds. Ground water can be seen flowing freely along the top of the Elwren and from springs at some locations at or in the vicinity of the site.

5.2.3 Hydrogeology

The ground water gradient at the Dye Burial Grounds is primarily south and southwest (Figures 5-3 through 5-6). The depth to the ground water table ranges from approximately 12 feet bgs to approximately 20 feet bgs.

Four ground water zones in three distinct aquifers were identified at site. In descending order, the aquifers are the Pennsylvanian sandstone, the Golconda/Haney Limestone, and the Beech Creek Limestone (including the lower part of the Big Clifty sandstone). The Pennsylvanian sandstone (the Mansfield Formation) is divided into upper and lower aquifers by an eastward thickening sequence of shale. The two Mansfield Formation aquifers are designated "lower" and "upper" Pennsylvanian. Ground water flow is through joints in the rock aquifers and also through connected intergranular pore spaces in some of the sandstones, particularly in the lower Pennsylvanian sandstone aquifer.

Shales hydraulically separate the three lower aquifers. The Beech Creek is considered to be protected from direct vertical infiltration of waters from the site by shale units above the Big Clifty sandstone. The Golconda-Haney is separated from the Pennsylvanian aquifers above by the Hardinsburg shale, which is up to 28 feet thick at the site. The Hardinsburg serves as an aquiclude to vertical infiltration of constituents from the Dye Burial Grounds; however, entry of constituents may be possible from exposed slopes. The lower Pennsylvanian aquifer is overlain by unsaturated sandstone and siltstone in the western portion of the site, and therefore, is susceptible to constituent infiltration from surface waters. Over much of the site a wedge of shale, which thickens considerably eastward, overlies the lower sandstone aquifer. This thick shale wedge on the east end of the site isolates the upper sandstone of the Mansfield from the lower sandstone and allows the upper Pennsylvanian aquifer to exist perched above the lower sandstone.

The upper Pennsylvanian aquifer (i.e., perched zone) is of limited areal extent separated only locally from the next lower aquifer by a discontinuous wedge of fine-grained sediments. The dye burial trenches are reportedly 6 feet deep. The base of the trenches probably contact or are very near the top of the aquifer. However, only the northeastern one-third of the trenches is sited in the saturated soil associated with this aquifer. Any leachate from the northeastern trench area potentially would have access to the uppermost aquifer. The upper Pennsylvanian has the potential to carry water to the north-northwest, in contrast to the general south-southwest flow in deeper aquifers at the site. The small area of saturated soil, however, limits the distance to which ground water and contaminants can be transported within the aquifer.

The sediments that separate the upper and lower Pennsylvanian aquifers are coarser to the west; thereby providing a better opportunity for ground water to percolate from the upper to lower Pennsylvanian aquifers. Although the base of the trenches may be in contact with the upper Pennsylvanian, the lower Pennsylvanian is more likely to receive infiltrating dye-contaminated water because of the limited area of saturation and because ground water would preferentially migrate from the upper to the lower Pennsylvanian aquifer. Flow in the lower Pennsylvanian is unconfined and is to the south-southwest, generally toward the valley of Little Sulphur Creek.

As part of a geochemical and dye tracer study in the Beech Creek Aquifer at the Ammunition Burning Grounds, an initial assessment was conducted to establish the contribution of dyes from SWMU 2 to ground water and springs in the vicinity of the sites (Baedke, 1998). Tracer dyes were analyzed qualitatively by spectrofluorophotometry. The maximum concentration of tracer dye (fluoroscein at 4 µg/L) was found in the seep southwest of the Dye Burial Grounds. The geochemical and tracer study concluded that elevated magnesium and sulfate concentrations (i.e., greater than site-specific background levels) in the Beech Creek Aquifer may be attributable to site operations activities at SWMU 2.

5.3 PREVIOUS INVESTIGATIONS

A brief description of the historical data collection activities conducted at SWMU 2, Dye Burial Grounds, is contained in this section. Ground water and seep samples have been collected at the locations illustrated in Figures 5-7 and 5-8. A tabular summary of the previous investigations completed for the site is presented in Table 5-1.

Various investigations were completed from 1981 to 1986 as part of several multi-site investigations. The first of which was the Initial Assessment Study (IAS) (NEESA, May 1983). The IAS was initiated in April 1981 in response to the Navy Assessment and Control of Installation Pollutants (NACIP) Program. The Naval Energy and Environmental Support Agency (NEESA) completed the IAS in May 1983 with assistance from the Ordnance Environmental Support Agency and the U.S. Army Corps of Engineers (U.S. ACE) Waterways Experiment Station (WES). The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environmental from past hazardous materials operations.

The IAS consisted of the installation of eight monitoring wells (Wells 02-01 through 02-08) along the perimeter of the site. During the installation of these wells, soil samples were collected and tested for

various soil characteristics. After the monitoring wells were installed, ground water samples were collected and analyzed for a comprehensive list of chemical constituents and RCRA water quality parameters. As part of the IAS, both quarterly and semi-annual sampling of the monitoring wells were initiated at Dye Burial Grounds. The list of soil tests performed and the chemical constituents included in the ground water analytical program is identified in Table 5-1.

Based on the initial conclusions of the IAS, it was determined that disposal activities at Dye Burial Ground did not present an immediate human health or environmental threat. However, the site was recommended for further study to evaluate potential long-term impacts.

In response to the recommendation presented in the IAS, an RFI Phase II Ground Water Assessment was performed at the Dye Burial Grounds in 1987-1990 (U.S. ACE, March 1991). The objective of the study was twofold: 1) to further refine the nature and extent of contamination at the site and 2) to further refine the hydrogeology at the site. Twelve well clusters (i.e., thirty-three additional individual wells - labeled 02C09 through 02C19) were installed. In 1988, 26 monitoring wells and one seep were sampled and analyzed for priority pollutant constituents.

The RFI Phase III ground water release characterization commenced in October 1990 with the addition of three monitoring wells (labeled 02C20 through 02C22). In addition to refinement of the nature and extent of contamination, the objective of this effort was to determine regional and site hydrogeology including distribution of aquifers, characteristics of ground water flow, and the influence of stratigraphy and geologic structure on ground water and constituent migration. This study included the collection of four rounds of ground water samples from the 44 monitoring wells. These samples were analyzed for Appendix 9 constituents, explosives, and miscellaneous water quality parameters.

In 1991, a geophysical investigation was conducted at the site to delineate the boundaries of the dye burial trenches and identify buried anomalies. Several anomalies were observed, in addition to the three known trenches.

From June 1996 though September 1998, the interim measures (i.e., construction of a cap system) was conducted at the site. The interim measures included site clearing, relocating an access road, establishing storm water controls, excavating dye-impacted materials, constructing the multi-layered cap system, and managing and disposing of dye-impacted water. During the site clearing, dye-contaminated soils were found outside the planned limits of the cap. In August 1996, U.S. EPA and NSWC conducted a field investigation. This investigation included the advancement of shallow borings at multiple locations, in order to determine the extent of the burials. Dye-contaminated materials were excavated and placed in

the subgrade of the area to be capped. Confirmation of excavation was performed by visual observation that no dye remained in the area; confirmation sampling was not conducted.

5.4 HAZARD IDENTIFICATION

The hazard identification characterizes those constituents that may be attributable to historical operations at the site. Based on knowledge of site practices and an interpretation of the historical data (i.e., comparison of detected constituents to risk-based screening criteria), a list of detected chemicals of interest was developed for Dye Burial Grounds. Detected chemicals of interest are defined as those chemicals, excluding blank contaminants, present at concentrations greater than risk-based screening criteria. Discussions of those constituents detected at concentrations in excess of current human health and ecological screening criteria are provided in Sections 5.4.1 (organics) and 5.4.2 (inorganics). A summary of the detected parameters of interest is contained in Section 5.4.3.

Historical site data were compared to human health and ecological criteria to identify chemicals of interest. Summaries of the comparison of historical site data to human health and ecological risk-based criteria are presented in Tables 5-2 (Upper Pennsylvanian), 5-3 (Lower Pennsylvanian), 5-4 (Upper Hardinsburg), 5-5 (Golconda/Haney), 5-6 (Beech Creek) and 5-7 (spring water). A brief description of the screening criteria used was provided in Section 4.2 of this work plan.

Figures 5-9 through 5-16 depict those locations where exceedances of human health and ecological risk-based criteria have been noted in ground water during previous investigations. Separate figures are provided for each ground water aquifer including the Upper Pennsylvanian, Lower Pennsylvanian, Golconda/Haney, and Beech Creek. For each aquifer, separate figures are presented to illustrate human health and ecological exceedances. Figures for the Upper Hardinsburg and spring water are not presented due to limited characterization data.

Because shallow ground water at the site appears as springs/seeps and discharges to surface water (most notably Little Sulphur Creek) and since surface water/sediment samples have not been collected from the site, historical ground water data were compared to ecological screening criteria for surface water. The comparison is considered to be conservative, as it does not take into account the dilution of contaminants in the creek. Thus, it should be noted that those chemicals identified as detected chemicals of interest based solely on the comparison of ground water data to surface water criteria may not actually be present in the surface water at concentrations of potential concern.

5.4.1 Organic Constituents

Benzene; chloroform; 1,1,2-trichloroethane; 1,4-dichlorobenzene; and Aroclor-1254 were detected in the ground water samples collected from SWMU 2, Dye Burial Ground. Similar to other SWMUs at the Base, these chemicals may be present at low levels in the ground water as a result of historical Basewide maintenance practices. Historically, it was common practice to treat areas alongside roadways with a mixture of herbicides and waste fuel oils. This practice was performed for insect control and dust suppression purposes. Since these constituents have been detected at low levels in the ground water at other SWMUs, these chemicals are not considered to be site-related constituents and were eliminated as detected parameters of interest for the site.

Acetone, methylene chloride, and some phthalates were detected in the ground water samples collected at the site. Several reported concentrations of these chemicals exceeded risk-based criteria, as illustrated on Figures 5-9 through 5-10. These chemicals were detected in the laboratory and field QC blanks associated with the site samples. They are not considered to be site-related constituents and were eliminated as parameters of interest for Dye Burial Grounds. These chemicals were reported at similar concentrations in environmental samples collected at other SWMUs, thereby, supporting the conclusion that the presence of these chemicals are attributable to contamination introduced through sampling (decontamination or ambient conditions) or laboratory analysis.

During the 1988 sampling event, 2,4-dinitrotoluene was detected in well 02-05. The presence of this constituent in site wells was not confirmed in subsequent sampling events. This constituent, as well as 2,4,6-trinitrotoluene, was found in the background monitoring well (02C10). The presence of these constituents in the background well and not in the other site wells supports historical operations information associated with the site in that explosives/munitions were not placed in the dye burial trenches. Consequently, 2,4-dinitrotoluene was eliminated as a detected parameter of interest for Dye Burial Grounds.

In the ground water samples collected at the site, several pesticides and a herbicide were reported at concentrations greater than the lowest screening criteria (ground water or surface water criteria). The pesticides/herbicide exceeding criteria in ground water include lindane, aldrin, heptachlor, heptachlor epoxide, endosulfan I, gamma-chlordane, 4,4'-DDE, and dinoseb. Pesticides/herbicide are not considered to be site-related constituents, but may, in fact, be attributable to Basewide insect control measures. Therefore, these chemicals were eliminated as detected parameters of interest for the site.

No organic constituents were positively detected in the seep sample collected from the Dye Burial Grounds.

5.4.2 Inorganic Constituents

A variety of inorganics were found in the ground water at Dye Burial Grounds. Those inorganics detected at concentrations in excess of the lowest screening criteria are as follow: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium (total), cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, zinc, chloride, fluoride, sulfate, sulfide, and nitrogen (as nitrate, as ammonia, and as total kjeldahl nitrogen).

The following metals were identified as parameters of interest for ground water solely on the basis that reported concentrations exceeded surface water screening criteria for ecological receptors in each aquifer: chromium (total), cobalt, copper, silver, vanadium, and zinc. As mentioned previously, this is a conservative comparison and serves to overestimate potential impacts to surface water as a result of ground water discharge. Although these constituents are listed in Section 5.4.3 as detected above the screening criteria, they may not be parameters of interest for Dye Burial Grounds.

Nickel and selenium were identified as a parameter of interest for ground water solely on the basis that reported concentrations exceeded surface water screening criteria for ecological receptors in each aquifer except for Golconda/Haney. In the Golconda/Haney aquifer, two detections of selenium (54 and 58 µg/L) were slightly greater than the Federal MCL/IDEM Tier I screening criteria (50 µg/L). Both of these detections were in Well 02C13. In the Golconda/Haney aquifer, four detections of nickel (122, 139, 156, and 299) were slightly greater than the Federal MCL/IDEM Tier I screening criteria (100 µg/L). All of these detections were in Well 02C11. Although these constituents are listed in Section 5.4.3 as detected above the screening criteria, they may not be parameters of interest for Dye Burial Grounds.

Inorganics were found in most wells in all four aquifers. There is some uncertainty in linking the presence of inorganics in ground water to activities at Dye Burial Grounds. Anomalously low pH levels were observed in some wells that exhibited elevated inorganic concentrations (i.e., above the risk-based screening criteria). Low pH (acidic conditions) in sandstone is most likely a natural phenomenon and responsible for the elevated concentrations of inorganics. In addition, the distribution of metals within the aquifers is not necessarily coincident with the proximity of the wells to the dye burial trenches, thereby supporting the suspicion that elevated concentrations of inorganics are naturally occurring. However, for conservative purposes and because there is some uncertainty associated with the historical data, inorganics were identified as detected parameters of interest.

A few inorganics were also detected in the seep sample collected from the site. Arsenic, lead, and selenium were detected at concentrations in excess of risk-based screening levels. These constituents were identified as detected parameters of interest for the site.

5.4.3 Summary of Detected Chemicals of Interest

Various inorganics were identified as detected chemicals of interest for the Dye Burial Grounds (i.e., chemicals reported at concentrations in excess of risk-based screening criteria). Since samples collected during previous investigations were not analyzed specifically for dye constituents, no data is available for these chemicals. Although some additional chemicals (other than inorganics) were detected at concentrations in excess of risk-based screening levels, the proposed analytical program for SWMU 2 will include only those constituents that are likely to be present as a result of site operations. Due to the uncertainty in the origin of the presence of inorganic compounds, these chemicals will be included in the analytical program. Other constituents found at the site were not considered to be related to past site operations as supported by historical chemical use information on the site.

5.5 PROPOSED INVESTIGATION

The proposed field investigation for SWMU 2, Dye Burial Grounds was developed based on a site-specific CSM. The general methodology used to develop the proposed investigation (and CSM) was presented in Section 4.0. This section of the work plan provides the rationale for the proposed site-specific investigation.

5.5.1 Conceptual Site Model

The CSM for the Dye Burial Grounds, which defines the contaminant source, transport mechanisms, exposure routes, and potential receptors for the site was presented as Figure 4-1. Based on a review of the existing data and visual field observations, a release of hazardous constituents to the surrounding soil has occurred as a result of historical site operations (i.e., burying dyes in trenches). Past investigations did not include analysis for dyes.

It is anticipated, however, that residual contaminants in the soil from the dye burial trenches have migrated to ground water via infiltration/percolation. Additional release mechanisms, which are expected to contribute to the contaminant transport, include discharge of ground water via springs/seeps to surface water/sediment (Little Sulphur Creek), re-entry of impacted surface water to lower aquifers, and deposition via surface water runoff.

The interim measure for the site, the multi-layer cap covers a large portion of the dye burial area. Therefore, generation of fugitive dust and volatile emissions from soil are not likely release mechanisms for the site. In addition, it is assumed that all dye-contaminated soil outside the limits of the cap has been excavated and placed underneath the cap. If, however, dye contaminated soil is found outside the capped area, these release mechanisms (i.e., fugitive dust and volatile emissions from soil) may be occurring and will require assessment.

Current and likely future land use at the Dye Burial Grounds is expected to be limited because the multi-layer cap placed on the site is not likely to be disturbed. The site currently is inactive; no burial activities occur under current land use. Based on the general scenarios and receptor classes identified in Section 4.0 of this Work Plan, trespassers (ages 7 to 16 years), maintenance and construction workers, recreational users, and ecological receptors may be exposed to contaminated site media.

A limited hypothetical future residential scenario, involving an evaluation of groundwater for drinking water purposes, will be performed in the risk assessment for informational purposes only (i.e., decision making. As mentioned in Section 4.1.4, residents and occupational workers are not likely potential receptors since the site is currently inactive and future development of the site is not anticipated because of land use limitations associated with the cap. Details regarding the assumed receptor characteristics (intake rate, frequency and duration of exposure, body weight, etc.) are defined in Sections 8.0 and 9.0 of this Work Plan, which present the methodologies for the human health and ecological risk assessments.

5.5.2 Proposed Sampling and Analysis

The primary objective of the proposed field investigation is:

- to delineate nature and extent of contamination,
- to obtain information to support a CMS,
- to collect field and laboratory data needed to evaluate the potential risks for those human and ecological receptors identified in the CSM, and
- to confirm the presence or absence of residual contamination at location subject to Interim Measures.

Table 5-8 summarizes the proposed sampling and analysis for SWMU 2, Dye Burial Grounds, including overall objectives and objectives for the selection of a particular sampling point. The remainder of this section provides the rationale for proposed sampling and analysis program.

The analytical program for the Dye Burial Grounds was developed based on the chemical categories represented by the list of detected chemicals of interest identified for the site in Section 5.4. As depicted on Table 5-8, soil, ground water, surface water, and sediment samples collected from the site will be analyzed for dyes, inorganics, and other miscellaneous parameters. Additionally, soil characteristic parameters (bulk density, grain size, CEC, pH, and TOC), which will be used qualitatively in the risk assessment, will be collected to assist in determining the likelihood of the potential fate and transport of contaminants at the site (and the potential for risks outside the site boundaries). This data will also be used in the CMS to evaluate remedial alternatives. Select water quality parameters will be analyzed for ground water and/or surface water.

Field parameters will be collected for ground water and surface water samples. Typical water quality indicators, such as pH, temperature, specific conductance, and turbidity, will be collected in the field for both ground water and surface water. Natural attenuation parameters (dissolved oxygen, oxidation-reduction potential, ferrous iron, etc.) will be analyzed for ground water at a mobile laboratory located at the site. As a health and safety requirement, soil samples will be screened during sample collection for volatiles using monitoring equipment (PID).

Figures 5-17 (soil), 5-18 (ground water), and 5-19 (surface water/sediment) illustrate the proposed sampling locations for the field investigation at the Dye Burial Grounds. A discussion of the rationale for the collection of these samples is provided in Sections 5.5.2.1 through 5.5.2.3.

The FSP, presented in Appendix A, provides details on the field sampling procedures (installation of soil borings or monitoring wells and collection of samples) to be used at the site. The associated HASP is contained in Appendix B. The QAPP, located in Appendix C, provides details on the analytical methodologies to be used for the proposed field investigation.

The data collected during the proposed field investigation will be used to assess potential risks for human and ecological receptors exposed to site media under current and/or future land use. A description of how the data obtained during the proposed field investigation will be managed prior to the risk assessment is presented in Section 6.0. General methodologies and techniques used to calculate potential risks for the site are provided in Sections 8.0 (human health) and 9.0 (ecological).

5.5.2.1 Soil Sampling

As previously explained, dye-impacted soil was excavated from the designated areas outside the cap limits. A summary of the excavation activities is taken from the Interim Measures Completion Report

(Morrison and Knudsen, 1999). The areal extents and depths of excavation were, at a minimum, to the lines and grades indicated on Figure I-1 in Appendix I. Soil removal ceased when no colors from dyes were visible within the excavated areas. When areas of dye-impacted soil were located near the perimeter of the cap, excavation was extended a minimum of 12 feet inside the perimeter drainage/anchor trench.

To prevent cross-contamination of clean areas, excavation of the dye-impacted soil began at the areas farthest from the cap limits and progressed toward the cap. Excavated soil was placed and spread in the central portion of the cap area. The excavated areas were backfilled with clean soil.

Other dye-impacted materials, including bagged personal protective equipment generated during work activities, were spread in a single layer within the cap limits to prevent detrimental cover subsidence. After dye-impacted materials were placed within the cap limits, they were covered with clean foundation fill. All dye-impacted materials placed within the cap limits were covered daily with clean soil or 10 mil plastic sheeting to prevent runoff water from contacting dye-impacted material.

The soil sampling program was developed based on the work performed during the interim measures activities. Surface and subsurface soil samples will be collected to confirm the presence or absence or residual contamination at those areas subject to Interim Measures and located outside the limits of the multi-layered cap system. The previously excavated areas were identified based on information (site maps, geophysical survey data, etc.) available from the historical reports for the site. The exact locations to be sampled will be confirmed during the field investigation by observing the prevailing geologic conditions (i.e., identifying the presence of natural soil horizons [fragipan] in contrast to soil used to backfill the excavation). Samples will be collected to evaluate the vertical and horizontal soil horizons at the previously excavated areas.

A minimum of seven subsurface soil samples will be collected from seven locations (02SB01, 02SB02, 02SB06, 02SB07, 02SB12, 02SB13, and 02SB14) within the boundaries of the previously excavated areas, as illustrated by green sampling locations on Figure 5-17. The soil samples will be collected at depths just below the depth of excavation to confirm the vertical approach used during the Interim Measures soil removal. The sampling depth will be determined in the field by identifying the interface between backfilled and natural soil horizons. Soil samples will be sent to the laboratory for quantitative dye and inorganic analysis. Thirty percent of the samples will be analyzed for miscellaneous parameters to fulfill CMS needs; the soil samples designated for these analyses will be randomly assigned during the field event. Additional subsurface soil samples from greater depths may be collected, if residual contamination is detected.

A minimum of 26 surface/subsurface soil samples will be collected from 13 locations outside the limits of the Interim Measures excavations, as illustrated by the red sampling locations on Figure 5-17. The soil samples will be collected at surface (0 to 2 feet bgs) and subsurface depths (greater than 2 feet bgs) to confirm the horizontal approach used during the Interim Measures soil removal. The exact sampling location and subsurface sampling depth will be determined in the field by identifying the interface between backfilled and natural soil horizons. Soil samples will be sent to the laboratory for expedited quantitation dye analysis. Additional soil locations outside the estimated limits of the excavations may be sampled, if residual contamination is detected. Proposed soil sample locations are presented in Figure 5-17.

5.5.2.2 Ground Water Sampling

A phased-approach for ground water sampling will be employed for SWMU 2. Although two rounds of ground water sampling are proposed, both sample rounds will be conducted during the one field event. Re-mobilization to the site will not be required because of the relatively quick turn-around time anticipated for the selected analyses. The proposed monitoring locations to be sampled are presented in Figure 5-18.

The first round of ground water samples will be collected from eight existing monitoring wells (02-01, 02-02, 02-05, 02-06 through 02-08, 02C11P3, and 02C12P3) located near the known waste disposal areas (i.e., trenches, previously excavated areas, etc.) and one upgradient monitoring well, 02C10P3. Dyes are expected to be present in these wells, which are either screened in the Upper or Lower Pennsylvanian aquifers. Round one wells 02-01 and 02C12P3 are Upper Pennsylvanian and all others are Lower Pennsylvanian wells. If dyes are not detected and if detected inorganic concentrations do not exceed upgradient concentrations, the second round of ground water sampling will not be conducted and the conclusion will be made that contamination is not migrating from the disposal areas. If dyes are detected or if detected inorganic concentrations exceed upgradient concentrations, the second round of ground water sampling will be conducted to evaluate the nature and extent of ground water contamination.

Up to seventeen existing monitoring wells will be sampled during the second round of ground water sampling, based on the interim sample round results, as illustrated on Figure 5-18 (orange-tagged monitoring wells). These wells are either screened in the Upper Pennsylvanian (wells 02C17P3 and 02C19P3), Lower Pennsylvanian (wells 02C10P3, 02C14P3, 02C17P2, and 02C19P2), Golconda/Haney (wells 02C09P2, 02C10P2, 02C11P2, 02C12P2, 02C14P2, 02C17, and 02C19), or Beech Creek aquifers (wells 02C09, 02C10, 02C11, and 02C12). An additional monitoring well cluster (02T01, 02T01P2,

02T01P3) may be installed at a location northeast of the site, if it is determined that ground water in the Pennsylvanian aquifer at the northeastern portion of the site flows in this direction.

All ground water samples collected at the site will be sent to the laboratory for quantitative dye and inorganic analysis. As mentioned previously, natural attenuation parameters and other miscellaneous water quality parameters also will be collected.

5.5.2.3 Surface Water/Sediment Sampling

Surface water and sediment samples will be collected from drainageways, tributaries of Little Sulphur Creek, and seeps/springs located near the site, which may be impacted by site activities.

Proposed drainageway and tributary sample locations (02SW/SD01 through 02SW/SD06) are presented in Figure 5-19. A total of six surface water and six collocated sediment samples will be collected from these locations to evaluate surface water runoff from the site and subsequent deposition to sediment.

It is estimated that surface water and sediment samples will be collected from four seeps or springs near SWMU 2. The exact locations to be sampled will be determined by a site visit (field survey). Consequently, proposed sampling locations are not presented in Figure 5-19.

All surface water and sediment samples collected will be sent to the laboratory for quantitative dye and inorganic analysis. As mentioned previously, other miscellaneous parameters also will be collected.

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TABLE 5-1

SUMMARY OF HISTORICAL SITE INVESTIGATIONS
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 3

INVESTIGATION (REPORT/REFERENCE)	EXTENT OF INVESTIGATION			RESULTS OF INVESTIGATION	
	SUMMARY	DATE OF SAMPLING	ANALYTICAL PROGRAM (PARAMETER/ANALYTICAL METHOD)	DETECTED PARAMETERS OF INTEREST	CONCLUSIONS
General Basewide Investigations[1] (1981-1986)	Installation of 8 monitoring wells in 1981. One well was upgradient of the site. The other wells were downgradient along the anticipated perimeter of the site. Quarterly/ semiannual ground water monitoring was instituted to identify the presence or absence of contamination. Physical soil testing to define hydrogeological characteristics. During the well installation, the soil originating from the well cuttings were analyzed for heavy metals.	November 1981 - August 1982 [2] February 1983 - June 1986[3]	Miscellaneous Physical Soil Testing (Cation Exchange Capacity, grain size, Atterberg limits, density, water content, and permeability tests) -- Various Methods RCRA Group I - III Parameters[4] - Various Methods	NA Upper Pennsylvanian Aquifer: As, Cr, Mn, Hg, Se, Ag and Sulfate Lower Pennsylvanian Aquifer: Lindane, As, Ba, Cd, Cr, Fe, Pb, Hg, Ag, and Chloride Upper Hardinsburg Aquifer: Cr, Mn, and Hg Golconda/Haney Aquifer: No Wells Screened in this aquifer Beech Creek Aquifer: No Wells Screened in this aquifer Spring Water Aquifer: No spring samples taken.	Geology consists of overburden ranging in thickness from 2 to 10 feet. This overburden is underlaid by interbedded shale and sandstone. Ground water flow direction was determined to be south-southwest. Depth to water table ranged from 12 to 20 feet bgs. A perched ground water system was encountered by well 2-1-81. The presence of the perched ground water zone indicates that ill-defined, preferential flow paths are likely to be present. The highest levels of constituents detected were in the lower Pennsylvanian aquifer. The highest levels of metals detected were primarily in well 02-06. Lindane was found in well 02-02. Detections of acetone, methylene chloride and phthalates are thought to be a result of laboratory contamination.
RFI Phase II Ground Water Assessment Dye Burial Grounds (DBG) - Draft Naval Weapons Support Center, Crane, Indiana, (USACE WES, March 1991)	Installed an additional 33 wells. Some were well clusters. 26 wells and a seep were sampled and analyzed for priority pollutant constituents.	June 1988	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Inorganics + CN -- SW-846 Methods 6010/7060/7471/7740 Miscellaneous Parameters - Ammonia as Nitrogen, Chloride, Nitrate as Nitrogen, Phenols, Sulfate, Total Kjeldahl Nitrogen, and Total Organic Carbon	Upper Pennsylvanian Aquifer: Chloroform, Sb, Cu, Pb, and Se Lower Pennsylvanian Aquifer: 1,1,2-TCA, Chloroform, 2,4-Dinitrotoluene, As, Cd, Ni, Se, Zn, and Ammonia as Nitrogen Upper Hardinsburg Aquifer: None Golconda/Haney Aquifer: Chloroform, Sb, As, Cd, Cr, Cu, Pb, Ni, Se, Zn, Ammonia as Nitrogen, and Nitrate as Nitrogen Beech Creek Aquifer: 1,4-Dichlorobenzene, Sb, As, Cr, Cu, Pb, Se, and Ammonia as Nitrogen Spring Water Aquifer: As, Pb, and Se	Ground water flow in the Upper Pennsylvanian is northwest and southeast but is limited. Ground water flow in the other aquifers is south and southwest. The Lower and Upper Pennsylvanian aquifers are hydraulically connected in the western part of the DBG area. None of the other aquifers are hydraulically connected. All but the Beech Creek aquifer are daylighted by valley cutting within a short distance of the DBG and potentially drain onto the surface. Well data for DBG suggest that all aquifers drain ultimately to the valley of Little Sulphur Creek with little or no drainage directly to Sulphur Creek to the east. Chlorofom was detected consistently throughout the aquifers. This constituent was detected in wells 02C12 and 02C13. In the Lower Pennsylvanian, 1,1,2-trichloroethane was detected in well 02-04 and 2,4-dinitrotoluene in well 02-05. 1,4-Dichlorobenzene was detected in well 02C11 located in the Beech Creek aquifer. The highest levels of metals were found in the Lower Pennsylvanian. High levels of metals were most consistently detected in wells 02C11, 02C12, 02C13, 02C14, 02C15 and 02C18. Each of these wells was screened within different aquifers. Detections of acetone, methylene chloride and phthalates are thought to be a result of laboratory contamination.

TABLE 5-1

SUMMARY OF HISTORICAL SITE INVESTIGATIONS
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 3

INVESTIGATION (REPORT/REFERENCE)	EXTENT OF INVESTIGATION			RESULTS OF INVESTIGATION	
	SUMMARY	DATE OF SAMPLING	ANALYTICAL PROGRAM (PARAMETER/ANALYTICAL METHOD)	DETECTED PARAMETERS OF INTEREST	CONCLUSIONS
RFI Phase III Release Characterization for Ground Water, Dye Burial Grounds (DBG) Naval Weapons Support Center, Crane, Indiana, (USACE WES, June 1994)	An additional 3 wells were installed beginning in 1990. Conducted four rounds of ground water monitoring for Appendix 9 constituents in all 44 DBG wells.	March 1991 - March 1992	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Organophosphorus Pesticides -- SW-846 Method 8140 Herbicides -- SW-846 Method 8150 Inorganics + CN -- SW-846 Methods 6010/7060/7471/7740 Explosives -- SW-846 Method 8330 Miscellaneous Parameters - Nitrate as Nitrogen, Nitrite as Nitrogen, and Sulfide,	Upper Pennsylvanian Aquifer: Benzene, Aldrin, Aroclor 1254, Heptachlor, Heptachlor epoxide, Sb, As, Cd, Cr, Co, Cu, Fe, Mn, and Se Lower Pennsylvanian Aquifer: Benzene, Chloroform, Aroclor 1254, Endosulfan I, Heptachlor, Al, Sb, Be, Cd, Co, Cu, Fe, Pb, Mn, Ni, Va, and Zn 2,4-Dinitrotoluene and 2,4,6-Trinitrotoluene were found in the background well screened in the Lower Pennsylvanian Aquifer. Upper Hardinsburg Aquifer: Benzene, Sb, and Co Golconda/Haney Aquifer: Benzene, Chloroform, 4,4'-DDE, gamma-Chlordane, Heptachlor, Dinoseb, Aroclor 1254, Al, Sb, As, Cd, Co, Cu, Fe, Pb, Mn, Ni, Se, and Zn Beech Creek Aquifer: Benzene, Aroclor 1254, gamma-Chlordane, Al, Sb, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, and Va Spring Water Aquifer: No spring samples taken.	Ground water flow at this site is primarily south-southwest. There are four aquifers at the site. These aquifers in ascending order are Beech Creek, Golconda/Haney, Lower Pennsylvanian and Upper Pennsylvanian. The three lower aquifers are hydraullically separated by shale. The upper aquifer is a perched zone of limited areal extent separated only locally from the next lower auifer by a discontinous wedge of fine-grained sediments. The Lower Pennsylvanian aquifer is the most susceptible to infiltration of constituents from the DBG. Flow in this aquifer is unconfined. Surface runoff from the DBG is to the southwest, ultimately into Little Sulphur Creek. A seep of ground water issuing from the slope southwest of the DBG at the elevation of the base of the Lower Pennsylvanian sandstone flows intermittently during the year. Several VOCs, Aroclor 1254, and some pesticides/herbicides were detected in the ground water. Similar constituents were detected at other SWMUs at the Base. It is likely that these constituents are attributable to landscaping maintenance activities conducted at the Base and not to specific DBG activities. Metals were found in all four aquifers. There is some uncertainty in linking the presence of metals in ground water to activities at the DBG. Anomalously low pH in some wells that were high in certain metals may have exacerbated the presence of metals. Low pH in sandstone is probably a natural phenomenon and responsible for the high level of metals. The distribution of metals within the aquifers is not necessarily coincident with the proximity of the wells to the dye burial trenches. Detections of acetone, methylene chloride, and phthalates are thought to be a result of laboratory contamination.
Interim Measure Geophysical Investigation at the DBG, NSWC Crane, Indiana (WES GL and U.S. ACE, 1991)	The geophysical investigation was conducted to delineate the boundaries of the burial trenches and identify buried anomalies.	January 1991	NA	NA	The geophysical investigation included electromagnetic (EM), magentic and ground penetrating radar (GPR) surveys. The investigation identified anomalies that may be interpreted as areas of soil disturbance caused by trenching activities or materials contained within them.

TABLE 5-1

SUMMARY OF HISTORICAL SITE INVESTIGATIONS
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 3

INVESTIGATION (REPORT/REFERENCE)	EXTENT OF INVESTIGATION			RESULTS OF INVESTIGATION	
	SUMMARY	DATE OF SAMPLING	ANALYTICAL PROGRAM (PARAMETER/ANALYTICAL METHOD)	DETECTED PARAMETERS OF INTEREST	CONCLUSIONS
Interim Measures Completion Report for Construction of Cap System at SWMU 02/11 NSWC Crane, Crane, Indiana (Morrison Knudsen Corporation, 1999)	Design and construct an engineered, multi-layer interim measures cap system over the dye burial areas.	June 1996 - September 1998	NA	NA	Site preparation, construction of support features, and construction of the engineered multi-layer interim measures cap system over the dye burial areas began in June 1996. The project scope included site clearing, relocating an access road, establishing storm water controls, excavating dye-impacted materials, constructing the multi-layered cap system, and managing and disposing of dye-impacted water. During the site clearing, subsurface dyes were encountered outside the trench limits. By July, a field investigation was initiated to determine the extent of the dye burials. Twelve shallow exporatory excavtions were made. Dyes were found in eight of the locations. In August, a formal investigation was conducted by USEPA and NSWCEPD. The investigation included shallow borings at multiple locations. Dye was found in some of these areas. Excavation of dye-impacted soil outside the cap limits began in November 1996. The excavated material was placed within the subgrade of the area to be capped. Because this work was being performed in the winter, precipitation and management of storm water became a problem. Work was stopped from January 1998 to April 1998. The installation of the cap was completed in September 1998.

Al	Aluminum								
As	Arsenic	CN	Cyanide	Hg	Mercury	Sb	Antimony	Va	Vanadium
Ag	Silver	Co	Cobalt	Mn	Manganese	Se	Selenium	VOC	Volatile Organic Compound
Ba	Barium	Cr	Chromium	NA	Not applicable	SVOC	Semivolatile Organic Compound	Zn	Zinc
Be	Beryllium	Cu	Copper	Ni	Nickel	SWMU	Solid Waste Management Unit		
bgs	Below ground surface	DBG	Dye Burial Grounds	Pb	Lead	TCA	Trichloroethane		
Cd	Cadmium	Fe	Iron	RFI	RCRA Facility Investigation				

1 Includes, but is not limited to, Hydrogeologic Investigations at Waste Disposal Sites (Dunbar, 1982), Initial Assessment Study of the Naval Weapons Support Center, Crane, Indiana (NEESA, 1983) and Definition of Contaminated Ground-Water Plumes at Selected Waste Disposal Sites (Dunbar, 1984).
2 Quarterly monitoring.
3 Semiannual monitoring.
4 Includes select inorganics, pesticides, herbicides, radionuclides, phenols, chloride, fluoride, organic bromine, organic chlorine, organic iodine, pH, specific conductivity, sulfate, and total organic carbon.
5 Includes phosphorus and tin.

TABLE 5-2

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/10	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/10	---	5	---	0	---	0.055	0.896	---	13
1,1,2-TRICHLOROETHANE	0/10	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/10	---	5	---	0	---	810	2090	---	47
1,1-DICHLOROETHENE	0/10	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/10	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/10	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/10	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/10	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/10	---	5-50	---	0	---	160	---	---	3680
ACETONE	6/10	1-19	100	02-01 (91c) (11/13/91)	0	---	610	768	---	78000
BENZENE	2/10	3.2-3.7	5	02C12P3 (91a) (03/16/91)	2	5	0.39	5	---	114
BROMODICHLOROMETHANE	0/10	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/10	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/10	---	10	---	0	---	8.7	24.9	---	---
CARBON DISULFIDE	0/10	---	5	---	0	---	1000	2380	---	84.1
CARBON TETRACHLORIDE	0/10	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/10	---	5	---	0	100	39	100	20[7]	10
CHLOROETHANE	0/10	---	10	---	0	---	8600	---	---	230000
CHLOROFORM	1/10	10	5	02C12P3 (88) (06/27/88)	1	80[6]	0.16	100	---	79
CHLOROMETHANE	0/10	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/7	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/10	---	5	---	0	---	0.081[8]	---	---	7.9
DIBROMOCHLOROMETHANE	0/10	---	5	---	0	80[6]	1	---	---	6400
ETHYLBENZENE	0/10	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	7/10	0.4-12	5	02-01 (91c) (11/13/91)	4	5	4.3	5	---	430
STYRENE	0/10	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/10	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/10	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/10	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/10	---	5	---	0	---	0.081[8]	---	---	7.9
TRICHLOROETHENE	0/10	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/10	---	50	---	0	---	410	1850	---	248.03
VINYL CHLORIDE	0/10	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	1/10	2	5	02C12P3 (91c) (11/13/91)	0	10000	1400[9]	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/9	---	10-11	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/9	---	10-11	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/9	---	10-11	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/9	---	10-11	---	0	600	17	231	---	87

TABLE 5-2

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
1,4-DICHLOROBENZENE	0/9	---	10-11	---	0	75	0.47	75	---	43
2,4,5-TRICHLOROPHENOL	0/6	---	10	---	0	---	3700	3650	---	---
2,4,6-TRICHLOROPHENOL	0/9	---	10-11	---	0	---	6.1	77.4	1[7]	2
2,4-DICHLOROPHENOL	0/9	---	10-11	---	0	---	110	110	2[7]	18
2,4-DIMETHYLPHENOL	0/9	---	10-11	---	0	---	730	730	0.3[7]	100.17
2,4-DINITROPHENOL	0/9	---	50-55	---	0	---	73	73	400[7]	4.07
2-CHLORONAPHTHALENE	0/9	---	10-11	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/9	---	10-11	---	0	---	38	38.4	---	8.8
2-METHYL-4,6-DINITROPHENOL	0/6	---	50-55	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/6	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/6	---	10	---	0	---	1800	1830	---	---
2-NITROANILINE	0/9	---	50	---	0	---	2.2	10	---	---
2-NITROPHENOL	0/9	---	10-11	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/6	---	20-22	---	0	---	0.15	1.89	---	99.75
3-NITROANILINE	0/9	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/9	---	10-11	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/9	---	20-22	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/6	---	20	---	0	---	150	146	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/9	---	10-11	---	0	---	---	---	---	---
4-METHYLPHENOL	0/6	---	10	---	0	---	180	183	---	---
4-NITROANILINE	0/6	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/9	---	50-55	---	0	---	2300	---	---	35
ACENAPHTHENE	0/9	---	10-11	---	0	---	370	461	---	9.9
ACENAPHTHYLENE	0/9	---	10-11	---	0	---	---	---	---	4840
ANILINE	0/6	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/9	---	10-11	---	0	---	1800	43.4	---	0.029
BENZIDINE	0/9	---	50-55	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/9	---	10-11	---	0	---	0.092	1.17	---	0.839
BENZO(A)PYRENE	0/9	---	10-11	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/9	---	10-11	---	0	---	0.092	1.17	---	9.07
BENZO(G,H,I)PERYLENE	0/9	---	10-11	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/9	---	10-11	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/6	---	50	---	0	---	150000	146000	---	---
BENZYL ALCOHOL	0/6	---	20	---	0	---	11000	11000	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/9	---	10-11	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/9	---	10-11	---	0	---	0.0098	0.3	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/9	---	10-11	---	0	---	0.27	4.23	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	4/9	2.3-2.9	10-11	02C13P3 (91c) (11/13/91)	4	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/9	---	10-11	---	0	---	7300	2690	---	49
CHRYSENE	0/9	---	10-11	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/9	---	10-11	---	0	---	0.0092	0.117	---	0.0016
DIBENZOFURAN	0/6	---	10	---	0	---	24	---	---	20

TABLE 5-2

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
DIETHYL PHTHALATE	1/9	4	10-11	02C13P3 (91b) (06/01/91)	1	---	29000	29200	---	3
DIMETHYL PHTHALATE	0/9	---	10-11	---	0	---	370000	365000	---	73
DI-N-BUTYL PHTHALATE	0/9	---	10-11	---	0	---	3700	3650	---	3
DI-N-OCTYL PHTHALATE	1/9	1.1	10-11	02C13P3 (91c) (11/13/91)	0	---	730	20	---	30
FLUORANTHENE	0/9	---	10-11	---	0	---	1500	206	---	8.1
FLUORENE	0/9	---	10-11	---	0	---	240	307	---	3.9
HEXACHLOROBENZENE	0/9	---	10-11	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/9	---	10-11	---	0	---	0.86	7.3	1[7]	0.134
HEXACHLOROCYCLOPENTADIENE	0/9	---	10-11	---	0	50	260	50	---	77.04
HEXACHLOROETHANE	0/9	---	10-11	---	0	---	4.8	7.68	---	30.5
INDENO(1,2,3-CD)PYRENE	0/9	---	10-11	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/9	---	10-11	---	0	---	71	896	---	900
NAPHTHALENE	0/9	---	10-11	---	0	---	6.2	307	---	44
NITROBENZENE	0/9	---	10-11	---	0	---	3.4	9.42	30[7]	740
N-NITROSODIMETHYLAMINE	0/9	---	10-11	---	0	---	0.0013	---	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/9	---	10-11	---	0	---	0.0096	0.46	---	---
N-NITROSODIPHENYLAMINE	0/9	---	10-11	---	0	---	14	174	---	13
PENTACHLOROPHENOL	0/9	---	50-55	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/9	---	10-11	---	0	---	---	---	---	2.1
PHENOL	0/6	---	10	---	0	---	22000	21900	300[7]	100
PYRENE	0/9	---	10-11	---	0	---	180	135	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/3	---	20	---	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/3	---	20	---	0	---	3.7	---	---	2.36
2,4-DINITROTOLUENE	0/7	---	0.02-20	---	0	---	73	1.25	---	230
2,6-DINITROTOLUENE	0/3	---	0.02-20	---	0	---	37	1.25	---	42
2,4,6-TRINITROTOLUENE	0/7	---	20	---	0	---	2.2	---	---	---
2-AMINO-4,6-DINITROTOLUENE	---	---	---	---	0	---	---	---	---	---
4-AMINO-2,6-DINITROTOLUENE	---	---	---	---	0	---	---	---	---	---
HMX	0/7	---	20	---	0	---	1800	---	---	---
RDX	0/7	---	20	---	0	---	0.61	---	---	---
TETRYL	0/7	---	50	---	0	---	370	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	2/4	0.02-0.12	1.9	02C12P3 (91a) (03/16/91)	0	---	370	---	---	686.33
2,4,5-TP (SILVEX)	2/8	0.2-0.55	0.5-1.7	02C13P3 (91a) (03/16/91)	0	50	290	---	---	326.64
2,4-D	0/8	---	3.8-12	---	0	70	370	---	---	---
4,4'-DDD	0/7	---	0.1-0.12	---	0	---	0.28	3.55	---	0.0011
4,4'-DDE	0/7	---	0.04-0.4	---	0	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/7	---	0.11-0.12	---	0	---	0.2	2.5	0.001	0.000952
ALDRIN	1/7	0.01	0.04	02C12P3 (91c) (11/13/91)	1	---	0.004	0.0501	---	0.0185
ALPHA-BHC	0/7	---	0.03	---	0	---	0.011	0.135	---	12.38
ALPHA-CHLORDANE	0/7	---	0.05-0.06	---	0	2	0.19	2	0.0043	0.00029

TABLE 5-2

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 4 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
AROCLOR-1016	0/7	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1221	0/7	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1232	0/7	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1242	0/7	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1248	0/7	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1254	2/7	0.46-0.47	1.3-1.4	02C12P3 (91a) (03/16/91)	**2**	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1260	0/7	---	1.2-1.4	---	0	0.5	0.034	0.5	0.014	0.000029
BETA-BHC	0/7	---	0.06-0.07	---	0	---	0.037	0.473	---	0.495
DELTA-BHC	0/7	---	0.09-0.1	---	0	---	---	---	---	666.67
DIELDRIN	0/7	---	0.02	---	0	---	0.0042	0.0532	0.0019	0.000026
DINOSEB	0/4	---	0-0.7	---	0	7	37	---	---	0.39
DISULFOTON	0/7	---	0.67-0.77	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	1/7	0.02	0.13-0.16	02C12P3 (91b) (06/01/91)	**1**	---	220	219	0.056	0.003
ENDOSULFAN II	0/7	---	0.04	---	0	---	220	219	0.056	0.003
ENDOSULFAN SULFATE	0/7	---	0.63-0.73	---	0	---	---	---	---	2.22
ENDRIN	0/11	---	0.04-0.07	---	0	2	11	0.2	0.0023	0.002
ENDRIN ALDEHYDE	0/7	---	0.22-0.26	---	0	---	---	---	---	0.15
ETHYL PARATHION	0/7	---	0.57-0.66	---	0	---	---	---	---	---
FAMPHUR	0/7	---	0.12-1.3	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/11	---	0.04-0.08	---	0	0.2	0.052	0.2	0.08	0.01
GAMMA-CHLORDANE	0/7	---	0.05-0.06	---	0	2	0.19	2	0.0043	0.00029
HEPTACHLOR	2/7	0.03-0.14	0.03	02C12P3 (91b) (06/01/91)	**2**	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	1/7	0.01	0.79-0.92	02C13P3 (91a) (03/16/91)	**1**	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/7	---	5.7-6.7	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/11	---	1.6-2	---	0	40	180	40	---	0.005
METHYL PARATHION	0/7	---	1.1-1.3	---	0	---	9.1	---	---	---
PHORATE	0/7	---	0.38-0.44	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/11	---	1.6-2.7	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	0/10	---	10-30	---	0	50-200[7,13]	37000	---	87	---
ANTIMONY	8/13	3-16.6	3-5	02C13P3 (91c) (11/13/91)	**6**	6	15	---	---	31
ARSENIC	4/19	2-24	2-10	02C13P3 (88) (06/27/88)	**4**	50	0.045	50	150	53
BARIUM	8/16	15-1400	10-100	02-01 (86a) (02/02/86)	0	2000	2600	2000	---	5000
BERYLLIUM	0/13	---	1-5	---	0	4	0.016	4	---	7.6
CADMIUM	3/19	0.27-6	0.1-10	02C12P3 (91b) (06/01/91)	**1**	5	18	5	2.2	0.66
CALCIUM	10/10	2260-337000	---	02C12P3 (91b) (06/01/91)	0	---	---	---	---	---
CHROMIUM (TOTAL)	5/19	1-70	1-20	02-01 (82b) (06/08/82)	**3**	100	180	100	11[4]	42
COBALT	6/10	6-40	6-20	02-01 (91c) (11/13/91)	**6**	---	2200	---	---	5
COPPER	6/13	1-32	1-5	02C12P3 (92) (03/28/92)	**5**	1300[15]	1400	---	9	5
CYANIDE	0/7	---	0.5-5	---	0	200	730	---	5.2[16]	5.2[16]
IRON	12/18	10-8220	10-40	02C13P3 (91c) (11/13/91)	**2**	300[7,13]	11000	---	---	---
LEAD	4/19	1-6	1-30	02C12P3 (88) (06/27/88)	**1**	15[15]	4	---	2.5	1.3

TABLE 5-2

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 5 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
MAGNESIUM	10/10	1700-241000	---	02C12P3 (91c) (11/13/91)	0	---	---	---	---	---
MANGANESE	18/21	9-2050	5-20	02C12P3 (91c) (11/13/91)	15	50[7,13]	1700	---	---	---
MERCURY	2/19	0.4-0.6	0.2-0.8	02-01 (82a) (03/09/82)	2	2	11	2	0.77	0.0013
NICKEL	12/13	3-54	5	02C13P3 (88) (06/27/88)	1	100	730	100	52	29
POTASSIUM	9/10	923-218000	1000	02C12P3 (92) (03/28/92)	0	---	---	---	---	---
SELENIUM	7/19	5-11	2-5	02-01 (86a) (02/02/86)	7	50	180	50	5	5
SILVER	2/19	8-10	1-10	02-01 (85a) (01/09/85)	2	100[7,13]	180	183	---	1
SODIUM	21/21	19000-242000	---	02-01 (82b) (06/08/82)	0	---	---	---	---	---
THALLIUM	0/13	---	1-8	---	0	2	2.9[17]	2	---	0.56
TIN	0/10	---	35-50	---	0	---	22000	---	---	73
VANADIUM	1/10	16	5-10	02C12P3 (92) (03/28/92)	0	---	260	---	---	19
ZINC	3/13	7-36	5-30	02C13P3 (88) (06/27/88)	0	5000[7,13]	11000	11000	120	58.9
Miscellaneous Parametes (ug/L, unless otherwise noted)										
AMMONIA, AS NITROGEN	3/3	28-121	---	02C12P3 (88) (06/27/88)	0	1000	1000	---	---	---
CHLORIDE	10/11	21300-226400	1	02-01 (88) (06/27/88)	1	250000[7,13]	---	---	230	---
NITRATE, AS NITROGEN	10/10	141-837	---	02C12P3 (92) (03/28/92)	0	10000	10000	---	---	---
NITRITE, AS NITROGEN	2/3	8-60	5	02C12P3 (92) (03/28/92)	0	1000	1000[18]	---	---	---
ORGANIC BROMINE	2/2	30	---	02-01 (84) (02/01/84)	0	---	---	---	---	---
ORGANIC CHLORINE	2/3	20-40	10	02-01 (84) (02/01/84)	0	---	---	---	---	---
ORGANIC IODINE	3/3	70-760	---	02-01 (84) (02/01/84)	0	---	---	---	---	---
pH (standard units)	12/12	6.4-7.2	---	02-01 (85b) (06/17/85)	0	---	---	---	6.5-9	---
PHENOLS	2/11	10-50	4-50	02-01 (82b) (06/08/82)	0	---	---	---	---	---
SPECIFIC CONDUCTIVITY (umho/cm)	11/11	1560-2900	---	02-01 (85a) (01/09/85)	0	---	---	---	---	---
SULFATE	14/14	42000-920000	---	02-01 (82a) (03/09/82)	1	500000	---	---	---	---
SULFIDE	1/7	162000	0.02	02-01 (91c) (11/13/91)	1	2	---	---	2	---
TOTAL COLIFORM (phm)	1/1	23000	---	02-01 (81) (11/30/81)	0	---	---	---	---	---
TOTAL KJELDAHL NITROGEN	3/3	434-1970	---	02C12P3 (88) (06/27/88)	1	1000[18]	1000[18]	---	---	---
TOTAL ORGANIC CARBON	13/14	2.3-57	1	02-01 (83c) (07/27/83)	0	---	---	---	---	---
TOTAL ORGANIC HALOGENS	8/8	52-140	---	02-01 (82a) (03/09/82)	0	---	---	---	---	---

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

TABLE 5-2

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 6 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable but not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

TABLE 5-3

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/57	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/57	---	5	---	0	---	0.055	0.896	---	13
1,1,2-TRICHLOROETHANE	2/57	5	5	02-04 (88) (06/27/88)	1	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/57	---	5	---	0	---	810	2090	---	47
1,1-DICHLOROETHENE	0/57	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/57	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/57	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	1/57	7	50-100	02C11P3 (91c) (11/13/91)	0	---	1900	2500	---	7100
2-HEXANONE	0/57	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/57	---	50-5000	---	0	---	160	---	---	3680
ACETONE	45/57	1.7-3500	100	02C18P2 (88) (06/27/88)	3	---	610	768	---	78000
BENZENE	16/57	0.81-9.9	5-10	02C18P2 (91a) (03/16/91)	17	5	0.39	5	---	114
BROMODICHLOROMETHANE	0/57	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/57	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/57	---	10	---	0	---	8.7	24.9	---	---
CARBON DISULFIDE	0/57	---	5	---	0	---	1000	2380	---	84.1
CARBON TETRACHLORIDE	0/57	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/57	---	5	---	0	100	39	100	20[7]	10
CHLOROETHANE	0/57	---	10	---	0	---	8600	---	---	230000
CHLOROFORM	3/57	1.1-7.4	5	02C13P2 (88) (06/27/88)	3	80[6]	0.16	100	---	79
CHLOROMETHANE	0/48	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/51	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/57	---	5	---	0	---	0.081[8]	---	---	7.9
DIBROMOCHLOROMETHANE	0/57	---	5	---	0	80[6]	1	---	---	6400
ETHYLBENZENE	2/57	1	5	02C11P3 (91c) (11/13/91)	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	47/57	1.1-29	5	02C17P2 (91a) (03/16/91)	28	5	4.3	5	---	430
STYRENE	0/57	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/57	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/57	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/57	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/57	---	5	---	0	---	0.081[8]	---	---	7.9
TRICHLOROETHENE	0/57	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/57	---	50	---	0	---	410	1850	---	248.03
VINYL CHLORIDE	0/57	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	3/57	4-7	5	02C15P2 (91c) (11/13/91)	0	10000	1400[9]	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/46	---	10-14	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/46	---	10-14	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/46	---	10-14	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/46	---	10-14	---	0	600	17	231	---	87
1,4-DICHLOROBENZENE	0/46	---	10-14	---	0	75	0.47	75	---	43

TABLE 5-3

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 6

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						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2,4,5-TRICHLOROPHENOL	0/38	---	10	---	0	---	3700	3650	---	---
2,4,6-TRICHLOROPHENOL	0/46	---	10-14	---	0	---	6.1	77.4	1[7]	2
2,4-DICHLOROPHENOL	1/46	12	10-14	02-05 (88) (06/27/88)	**1**	---	110	110	2[7]	18
2,4-DIMETHYLPHENOL	0/46	---	10-14	---	0	---	730	730	0.3[7]	100.17
2,4-DINITROPHENOL	0/46	---	50-70	---	0	---	73	73	400[7]	4.07
2-CHLORONAPHTHALENE	0/46	---	10-14	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/46	---	10-14	---	0	---	38	38.4	---	8.8
2-METHYL-4,6-DINITROPHENOL	0/46	---	50-70	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/38	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/38	---	10	---	0	---	1800	1830	---	---
2-NITROANILINE	0/38	---	50	---	0	---	2.2	10	---	---
2-NITROPHENOL	0/46	---	10-14	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/46	---	20-28	---	0	---	0.15	1.89	---	99.75
3-NITROANILINE	0/38	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/46	---	10-14	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/46	---	20-28	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/38	---	20	---	0	---	150	146	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/49	---	10-14	---	0	---	---	---	---	---
4-METHYLPHENOL	0/38	---	10	---	0	---	180	183	---	---
4-NITROANILINE	0/38	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/46	---	5-70	---	0	---	2300	---	---	35
ACENAPHTHENE	0/46	---	10-14	---	0	---	370	461	---	9.9
ACENAPHTHYLENE	0/46	---	10-14	---	0	---	---	---	---	4840
ANILINE	0/38	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/46	---	10-14	---	0	---	1800	43.4	---	0.029
BENZIDINE	0/46	---	50-70	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/46	---	10-14	---	0	---	0.092	1.17	---	0.839
BENZO(A)PYRENE	0/46	---	10-14	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/46	---	10-14	---	0	---	0.092	1.17	---	9.07
BENZO(G,H,I)PERYLENE	0/46	---	10-14	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/46	---	10-14	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/38	---	50	---	0	---	150000	146000	---	---
BENZYL ALCOHOL	0/38	---	20	---	0	---	11000	11000	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/46	---	10-14	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/46	---	10-14	---	0	---	0.0098	0.3	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/46	---	10-14	---	0	---	0.27	4.23	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	33/46	1.4-150	10-12	02C13P2 (91c) (11/13/91)	**27**	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/46	---	10-14	---	0	---	7300	2690	---	49
CHRYSENE	0/46	---	10-14	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/46	---	10-14	---	0	---	0.0092	0.117	---	0.0016
DIBENZOFURAN	0/38	---	10	---	0	---	24	---	---	20
DIETHYL PHTHALATE	9/46	0.6-23	10-14	02C20P3 (91b) (06/01/91)	**8**	---	29000	29200	---	3
DIMETHYL PHTHALATE	0/46	---	10-14	---	0	---	370000	365000	---	73

TABLE 5-3

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
DI-N-BUTYL PHTHALATE	0/46	---	10-14	---	0	---	3700	3650	---	3
DI-N-OCTYL PHTHALATE	2/46	1.7-1.8	10-14	02C13P2 (91c) (11/13/91)	0	---	730	20	---	30
FLUORANTHENE	0/46	---	10-14	---	0	---	1500	206	---	8.1
FLUORENE	0/46	---	10-14	---	0	---	240	307	---	3.9
HEXACHLOROBENZENE	0/46	---	10-14	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/46	---	10-14	---	0	---	0.86	7.3	1[7]	0.134
HEXACHLOROCYCLOPENTADIENE	0/46	---	10-14	---	0	50	260	50	---	77.04
HEXACHLOROETHANE	0/46	---	10-14	---	0	---	4.8	7.68	---	30.5
INDENO(1,2,3-CD)PYRENE	0/46	---	10-14	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/46	---	10-14	---	0	---	71	896	---	900
NAPHTHALENE	0/46	---	10-14	---	0	---	6.2	307	---	44
NITROBENZENE	0/46	---	10-20	---	0	---	3.4	9.42	30[7]	740
N-NITROSODIMETHYLAMINE	0/46	---	10-14	---	0	---	0.0013	---	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/46	---	10-14	---	0	---	0.0096	0.46	---	---
N-NITROSODIPHENYLAMINE	0/46	---	10-14	---	0	---	14	174	---	13
PENTACHLOROPHENOL	0/46	---	50-70	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/46	---	10-14	---	0	---	---	---	---	2.1
PHENOL	0/38	---	10	---	0	---	22000	21900	300[7]	100
PYRENE	0/46	---	10-14	---	0	---	180	135	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/14	---	20	---	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/14	---	20	---	0	---	3.7	---	---	2.36
2,4-DINITROTOLUENE	1/46	12	0.02-20	02-05 (88) (06/27/88)	1	---	73	1.25	---	230
2,6-DINITROTOLUENE	0/14	---	0.02-20	---	0	---	37	1.25	---	42
2,4,6-TRINITROTOLUENE	0/47	---	20	---	0	---	2.2	---	---	---
HMX	0/47	---	20	---	0	---	1800	---	---	---
RDX	0/47	---	20	---	0	---	0.61	---	---	---
TETRYL	0/47	---	50	---	0	---	370	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	13/35	0.01-0.28	0-2.5	02-07 (91a) (03/16/91)	0	---	370	---	---	686.33.
2,4,5-TP (SILVEX)	18/59	0.31-0.67	0.3-2.1	02C11P3 (91b) (06/01/91)	0	50	290	---	---	326.64
2,4-D	8/59	0.02-0.23	0-15	02C16P2 (91a) (03/16/91)	0	70	370	---	---	---
4,4'-DDD	0/46	---	0.1-0.15	---	0	---	0.28	3.55	---	0.0011
4,4'-DDE	0/46	---	0.04-0.4	---	0	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/46	---	0.11-0.16	---	0	---	0.2	2.5	0.001	0.000952
ALDRIN	0/46	---	0.04-0.05	---	0	---	0.004	0.0501	---	0.0185
ALPHA-BHC	0/46	---	0.03-0.04	---	0	---	0.011	0.135	---	12.38
ALPHA-CHLORDANE	0/46	---	0.05-0.07	---	0	2	0.19	2	0.0043	0.00029
AROCLOR-1016	0/46	---	0.6-0.9	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1221	0/46	---	0.6-0.9	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1232	0/46	---	0.6-0.9	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1242	0/46	---	0.6-0.9	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1248	0/46	---	0.6-0.9	---	0	0.5	0.034	0.5	0.014	0.000029

TABLE 5-3

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 4 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
AROCLOR-1254	6/46	0.15-0.78	1.2-1.8	02C14P3 (91c) (11/13/91)	**6**	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1260	0/46	---	1.2-1.8	---	0	0.5	0.034	0.5	0.014	0.000029
BETA-BHC	0/46	---	0.06-0.08	---	0	---	0.037	0.473	---	0.495
DELTA-BHC	0/46	---	0.09-0.12	---	0	---	---	---	---	666.67
DIELDRIN	0/46	---	0.02-0.03	---	0	---	0.0042	0.0532	0.0019	0.000026
DINOSEB	5/35	0.02-0.07	0-0.86	02C19P2 (91a) (03/16/91)	0	7	37	---	---	0.39
DISULFOTON	0/46	---	0.67-0.95	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	1/46	0.01	0.13-0.19	02C11P3 (91a) (03/16/91)	**1**	---	220	219	0.056	0.003
ENDOSULFAN II	0/46	---	0.04-0.05	---	0	---	220	219	0.056	0.003
ENDOSULFAN SULFATE	0/46	---	0.63-0.89	---	0	---	---	---	---	2.22
ENDRIN	0/70	---	0.04-0.08	---	0	2	11	0.2	0.0023	0.002
ENDRIN ALDEHYDE	5/46	0.08-0.12	0.22-0.31	02-06 (91b) (06/01/91)	0	---	---	---	---	0.15
ETHYL PARATHION	0/46	---	0.57-0.81	---	0	---	---	---	---	---
FAMPHUR	0/46	---	1.1-1.6	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	1/70	0.11	0.04-0.08	02-02 (81) (11/30/81)	**1**	0.2	0.052	0.2	0.08	0.01
GAMMA-CHLORDANE	0/46	---	0.05-0.07	---	0	2	0.19	2	0.0043	0.00029
HEPTACHLOR	2/46	0.01-0.03	0-0.04	02-02 (91a) (03/16/91)	**2**	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/46	---	0-1.1	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/46	---	5.7-8.1	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/70	---	1.6-2.4	---	0	40	180	40	---	0.005
METHYL PARATHION	0/46	---	1.1-1.6	---	0	---	9.1	---	---	---
PHORATE	0/46	---	0.38-0.54	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/70	---	1.6-3.2	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	30/63	206-29500	10-30	02C11P3 (91a) (03/16/91)	**29**	50-200[7,13]	37000	---	87	---
ANTIMONY	47/72	3-22.1	3-5	02C14P3 (91c) (11/13/91)	**40**	6	15	---	---	31
ARSENIC	11/108	1-22	1-10	02C13P2 (88) (06/27/88)	**11**	50	0.045	50	150	53
BARIUM	38/99	10-4700	10-100	02-06 (86a) (02/02/86)	**6**	2000	2600	2000	---	5000
BERYLLIUM	16/72	1-7	1-5	02C22P3 (91b) (06/01/91)	**16**	4	0.016	4	---	7.6
CADMIUM	26/108	0.36-13	0.1-10	02-06 (91b) (06/01/91)	**23**	5	18	5	2.2	0.66
CALCIUM	63/63	128000-676000	---	02-06 (91b) (06/01/91)	0	---	---	---	---	---
CHROMIUM (TOTAL)	22/108	1-40	1-20	02-05 (82b) (06/08/82)	**14**	100	180	100	11[4]	42
COBALT	61/63	7-697	6-20	02-06 (91c) (11/13/91)	**61**	---	2200	---	---	5
COPPER	35/72	1-86	1-5	02C13P2 (88) (06/27/88)	**33**	1300	1400	---	9	5
CYANIDE	0/46	---	0.5-5	---	0	200	730	---	5.2[16]	5.2[16]
IRON	102/112	14-121000	10-40	02C22P3 (91c) (11/13/91)	**59**	300[7,13]	11000	---	---	---
LEAD	19/108	1-16	1-30	02C11P3 (91a) (03/16/91)	**15**	15[15]	4	---	2.5	1.3
MAGNESIUM	63/63	7830-413000	---	02-06 (91b) (06/01/91)	0	---	---	---	---	---
MANGANESE	125/128	5-30100	5-20	02C22P3 (91a) (03/16/91)	**125**	50[7,13]	1700	---	---	---
MERCURY	3/108	0.5-3.4	0.2-0.8	02-06 (86a) (02/02/86)	**3**	2	11	2	0.77	0.0013
NICKEL	67/72	2-1850	5	02-06 (91c) (11/13/91)	**60**	100	730	100	52	29
POTASSIUM	62/63	3130-15400	1000	02C22P3 (91c) (11/13/91)	0	---	---	---	---	---

TABLE 5-3

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 5 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
SELENIUM	15/108	2.1-8	1-10	02C15P2 (88) (06/27/88)	**7**	50	180	50	5	5
SILVER	10/108	7-18	1-10	02-06 (86a) (02/02/86)	**10**	100[7,13]	180	183	---	1
SODIUM	119/119	8540-163000	---	02C20P3 (91a) (03/16/91)	0	---	---	---	---	---
THALLIUM	0/72	---	1-8	---	0	2	2.9[17]	2	---	0.56
TIN	0/63	---	35-50	---	0	---	22000	---	---	73
VANADIUM	5/63	6-23	5-10	02-05 (92) (03/28/92)	**1**	---	260	---	---	19
ZINC	51/72	5-1950	5-30	02C11P3 (88) (06/27/88)	**37**	5000[7,13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L, unless otherwise noted)										
AMMONIA, AS NITROGEN	9/9	49-3420	---	02C11P3 (88) (06/27/88)	**2**	1000	1000	---	---	---
CHLORIDE	51/57	12000-860000	1000	02-04 (82b) (06/08/82)	**2**	250000[7,13]	---	---	---	---
FLUORIDE	33/33	130-3000	---	02-05 (86a) (02/02/86)	**19**	---	---	---	230	---
NITRATE, AS NITROGEN	28/49	23-1080	20-50	02C11P3 (88) (06/27/88)	0	10000	10000	---	---	---
NITRITE, AS NITROGEN	14/16	5-17	5	02C22P3 (92) (03/28/92)	0	1000	1000[18]	---	---	---
ORGANIC BROMINE	1/17	5	2-10	02-07 (84) (01/31/84)	0	---	---	---	---	---
ORGANIC CHLORINE	3/17	30-100	10	02-07 (84) (01/31/84)	0	---	---	---	---	---
ORGANIC IODINE	10/17	5-29	10	02-07 (84) (01/31/84)	0	---	---	---	---	---
pH (standard units)	78/78	5.5-7.3	---	02-02 (85b) (06/17/85)	0	---	---	---	6.5-9	---
PHENOLS	13/55	10-50	4-50	02-04 (85a) (01/08/85)	0	---	---	---	---	---
SPECIFIC CONDUCTIVITY (uhmo/cm)	65/65	1200-5400	---	02-06 (86a) (02/02/86)	0	---	---	---	---	---
SULFATE	74/74	10000-2810000	---	02-06 (83b) (02/23/83)	**63**	500000	---	---	---	---
SULFIDE	9/46	23-249	20	02-07 (91c) (11/13/91)	**9**	2	---	---	2	---
TOTAL KJELDAHL NITROGEN	9/9	404-8900	---	02C13P2 (88) (06/27/88)	**5**	1000[18]	1000[18]	---	---	---
TOTAL ORGANIC CARBON	61/74	1000-98000	1000-2000	02-05 (83b) (02/23/83)	0	---	---	---	---	---
TOTAL ORGANIC HALOGENS	41/48	0.62-160	10	02-05 (82a) (03/09/82)	0	---	---	---	---	---

Note: Does not include samples collected from the upgradient well cluster 02C10, which are considered to represent upgradient site conditions not impacted by site operations.

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.

TABLE 5-3

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 6 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]

4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable but not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

TABLE 5-4

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER HARDINSBURG AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/3	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/3	---	5	---	0	---	0.055	0.896	---	13
1,1,2-TRICHLOROETHANE	0/3	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/3	---	5	---	0	---	810	2090	---	47
1,1-DICHLOROETHENE	0/3	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/3	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/3	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/3	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/3	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/3	---	50	---	0	---	160	---	---	3680
ACETONE	2/3	6-9.4	100	02-03 (91a) (03/16/91)	0	---	610	768	---	78000
BENZENE	1/3	1.2	5	02-03 (91a) (03/16/91)	1	5	0.39	5	---	114
BROMODICHLOROMETHANE	0/3	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/3	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/3	---	10	---	0	---	8.7	24.9	---	---
CARBON DISULFIDE	0/3	---	5	---	0	---	1000	2380	---	84.1
CARBON TETRACHLORIDE	0/3	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/3	---	5	---	0	100	39	100	20[7]	10
CHLOROETHANE	0/3	---	10	---	0	---	8600	---	---	230000
CHLOROFORM	0/3	---	5	---	0	80[6]	0.16	100	---	79
CHLOROMETHANE	0/3	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/3	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/3	---	5	---	0	---	0.081[8]	---	---	7.9
DIBROMOCHLOROMETHANE	0/3	---	5	---	0	80[6]	1	---	---	6400
ETHYLBENZENE	0/3	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	3/3	2.6-18	---	02-03 (91b) (06/01/91)	2	5	4.3	5	---	430
STYRENE	0/3	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/3	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/3	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/3	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/3	---	5	---	0	---	0.081[8]	---	---	7.9
TRICHLOROETHENE	0/3	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/3	---	50	---	0	---	410	1850	---	248.03
VINYL CHLORIDE	0/3	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	0/3	---	5	---	0	10000	1400[9]	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/2	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/2	---	10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/2	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/2	---	10	---	0	600	17	231	---	87

TABLE 5-4

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER HARDINSBURG AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
1,4-DICHLOROBENZENE	0/2	---	10	---	0	75	0.47	75	---	43
2,4,5-TRICHLOROPHENOL	0/2	---	10	---	0	---	3700	3650	---	---
2,4,6-TRICHLOROPHENOL	0/2	---	10	---	0	---	6.1	77.4	1[7]	2
2,4-DICHLOROPHENOL	0/2	---	10	---	0	---	110	110	2[7]	18
2,4-DIMETHYLPHENOL	0/2	---	10	---	0	---	730	730	0.3[7]	100.17
2,4-DINITROPHENOL	0/2	---	50	---	0	---	73	73	400[7]	4.07
2-CHLORONAPHTHALENE	0/2	---	10	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/2	---	10	---	0	---	38	38.4	---	8.8
2-METHYL-4,6-DINITROPHENOL	0/2	---	50	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/2	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/2	---	10	---	0	---	1800	1830	---	---
2-NITROANILINE	0/2	---	50	---	0	---	2.2	10	---	---
2-NITROPHENOL	0/2	---	10	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/2	---	20	---	0	---	0.15	1.89	---	99.75
3-NITROANILINE	0/2	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/2	---	10	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/2	---	20	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/2	---	20	---	0	---	150	146	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/2	---	10	---	0	---	---	---	---	---
4-METHYLPHENOL	0/2	---	10	---	0	---	180	183	---	---
4-NITROANILINE	0/2	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/2	---	50	---	0	---	2300	---	---	35
ACENAPHTHENE	0/2	---	10	---	0	---	370	461	---	9.9
ACENAPHTHYLENE	0/2	---	10	---	0	---	---	---	---	4840
ANILINE	0/2	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/2	---	10	---	0	---	1800	43.4	---	0.029
BENZIDINE	0/2	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/2	---	10	---	0	---	0.092	1.17	---	0.839
BENZO(A)PYRENE	0/2	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/2	---	10	---	0	---	0.092	1.17	---	9.07
BENZO(G,H,I)PERYLENE	0/2	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/2	---	10	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/2	---	50	---	0	---	150000	146000	---	---
BENZYL ALCOHOL	0/2	---	20	---	0	---	11000	11000	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/2	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/2	---	10	---	0	---	0.0098	0.3	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/2	---	10	---	0	---	0.27	4.23	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	2/2	1-2.9	---	02-03 (91a) (03/16/91)	1	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/2	---	10	---	0	---	7300	2690	---	49
CHRYSENE	0/2	---	10	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/2	---	10	---	0	---	0.0092	0.117	---	0.0016
DIBENZOFURAN	0/2	---	10	---	0	---	24	---	---	20

TABLE 5-4

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER HARDINSBURG AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
DIETHYL PHTHALATE	1/2	11	10	02-03 (91b) (06/01/91)	1	---	29000	29200	---	3
DIMETHYL PHTHALATE	0/2	---	10	---	0	---	370000	365000	---	73
DI-N-BUTYL PHTHALATE	0/2	---	10	---	0	---	3700	3650	---	3
DI-N-OCTYL PHTHALATE	0/2	---	10	---	0	---	730	20	---	30
FLUORANTHENE	0/2	---	10	---	0	---	1500	206	---	8.1
FLUORENE	0/2	---	10	---	0	---	240	307	---	3.9
HEXACHLOROBENZENE	0/2	---	10	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/2	---	10	---	0	---	0.86	7.3	1[7]	0.134
HEXACHLOROCYCLOPENTADIENE	0/2	---	10	---	0	50	260	50	---	77.04
HEXACHLOROETHANE	0/2	---	10	---	0	---	4.8	7.68	---	30.5
INDENO(1,2,3-CD)PYRENE	0/2	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/2	---	10	---	0	---	71	896	---	900
NAPHTHALENE	0/2	---	10	---	0	---	6.2	307	---	44
NITROBENZENE	0/2	---	10	---	0	---	3.4	9.42	30[7]	740
N-NITROSODIMETHYLAMINE	0/2	---	10	---	0	---	0.0013	---	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/2	---	10	---	0	---	0.0096	0.46	---	---
N-NITROSODIPHENYLAMINE	0/2	---	10	---	0	---	14	174	---	13
PENTACHLOROPHENOL	0/2	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/2	---	10	---	0	---	---	---	---	2.1
PHENOL	0/2	---	10	---	0	---	22000	21900	300[7]	100
PYRENE	0/2	---	10	---	0	---	180	135	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/1	---	20	---	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/1	---	20	---	0	---	3.7	---	---	2.36
2,4-DINITROTOLUENE	0/3	---	0.02-20	---	0	---	73	1.25	---	230
2,6-DINITROTOLUENE	0/1	---	20	---	0	---	37	1.25	---	42
2,4,6-TRINITROTOLUENE	0/3	---	20	---	0	---	2.2	---	---	---
HMX	0/3	---	20	---	0	---	1800	---	---	---
RDX	0/3	---	20	---	0	---	0.61	---	---	---
TETRYL	0/3	---	50	---	0	---	370	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	1/1	0.18	---	02-03 (91a) (03/16/91)	0	---	370	---	---	686.33
2,4,5-TP (SILVEX)	1/4	0.69	0.5	02-03 (91a) (03/16/91)	0	50	290	---	---	326.64
2,4-D	1/4	0.17	3.8	02-03 (91a) (03/16/91)	0	70	370	---	---	---
4,4'-DDD	0/1	---	0.11	---	0	---	0.28	3.55	---	0.0011
4,4'-DDE	0/1	---	0.04	---	0	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/1	---	0.12	---	0	---	0.2	2.5	0.001	0.000952
ALDRIN	0/1	---	0.04	---	0	---	0.004	0.0501	---	0.0185
ALPHA-BHC	0/1	---	0.03	---	0	---	0.011	0.135	---	12.38
ALPHA-CHLORDANE	0/1	---	0.05	---	0	2	0.19	2	0.0043	0.00029
AROCLOR-1016	0/1	---	0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1221	0/1	---	0.7	---	0	0.5	0.034	0.5	0.014	0.000029

TABLE 5-4

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER HARDINSBURG AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 4 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
AROCLOR-1232	0/1	---	0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1242	0/1	---	0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1248	0/1	---	0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1254	0/1	---	1.3	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1260	0/1	---	1.3	---	0	0.5	0.034	0.5	0.014	0.000029
BETA-BHC	0/1	---	0.06	---	0	---	0.037	0.473	---	0.495
DELTA-BHC	0/1	---	0.09	---	0	---	---	---	---	666.67
DIELDRIN	0/1	---	0.02	---	0	---	0.0042	0.0532	0.0019	0.000026
DINOSEB	1/1	0.01	---	02-03 (91a) (03/16/91)	0	7	37	---	---	0.39
DISULFOTON	0/1	---	0.7	---	0	---	1.5	---	---	0.0402
ENDOSULFAN II	0/1	---	0.04	---	0	---	220	219	0.056	0.003
ENDOSULFAN SULFATE	0/1	---	0.66	---	0	---	---	---	---	2.22
ENDRIN	0/5	---	0.06	---	0	2	11	0.2	0.0023	0.002
ENDRIN ALDEHYDE	0/1	---	0.23	---	0	---	---	---	---	0.15
ETHYL PARATHION	0/1	---	6	---	0	---	---	---	---	---
FAMPHUR	0/1	---	1.2	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/5	---	0.08	---	0	0.2	0.052	0.2	0.08	0.01
GAMMA-CHLORDANE	0/1	---	0.05	---	0	2	0.19	2	0.0043	0.00029
HEPTACHLOR	0/1	---	0.03	---	0	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/1	---	0.83	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/1	---	6	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/5	---	1.8	---	0	40	180	40	---	0.005
METHYL PARATHION	0/1	---	1.2	---	0	---	9.1	---	---	---
PHORATE	0/1	---	0.4	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/5	---	2.4	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	0/4	---	10-30	---	0	50-200[7,13]	37000	---	87	---
ANTIMONY	3/4	12.3-18.4	3	02-03 (91b) (06/01/91)	3	6	15	---	---	31
ARSENIC	0/10	---	1-10	---	0	50	0.045	50	150	53
BARIUM	6/10	15-1200	100	02-03 (86a) (02/03/86)	0	2000	2600	2000	---	5000
BERYLLIUM	0/4	---	1	---	0	4	0.016	4	---	7.6
CADMIUM	1/10	0.28	0.4-10	02-03 (92) (03/28/92)	0	5	18	5	2.2	0.66
CALCIUM	4/4	172000-190000	---	02-03 (92) (03/28/92)	0	---	---	---	---	---
CHROMIUM (TOTAL)	2/10	20	5-20	02-03 (81) (11/30/81)	2	100	180	100	11[4]	42
COBALT	3/4	13-37	6	02-03 (92) (03/28/92)	3	---	2200	---	---	5
COPPER	1/4	40	5	02-03 (91c) (11/13/91)	1	1300	1400	---	9	5
CYANIDE	0/3	---	5	---	0	200	730	---	5.2[16]	5.2
IRON	4/12	13-240	10-40	02-03 (81) (11/30/81)	0	300[7,13]	11000	---	---	---
LEAD	1/10	1.2	1-30	02-03 (91b) (06/01/91)	0	15[15]	4	---	2.5	1.3
MAGNESIUM	4/4	47200-59900	---	02-03 (92) (03/28/92)	0	---	---	---	---	---
MANGANESE	14/15	19-7000	5	02-03 (81) (11/30/81)	11	50[7,13]	1700	---	---	---
MERCURY	2/10	0.7-900	0.2-0.3	02-03 (82d) (10/19/82)	2	2	11	2	0.77	0.0013

TABLE 5-4

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER HARDINSBURG AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 5 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
NICKEL	1/4	5	5	02-03 (92) (03/28/92)	0	100	730	100	52	29
POTASSIUM	4/4	3390-5790	---	02-03 (91b) (06/01/91)	0	---	---	---	---	---
SELENIUM	1/10	2	2-5	02-03 (86a) (02/03/86)	0	50	180	50	5	5
SILVER	0/10	---	1-10	---	0	100[7,13]	180	183	---	1
SODIUM	12/12	14100-43000	---	02-03 (84) (02/01/84)	0	---	---	---	---	---
THALLIUM	0/4	---	2-8	---	0	2	2.9[17]	2	---	0.56
TIN	0/4	---	35-50	---	0	---	22000	---	---	73
VANADIUM	1/4	11	5-10	02-03 (91c) (11/13/91)	0	---	260	---	---	19
ZINC	0/4	---	5-10	---	0	5000[7,13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L, unless otherwise noted)										
CHLORIDE	7/8	1100-2400	1000	02-03 (86a) (02/03/86)	0	250000[7,13]	---	---	---	---
FLUORIDE	5/5	190-430	---	02-03 (81) (11/30/81)	3	---	---	---	230	---
NITRATE, AS NITROGEN	2/5	100-120	20-50	02-03 (82d) (10/19/82)	0	10000	10000	---	---	---
NITRITE, AS NITROGEN	1/1	9	---	02-03 (92) (03/28/92)	0	1000	1000[18]	---	---	---
ORGANIC BROMINE	0/3	---	2-10	---	0	---	---	---	---	---
ORGANIC CHLORINE	1/3	50	10	02-03 (84) (02/01/84)	0	---	---	---	---	---
ORGANIC IODINE	1/3	3	10	02-03 (84) (02/01/84)	0	---	---	---	---	---
pH (standard units)	10/10	6.3-7.6	---	02-03 (85a) (01/08/85)	0	---	---	---	6.5-9	---
PHENOLS	4/8	10-100	4-10	02-03 (85a) (01/08/85)	0	---	---	---	---	---
SPECIFIC CONDUCTIVITY (uhmo/cm)	11/11	640-1550	---	02-03 (81) (11/30/81)	0	---	---	---	---	---
SULFATE	11/11	340000-750000	---	02-03 (83b) (02/28/83)	1	500000	---	---	---	---
SULFIDE	0/3	---	20	---	0	2	---	---	2	---
TOTAL ORGANIC CARBON	10/11	2000-66000	1000	02-03 (83b) (02/28/83)	0	---	---	---	---	---

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).

TABLE 5-4

HISTORICAL DATA SUMMARY - GROUND WATER, UPPER HARDINSBURG AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 6 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]

7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable but not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

TABLE 5-5

HISTORICAL DATA SUMMARY - GROUND WATER, GOLCONDA/HANEY AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	1/35	1.5	5	02C12P2 (91a) (03/16/91)	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/35	---	5	---	0	---	0.055	0.896	---	13
1,1,2-TRICHLOROETHANE	0/35	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/35	---	5	---	0	---	810	2090	---	47
1,1-DICHLOROETHENE	0/35	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/35	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/35	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/35	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/35	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	1/35	2	5-50	02C11P2 (91c) (11/13/91)	0	---	160	---	---	3680
ACETONE	26/35	1.7-7840	5-100	02C14P2 (88) (06/27/88)	**4**	---	610	768	---	78000
BENZENE	12/35	1.1-9	5	02C20P2 (91a) (03/16/91)	**12**	5	0.39	5	---	114
BROMODICHLOROMETHANE	0/35	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/35	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/35	---	10	---	0	---	8.7	24.9	---	---
CARBON DISULFIDE	0/35	---	5	---	0	---	1000	2380	---	84.1
CARBON TETRACHLORIDE	0/35	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/35	---	5	---	0	100	39	100	20[7]	10
CHLOROETHANE	0/35	---	10-1000	---	0	---	8600	---	---	230000
CHLOROFORM	0/35	1-11	5	02C13 (88) (06/27/88)	**8**	80[6]	0.16	100	---	79
CHLOROMETHANE	0/35	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/28	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/35	---	5	---	0	---	0.081[8]	---	---	7.9
DIBROMOCHLOROMETHANE	0/35	---	5	---	0	80[6]	1	---	---	6400
ETHYLBENZENE	0/35	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	29/35	0.5-27	5	02C18 (88) (06/27/88)	**15**	5	4.3	5	---	430
STYRENE	0/35	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/35	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	2/35	1-1.8	5	02C14P2 (91a) (03/16/91)	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/35	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/35	---	5-5.8	---	0	---	0.081[8]	---	---	7.9
TRICHLOROETHENE	0/35	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/35	---	50	---	0	---	410	1850	---	248.03
VINYL CHLORIDE	0/35	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	4/35	2	5	02C11P2 (91c) (11/13/91)	0	10000	1400[9]	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/21	---	10-30	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/21	---	10-30	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/21	---	10-150	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/21	---	10-30	---	0	600	17	231	---	87
1,4-DICHLOROBENZENE	0/21	---	10-30	---	0	75	0.47	75	---	43

TABLE 5-5

HISTORICAL DATA SUMMARY - GROUND WATER, GOLCONDA/HANEY AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2,4,5-TRICHLOROPHENOL	0/16	---	10-18	---	0	---	3700	3650	---	---
2,4,6-TRICHLOROPHENOL	0/21	---	10-30	---	0	---	6.1	77.4	1[7]	2
2,4-DICHLOROPHENOL	0/21	---	10-30	---	0	---	110	110	2[7]	18
2,4-DIMETHYLPHENOL	0/21	---	10-30	---	0	---	730	730	0.3[7]	100.17
2,4-DINITROPHENOL	0/21	---	50-150	---	0	---	73	73	400[7]	4.07
2-CHLORONAPHTHALENE	0/21	---	10-30	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/21	---	10-30	---	0	---	38	38.4	---	8.8
2-METHYL-4,6-DINITROPHENOL	0/21	---	10-150	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/16	---	10-18	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/16	---	10-18	---	0	---	1800	1830	---	---
2-NITROANILINE	0/16	---	50-90	---	0	---	2.2	10	---	---
2-NITROPHENOL	0/21	---	10-30	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/21	---	10-46	---	0	---	0.15	1.89	---	99.75
3-NITROANILINE	0/16	---	50-90	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/21	---	10-30	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/21	---	20-60	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/16	---	20-36	---	0	---	150	146	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/21	---	10-30	---	0	---	---	---	---	---
4-METHYLPHENOL	0/16	---	10-18	---	0	---	180	183	---	---
4-NITROANILINE	0/16	---	50-90	---	0	---	---	---	---	---
4-NITROPHENOL	0/21	---	50-150	---	0	---	2300	---	---	35
ACENAPHTHENE	0/21	---	10-30	---	0	---	370	461	---	9.9
ACENAPHTHYLENE	0/21	---	10-30	---	0	---	---	---	---	4840
ANILINE	0/16	---	20-36	---	0	---	12	---	---	0.44
ANTHRACENE	0/21	---	10-30	---	0	---	1800	43.4	---	0.029
BENZIDINE	0/21	---	20-115	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/21	---	10-30	---	0	---	0.092	1.17	---	0.839
BENZO(A)PYRENE	0/21	---	10-30	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/21	---	10-30	---	0	---	0.092	1.17	---	9.07
BENZO(G,H,I)PERYLENE	0/21	---	10-30	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/21	---	10-30	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/16	---	50-90	---	0	---	150000	146000	---	---
BENZYL ALCOHOL	0/16	---	20-36	---	0	---	11000	11000	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/21	---	10-230	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/21	---	10-30	---	0	---	0.0098	0.3	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/21	---	10-30	---	0	---	0.27	4.23	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	18/21	1.7-91	10-30	02C11P2 (88) (06/27/88)	17	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/21	---	10-30	---	0	---	7300	2690	---	49
CHRYSENE	0/21	---	10-30	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/21	---	10-30	---	0	---	0.0092	0.117	---	0.0016
DIBENZOFURAN	0/16	---	10-18	---	0	---	24	---	---	20
DIETHYL PHTHALATE	1/21	4.4	10-30	02C13 (91b) (06/01/91)	1	---	29000	29200	---	3

TABLE 5-5

HISTORICAL DATA SUMMARY - GROUND WATER, GOLCONDA/HANEY AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
DIMETHYL PHTHALATE	0/21	---	10-30	---	0	---	370000	365000	---	73
DI-N-BUTYL PHTHALATE	0/21	---	10-30	---	0	---	3700	3650	---	3
DI-N-OCTYL PHTHALATE	0/21	---	10-30	---	0	---	730	20	---	30
FLUORANTHENE	0/21	---	10-30	---	0	---	1500	206	---	8.1
FLUORENE	0/21	---	10-30	---	0	---	240	307	---	3.9
HEXACHLOROBENZENE	0/21	---	10-30	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/21	---	10-30	---	0	---	0.86	7.3	1[7]	0.134
HEXACHLOROCYCLOPENTADIENE	0/21	---	10-30	---	0	50	260	50	---	77.04
HEXACHLOROETHANE	0/21	---	10-30	---	0	---	4.8	7.68	---	30.5
INDENO(1,2,3-CD)PYRENE	0/21	---	10-30	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/21	---	10-30	---	0	---	71	896	---	900
NAPHTHALENE	0/21	---	10-30	---	0	---	6.2	307	---	44
NITROBENZENE	0/21	---	10-30	---	0	---	3.4	9.42	30[7]	740
N-NITROSODIMETHYLAMINE	0/21	---	10-50	---	0	---	0.0013	---	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/21	---	10-30	---	0	---	0.0096	0.46	---	---
N-NITROSODIPHENYLAMINE	0/21	---	10-30	---	0	---	14	174	---	13
PENTACHLOROPHENOL	0/21	---	10-150	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/21	---	10-30	---	0	---	---	---	---	2.1
PHENOL	0/16	---	10-18	---	0	---	22000	21900	300[7]	100
PYRENE	0/21	---	10-30	---	0	---	180	135	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/6	---	20	---	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/6	---	20	---	0	---	3.7	---	---	2.36
2,4-DINITROTOLUENE	0/20	---	0.02-20	---	0	---	73	1.25	---	230
2,6-DINITROTOLUENE	0/6	---	0.02-20	---	0	---	37	1.25	---	42
2,4,6-TRINITROTOLUENE	0/20	---	20	---	0	---	2.2	---	---	---
HMX	0/20	---	20	---	0	---	1800	---	---	---
RDX	0/20	---	20	---	0	---	0.61	---	---	---
TETRYL	0/20	---	50	---	0	---	370	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	5/11	0.01-0.14	1.9-3.1	02C12P2 (91a) (03/16/91)	0	---	370	---	---	686.33
2,4,5-TP (SILVEX)	6/11	0.43-0.76	1.7-3.1	02C12P2 (91a) (03/16/91)	0	50	290	---	---	326.64
2,4-D	2/11	0.02-0.25	0-19	02C12P2 (91a) (03/16/91)	0	70	370	---	---	---
4,4'-DDD	0/15	---	0.11-0.12	---	0	---	0.28	3.55	---	0.0011
4,4'-DDE	1/15	0.01	0.04-0.4	02C17 (91b) (06/01/91)	1	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/15	---	0.11-0.13	---	0	---	0.2	2.5	0.001	0.000952
ALDRIN	0/15	---	0.04	---	0	---	0.004	0.0501	---	0.0185
ALPHA-BHC	0/15	---	0.03	---	0	---	0.011	0.135	---	12.38
ALPHA-CHLORDANE	0/15	---	0.04-0.06	---	0	2	0.19	2	0.0043	0.00029
AROCLOR-1016	0/15	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1221	0/15	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1232	0/15	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1242	0/15	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029

TABLE 5-5

HISTORICAL DATA SUMMARY - GROUND WATER, GOLCONDA/HANEY AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 4 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
AROCLOR-1248	0/15	---	0.6-0.7	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1254	6/15	0.19-1.2	1.2-1.3	02C12P2 (91c) (11/13/91)	**6**	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1260	0/15	---	1.2-1.4	---	0	0.5	0.034	0.5	0.014	0.000029
BETA-BHC	0/15	---	0.06-0.07	---	0	---	0.037	0.473	---	0.495
DELTA-BHC	0/15	---	0.09-0.1	---	0	---	---	---	---	666.67
DIELDRIN	0/15	---	0.02	---	0	---	0.0042	0.0532	0.0019	0.000026
DINOSEB	2/11	0.03-0.71	0-1.1	02C22P2 (91a) (03/16/91)	**1**	7	37	---	---	0.39
DISULFOTON	0/15	---	0.67-0.77	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/15	---	0.13-0.15	---	0	---	220	219	0.056	0.003
ENDOSULFAN II	0/15	---	0.04	---	0	---	220	219	0.056	0.003
ENDOSULFAN SULFATE	0/15	---	0.63-0.74	---	0	---	---	---	---	2.22
ENDRIN	0/15	---	0.06-0.07	---	0	2	11	0.2	0.0023	0.002
ENDRIN ALDEHYDE	0/15	---	0.22-0.25	---	0	---	---	---	---	0.15
ETHYL PARATHION	0/15	---	0.57-0.66	---	0	---	---	---	---	---
FAMPHUR	0/15	---	1.1-1.3	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/15	---	0.04	---	0	0.2	0.052	0.2	0.08	0.01
GAMMA-CHLORDANE	1/15	0.02	0.04-0.06	02C12P2 (91c) (11/13/91)	**1**	2	0.19	2	0.0043	0.00029
HEPTACHLOR	4/15	0.01-0.08	0.03	02C14P2 (91b) (06/01/91)	**4**	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/15	---	0.79-0.91	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/15	---	5.7-6.6	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/15	---	1.7-1.9	---	0	40	180	40	---	0.005
METHYL PARATHION	0/15	---	1.1-1.3	---	0	---	9.1	---	---	---
PHORATE	0/15	---	0.38-0.44	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/15	---	2.3-2.6	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	4/37	18-310	10-30	02C19 (91b) (06/01/91)	**3**	50-200[7,13]	37000	---	87	---
ANTIMONY	28/44	3.3-23.4	3-50	02C13 (91b) (06/01/91)	**25**	6	15	---	---	31
ARSENIC	6/44	2.4-24	2-5	02C18 (88) (06/27/88)	**6**	50	0.045	50	150	53
BARIUM	34/37	11-84	10	02C14P2 (92) (03/28/92)	0	2000	2600	2000	---	5000
BERYLLIUM	1/44	1	1-5	02C11P2 (92) (03/28/92)	**1**	4	0.016	4	---	7.6
CADMIUM-	6/44	0.3-2.26	0.1-4	02C11P2 (92) (03/28/92)	**3**	5	18	5	2.2	0.66
CALCIUM	36/37	7600-266000	100	2C14P2 (91c) (11/13/91)-AV	0	---	---	---	---	---
CHROMIUM (TOTAL)	11/44	1-12	1-5	02C14P2 (88) (06/27/88)	**1**	100	180	100	11[4]	42
COBALT	29/37	7-75	6-20	02C11P2 (92) (03/28/92)	**29**	---	2200	---	---	5
COPPER	26/44	1-230	1-5	02C12P2 (92) (03/28/92)	**23**	1300	1400	---	9	5
CYANIDE	0/28	---	0.5-5	---	0	200	730	---	5.2[16]	5.2
IRON	10/37	10-549	10-40	02C19 (91b) (06/01/91)	**2**	300[7,13]	11000	---	---	---
LEAD	13/44	1-26	1	02C14P2 (88) (06/27/88)	**10**	15[15]	4	---	2.5	1.3
MAGNESIUM	36/37	142-106000	150	02C19 (92) (03/28/92)	0	---	---	---	---	---
MANGANESE	26/37	6-415	5	02C11P2 (91a) (03/16/91)	**8**	50[7,13]	1700	---	---	---
MERCURY	0/44	---	0.2-8	---	0	2	11	2	0.77	0.0013
NICKEL	19/44	1-299	5	02C11P2 (92) (03/28/92)	**5**	100	730	100	52	29

TABLE 5-5

HISTORICAL DATA SUMMARY - GROUND WATER, GOLCONDA/HANEY AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 5 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
POTASSIUM	37/37	3810-50500	---	02C16 (91a) (03/16/91)	0	---	---	---	---	---
SELENIUM	16/44	2.2-58	2-5	02C13 (91c) (11/13/91)	11	50	180	50	5	5
SILVER	0/44	---	1	---	0	100[7,13]	180	183	---	1
SODIUM	44/44	2450-106000	---	02C18 (91c) (11/13/91)	0	---	---	---	---	---
THALLIUM	0/44	---	1-8	---	0	2	2.9[17]	2	---	0.56
TIN	0/37	---	35-50	---	0	---	22000	---	---	73
VANADIUM	3/37	7-17	5-10	02C12P2 (92) (03/28/92)	0	---	260	---	---	19
ZINC	11/44	7-428	5-30	02C11P2 (92) (03/28/92)	5	5000[7,13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L, unless otherwise noted)										
AMMONIA, AS NITROGEN	7/7	222-1940	10	02C14P2 (88) (06/27/88)	1	1000	1000	---	---	---
CHLORIDE	7/7	6700-48200	---	02C11P2 (88) (06/27/88)	8	250000[7,13]	---	---	230	---
NITRATE, AS NITROGEN	14/16	44-10600	20	02C18 (92) (03/28/92)	1	10000	10000	---	---	---
NITRITE, AS NITROGEN	8/10	5-106	5	02C20P2 (92) (03/28/92)	0	1000[18]	1000[18]	---	---	---
PHENOLS	0/5	---	10-30	---	0	---	---	---	---	---
SULFATE	7/7	13700-342000	---	02C11P2 (88) (06/27/88)	0	500000	---	---	---	---
SULFIDE	5/28	25-93	20	02C18 (91c) (11/13/91)	5	2	---	---	2	---
TOTAL KJELDAHL NITROGEN	7/7	586-7780	---	02C16 (88) (06/27/88)	4	1000[18]	1000[18]	---	---	---
TOTAL ORGANIC CARBON	6/7	1100-7000	1000	02C16 (88) (06/27/88)	0	---	---	---	---	---

Note: Does not include samples collected from the upgradient well cluster 02C10, which are considered to represent upgradient site conditions not impacted by site operations.

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable but not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.

TABLE 5-5

HISTORICAL DATA SUMMARY - GROUND WATER, GOLCONDA/HANEY AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 6 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]

10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

TABLE 5-6

HISTORICAL DATA SUMMARY - GROUND WATER, BEECH CREEK AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/14	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/14	---	5	---	0	---	0.055	0.896	---	13
1,1,2-TRICHLOROETHANE	0/14	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/14	---	5	---	0	---	810	2090	---	47
1,1-DICHLOROETHENE	0/14	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/14	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/14	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/14	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/14	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/14	4	50	02C11 (91c) (11/13/91)	0	---	160	---	---	3680
ACETONE	10/14	4.4-2670	100	02C11 (88) (06/27/88)	1	---	610	768	---	78000
BENZENE	4/14	0.92-8.6	5	02C12 (91a) (03/16/91)	4	5	0.39	5	---	114
BROMODICHLOROMETHANE	0/14	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/14	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/14	---	10	---	0	---	8.7	24.9	---	---
CARBON DISULFIDE	0/14	---	5	---	0	---	1000	2380	---	84.1
CARBON TETRACHLORIDE	0/14	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/14	---	5	---	0	100	39	100	20[7]	10
CHLOROETHANE	0/14	---	10	---	0	---	8600	---	---	230000
CHLOROFORM	0/14	---	5	---	0	80[6]	0.16	100	---	79
CHLOROMETHANE	0/14	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/12	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/14	---	5	---	0	---	0.081[8]	---	---	7.9
DIBROMOCHLOROMETHANE	0/14	---	5	---	0	80[6]	1	---	---	6400
ETHYLBENZENE	0/14	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	12/14	0.5-13	5	02C09 (91c) (11/13/91)	8	5	4.3	5	---	430
STYRENE	0/14	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/14	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	3/14	2-3.5	5	02C12 (91a) (03/16/91)	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/14	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/14	---	5	---	0	---	0.081[8]	---	---	7.9
TRICHLOROETHENE	0/14	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/14	---	50	---	0	---	410	1850	---	248.03
VINYL CHLORIDE	0/14	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	1/14	2	5	02C12 (91c) (11/13/91)	0	10000	1400[9]	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/8	---	10-13	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/8	---	10-13	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/8	---	10-13	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/8	---	10-13	---	0	600	17	231	---	87
1,4-DICHLOROBENZENE	1/8	54	10	02C11 (88) (06/27/88)	1	75	0.47	75	---	43

TABLE 5-6

HISTORICAL DATA SUMMARY - GROUND WATER, BEECH CREEK AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2,4,5-TRICHLOROPHENOL	0/6	---	10	---	0	---	3700	3650	---	---
2,4,6-TRICHLOROPHENOL	0/8	---	10-13	---	0	---	6.1	77.4	1[7]	2
2,4-DICHLOROPHENOL	0/8	---	10-13	---	0	---	110	110	2[7]	18
2,4-DIMETHYLPHENOL	0/8	---	10-13	---	0	---	730	730	0.3[7]	100.17
2,4-DINITROPHENOL	0/8	---	50-65	---	0	---	73	73	400[7]	4.07
2-CHLORONAPHTHALENE	0/8	---	10-13	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/8	---	10-13	---	0	---	38	38.4	---	8.8
2-METHYL-4,6-DINITROPHENOL	0/8	---	50-65	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/6	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/6	---	10	---	0	---	1800	1830	---	---
2-NITROANILINE	0/6	---	50	---	0	---	2.2	10	---	---
2-NITROPHENOL	0/8	---	10-13	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/8	---	20-26	---	0	---	0.15	1.89	---	99.75
3-NITROANILINE	0/6	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/8	---	10-13	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/8	---	20-26	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/6	---	20	---	0	---	150	146	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/8	---	10-13	---	0	---	---	---	---	---
4-METHYLPHENOL	0/6	---	10	---	0	---	180	183	---	---
4-NITROANILINE	0/6	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/8	---	50-65	---	0	---	2300	---	---	35
ACENAPHTHENE	0/8	---	10-13	---	0	---	370	461	---	9.9
ACENAPHTHYLENE	0/8	---	10-13	---	0	---	---	---	---	4840
ANILINE	0/6	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/8	---	10-13	---	0	---	1800	43.4	---	0.029
BENZIDINE	0/8	---	50-65	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/8	---	10-13	---	0	---	0.092	1.17	---	0.839
BENZO(A)PYRENE	0/8	---	10-13	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/8	---	10-13	---	0	---	0.092	1.17	---	9.07
BENZO(G,H,I)PERYLENE	0/8	---	10-13	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/8	---	10-13	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/6	---	50	---	0	---	150000	146000	---	---
BENZYL ALCOHOL	0/6	---	20	---	0	---	11000	11000	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/8	---	10-13	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/8	---	10-13	---	0	---	0.0098	0.3	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/8	---	10-13	---	0	---	0.27	4.23	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	8/8	1.4-1460	---	02C11 (88) (06/27/88)	**6**	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	1/8	17	10	02C11 (88) (06/27/88)	0	---	7300	2690	---	49
CHRYSENE	0/8	---	10-13	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/8	---	10-13	---	0	---	0.0092	0.117	---	0.0016
DIBENZOFURAN	0/6	---	10	---	0	---	24	---	---	20
DIETHYL PHTHALATE	0/8	---	10-13	---	0	---	29000	29200	---	3

TABLE 5-6

HISTORICAL DATA SUMMARY - GROUND WATER, BEECH CREEK AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
DIMETHYL PHTHALATE	0/8	---	10-13	---	0	---	370000	365000	---	73
DI-N-BUTYL PHTHALATE	0/8	---	10-13	---	0	---	3700	3650	---	3
DI-N-OCTYL PHTHALATE	1/8	29	10	02C11 (88) (06/27/88)	1	---	730	20	---	30
FLUORANTHENE	0/8	---	10-13	---	0	---	1500	206	---	8.1
FLUORENE	0/8	---	10-13	---	0	---	240	307	---	3.9
HEXACHLOROBENZENE	0/8	---	10-13	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/8	---	10-13	---	0	---	0.86	7.3	1[7]	0.134
HEXACHLOROCYCLOPENTADIENE	0/8	---	10-13	---	0	50	260	50	---	77.04
HEXACHLOROETHANE	0/8	---	10-13	---	0	---	4.8	7.68	---	30.5
INDENO(1,2,3-CD)PYRENE	0/8	---	10-13	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/8	---	10-13	---	0	---	71	896	---	900
NAPHTHALENE	0/8	---	10-13	---	0	---	6.2	307	---	44
NITROBENZENE	0/8	---	10-13	---	0	---	3.4	9.42	30[7]	740
N-NITROSODIMETHYLAMINE	0/8	---	10-13	---	0	---	0.0013	---	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/8	---	10-13	---	0	---	0.0096	0.46	---	---
N-NITROSODIPHENYLAMINE	0/8	---	10-13	---	0	---	14	174	---	13
PENTACHLOROPHENOL	0/8	---	50-65	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/8	---	10-13	---	0	---	---	---	---	2.1
PHENOL	0/6	---	10	---	0	---	22000	21900	300[7]	100
PYRENE	0/8	---	10-13	---	0	---	180	135	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/3	---	20	---	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/3	---	20	---	0	---	3.7	---	---	2.36
2,4-DINITROTOLUENE	0/10	---	0.02-20	---	0	---	73	1.25	---	230
2,6-DINITROTOLUENE	0/3	---	0.02-20	---	0	---	37	1.25	---	42
2,4,6-TRINITROTOLUENE	0/10	---	20	---	0	---	2.2	---	---	---
HMX	0/10	---	20	---	0	---	1800	---	---	---
RDX	0/10	---	20	---	0	---	0.61	---	---	---
TETRYL	0/10	---	50	---	0	---	370	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	1/3	0.27	1.9-2.4	02C14 (91a) (03/16/91)	0	---	370	---	---	686.33
2,4,5-TP (SILVEX)	1/3	3.5	1.7-2	02C14 (91a) (03/16/91)	0	50	290	---	---	326.64
2,4-D	1/3	0.05	12-14	02C14 (91a) (03/16/91)	0	70	370	---	---	---
4,4'-DDD	0/9	---	0-0.13	---	0	---	0.28	3.55	---	0.0011
4,4'-DDE	0/9	---	0.04-0.4	---	0	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/9	---	0.11-0.15	---	0	---	0.2	2.5	0.001	0.000952
ALDRIN	0/9	---	0.04-0.05	---	0	---	0.004	0.0501	---	0.0185
ALPHA-BHC	0/9	---	0.03-0.04	---	0	---	0.011	0.135	---	12.38
ALPHA-CHLORDANE	0/9	---	0.05-0.06	---	0	2	0.19	2	0.0043	0.00029
AROCLOR-1016	0/9	---	0.6-0.8	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1221	0/9	---	0.6-0.8	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1232	0/9	---	0.6-0.8	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1242	0/9	---	0.6-0.8	---	0	0.5	0.034	0.5	0.014	0.000029

TABLE 5-6

HISTORICAL DATA SUMMARY - GROUND WATER, BEECH CREEK AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 4 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
AROCLOR-1248	0/9	---	0.6-0.8	---	0	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1254	4/9	0.13-1.3	1.2-1.6	02C12 (91c) (11/13/91)	4	0.5	0.034	0.5	0.014	0.000029
AROCLOR-1260	0/9	---	1.2-1.6	---	0	0.5	0.034	0.5	0.014	0.000029
BETA-BHC	0/9	---	0.06-0.07	---	0	---	0.037	0.473	---	0.495
DELTA-BHC	0/9	---	0.09-0.11	---	0	---	---	---	---	666.67
DIELDRIN	0/9	---	0.02	---	0	---	0.0042	0.0532	0.0019	0.000026
DINOSEB	1/3	0.04	0.68-0.83	02C14 (91a) (03/16/91)	0	7	37	---	---	0.39
DISULFOTON	0/9	---	0.67-0.85	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/9	---	0.13-0.17	---	0	---	220	219	0.056	0.003
ENDOSULFAN II	0/9	---	0.04-0.05	---	0	---	220	219	0.056	0.003
ENDOSULFAN SULFATE	0/9	---	0.63-0.8	---	0	---	---	---	---	2.22
ENDRIN	0/9	---	0.06-0.07	---	0	2	11	0.2	0.0023	0.002
ENDRIN ALDEHYDE	0/9	---	0.22-0.28	---	0	---	---	---	---	0.15
ETHYL PARATHION	0/9	---	0.57-0.73	---	0	---	---	---	---	---
FAMPHUR	0/9	---	1.1-1.5	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/9	---	0.04-0.05	---	0	0.2	0.052	0.2	0.08	0.01
GAMMA-CHLORDANE	1/9	0.02	0.05-0.06	02C12 (91c) (11/13/91)	1	2	0.19	2	0.0043	0.00029
HEPTACHLOR	0/9	---	0.03-0.04	---	0	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/9	---	0.79-1	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/9	---	5.7-7.3	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/9	---	1.7-2.1	---	0	40	180	40	---	0.005
METHYL PARATHION	0/9	---	1.1-1.5	---	0	---	9.1	---	---	---
PHORATE	0/9	---	0.38-0.49	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/9	---	2.3-2.9	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	2/17	23-64	10-30	02C20 (91c) (11/13/91)	1	50-200[7,13]	37000	---	87	---
ANTIMONY	13/19	4.1-39	3-5	02C11 (91b) (06/01/91)	12	6	15	---	---	31
ARSENIC	11/19	2-21.7	2-5	02C12 (91c) (11/13/91)	11	50	0.045	50	150	53
BARIUM	15/17	12-60	10-20	02C14 (92) (03/28/92)	0	2000	2600	2000	---	5000
BERYLLIUM	0/19	---	1-5	---	0	4	0.016	4	---	7.6
CADMIUM	2/19	0.29-3.26	0.1-4	02C09 (92) (03/28/92)	1	5	18	5	2.2	0.66
CALCIUM	17/17	4320-287000	---	02C12 (92) (03/28/92)	0	---	---	---	---	---
CHROMIUM (TOTAL)	8/19	1-15	5	02C11 (88) (06/27/88)	3	100	180	100	11[4]	42
COBALT	10/17	20-46	6-20	02C11 (92) (03/28/92)	10	---	2200	---	---	5
COPPER	12/19	5-172	1-5	02C20 (92) (03/28/92)	12	1300	1400	---	9	5
CYANIDE	0/11	---	5	---	0	200	730	---	5.2[16]	5.2
IRON	5/17	24-241	10-40	02C12 (92) (03/28/92)	0	300[7,13]	11000	---	---	---
LEAD	9/19	1-32	1	02C11 (88) (06/27/88)	7	15[15]	4	---	2.5	1.3
MAGNESIUM	17/17	114-230000	---	02C12 (92) (03/28/92)	0	---	---	---	---	---
MANGANESE	12/17	5-1380	5	02C12 (92) (03/28/92)	1	50[7,13]	1700	---	---	---
MERCURY	0/19	---	0.2-2	---	0	2	11	2	0.77	0.0013
NICKEL	7/19	5-34	5	02C12 (92) (03/28/92)	1	100	730	100	52	29

TABLE 5-6

HISTORICAL DATA SUMMARY - GROUND WATER, BEECH CREEK AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 5 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
POTASSIUM	17/17	4310-650000	---	02C12 (91c) (11/13/91)	0	---	---	---	---	---
SELENIUM	11/19	2-14	2	02C11 (88) (06/27/88)	6	50	180	50	5	5
SILVER	0/19	---	1	---	0	100[7,13]	180	183	---	1
SODIUM	17/17	52500-247000	---	02C12 (91c) (11/13/91)	0	---	---	---	---	---
THALLIUM	0/19	---	1-8	---	0	2	2.9[17]	2	---	0.56
TIN	0/17	---	35-50	---	0	---	22000	---	---	73
VANADIUM	4/17	11-21	5-10	02C20 (92) (03/28/92)	3	---	260	---	---	19
ZINC	2/19	11-38	5-30	02C11 (88) (06/27/88)	0	5000[7,13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L, unless otherwise noted)										
AMMONIA, AS NITROGEN	2/2	3420	---	02C11 (88) (06/27/88)	2	1000	1000	---	---	---
CHLORIDE	1/2	18400	5000	02C11 (88) (06/27/88)	1	250000[7,13]	---	---	230	---
NITRATE, AS NITROGEN	5/7	60-2870	20	02C20 (92) (03/28/92)	0	10000	10000	---	---	---
NITRITE, AS NITROGEN	5/5	6-210	---	02C14 (92) (03/28/92)	0	1000[18]	1000[18]	---	---	---
PHENOLS	0/2	---	10-130	---	0	---	---	---	---	---
SULFATE	2/2	205000-392000	---	02C11 (88) (06/27/88)	0	500000	---	---	---	---
SULFIDE	1/11	28	20	02C14 (91c) (11/13/91)	1	2	---	---	2	---
TOTAL KJELDAHL NITROGEN	2/2	339-5400	---	02C11 (88) (06/27/88)	1	1000[18]	1000[18]	---	---	---
TOTAL ORGANIC CARBON	1/2	21800	1000	02C11 (88) (06/27/88)	0	---	---	---	---	---

Note: Does not include samples collected from the upgradient well cluster 02C10, which are considered to represent upgradient site conditions not impacted by site operations.

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

TABLE 5-6

HISTORICAL DATA SUMMARY - GROUND WATER, BEECH CREEK AQUIFER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 6 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA; December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable but not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

TABLE 5-7

HISTORICAL DATA SUMMARY - SPRING WATER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/1	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/1	---	5	---	0	---	0.055	0.896	---	13
1,1,2-TRICHLOROETHANE	0/1	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/1	---	5	---	0	---	810	2090	---	47
1,1-DICHLOROETHENE	0/1	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/1	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/1	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/1	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/1	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/1	---	50	---	0	---	160	---	---	3680
ACETONE	0/1	---	100	---	0	---	610	768	---	78000
BENZENE	0/1	---	5	---	0	5	0.39	5	---	114
BROMODICHLOROMETHANE	0/1	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/1	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/1	---	10	---	0	---	8.7	24.9	---	---
CARBON DISULFIDE	0/1	---	5	---	0	---	1000	2380	---	84.1
CARBON TETRACHLORIDE	0/1	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/1	---	5	---	0	100	39	100	20[7]	10
CHLOROETHANE	0/1	---	10	---	0	---	8600	---	---	230000
CHLOROFORM	0/1	---	5	---	0	80[6]	0.16	100	---	79
CHLOROMETHANE	0/1	---	10	---	0	---	1.5	---	---	---
CIS-1,3-DICHLOROPROPENE	0/1	---	5	---	0	70	61	70	---	---
DIBROMOCHLOROMETHANE	0/1	---	5	---	0	80[6]	1	---	---	6400
ETHYLBENZENE	0/1	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	0/1	---	5	---	0	5	4.3	5	---	430
STYRENE	0/1	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/1	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/1	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/1	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/1	---	5	---	0	---	0.081[8]	---	---	7.9
TRICHLOROETHENE	0/1	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/1	---	50	---	0	---	410	1850	---	248.03
VINYL CHLORIDE	0/1	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	0/1	---	5000	---	0	10000	1400[9]	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/1	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/1	---	10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/1	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/1	---	10	---	0	600	17	231	---	87
1,4-DICHLOROBENZENE	0/1	---	10	---	0	75	0.47	75	---	43
2,4,6-TRICHLOROPHENOL	0/1	---	10	---	0	---	6.1	77.4	1[7]	2

TABLE 5-7

HISTORICAL DATA SUMMARY - SPRING WATER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2,4-DICHLOROPHENOL	0/1	---	10	---	0	---	110	110	2[7]	18
2,4-DIMETHYLPHENOL	0/1	---	10	---	0	---	730	730	0.3[7]	100.17
2,4-DINITROPHENOL	0/1	---	50	---	0	---	73	73	400[7]	4.07
2,4-DINITROTOLUENE	0/1	---	10	---	0	---	73	1.25	---	230
2,6-DINITROTOLUENE	0/1	---	10	---	0	---	37	1.25	---	42
2-CHLORONAPHTHALENE	0/1	---	10	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/1	---	10	---	0	---	38	38.4	---	8.8
2-METHYL-4,6-DINITROPHENOL	0/1	---	50	---	0	---	---	---	---	---
2-NITROPHENOL	0/1	---	10	---	0	---	0.15	1.89	---	99.75
3,3'-DICHLOROBENZIDINE	0/1	---	20	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/1	---	10	---	0	---	---	---	3000[7]	20
4-CHLORO-3-METHYLPHENOL	0/1	---	20	---	0	---	150	146	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/1	---	10	---	0	---	180	183	---	---
4-NITROPHENOL	0/1	---	50	---	0	---	370	461	---	9.9
ACENAPHTHENE	0/1	---	10	---	0	---	---	---	---	4840
ACENAPHTHYLENE	0/1	---	10	---	0	---	12	---	---	0.44
ANTHRACENE	0/1	---	10	---	0	---	1800	43.4	---	0.029
BENZIDINE	0/1	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/1	---	10	---	0	---	0.092	1.17	---	0.839
BENZO(A)PYRENE	0/1	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/1	---	10	---	0	---	0.092	1.17	---	9.07
BENZO(G,H,I)PERYLENE	0/1	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/1	---	10	---	0	---	0.92	0.8	---	0.0056
BIS(2-CHLOROETHOXY)METHANE	0/1	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/1	---	10	---	0	---	0.0098	0.3	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/1	---	10	---	0	---	0.27	4.23	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	0/1	---	10	---	0	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/1	---	10	---	0	---	7300	2690	---	49
CHRYSENE	0/1	---	10	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/1	---	10	---	0	---	0.0092	0.117	---	0.0016
DIETHYL PHTHALATE	0/1	---	10	---	0	---	29000	29200	---	3
DIMETHYL PHTHALATE	0/1	---	10	---	0	---	370000	365000	---	73
DI-N-BUTYL PHTHALATE	0/1	---	10	---	0	---	3700	3650	---	3
DI-N-OCTYL PHTHALATE	0/1	---	10	---	0	---	730	20	---	30
FLUORANTHENE	0/1	---	10	---	0	---	1500	206	---	8.1
FLUORENE	0/1	---	10	---	0	---	240	307	---	3.9
HEXACHLOROBENZENE	0/1	---	10	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/1	---	10	---	0	---	0.86	7.3	1[7]	0.134
HEXACHLOROCYCLOPENTADIENE	0/1	---	10	---	0	50	260	50	---	77.04
HEXACHLOROETHANE	0/1	---	10	---	0	---	4.8	7.68	---	30.5
INDENO(1,2,3-CD)PYRENE	0/1	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/1	---	10	---	0	---	71	896	---	900

TABLE 5-7

HISTORICAL DATA SUMMARY - SPRING WATER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]
NAPHTHALENE	0/1	---	10	---	0	---	6.2	307	---	44
NITROBENZENE	0/1	---	10	---	0	---	3.4	9.42	30[7]	740
N-NITROSODIMETHYLAMINE	0/1	---	10	---	0	---	0.0013	---	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/1	---	10	---	0	---	0.0096	0.46	---	---
N-NITROSODIPHENYLAMINE	0/1	---	10	---	0	---	14	174	---	13
PENTACHLOROPHENOL	0/1	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/1	---	10	---	0	---	---	---	---	2.1
PYRENE	0/1	---	10	---	0	---	180	135	---	0.3
Dissolved Inorganics (ug/L)										
ANTIMONY	0/1	---	5	---	0	6	15	---	---	31
ARSENIC	1/1	14	---	02-SP-C (88) (06/27/88)	1	50	0.045	50	150	53
BERYLLIUM	0/1	---	5	---	0	4	0.016	4	---	7.6
CADMIUM	1/1	0.1	---	02-SP-C (88) (06/27/88)	0	5	18	5	2.2	0.66
CHROMIUM (TOTAL)	0/1	---	1	---	0	100	180[4]	100	11[14]	42
COPPER	0/1	---	1	---	0	1300	1400	---	11	5
LEAD	1/1	2	---	02-SP-C (88) (06/27/88)	1	15[15]	4	---	2.5	1.3
MERCURY	0/1	---	0.8	---	0	2	11	2	0.77	0.0013
NICKEL	1/1	1	---	02-SP-C (88) (06/27/88)	0	100	730	100	52	29
SELENIUM	1/1	7	---	02-SP-C (88) (06/27/88)	1	50	180	50	5	5
SILVER	0/1	---	1	---	0	100[7,13]	180	183	---	1
SODIUM	1/1	6100	---	02-SP-C (88) (06/27/88)	0	---	---	---	---	---
THALLIUM	0/1	---	1	---	0	2	2.9[7]	2	---	0.56
ZINC	0/1	---	30	---	0	5000[7,13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L)										
AMMONIA, AS NITROGEN	1/1	35	---	02-SP-C (88) (06/27/88)	0	1000	1000	---	---	---
CHLORIDE	0/1	---	5000	---	0	250000[7,13]	---	---	230	---
NITRATE, AS NITROGEN	1/1	222	---	02-SP-C (88) (06/27/88)	0	10000	10000	---	---	---
PHENOLS	0/1	---	10	---	0	---	---	---	---	---
SULFATE	1/1	41000	---	02-SP-C (88) (06/27/88)	0	500000	---	---	---	---
TOTAL ORGANIC CARBON	0/1	---	1000	---	0	---	---	---	---	---

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

TABLE 5-7

HISTORICAL DATA SUMMARY - SPRING WATER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 4 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater (Chronic)[4]	U.S. EPA Region 5 Surface Water EDQL[5]

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable but not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

TABLE 5-8

SUMMARY OF OBJECTIVES/PROPOSED SAMPLING
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 2

OVERALL OBJECTIVES FOR SAMPLING PROGRAM					
TYPE OF PROGRAM/SAMPLING OBJECTIVE	PARAMETER TYPE	TARGET CONSTITUENTS(1)	OBJECTIVE FOR ANALYSIS	LIMIT OF DETECTION	EVALUATIONS TO BE PERFORMED
Type: RFI/CMS/Risk Assessment to fulfill requirements of RCRA Part B permit. Objectives: Evaluate nature and extent of contamination (in all affected media) for RFI. Obtain additional information needed to complete a Corrective Measures Study. Determine human health and ecological risks for potential receptors exposed to site media under current and future land use. Confirm the presence or absence of contamination at previously excavated areas (i.e., Interim Measures excavations).	Field	**GROUND WATER AND SURFACE WATER:** Temperature Turbidity pH Specific Conductance Alkalinity	Evaluate general water quality and to ensure that ground water is representative of aquifer formation water.	As per selected field instrumentation, which will be calibrated according to manufacturer's manuals.	Qualitatively used to evaluate general water quality.
		GROUND WATER: Ferrous Iron Carbon Dioxide Nitrate Nitrite Sulfide and Hydrogen Sulfide Dissolved Oxygen Oxidation Reduction Potential	Evaluate general water quality.	As per selected field instrumentation and/or field test kit, which will be calibrated according to manufacturer's manuals.	Evaluate natural attenuation.
		SOIL: Visual observation of the interface between the backfilled and natural soil horizons.	To determine the correct subsurface soil sample depth.	As per selected field instrumentation, which will be calibrated according to manufacturer's manuals.	NA
	Laboratory	**ALL MEDIA:** Dyes Appendix IX Metals (total and dissolved(2)) To determine if metals present at the site are a result of the DBG activities or the naturally occurring low pH of the sandstone in the area. Other Metals (Al, Ca, Fe, Mg, Mn, K, Na) (total and dissolved(2))	To obtain a representative presentation of the nature and quantity of constituents that were released to media by past operational activities.	Reporting limit low enough to meet Federal/State ARARs/TBCs and evaluate adverse human health and environmental impacts.	Comparison of constituents found in site media to risk-based screening criteria to determine if these media were impacted by past site operations. Comparison of inorganic site soil data to established Basewide background levels for similar soil types. Estimate human health risks as outlined in Section 8.0, Figure 8-1. Estimate ecological risks as outlined in Section 9.0, Figure 9-1. Evaluate remedial alternatives.
		GROUND WATER: TOC TSS Sulfate Chloride	Used to establish water quality.	As per chosen laboratory methods.	Evaluate general water quality.
		SURFACE WATER: TOC TSS	Used to establish water quality in surface water.	As per chosen laboratory methods.	To be used to assess the potential risks for ecological receptors.
		SOIL: Grain size pH CEC Bulk Density TOC	Evaluate soil conditions (e.g., migration potential, etc.)	As per chosen laboratory methods.	Evaluate remedial alternatives.

TABLE 5-8

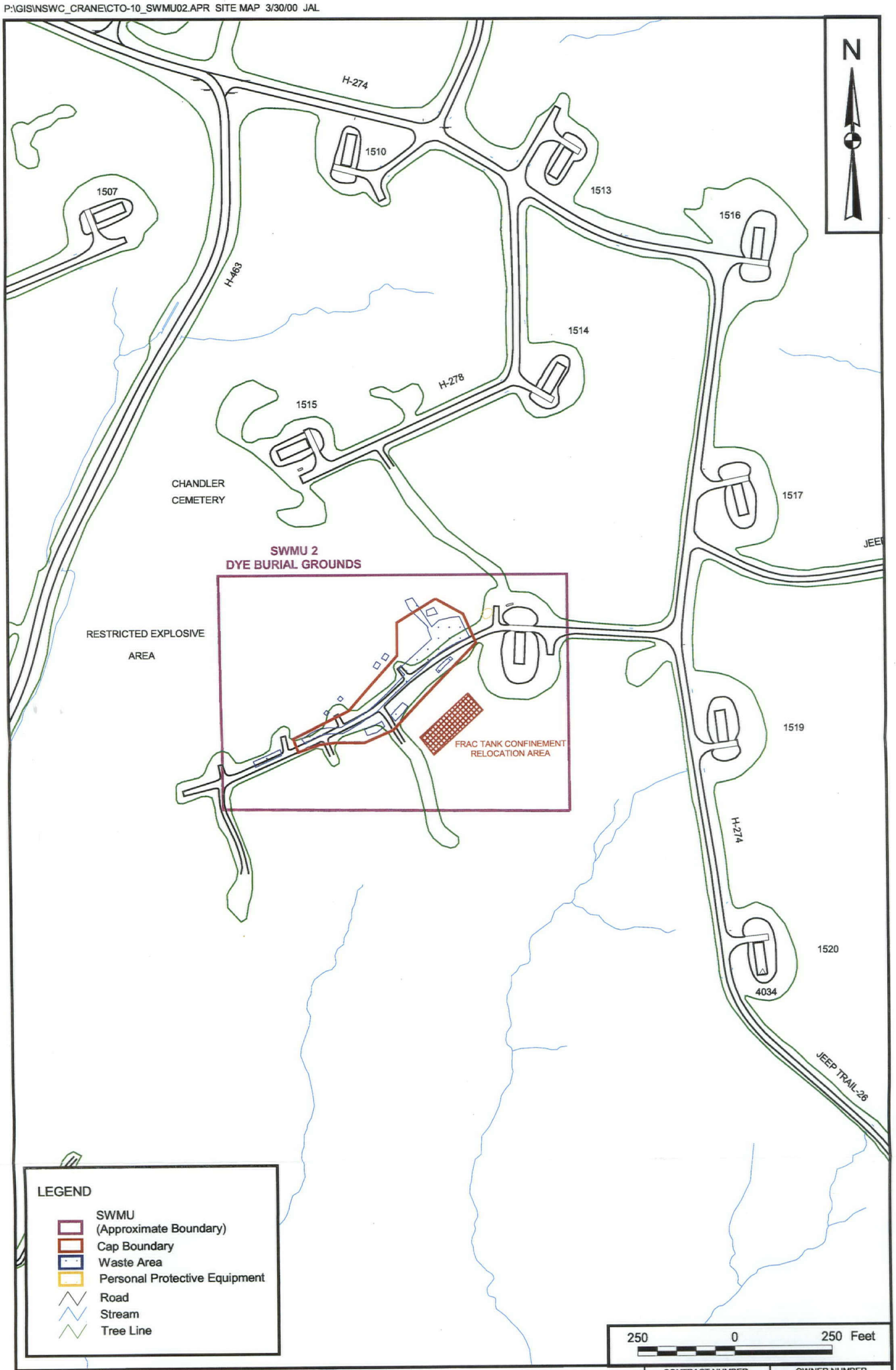
SUMMARY OF OBJECTIVES/PROPOSED SAMPLING
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 2

SPECIFIC OBJECTIVES FOR SAMPLING LOCATIONS				
MEDIUM	SAMPLE COLLECTION TECHNIQUE	SAMPLING POINT(5)		
		SAMPLE LOCATION	COMMENT	OBJECTIVE OF LOCATION
Surface/Subsurface Soil	Grab specific collection technique identified in FSP, Section 2.4.2.3.	02SB01, 02SB02, 02SB06, 02SB07, 02SB12, 02SB13, 02SB14	**Quantitative Analysis.** Seven sample locations inside the boundaries of the previously excavated areas (and outside the limits of the multi-layered cap). Collected at a depth just below the previous excavation; depths to be determined in the field by visual observations (i.e., the identification of natural soil horizons vs. backfill material). A minimum of seven samples will be collected. More samples at greater depths may be collected if contamination is detected.	Confirm the presence or absence of dye contamination at previously excavated areas, which are not located under the multi-layered cap. Evaluates the vertical approach used during excavation. Identifies the residual contamination to which receptors may be exposed.
		02SB03 through 02SB05, 02SB08 through 02SB11, 02SB15 through 02SB20	**Quantitative Analysis.** Thirteen sample locations outside the boundaries of the previously excavated areas (and outside the limits of the multi-layered cap). Collected at surface (0 to 2 feet bgs) and subsurface depths; subsurface depths to be determined in the field. A minimum of two samples per location for a total of 26 samples will be collected. More samples may be collected at additional locations if contamination is detected.	Confirm the presence or absence of dye contamination at locations surrounding the previously excavated areas, which are located outside the limits of the multi-layered cap. Evaluates the horizontal approach used during excavation. Identifies the residual contamination to which receptors may be exposed.
Ground Water	Grab sample; specific collection technique identified in FSP, Section 2.4.1.3.	02-01, 02-02, 02-05, 02-06, 02-07, 02-08, 02C10P3, 02C11P3, 02C12P3	First Round: **Quantitative Analysis.** Nine wells to be sampled, including an upgradient well (02CP10P3). Wells are screened in the Upper and Lower Pennsylvanian aquifers at locations central to known waste areas.	Evaluate ground water quality in aquifers and at locations expected to be impacted by site activities.
		02C09, 02C09P2, 02C10, 02C10P2, 02C11, 02C11P2, 02C12, 02C12P2, 02C14, 02C14P2, 02C14P3, 02C17, 02C17P2, 02C17P3, 02C19, 02C19P2, 02C19P3, 02T01, 02T01P2, 02T01P3	Second Round: **Quantitative Analysis.** 20 wells to be sampled at varying locations and in deeper aquifers than the Pennsylvanian Aqufer.	Evaluate ground water quality to determine the extent of ground water contamination.
Surface Water/Sediment(4)	Grab sample; specific collection technique identified in FSP, surface water in Section 2.4.3, sediment in Section 2.4.4.	02SW/SD01 through 02SW/SD06	**Quantitative Analysis.** Sample locations in drainage areas or unnamed tributaries leading to Little Sulphur Creek.	Evaluate surface water/sediment quality at locations potentially affected by site activities.
		02SW/SD07 through 02SW/SD10	**Quantitative Analysis.** Four seeps will be sampled. The exact locations of the seeps will be determined during a site visit (field survey).	Surface water/sediment quality at seep locations, which may be impacted by site activities.

ARARs	Applicable, Relevant, and Appropriate Requirements	QAPP	Quality Assurance Project Plan	Al	Aluminum	K	Potassium
CEC	Cation Exchange Capacity	TOC	Total Organic Carbon	Ca	Calcium	Na	Sodium
DBG	Dye Burial Ground	TSS	Total Suspended Solids	Fe	Iron	RCRA	Resource Conservation and Recovery Act
FSP	Field Sampling Plan	TBCs	To Be Considered Values	Mg	Magnesium	RFI	RCRA Facility Investigation
NA	Not Applicable	PID	Photoionization Detector	Mn	Manganese	CMS	Corrective Measures Study

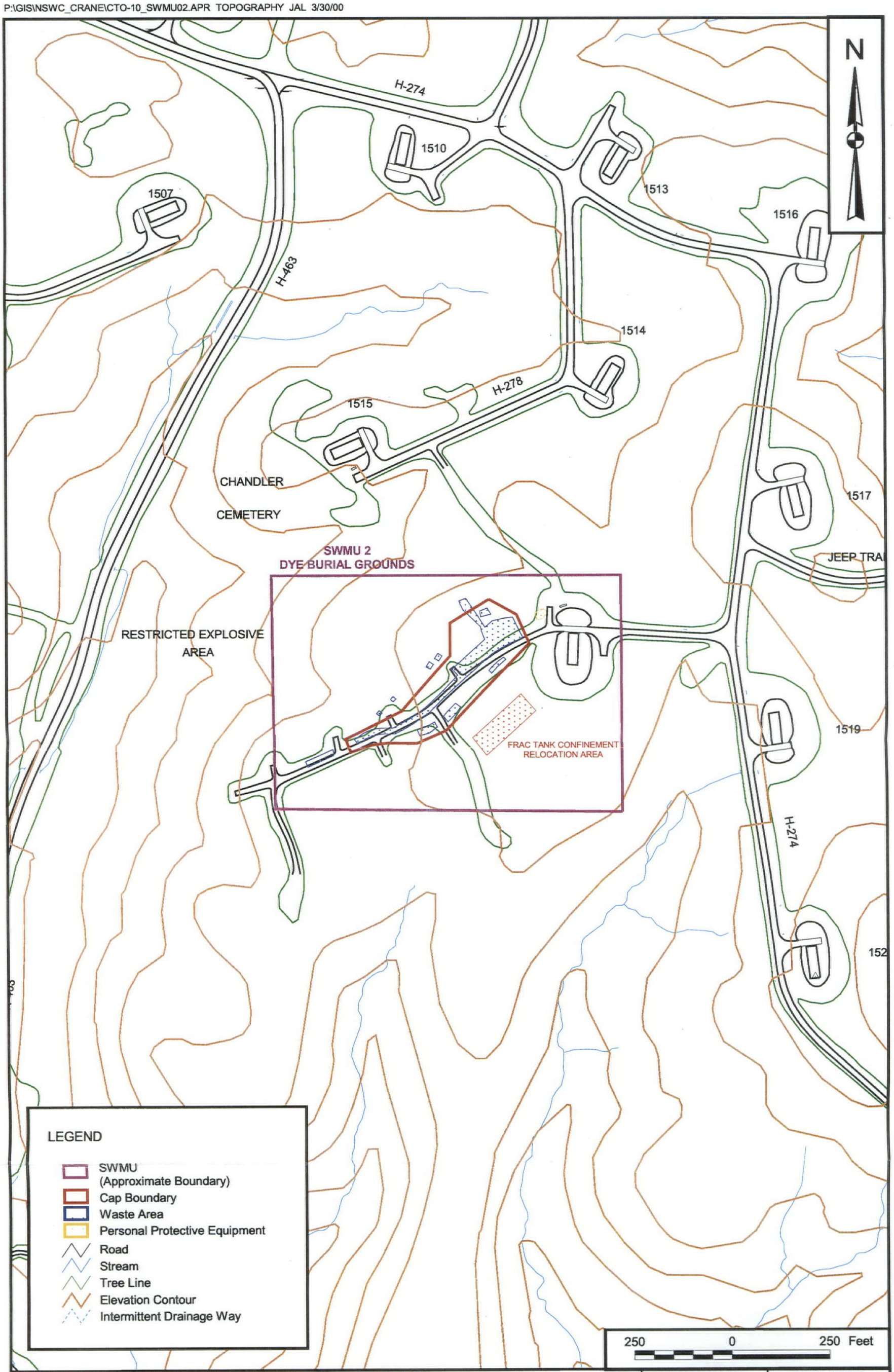
1 The list of specific chemicals included as target constituents are identified in Table 1-1. Constituents to be analyzed for all sample, all matrices collected, unless otherwise noted.
2 Total and dissolved inorganic analyses will be performed for surface water matrices.
3 Analyses to be performed on 30 percent of the soil samples collected.
4 Due to the intermittent nature of the surface water, samples may not be able to be collected during the field program.

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR SITE MAP 3/30/00 JAL



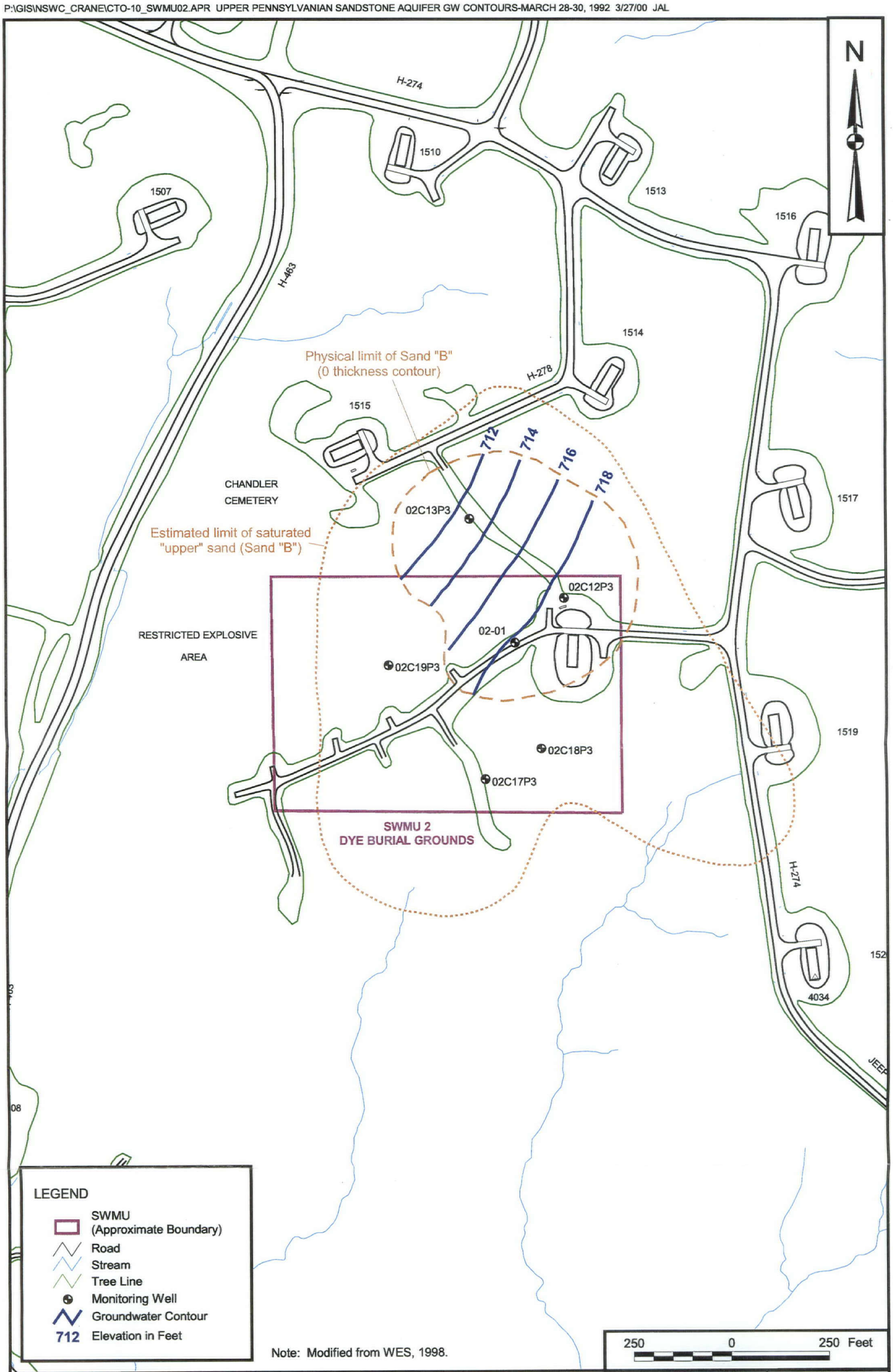
DRAWN BY J. LAMEY	DATE 7/28/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER 0010
CHECKED BY	DATE	SITE MAP SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-1 / REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR TOPOGRAPHY JAL 3/30/00



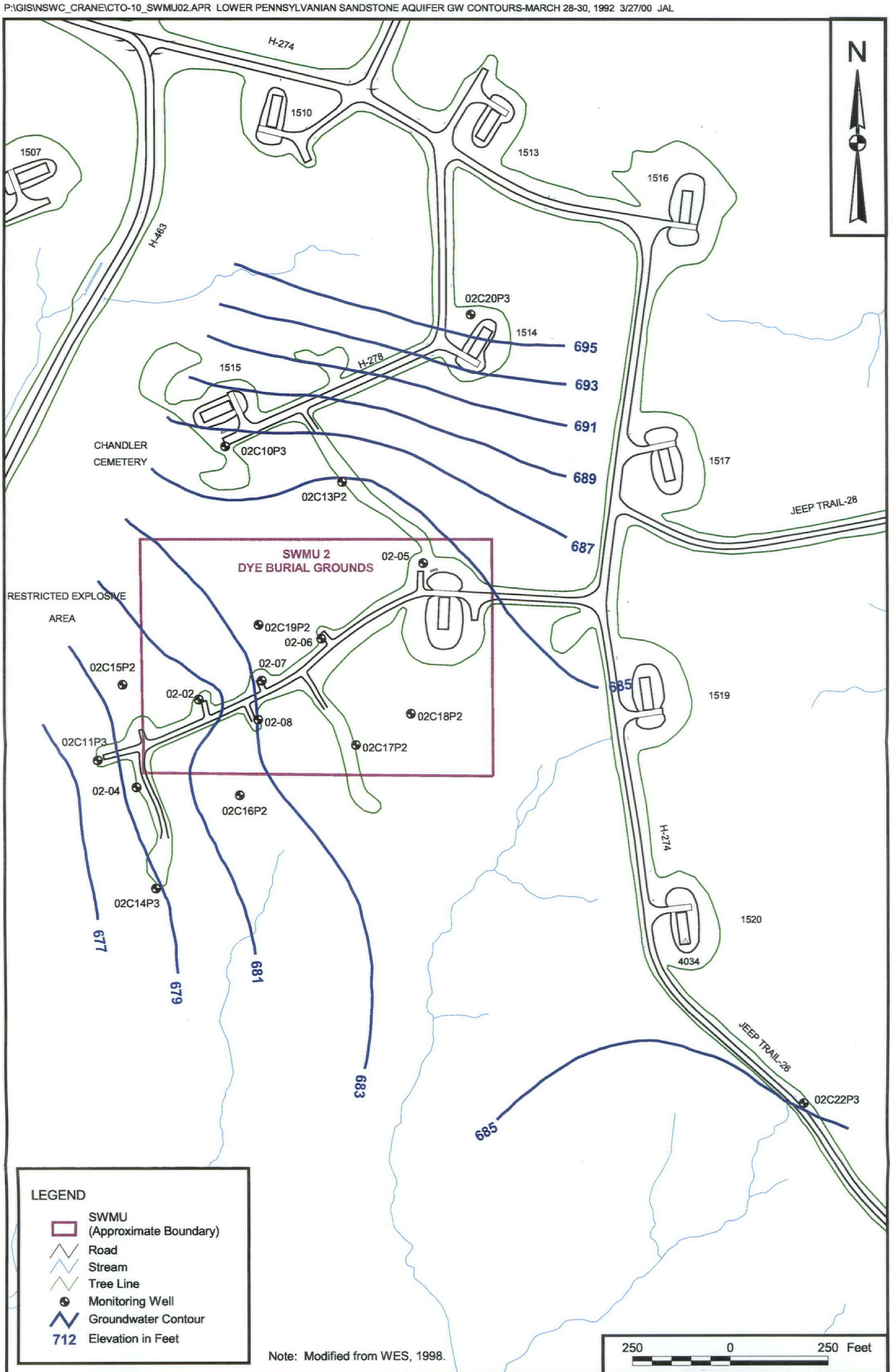
DRAWN BY J. LAMEY	DATE 3/30/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER 0010
CHECKED BY	DATE	TOPOGRAPHY IN SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-2 / REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR UPPER PENNSYLVANIAN SANDSTONE AQUIFER GW CONTOURS-MARCH 28-30, 1992 3/27/00 JAL



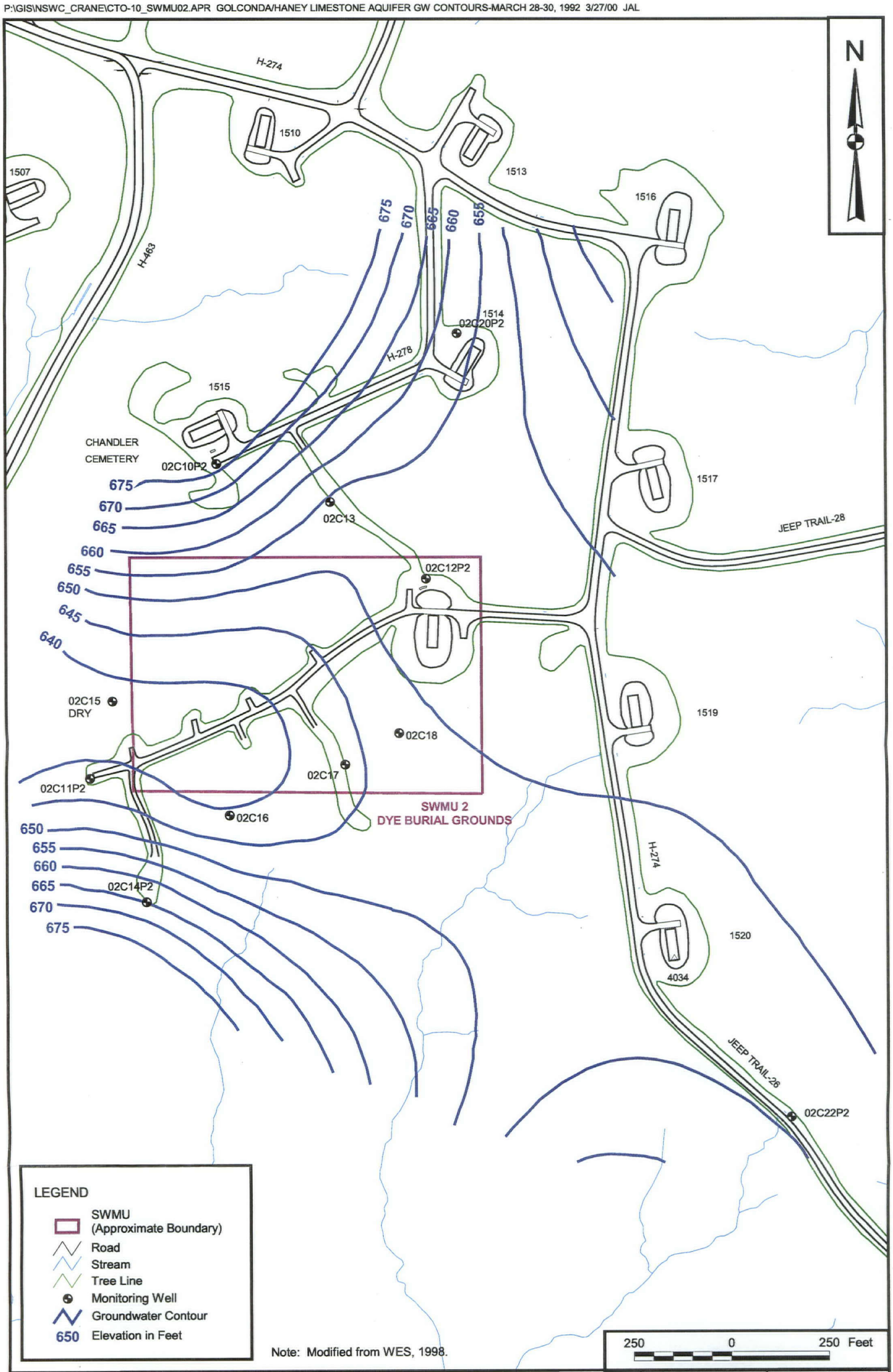
DRAWN BY J. LAMEY	DATE 3/27/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER 0010
CHECKED BY	DATE	UPPER PENNSYLVANIAN SANDSTONE AQUIFER GROUNDWATER CONTOURS AND LIMITS OF SATURATED ZONE AND SAND "B" MARCH 28-30, 1992 SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-3 / REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR LOWER PENNSYLVANIAN SANDSTONE AQUIFER GW CONTOURS-MARCH 28-30, 1992 3/27/00 JAL



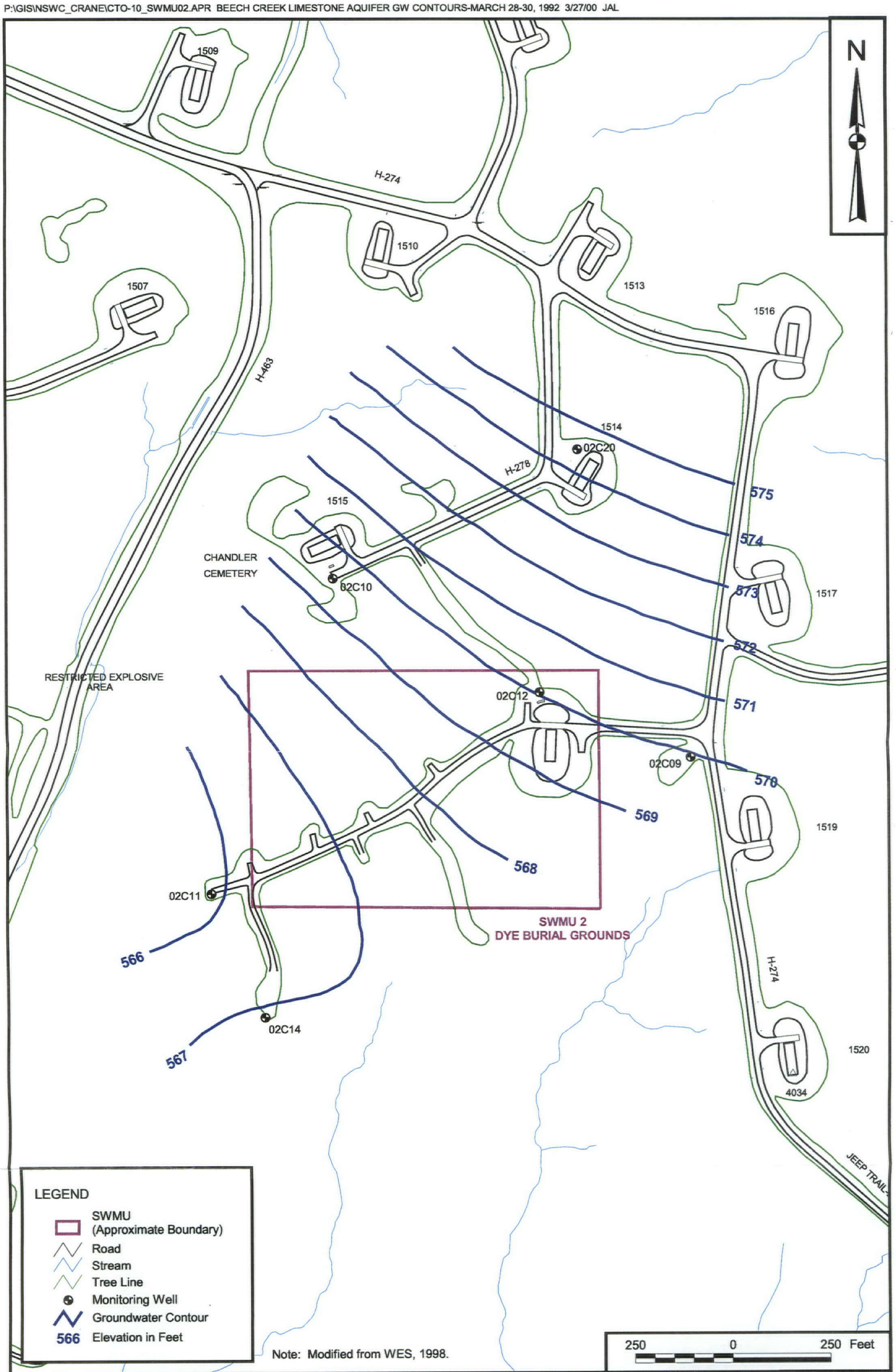
DRAWN BY J. LAMEY	DATE 3/27/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER 0010
CHECKED BY	DATE	LOWER PENNSYLVANIAN SANDSTONE AQUIFER GROUNDWATER CONTOURS MARCH 28-30, 1992 SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY	DATE
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 5-4	REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR GOLCONDA/HANEY LIMESTONE AQUIFER GW CONTOURS-MARCH 28-30, 1992 3/27/00 JAL



DRAWN BY J. LAMEY	DATE 3/27/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER 0010
CHECKED BY	DATE	GOLCONDA/HANEY LIMESTONE AQUIFER GROUNDWATER CONTOURS MARCH 28-30, 1992 SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY —	DATE —
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-5	REV 0

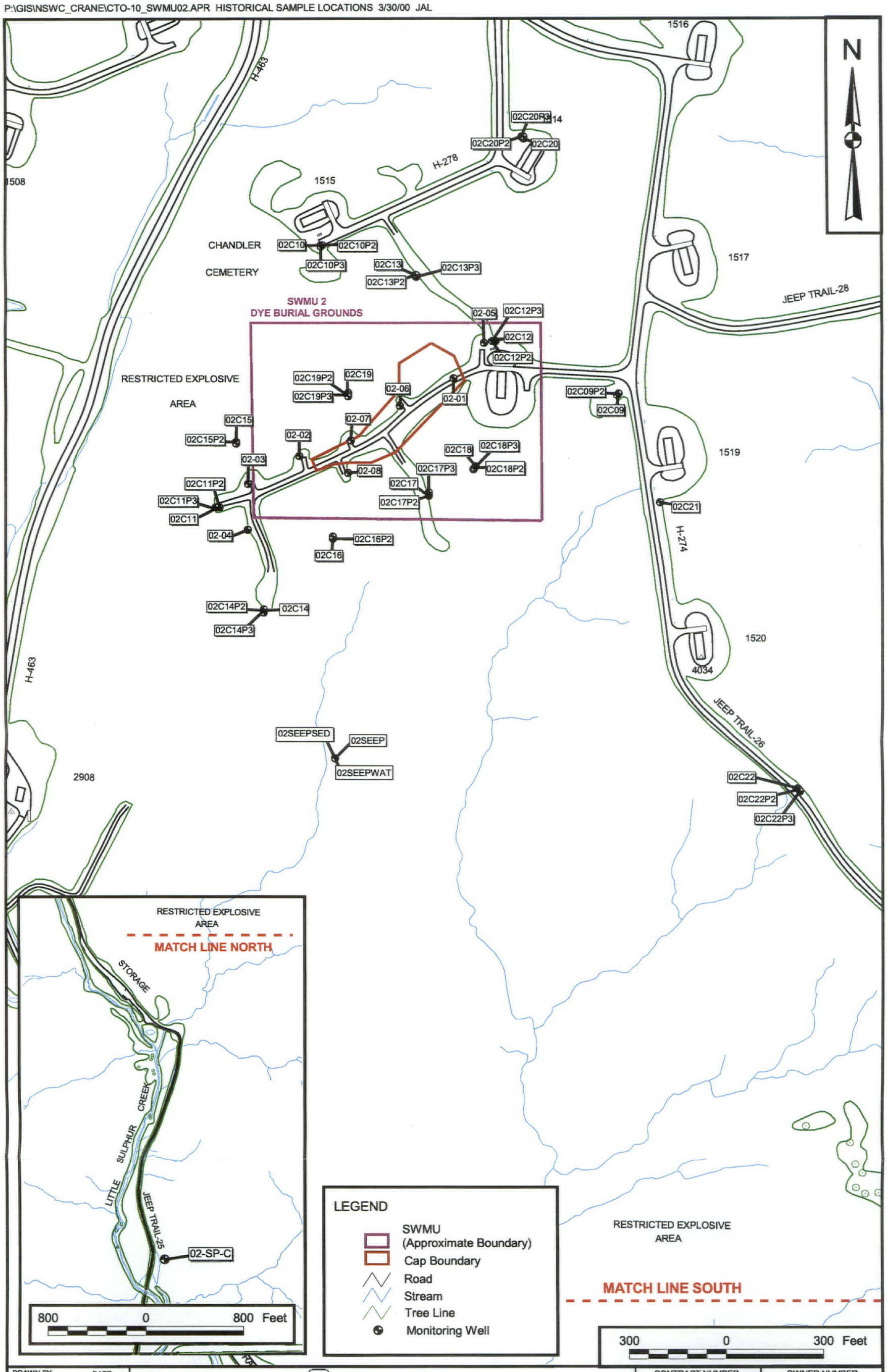
P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR BEECH CREEK LIMESTONE AQUIFER GW CONTOURS-MARCH 28-30, 1992 3/27/00 JAL



Note: Modified from WES, 1998.

DRAWN BY J. LAMEY	DATE 3/27/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER 0010
CHECKED BY	DATE	BEECH CREEK LIMESTONE AQUIFER GROUNDWATER CONTOURS MARCH 28-30, 1992 SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY / DATE
COST/SCHEDULE-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 5-6 / REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR HISTORICAL SAMPLE LOCATIONS 3/30/00 JAL

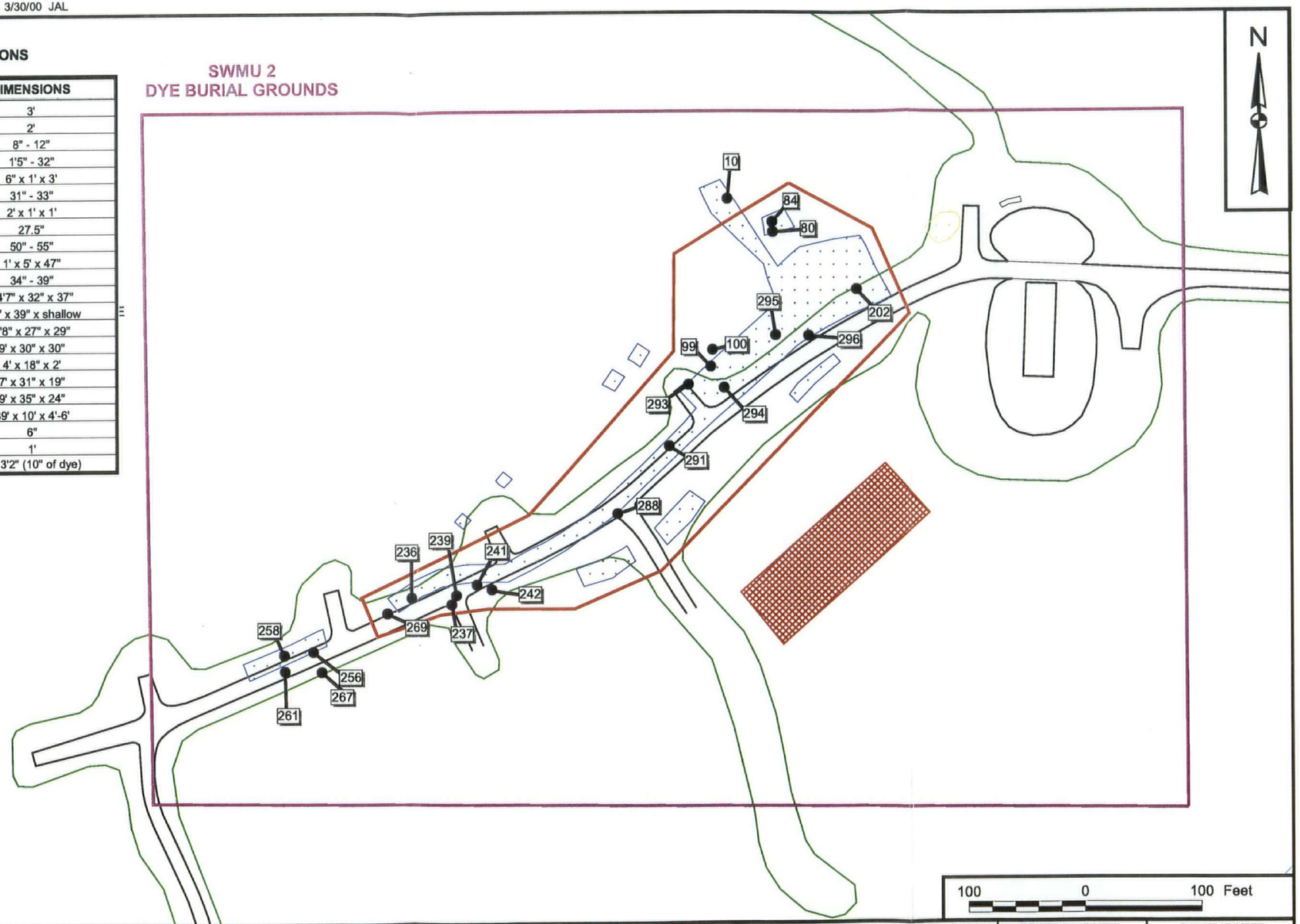


DRAWN BY J. LAMEY — DATE 7/29/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER —
CHECKED BY — DATE —	HISTORICAL SAMPLE LOCATIONS SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — DATE —	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 5-7	REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR HISTORIC SOIL SAMPLE LOCATIONS 3/30/00 JAL

HISTORICAL NSWC - EPA SOIL SAMPLE DYE LOCATIONS

LOCATION	DYE COLOR	DIMENSIONS
10	Green-Blue	3'
100	Blue	2'
202	Red	8" - 12"
236	Yellow & Blue	1'5" - 32"
237	Yellow	6" x 1' x 3'
239	Blue	31" - 33"
241	Yellow & Blue	2' x 1' x 1'
242	Yellow	27.5"
256	Purple	50" - 55"
258	Purple & Dark Blue	1' x 5' x 47"
261	Purple	34" - 39"
267	Purple & Blue	14'7" x 32" x 37"
269	Yellow & Blue	6'5" x 39" x shallow
288	Unknown	9'8" x 27" x 29"
291	Unknown	9' x 30" x 30"
293	Green	4' x 18" x 2'
294	Green	7' x 31" x 19"
295	Unknown	9' x 35" x 24"
296	Purple, Green, Yellow, Red, & Orange-Yellow	39' x 10' x 4'-6'
80	Red	6"
84	Blue & Red	1'
99	Green-Blue	hit 3'2" (10" of dye)



LEGEND

- Historical NSWC-EPA Soil Sample Location
- SWMU (Approximate Boundary)
- Cap Boundary
- Road
- Stream
- Tree Line
- Waste Areas
- Personal Protective Equipment

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY J. LAMEY	DATE 8/11/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY —	DATE —	HISTORICAL SOIL SAMPLE LOCATIONS SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-8 / REV 0

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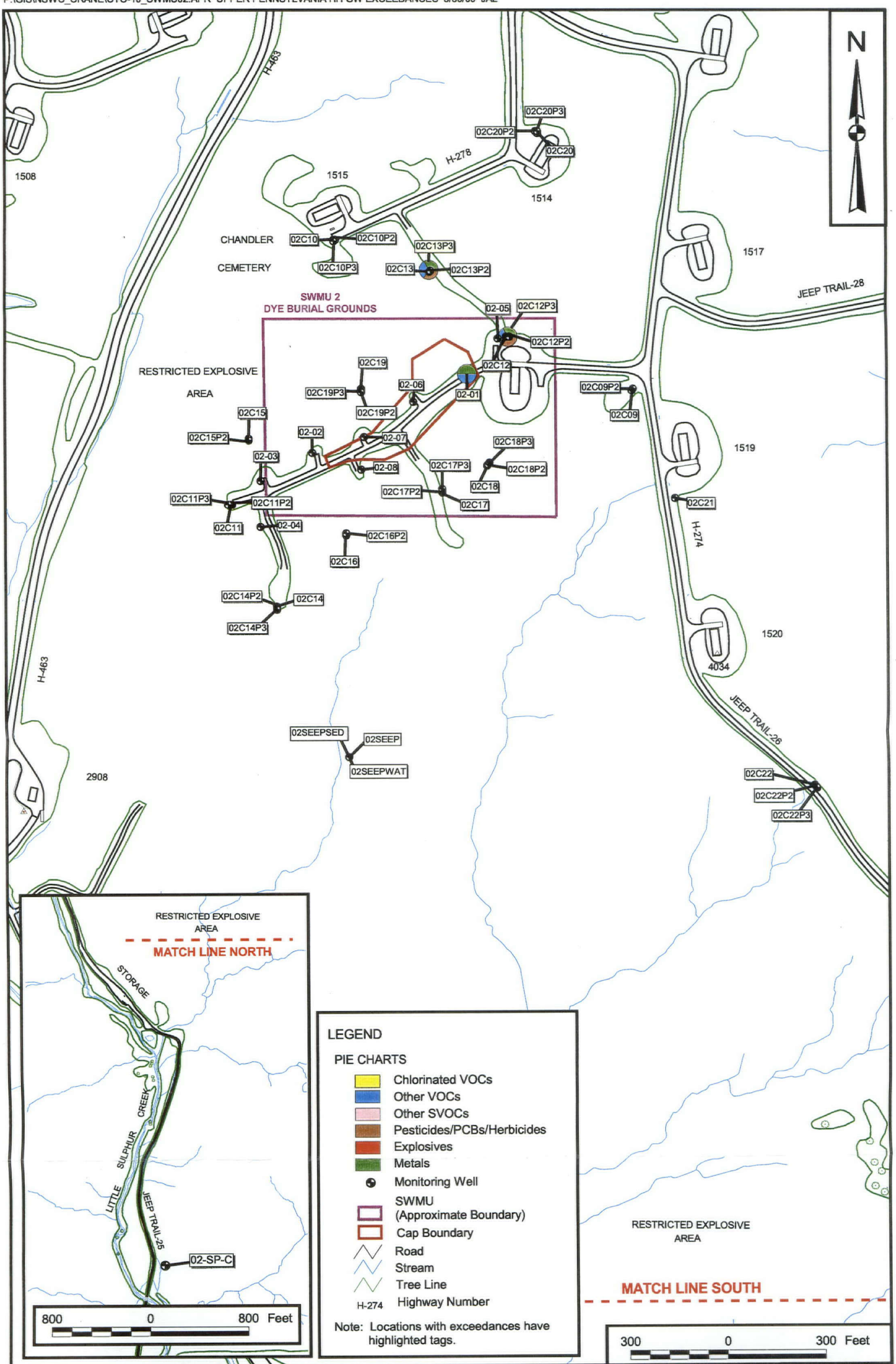

DRAWN BY J. LAMEY	DATE 8/2/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY —	DATE —	GROUND WATER EXCEEDANCES - HUMAN HEALTH UPPER PENNSYLVANIAN AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-9 / REV 0

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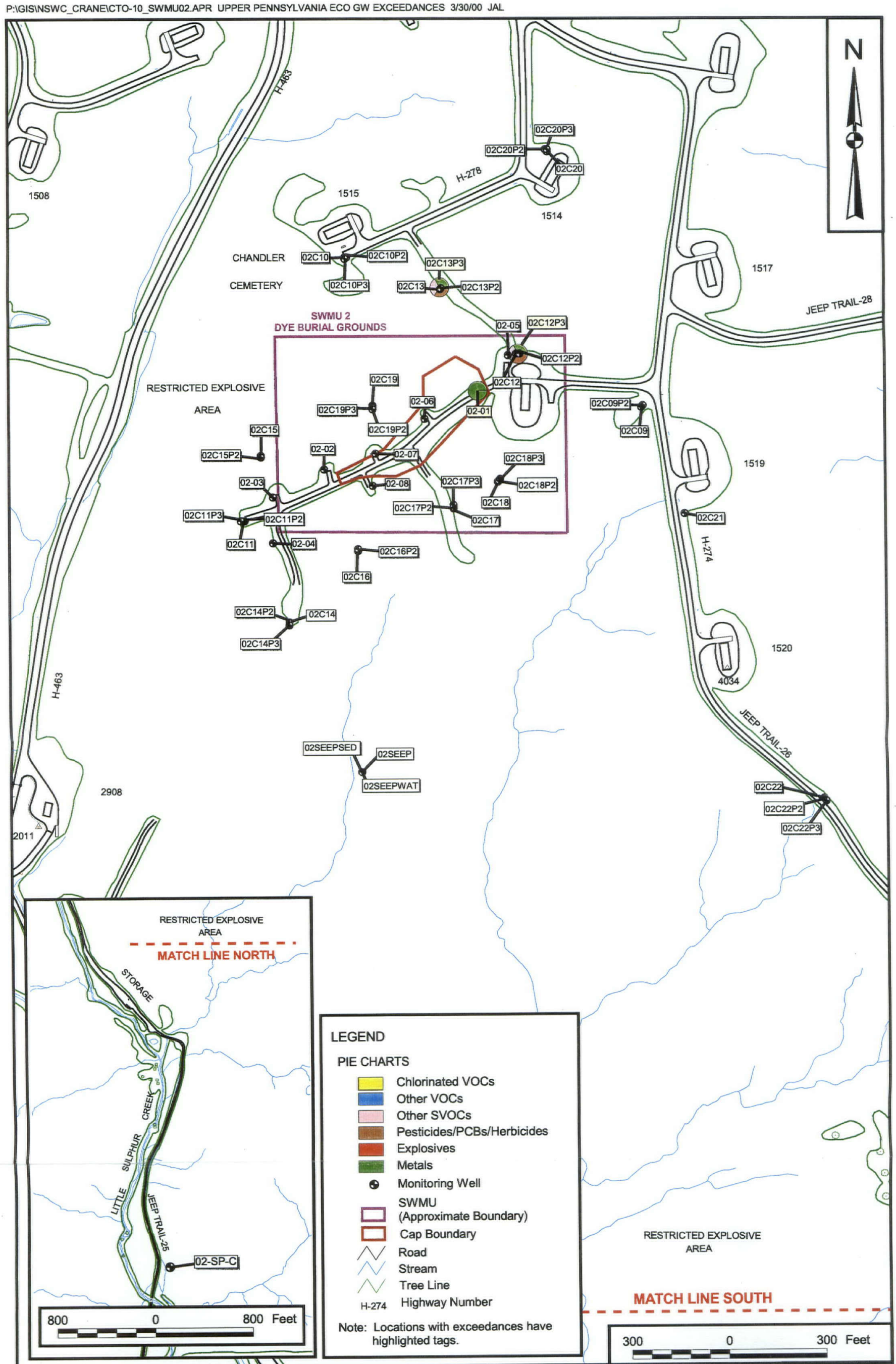
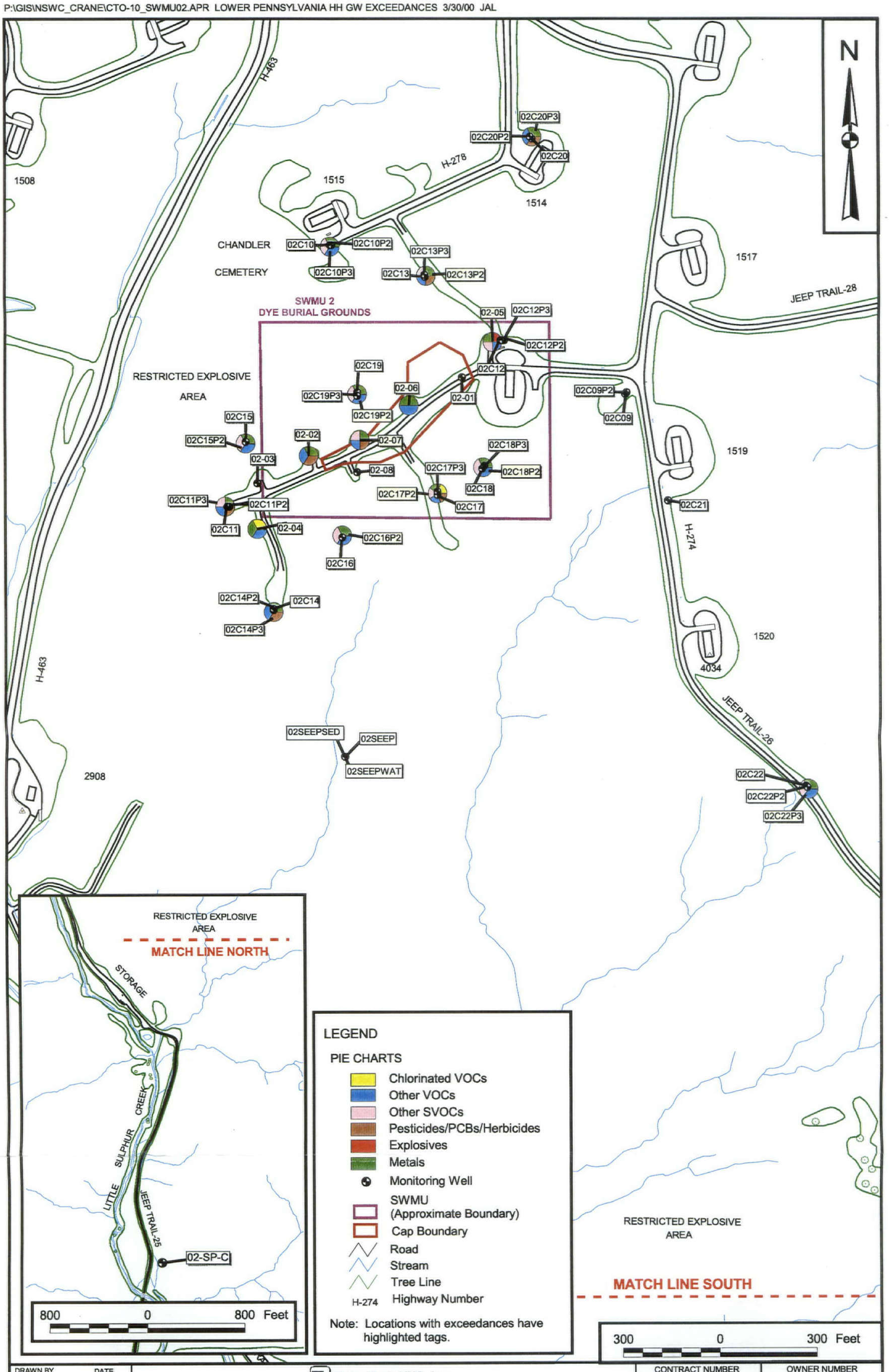


DRAWN BY J. LAMEY — DATE 8/2/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER —
CHECKED BY — DATE —	GROUND WATER EXCEEDANCES - ECOLOGICAL UPPER PENNSYLVANIAN AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — DATE —	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 5-10	REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR LOWER PENNSYLVANIA HH GW EXCEEDANCES 3/30/00 JAL



DRAWN BY J. LAMEY	DATE 8/9/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY —	DATE —	GROUND WATER EXCEEDANCES - HUMAN HEALTH LOWER PENNSYLVANIAN AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-11 / REV 0

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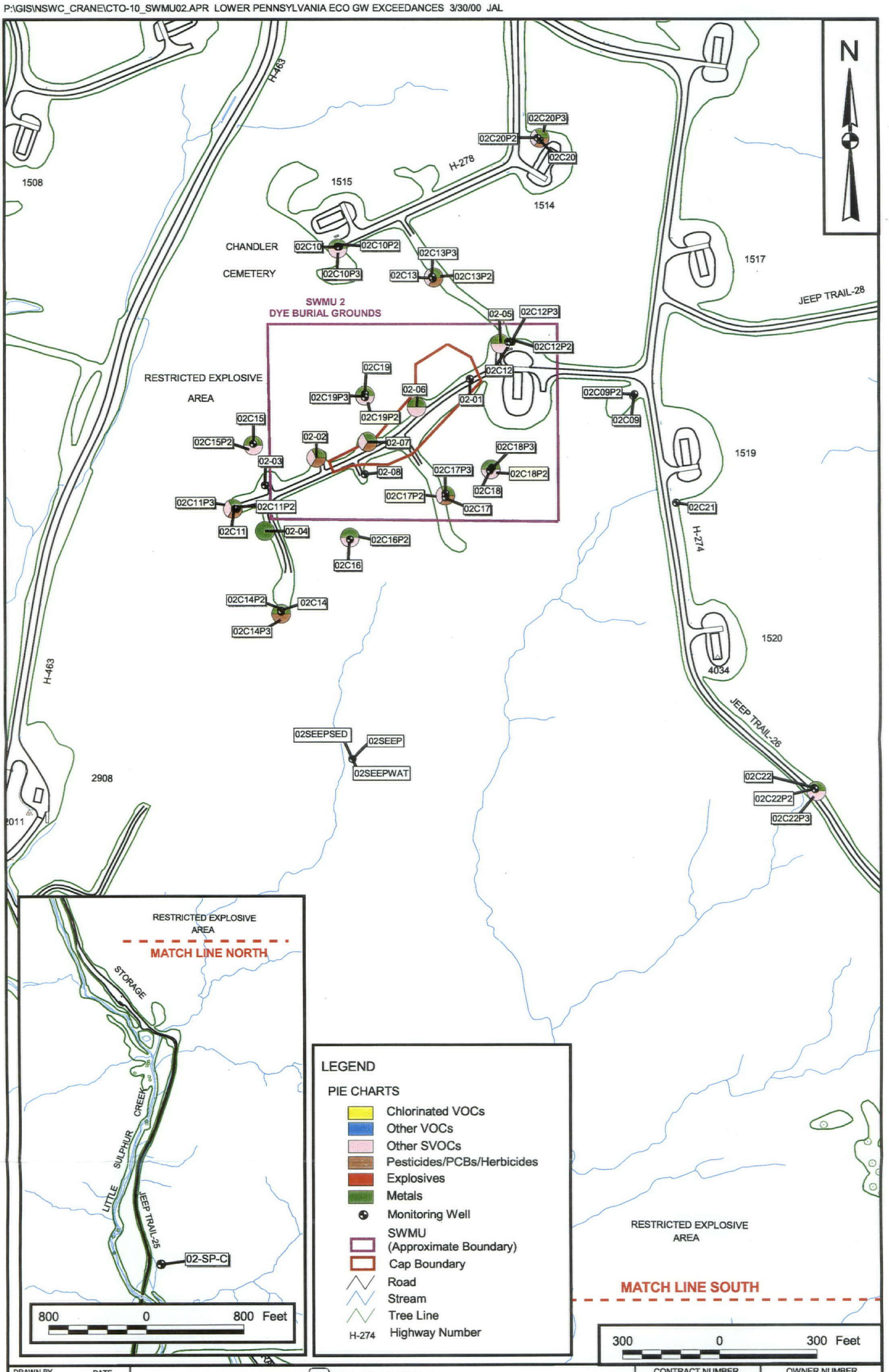
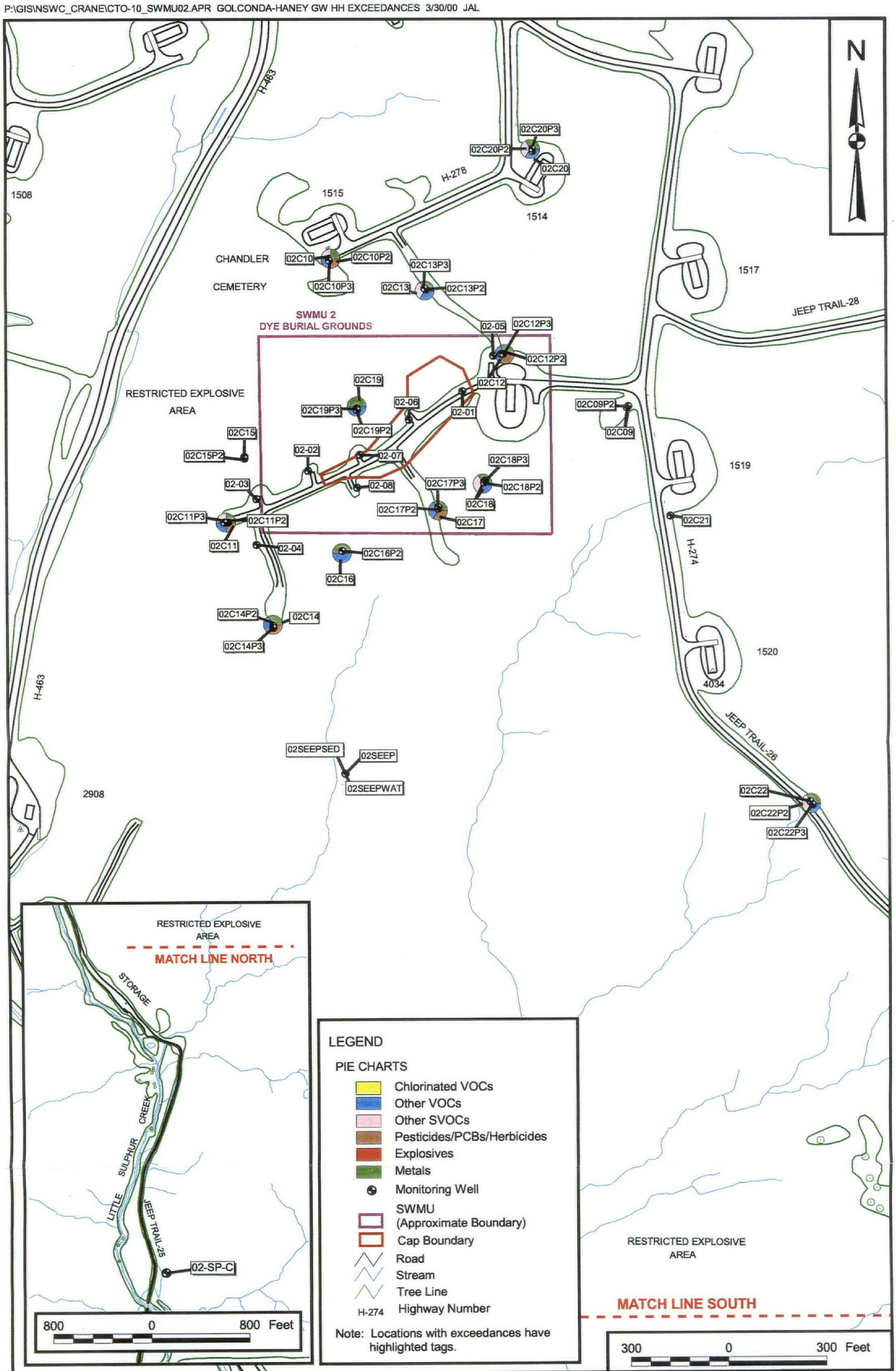


DRAWN BY J. LAMEY — DATE 8/9/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER —
CHECKED BY — DATE —	GROUND WATER EXCEEDANCES - ECOLOGICAL LOWER PENNSYLVANIAN AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — DATE —	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 5-12	REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR GOLCONDA-HANEY GW HH EXCEEDANCES 3/30/00 JAL



DRAWN BY J. LAMEY	DATE 8/9/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY —	DATE —	GROUND WATER EXCEEDANCES - HUMAN HEALTH GOLCONDA/HANEY AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-13 / REV 0

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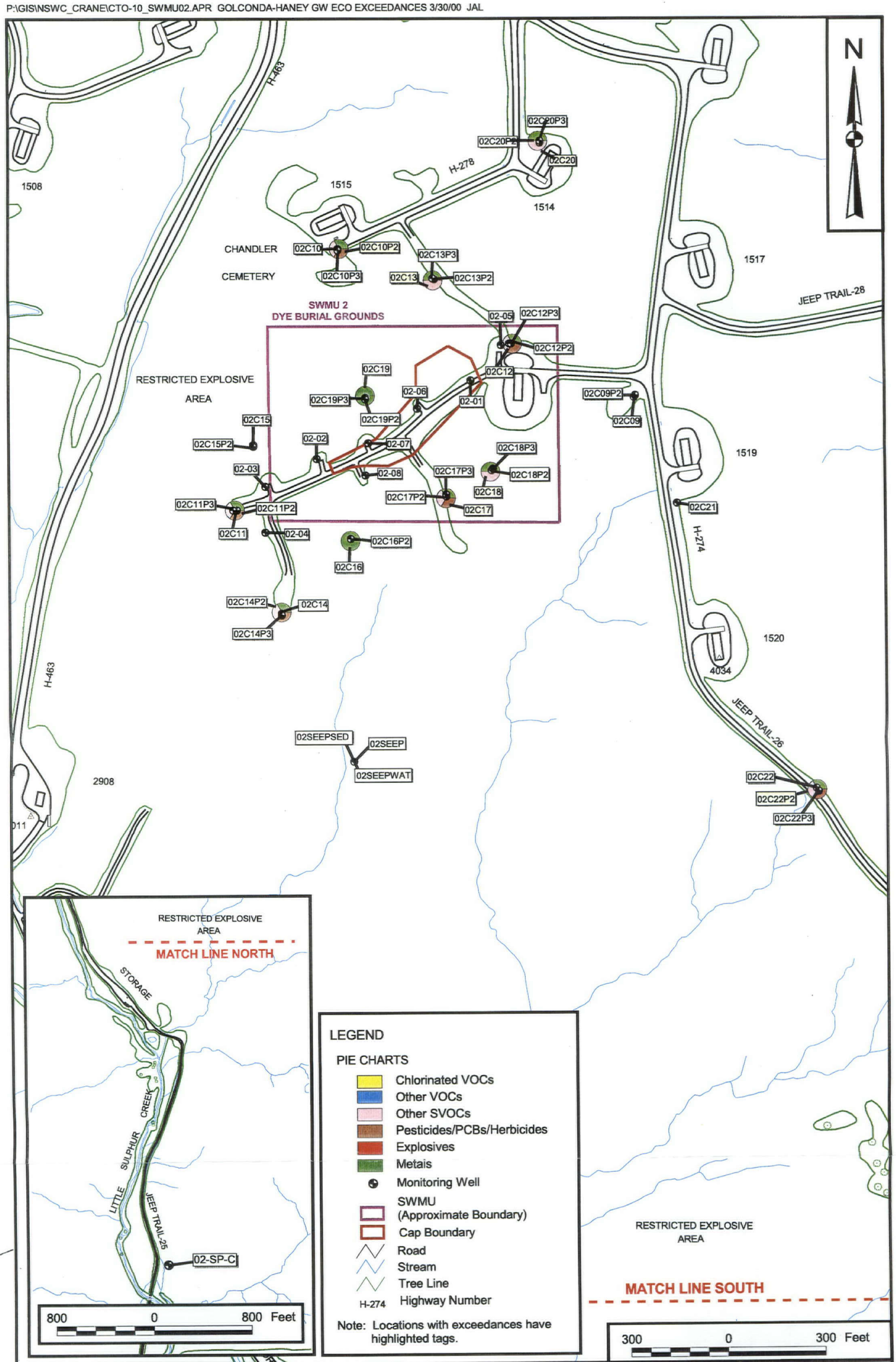
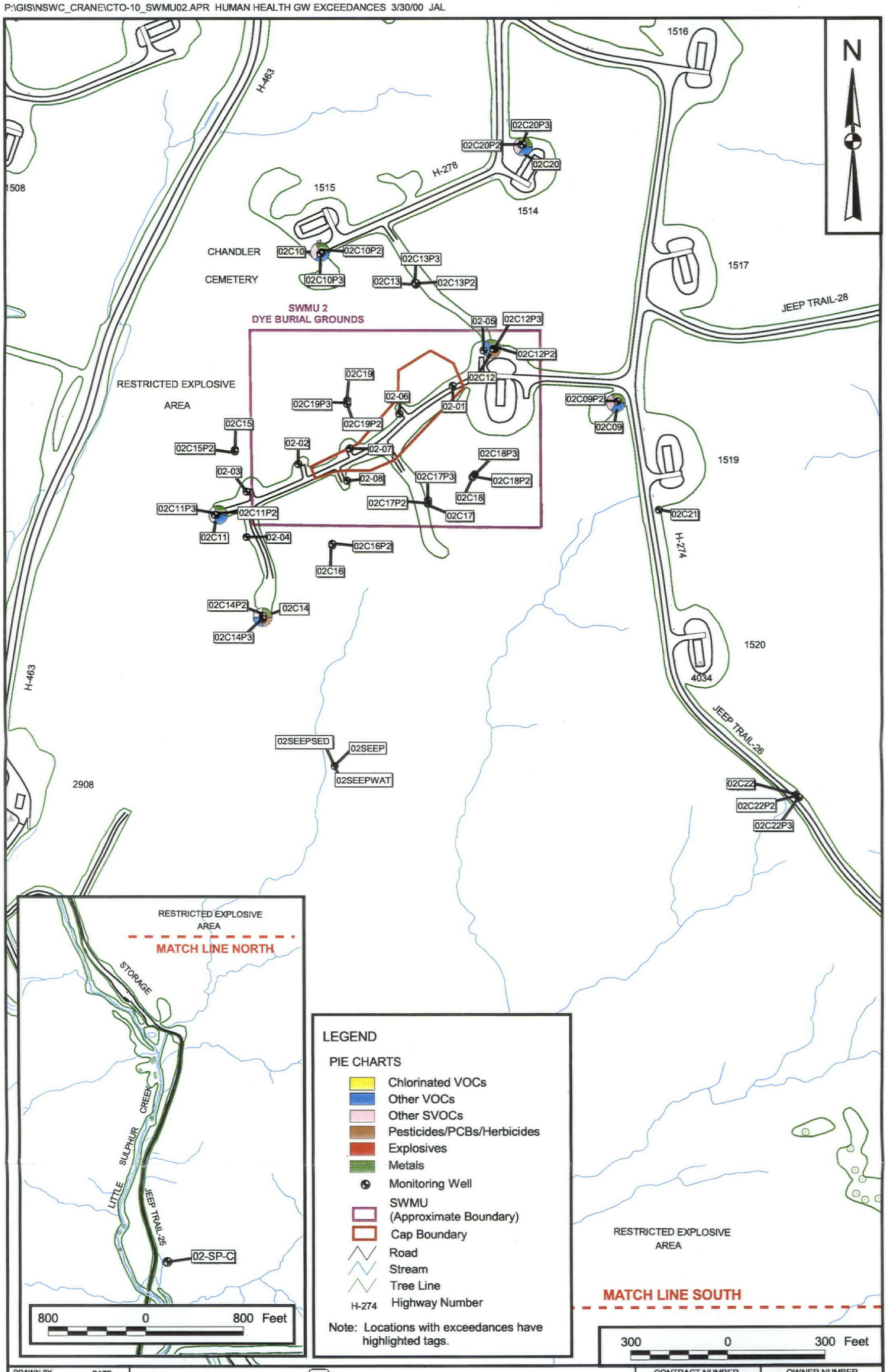


DRAWN BY J. LAMEY	DATE 8/9/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY	DATE	GROUND WATER EXCEEDANCES - ECOLOGICAL GOLCONDA/HANEY AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-14 / REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR HUMAN HEALTH GW EXCEEDANCES 3/30/00 JAL



DRAWN BY J. LAMEY	DATE 8/2/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY —	DATE —	GROUND WATER EXCEEDANCES - HUMAN HEALTH BEECH CREEK AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-15 / REV 0

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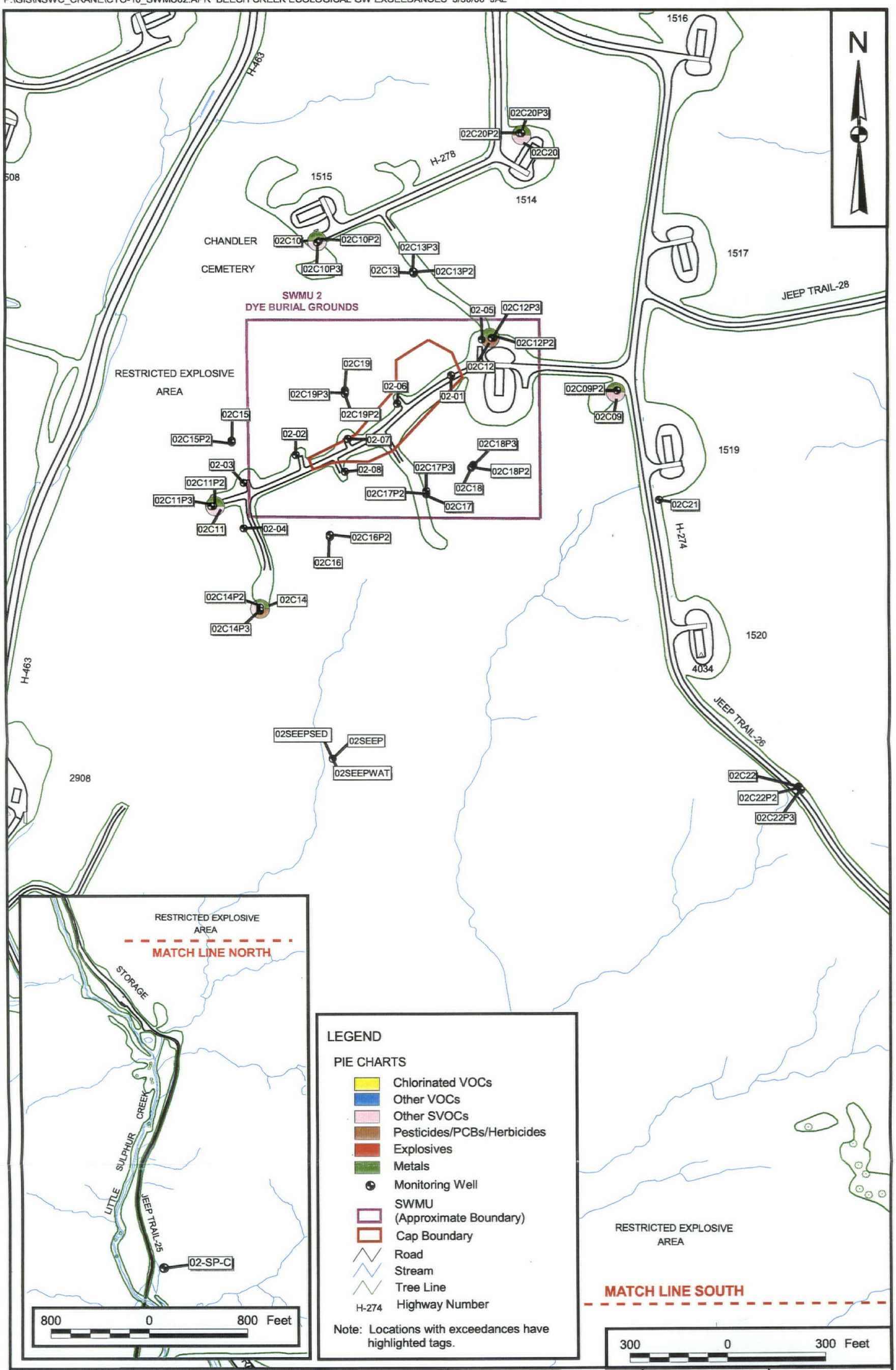

DRAWN BY J. LAMEY	DATE 8/2/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY	DATE	GROUND WATER EXCEEDANCES - ECOLOGICAL BEECH CREEK AQUIFER SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-16 / REV 0

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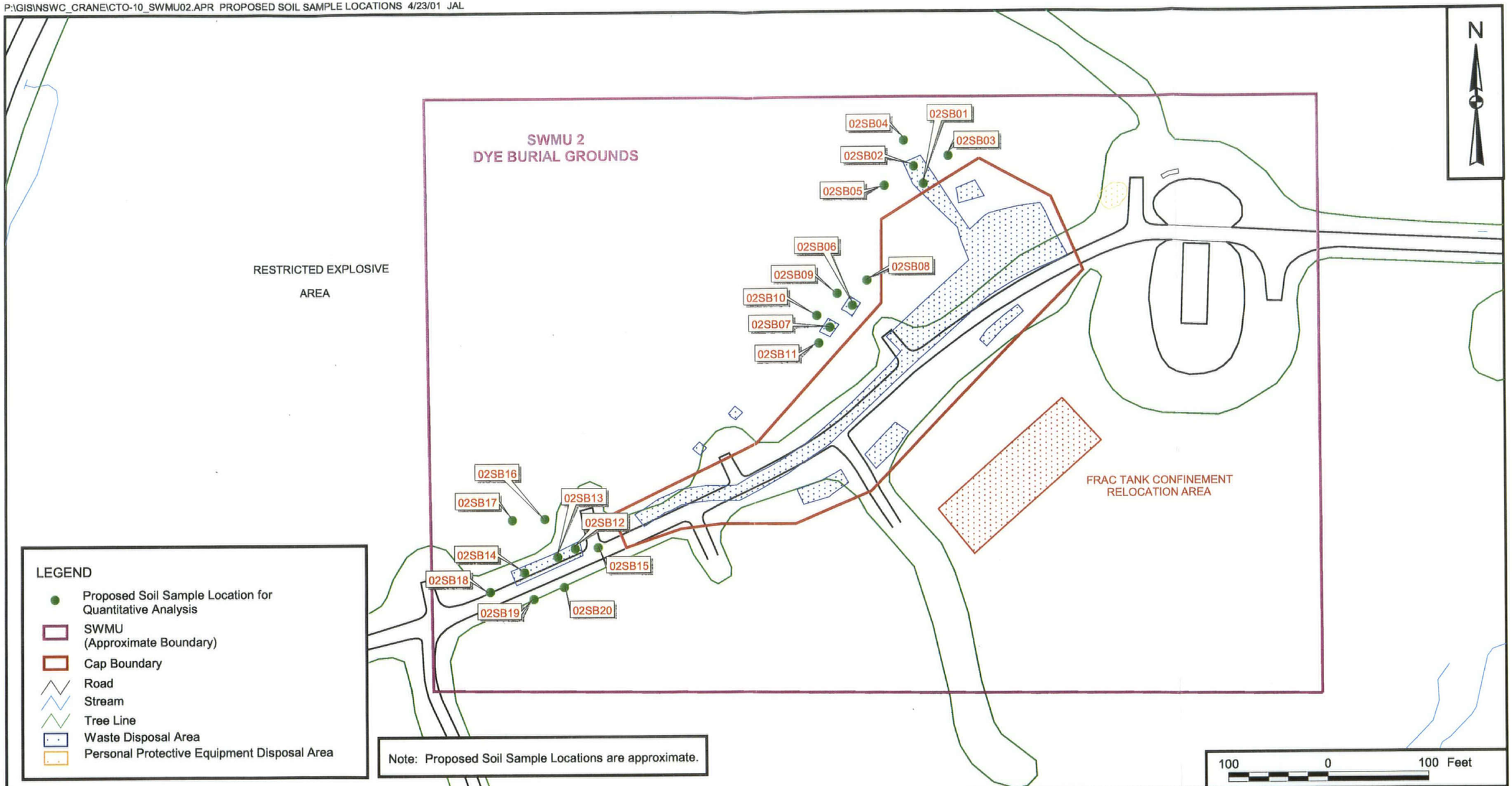


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

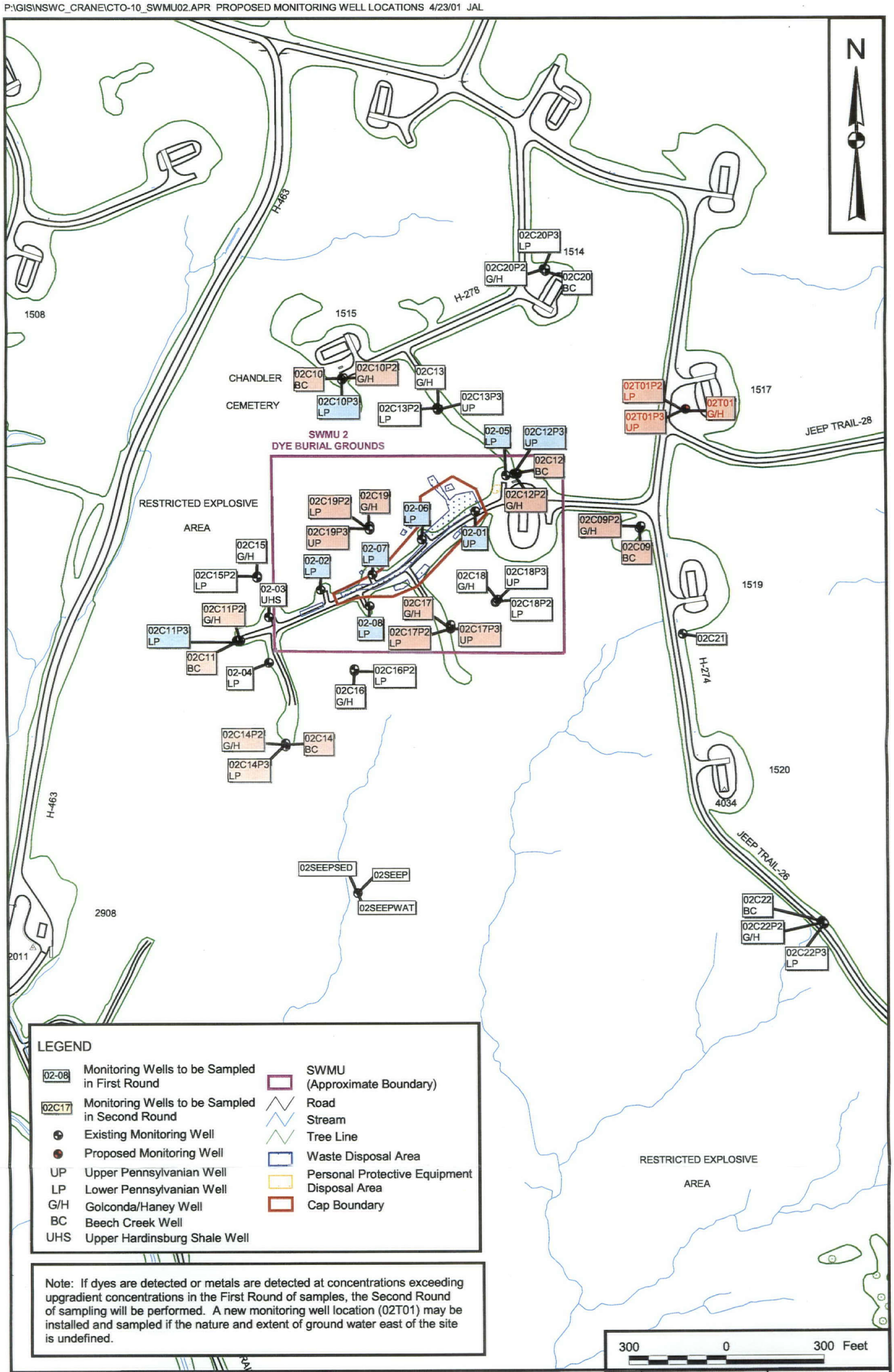
DRAWN BY J. LAMEY	DATE 8/4/99
CHECKED BY	DATE
COST/SCHEDULE-AREA	
SCALE AS NOTED	

Tetra Tech NUS, Inc.

PROPOSED SOIL SAMPLE LOCATIONS
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA

CONTRACT NUMBER 7141	OWNER NUMBER —
APPROVED BY —	DATE —
APPROVED BY —	DATE —
DRAWING NO. FIGURE 5-17	REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR PROPOSED MONITORING WELL LOCATIONS 4/23/01 JAL



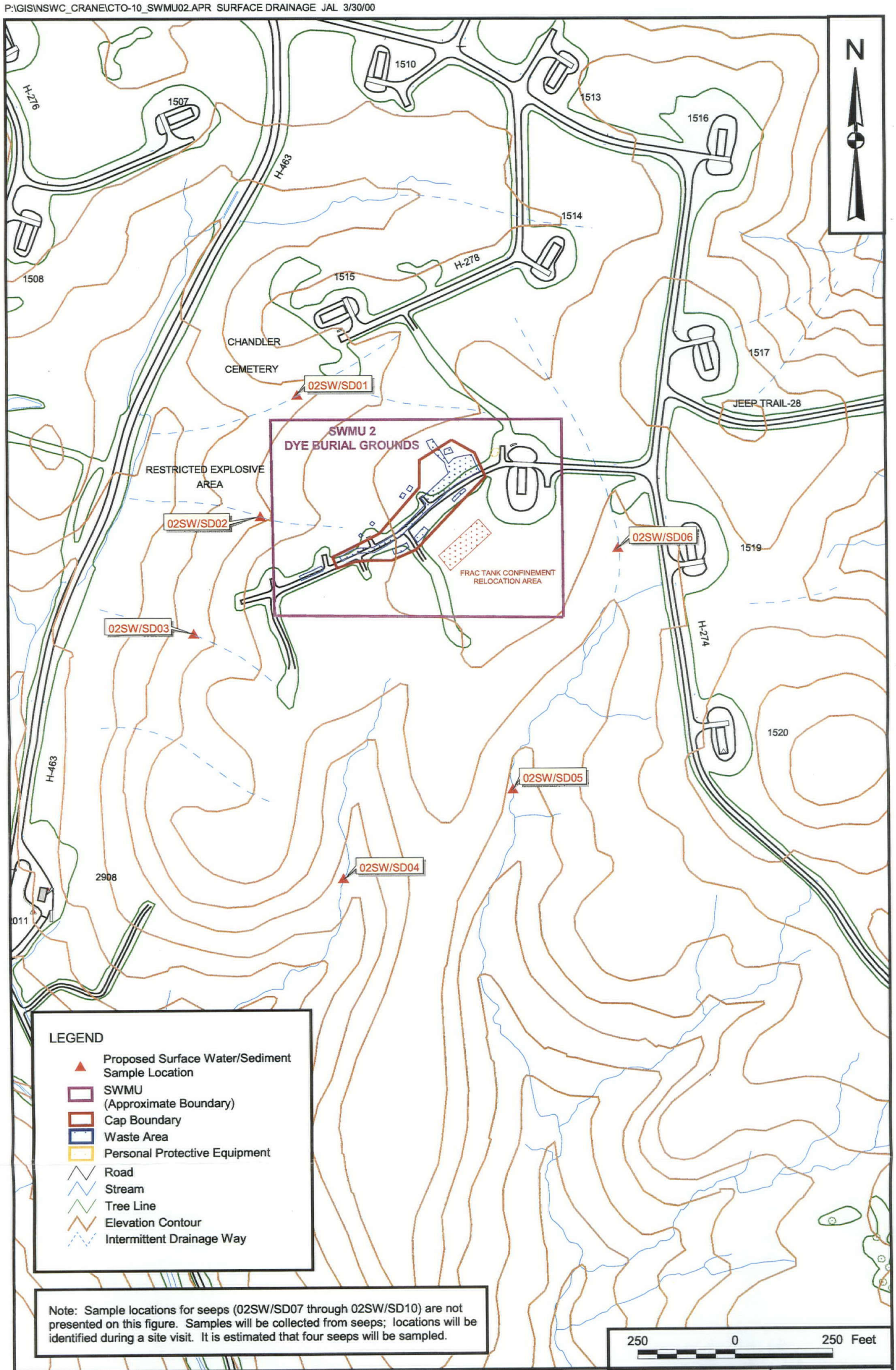
LEGEND

02-08	Monitoring Wells to be Sampled in First Round		SWMU (Approximate Boundary)
02C17	Monitoring Wells to be Sampled in Second Round		Road
	Existing Monitoring Well		Stream
	Proposed Monitoring Well		Tree Line
UP	Upper Pennsylvanian Well		Waste Disposal Area
LP	Lower Pennsylvanian Well		Personal Protective Equipment Disposal Area
G/H	Golconda/Haney Well		Cap Boundary
BC	Beech Creek Well		
UHS	Upper Hardinsburg Shale Well		

Note: If dyes are detected or metals are detected at concentrations exceeding upgradient concentrations in the First Round of samples, the Second Round of sampling will be performed. A new monitoring well location (02T01) may be installed and sampled if the nature and extent of ground water east of the site is undefined.

DRAWN BY J. LAMEY	DATE 8/4/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER —
CHECKED BY	DATE	PROPOSED GROUND WATER SAMPLING LOCATIONS SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-18 / REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU02.APR SURFACE DRAINAGE JAL 3/30/00



Note: Sample locations for seeps (02SW/SD07 through 02SW/SD10) are not presented on this figure. Samples will be collected from seeps; locations will be identified during a site visit. It is estimated that four seeps will be sampled.

DRAWN BY J. LAMEY	DATE 8/3/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141 / OWNER NUMBER 0010
CHECKED BY	DATE	PROPOSED SURFACE WATER AND SEDI MENT LOCATIONS SWMU 2 - DYE BURIAL GROUNDS NSWC CRANE, INDIANA	APPROVED BY / DATE
COST/SCHEDULE-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 5-19 / REV 0

6.0 DATA MANAGEMENT

All environmental and physical data collected for the SWMU will be incorporated into a Basewide relational database and EGIS. TtNUS has the responsibility of managing the data obtained during the proposed field investigations, in addition to the existing data collected during previous site investigations. The general procedures to be used to manage the data collected to support RFI/CMS and risk assessment activities at SWMU 2 are presented in this section. Data management activities specific to the reduction, validation, and reporting of the field and laboratory data are presented in Section 9.0 of the associated QAPP.

6.1 PROJECT PLANNING

To ensure that the data collected meet the needs of the project, several project planning procedures will be implemented prior to the conductance of the proposed field investigations for SWMU 2. These planning procedures are explained below.

6.1.1 Kick-off Meeting

Prior to conducting the proposed field investigation, an internal TtNUS kick-off meeting will be conducted to outline the data needs of the task order. Attendees to the kick-off meeting will include the TOM, the human health risk assessment lead, the ecological risk assessment lead, the project engineer, the FOL, the project chemist, the data management lead, and the EGIS lead. The data management lead will distribute a copy of the data management checklist (Appendix E) and will lead the project team through its contents. A review of the data management checklist will allow the project team to better understand how the data will be managed and manipulated to achieve the project needs and objectives. A completed copy of the data management checklist will be maintained in the TtNUS project central file and distributed to all project team members within 7 days of the kick-off meeting.

6.1.2 Sample Nomenclature and Survey Data Requirements

Sample nomenclature for the project is established in CTO 10 SOP 10 in FSP Attachment B. It is the responsibility of the FOL to comply with the sample and location nomenclature. It is also the responsibility of the FOL to coordinate with the EGIS lead to ensure that all survey technical specifications require the proper coordinate system, which is Indiana State Planar - North American Datum 1983 for the horizontal coordinates and National Geodetic Vertical Datum 1988 for the vertical coordinates.

6.1.3 Sample Tracking

A sample tracking system will be used to monitor and ensure that all samples identified in the proposed field investigations are collected. Prior to field mobilization, the FOL will coordinate with the Sample Management Coordinator (SMC) to initiate a sample tracking process. It is the responsibility of the TOM to ensure that a sampling tracking procedure is implemented. If a field change has taken place, the FOL will be required to complete the Field Change Notification Form to document deviations from the proposed sampling.

6.1.4 Laboratory Electronic Deliverables

According to all laboratory technical specifications for NSWC Crane, the analytical laboratories will be contractually required to deliver the analytical data in the standard Electronic Data Deliverable (EDD) format provided in Appendix F. Particular attention will be paid to the EDD requirements for validated vs. non-validated data. Once all samples and analyses are accounted for, the SMC will forward the analytical data to TtNUS for incorporation into the NSWC Crane database.

6.2 DATABASE

The contents of the database to be maintained by TtNUS for SWMU 2 are outlined in the Database Structure, provided in Appendix G. The Database Structure will outline what data are contained within the database (by investigation, media, etc.), the generator of the data (TtNUS, Corps of Engineers, etc.), and the level of quality of the data, where applicable.

It is the responsibility of the TtNUS data manager to coordinate with the NSWC Crane project team to keep the Database Structure current and make available the most recent version to all team members. A copy of the Database Structure will be maintained in the project central file at TtNUS's Pittsburgh, Pennsylvania, office.

6.3 THE ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEM

All environmental data collected in support of the NSWC Crane project will be incorporated into the EGIS. The themes, layers, and database information contained in the EGIS are outlined in the GIS Structure (Appendix H). The NSWC Crane EGIS shall be made available to all members of the project team. CD-ROM EGIS deliverables shall be made available on request from SOUTHDIV.

6.4 MAPPING AND GRAPHICS

CADD mapping is generally provided by NSWC Crane. TtNUS will not use metadata to track changes to the mapping. In addition, Tri-Service Spatial Data Standards (TSSDS) will not be used, unless the mapping from the facility already incorporates the standards. TSSDS also will not used in the final EGIS, based on the view that limited utility is gained from the substantial time required to incorporate the standards.

In addition to CADD mapping, Digital Ortho Quarter Quads (DOQ), aerial photography, and U.S. Geological Survey (USGS) 7.5 minute Quads will be obtained. The Quads will be obtained from either the USGS or other suppliers, while the aerial photography will be provided by the facility. As necessary, the images are warped to the predetermined coordinate system using Microstation. Again, metadata are not used to track the changes.

From the survey data collected for the proposed investigations, sampling locations will be organized, and then a sample-vs-location table will be built so that the data can be loaded into the sample_data.dbf table (Appendix G).

6.5 SOFTWARE

TtNUS will standardize on the following software packages when managing and manipulating data for the NSWC Crane project:

- Data Management - Microsoft Visual FoxPro 6.0
- EGIS - ArcView 3.1
- 3-D Visualization - EVS Pro 3.0
- Statistical Analysis - Statistica 5.1
- Terrain Analysis - TerraModel 9.4.1

6.6 STORAGE OF DATA

TtNUS uses NT for Networks as its Information Management System (IMS). The NT IMS has a storage capacity of 2 Gigabytes and currently serves more than 110 desktop computers. The NT IMS automatically backs-up the system on a daily basis, thereby disallowing more than 1 day of work being lost should the network crash or malfunction. The database management and EGIS groups have been allocated distinct drives on the Local Area Network (LAN). All environmental data for NSWC Crane will

be stored on \\nusrpitbdc1\sdiv\NSWC_Crane subfolder of this drive on the NT Server. All tables, queries, programs, and reports will be saved in the NSWC_Crane.pjx file in Microsoft Visual FoxPro. The NSWC Crane EGIS will be stored on \\nusrpitbdc1\gis\NSWC_Crane on the NT Server. All ArcView project files (*.apr) will be documented in a text file called readme_project.txt. This text file will also be stored on \\nusrpitbdc1\gis\NSWC_Crane.

7.0 RCRA FACILITY INVESTIGATION

The results of the proposed field investigation, identified in Section 5.5.2, will be used to complete RFI activities at SWMU 2. The RCRA Corrective Action Process involves two programs (or paths) that can be conducted at a site that poses a potential threat to human health or the environment. The two paths are the Corrective Action Process itself and Interim Measures. An interim measure has already been conducted at SWMU 2. However, RFI activities for SWMU 2 are not considered to be complete because the nature and extent of contamination have not been thoroughly defined (i.e., samples have not been specifically analyzed for dye constituents, the absence or presence of residual dye contamination at the previously disturbed soil areas has not been determined, etc.).

A brief summary of the objective of the RFI and the contents of the RFI Report are provided in this section. Section 7.1 describes the goals of the RFI. A discussion of the information to be presented in the RFI Report is provided in Section 7.2.

7.1 OBJECTIVE

The purpose of the RFI is to determine the nature, extent, direction, and rate of migration of hazardous wastes, including hazardous constituents, in soils, groundwater, surface water/sediment, and/or air. From multimedia analyses, the types and concentrations of contaminants present, the boundaries of any contamination (e.g., plumes), and the rate and direction of contaminant movement will be determined in each of the impacted media. Sufficient data will be generated during the RFI to allow performance of risk assessments as an outline of data collection and analyses results of the risk assessment will be used to either determine the need for the next step in the corrective action process (the CMS) or, alternatively, used to support the recommendation for no further action.

7.2 RCRA FACILITY INVESTIGATION (RFI) REPORT

Once all analyses from the proposed field investigation are reviewed in combination with the historical data for the site, an RFI Report will be prepared that provides a summation of the data and recommendations for further action (no further action, corrective measures, etc.). Because some RFI activities and interim measures have already been conducted at SWMU 2, the RFI Report to be prepared for the proposed field investigation will summarize and expand on information presented in the historical reports.

Based on the requirements identified in NSWC Crane's RCRA Part B Permit, the RFI Report will consist of a discussion of the following:

- Environmental Setting
- Source/Waste Characterization
- Contamination Characterization
- Potential Receptors
- Conclusions/Recommendations

Each of these components, which is integral to the refinement of the CSM for SWMU 2 (Section 4.1), is discussed briefly in the remainder of this section.

7.2.1 Environmental Setting

A characterization of the hydrogeologic, soil, surface water, sediment, and air conditions at the facility and/or SWMU will be provided in the environmental setting section. The hydrogeologic information will include:

- A description of the regional and facility-specific geologic and hydrogeologic conditions, which impact ground water beneath the site.

- Identification of topographic or man-made features that may influence ground water flow.

- Classification of the hydrogeologic units and structural geology based on data obtained during the RFI field event.

- Presentation of the structural geology and hydrogeologic cross sections.

A description of physical and chemical characteristics of potentially impacted media will be presented in the RFI Report. Soil characteristics, such as hydraulic conductivity, pH, permeability, and porosity, will be defined. Surface water bodies (creeks, streams, tributaries, etc.) and drainage ways, which may act as a migration pathway for contaminants, will be identified. A discussion of the prevailing climate (rainfall, temperature, wind speed and direction, etc.) at the facility will also provided as part of the environmental setting section.

7.2.2 Source/Waste Characterization

The source/waste characterization section of the RFI Report will be compiled using the various historical reports available for the site. Source information, such as the location and type of unit, design features, and operating practices, will be identified. The types of waste disposed at the site, as well as physical, chemical, and migration characteristics of the waste, will be discussed. For those chemicals detected in the site media, a summary of literature values available for the physical constants will be provided in tabular format. General descriptions of contaminant fate and transport for those chemicals (or classes of chemicals) detected at the site will also be presented.

7.2.3 Contamination Characterization

The contaminant-specific analytical data collected during the proposed field investigation will be used to characterize the nature and extent of contamination at the site. Horizontal and vertical extent of contamination and migration will be defined. Media-specific discussions and presentations of the chemical-specific analytical data will be provided in the RFI Report. A summary of the positively detected chemicals only will be presented within the body of the report. The following summary statistics for chemicals detected in the site media will also be tabulated and presented within the body of the report:

- Frequency of Detection
- Range of Detection
- Range of Nondetects (sample-specific detection limits)
- Average of All Results (using one-half the sample-specific detection limit for nondetects)
- Average of Positive Results

The entire analytical database (including nondetects and detects) for the proposed RFI field effort will be appended to the report.

7.2.4 Potential Receptors

A preliminary identification of the general types of potential receptors exposed to contaminated media at SWMU 2 was provided in Section 4.1.4 of this Work Plan. This information will be expanded upon in the RFI Report, as part of the Baseline Human Health and Screening-Level Ecological Risk Assessments. Current and projected future land uses (recreational, residential, commercial, etc.) will also be defined.

8.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

This section of the Work Plan outlines the general methodologies and procedures that will be used to conduct a Baseline Human Health Risk Assessment for SWMU 2 at NSWC Crane. The objective of the risk assessment is to determine whether detected concentrations of chemicals at the site pose a significant threat to potential human receptors under current and/or future land use. The potential risks to human receptors will be estimated based on the assumption that no further actions are taken to control contaminant releases.

The following current U.S. EPA and IDEM risk assessment guidance were used to develop the framework for the Baseline Human Health Risk Assessment:

- U.S. EPA, December 1989. Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA 540/1-89/002.

- U.S. EPA, March 25, 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Washington, D.C. OSWER Directive 9285.6-03.

- U.S. EPA, January 1992. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development, Washington, D.C. EPA/600/8-91/011B.

- U.S. EPA, May 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication No. 9285.7-081.

- U.S. EPA, May 1993. Distribution of Preliminary Review Draft: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Office of Solid Waste and Emergency Response, Washington, D.C.

- U.S. EPA, May 1996. Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response, Washington, D.C. EPA/540/R-95/128.

- U.S. EPA, August 1997. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/P-95/002Fa.

- U.S. EPA, November 1998. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment, Interim Guidance.

- IDEM, October 1997. RISC (Risk-Integrated System of Cleanups). Indiana Department of Environmental Management, Office of Environmental Response.

A Baseline Human Health Risk Assessment consists of five components: (1) Data Evaluation, (2) Exposure Assessment, (3) Toxicity Assessment, (4) Risk Characterization, and (5) Uncertainty Analysis. Sections 8.1 through 8.5 of this Work Plan contain detailed discussions of the methodologies to be followed for the five components of the risk assessment. A schematic diagram of the general risk assessment process is provided as Figure 8-1.

Three major aspects of chemical contamination and environmental fate and transport must be considered to evaluate potential risks: (1) contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action, (2) potential exposure points must exist, and (3) human receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure. If any one of the factors listed above is absent for a site, the exposure route is regarded as incomplete, and no potential risks will be considered to exist for human receptors.

The Baseline Human Health Risk Assessment and RFI Report for SWMU 2 will be prepared and submitted under the same cover (as one document). The risk assessment will be included in a separate section of the report.

8.1 DATA EVALUATION

Data evaluation, the first component of a Baseline Human Health Risk Assessment, is a media-specific task involving the compilation and evaluation of analytical data. The main objective of the data evaluation is to develop a media-specific list of COPCs, which will be used to quantitatively determine potential human health risks for site media.

8.1.1 Data Usability

Data collected for the proposed field investigation, which was described in Section 5.5 of this Work Plan, will be used to assess risks to potential human receptors. All analytical data used in the quantitative estimation of potential risks will be subjected to data validation. A discussion of data validation protocol to be followed is provided in Section 9.0 of the associated QAPP. A Data Quality Report will be generated

for the proposed field investigation data. This report will provide information on precision, accuracy, representativeness, completeness, and comparability. A brief summary of the results of the data validation also will be included.

Quantitative or qualitative analytical results only from the target analyte lists for the proposed field investigation will be used in the risk evaluation. Typically, unfiltered results for ground water and surface water are used to assess risks associated with these media. Filtered results will be used for the risk assessment if the associated unfiltered samples are found to be turbid. Field measurements, data regarded as unreliable (i.e., qualified as "R" during the data validation process), and results of Tentatively Identified Compound (TIC) analyses will not be used in the quantitative risk assessment. However, these data may be used to substantiate the conclusions of the quantitative risk analysis.

Because of uncertainties associated with data quality, historical data collected during previous RFIs will not be used to quantitatively assess potential risks at SWMU 2. The quality associated with the historical data has not been adequately documented, and the data do not seem to have been validated. The data packages (including the raw data) cannot be obtained to ascertain the level of quality associated with the data or to independently validate the data. However, these data may be used in a qualitative fashion to support the conclusions of the quantitative risk analysis. The proposed field investigations were developed to be comprehensive (i.e., locations sampled historically, as well as data gap locations, were included); thus, the uncertainty associated with the elimination of the historical data from the quantitative risk assessment will not be significant.

8.1.2 Selection of Chemicals of Potential Concern

The selection of COPCs is a qualitative screening process used to limit the number of chemicals and exposure routes quantitatively evaluated in the Baseline Human Health Risk Assessment to those site-related constituents that dominate overall potential risks. Screening by risk-based concentrations and Basewide background levels will be used to focus the risk assessment on meaningful chemicals and exposure routes.

In general, a chemical will be selected as a COPC and retained for further quantitative risk evaluation if (1) the maximum detection in a sampled medium exceeds the lowest risk-based concentration and (2) the chemical is determined to be present at concentrations exceeding background. Chemicals eliminated from further evaluation at this time are assumed to present minimal risks to potential human receptors.

Dye compounds that are tentatively identified during analysis will not be used quantitatively during the risk assessment. These results will be discussed qualitatively in the uncertainty section of the risk assessment. The uncertainty associated with omitting the compound from a quantitative risk assessment would be discussed.

8.1.2.1 COPC Screening Levels

Several types of screening levels will be used to identify COPCs for SWMUs 4, 5, 9, and 10. Screening concentrations based on U.S. EPA Region IX Preliminary Remediation Goals (PRGs) (U.S. EPA, Region IX, October 2000) will be used, as well as other IDEM and U.S. EPA criteria. The risk-based screening concentrations will correspond to a systemic hazard quotient of 0.1 (for noncarcinogens) or a lifetime cancer risk of 1E-6 (for carcinogens). Note that the Region IX PRGs are based on a hazard quotient of 1.0 while the screening concentrations are based on a hazard quotient of 0.1. The screening concentrations are based on a hazard quotient of 0.1 so that additive noncarcinogenic risks for all chemicals do not exceed 1.0. The screening levels to be used for each media in the risk assessment are briefly discussed below.

<u>Soil/Sediment</u>

The following criteria will be used to select COPC for soil (surface and subsurface soil):

- U.S. EPA Region 9 PRGs for Residential Soil (U.S. EPA Region 9, May 1998).
- U.S. EPA Generic Soil Screening Levels (SSLs) for Migration to Ground Water (U.S. EPA, May 1996).
- U.S. EPA Generic SSLs for Transfers from Soil to Air (U.S. EPA, May 1996).
- IDEM Tier I Cleanup Levels for Surface Soil (IDEM, October 1997).
- IDEM Tier I Cleanup Levels for Subsurface Soil (IDEM, October 1997).

If the maximum concentration of a constituent exceeds any of these criteria (and the constituent is considered to be present at concentrations greater than Basewide background levels), the chemical will be selected as a COPC for soil and carried through to the quantitative risk assessment.

Because of the different exposure scenarios for potential human receptors, COPCs will be identified for surface and subsurface soil. Surface soil will be defined as soil collected from 0 to 2 feet bgs. Subsurface soil will be defined as soil collected from depths greater than 2 feet bgs.

The comparison of site soil data to U.S. EPA Generic SSLs for transfers from soil to air will be used to identify whether a quantitative analysis of this exposure pathway is warranted. If the maximum soil concentration of a chemical exceeds the SSL, a quantitative evaluation of potential risks from inhalation will be performed, as described in Section 8.2.4. Otherwise, the risks associated with the inhalation pathway will be considered insignificant, and the exposure pathway will be eliminated from further evaluation.

No specific screening levels exist for human exposure to sediment. COPCs will be selected for sediment by comparing detected site concentrations to the following:

- U.S. EPA Region 9 PRGs for Residential Soil (U.S. EPA Region 9, May 1998).
- IDEM Tier I Cleanup Levels for Surface Soil (IDEM, October 1997).

U.S. EPA Generic SSLs for transfers from soil to air and for migration to ground water are not considered to be appropriate for sediment screening because of high moisture content associated with sediment matrices. The use of soil screening levels for sediment COPC identification is regarded as a conservative approach because anticipated exposure to sediment is less than anticipated exposure to soil.

Ground Water/Surface Water

The same screening levels will be used to select COPCs for ground water and surface water. The following criteria will be used:

- U.S. EPA Region 9 PRGs for Tap Water (U.S. EPA, Region 9, May 1998).
- IDEM Tier I Cleanup Levels for Residential Ground Water (IDEM, October 1997).
- U.S. EPA MCLs (U.S. EPA, October 1996).

If the maximum concentration of a constituent exceeds any of these criteria (and the constituent is considered to be present at concentrations greater than Basewide background levels), the chemical will be selected as a COPC and carried through to the quantitative risk assessment.

Risk-based COPC screening levels for tap water ingestion, which are based on daily, residential exposure assumptions, will be used to select COPCs for ground water and surface water. In general, the use of tap water screening levels is regarded as a highly conservative approach to COPC selection at SWMU 2 because ground water at the sites is not used as a potable drinking water source. Currently, there is no direct exposure to ground water at the four SWMUs. In addition, potential human exposure to surface

water at SWMU 2 is expected to be limited to incidental exposures (such as that which occurs during trespassing), which is significantly less than the daily exposure assumed during the development of the aforementioned ground water screening criteria.

Federal AWQC will not be used to select COPCs for surface water. AWQC applicable to the protection of human health will not be used since surface water present at SWMU 2 is not currently used and will not be used in the future as a potable drinking water source. In addition, the surface water bodies present at the sites do not support game fish populations because of their size and intermittent nature. Lake Greenwood is used as a drinking water supply for the facility. Ground water impacted by historical operations at SWMU 2 does discharge to nearby surface water bodies (Sulfur Creek and its tributaries). However, none of the surface water bodies affect Lake Greenwood.

8.1.2.2 Lead as a COPC

Limited criteria are available to evaluate the potential risks associated with lead. There are no risk-based concentrations for this chemical since the U.S. EPA has not derived toxicity values for lead. However, recommended screening levels are available for lead in soil which are used to indicate the need for response activities. Guidance from both the Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and the Office of Solid Waste and Emergency Response (OSWER) recommend 400 mg/kg as the lowest screening level for lead-contaminated soil in a residential setting, where children are frequently present (U.S. EPA, July 14, 1994). OPPTS identifies 2,000 to 5,000 mg/kg as an appropriate range for areas where contact with soil by children in a residential setting is less frequent.

At this time, no screening level is available for non-residential areas involving adult and adolescent exposure only. A value of 400 mg/kg will be used as a screening level for soil and sediment. The Safe Drinking Water Act Action Level of 15 µg/L will be used as the screening level for lead in ground water and surface water.

8.1.2.3 Essential Nutrients and Chemicals without Toxicity Criteria

The essential nutrients calcium, magnesium, potassium, and sodium will not be identified as COPCs for SWMU 2. These inorganic chemicals are naturally abundant in environmental matrices and are only toxic at high doses. In addition, because of the lack of toxicity criteria, risk-based COPC screening levels are not available for some dye constituents. These chemicals will not be selected as COPCs as they can not be addressed during the quantitative risk assessment. However, these chemicals will be mentioned in the

data evaluation section, after the identification of COPCs, and qualitatively addressed in the uncertainty section of the risk assessment.

8.1.2.4 Determination of Site-Related Chemicals

Chemicals found at concentrations indicative of background levels are not considered to be site-related contaminants and will not be retained as COPCs for the quantitative risk assessment. The use of Basewide background soil data will determine if detected chemicals are present at naturally occurring levels. Conventional statistical methods (e.g., Bartlett's T-test, etc.) will be employed to compare site concentrations for SWMU 2 to background concentrations. The elimination of detected chemicals based on background data for soil will be limited to inorganics only.

8.1.3 COPC Summary Screening Tables

Media-specific tables summarizing the selection of COPCs will be included in the risk assessments. At a minimum, the following information will be included in the summary tables: (1) maximum concentration in a single sample of all detected chemicals, (2) frequency of detection, (3) location of maximum concentration, (4) COPC screening levels, and (5) results of COPC screening process. An example format of a typical COPC summary screening table is provided as Table 8-1.

8.2 EXPOSURE ASSESSMENT

This portion of the risk assessment defines and evaluates, quantitatively or qualitatively, the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, identify potentially exposed populations and applicable exposure pathways, calculate concentrations of COPCs to which receptors might be exposed, and estimate chemical intakes under the identified exposure scenarios.

Actual or potential exposures at SWMU 2 will be determined based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has three components: (1) a source of chemicals that can be released to the environment, (2) a route of contaminant transport through an environmental medium, and (3) an exposure or contact point for a human receptor.

8.2.1 Conceptual Site Model

The development of a CSM is an essential component of the exposure assessment. The CSM will integrate information regarding the physical characteristics of the site, exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify potential exposure routes and receptors to be evaluated in the risk assessment. A well-defined CSM will allow for a better understanding of the risks at a site and will aid the risk managers in the identification of the potential need for remediation. A general discussion of the contents of a CSM was provided in Section 4.0 of this Work Plan.

A site-specific CSM for SWMU 2 was presented in Section 4.1 of this Work Plan and is illustrated in Figure 4-1. The model was used to develop the proposed field investigation to ensure that the data collected meet the needs of the risk assessments. Sources of contamination, contaminant release mechanisms, transport/migration pathways, exposure routes, and potential receptors are defined for SWMU 2. The CSM will be refined during the risk assessment process using the data and information collected as part of the proposed field investigations.

Table 4-1 provided a site-specific summary of the potential receptors to be evaluated for SWMU 2. A summary of the exposure routes that will be addressed quantitatively for each human receptor is provided in Table 8-2.

8.2.2 Central Tendency Exposure vs. Reasonable Maximum Exposure

Traditionally, exposures evaluated in the human health risk assessment were based on the concept of a Reasonable Maximum Exposure (RME) only, which is defined as "the maximum exposure that is reasonably expected to occur at a site" (U.S. EPA, December 1989). However, recent risk assessment guidance (U.S. EPA, February, 1992) indicates the need to address an average case or Central Tendency Exposure (CTE).

To provide a full characterization of potential exposure, both RME and CTE will be evaluated in the risk assessments for SWMU 2. The available guidance (U.S. EPA, May 1993) concerning the evaluation of CTE is limited and at times vague. Therefore, professional judgment may be exercised when defining CTE conditions for a particular receptor at a site.

8.2.3 Exposure Concentrations

The exposure concentration, which is calculated for COPCs only, is a reasonable maximum estimate of the chemical concentration that is likely to be contacted over time by a receptor and is used to calculate estimated exposure intakes. The 95 percent upper confidence limit (UCL), which is based on the distribution of a data set, is considered to be the best estimate of the exposure concentration for data sets with 10 or more samples (U.S. EPA, May 1992). The 95 percent UCL will be used as the exposure concentration to assess RME and CTE risks (U.S. EPA, May 1993). For data sets with less than 10 samples, the UCL is considered to be a poor estimate of the mean, and the exposure concentration will be defined as the maximum detection.

Conventional statistical methods (i.e., the Shapiro-Wilk W-Test) will be used to determine the distribution and UCL of a particular data set (Gilbert, 1987; U.S. EPA, May 1992). Detailed sample calculations, as well as general methodology for the statistical evaluation, will be presented in the site-specific risk assessments. Only the "original" of a field duplicate sample pair will be used as the concentration value at a given sampling point. Nondetected data points will be utilized; in general, one-half the sample-specific detection limit will be employed for these analytical results. If the calculated 95 percent UCL exceeds the maximum detected concentration, the maximum will be used as exposure concentration in place of the UCL.

8.2.4 Chemical Intake Estimation

The methodologies and techniques used to estimate exposure intakes are presented in this section of the Work Plan. Intakes for the identified potential receptor groups will be calculated using current U.S. EPA risk assessment guidance (U.S. EPA, December 1989 and January 1992) and presented in the risk assessment spreadsheets. Risk assessment spreadsheets will be appended to the risk assessments as support documentation.

Noncarcinogenic intakes will be estimated using the concept of an average annual exposure. Carcinogenic intakes will be calculated as an incremental lifetime exposure, which will assume a life expectancy of 70 years. Equations used to calculate estimated intakes are provided below. Assumptions regarding exposure are presented in Table 8-3.

8.2.4.1 Inhalation of Air and Fugitive Dust/Volatile Emissions

The amount of a chemical a receptor takes in as a result of respiration is determined using the concentration of the contaminant in air. Intakes of both particulates and vapors/gases from soil will be calculated using the same equation, as follows (U.S. EPA, December 1989):

$$Intake_{ai} = (C_{ai})(IR_a)(ET)(EF)(ED) / (BW)(AT)$$

where:

$Intake_{ai}$	=	intake of chemical "i" from air via inhalation (mg/kg/day)
C_{ai}	=	concentration of chemical "i" in air (mg/m^3)
IR_a	=	inhalation rate (m^3/hr)
ET	=	exposure time (hours/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yrs x 365 days/yr

The concentration of a chemical in air will be developed using modeling techniques, measured soil concentrations, and additional site-specific information.

As mentioned previously in Section 8.1.2.1, a qualitative evaluation of exposure (i.e., comparison of maximum site soil concentrations to U.S. EPA Generic SSLs for transfers from soil to air) will be used to identify whether a quantitative analysis of this exposure pathway is warranted. If it is determined that a quantitative evaluation is not required, the potential risks associated with the inhalation pathway will be regarded as minimal and no further evaluation will be performed.

8.2.4.2 Dermal Contact with Soil/Sediment

Direct physical contact with soil (and sediment) may result in the dermal absorption of chemicals. Exposures associated with the dermal route are estimated in the following manner (U.S. EPA, December 1989 and January 1992):

$$Intake_{si} = (C_{si})(SA)(AF)(ABS)(CF)(EF)(ED) / (BW)(AT)$$

where:

$Intake_{si}$	=	amount of chemical "i" absorbed during contact with soil/sediment (mg/kg/day)
C_{si}	=	concentration of chemical "i" in soil/sediment (mg/kg)
SA	=	skin surface area available for contact (cm^2/day)
AF	=	skin adherence factor (mg/cm^2)
ABS	=	absorption factor (dimensionless)
CF	=	conversion factor (1E-6 kg/mg)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yrs x 365 days/yr

Exposed surface areas of body available for dermal contact are determined on a receptor-specific basis since they correspond with assumed human activities and clothing worn during exposure events. Current guidance (U.S. EPA, January 1992; U.S. EPA, August 1997) were used to develop the default assumptions concerning the amount of skin surface area available for contact for a receptor. To maintain consistency from project to project, input parameters previously used for other NSWC Crane risk assessments (B&R Environmental, 1997) were also reviewed when developing the exposed surface areas. The rationales used to select the skin areas are as follows:

- For maintenance and occupational workers exposed to surface soil, the surface area available for soil contact is assumed to be the hands and forearms of an adult male. The skin surface area is 2,300 cm^2 for the CTE and is 2,830 cm^2 for the RME. These values represent the 50th and 95th percentile areas for the hands and forearms, respectively (U.S. EPA, August 1997).

- For construction workers exposed to surface and subsurface soil, the surface areas for the RME (5,800 cm^2) and CTE (5,000 cm^2) are the values recommended for soil contact by the U.S. EPA in the Exposure Factors Handbook (U.S. EPA, August 1997). These values represent 25 percent of the total body surface area of an adult male.

- For adolescent trespassers, 25 percent of the total body surface area for an adolescent (aged 6 to 16) will be assumed to be available for surface soil and/or sediment contact. The RME value (3,820 cm^2) will be derived from the 95th percentile surface area data and the CTE value (3,100 cm^2) will be derived from the 50th percentile data, as provided in Table 6-6 of the Exposure Factors Handbook (U.S. EPA, August 1997).

- For adult recreational users assumed to be exposed to surface soil and sediment, the exposed surface area available for contact will be the sum of the feet, lower, legs, hands, and arms of an adult male. This skin surface area is 7,770 cm^2 for the CTE and is 9,190 cm^2 for the RME. These values represent the 50th and 95th percentile areas for the feet, lower legs, hands and forearms, respectively (U.S. EPA, August 1997).

The published range for the soil adherence factor is 0.2 to 1.0 mg/cm^2 (U.S. EPA, January 1992). Soil adherence factors of 1.0 and 0.2 will be used to evaluate RME and CTE, respectively. Current U.S. EPA guidance (U.S. EPA, November 1998) will be used to determine chemical-specific dermal absorption factors.

8.2.4.3 Incidental Ingestion of Soil/Sediment

Incidental ingestion of soil (and sediment) by potential receptors coincides with dermal exposure. Exposures associated with incidental ingestion are estimated in the following manner (U.S. EPA, December 1989):

$$Intake_{si} = (C_{si})(IR_s)(FI)(EF)(ED)(CF)\ /(BW)(AT)$$

where:

$Intake_{si}$	=	intake of contaminant "i" from soil or sediment (mg/kg/day)
C_{si}	=	concentration of contaminant "i" in soil or sediment (mg/kg)
IR_s	=	ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (dimensionless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor (1E-6 kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days);

for noncarcinogens, AT = ED x 365 days/yr;
for carcinogens, AT = 70 yrs x 365 days/yr

The same exposure frequencies and durations used in the estimation of dermal intakes will be used to estimate exposure via incidental ingestion. Default values of 1.0 (RME) and 0.5 (CTE) will be used for the fraction of soil ingested from the source.

8.2.4.4 Dermal Contact with Ground Water/Surface Water

The same equation is used to estimate intakes for dermal contact with ground water and surface water. Direct contact with ground water at SWMU 2 is limited. As mentioned previously in Section 4.0, the site is not expected to be developed under future land use because of the nature of the site (i.e., a burial area which is covered with a multilayered cap system). An evaluation of the use of groundwater for potable (residential) purposes is provided for information purposes only to aid risk managers in making risk management decisions.

Potable groundwater users (residents) are assumed to use ground water for domestic purposes (i.e., bathing, showering, washing dishes), which can result in a dermal exposure. Dermal contact with surface water may also occur while receptors are involved in certain activities, such as trespassing or recreational sport (hiking, biking, etc.).

The following equation will be used to assess exposures resulting from dermal contact with water (U.S. EPA, January 1992):

$$DAD_{wi} = (DA_{event})(EV)(ED)(EF)(A) / (BW)(AT)$$

where:

DAD_{wi}	=	dermally absorbed dose of chemical "i" from water (mg/kg/day)
DA_{event}	=	absorbed dose per event (mg/cm^2-event)
EV	=	event frequency (events/day)
ED	=	exposure duration (yr)
EF	=	exposure frequency (days/yr)
A	=	skin surface area available for contact (cm^2)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;

for carcinogens, AT = 70 yrs x 365 days/yr

Ground water exposure for potable groundwater users are assumed to occur on a daily basis. Exposure to ground water for construction workers and exposure to surface water for residents, trespassers, and recreational users will be limited to infrequent exposure events. Dermal intakes for residents will assume total body exposure. For trespassers and recreational users, the exposed surface area of the body available for contact will be determined based on assumed activities and will be similar to the assumptions outlined for dermal contact with soil and sediment.

The absorbed dose per event (DA_{event}) will be estimated using a nonsteady-state approach for organic compounds and a traditional steady-state approach for inorganics. For organics, the following equations apply:

$$\text{If } t_{event} < t^*, \text{then: } DA_{event} = (2K_p)(C_{wi})(CF)\left[\frac{\sqrt{6\,T\,t_{event}}}{\pi}\right]$$

$$\text{If } t_{event} > t^*, \text{then: } DA_{event} = (K_p)(C_{wi})(CF)\left[\frac{t_{event}}{1+B} + 2T\left[\frac{1+3B}{1+B}\right]\right]$$

where:

t_{event}	=	duration of event (hr/event)
t^*	=	time it takes to reach steady-state conditions (hr)
K_p	=	permeability coefficient from water through skin (cm/hr)
C_{wi}	=	concentration of chemical "i" in water (mg/L)
T	=	lag time (hr)
π	=	constant (dimensionless; equal to 3.141592654)
CF	=	conversion factor (1E-3 L/cm^3)
B	=	partitioning constant derived by Bunge Model (dimensionless)

Values for the chemical-specific parameters (t_{event}, t^*, K_p, T, and B) will be obtained from the current dermal guidance (U.S. EPA, January 1992, Table 5-8). If no published values are available for a particular compound, they will be calculated using equations provided in the cited guidance.

The following nonsteady-state equation will be used to estimate DA_{event} for inorganics:

$$DA_{event} = (K_p)\,(C_{wi})\,(t_{event})$$

In general, the recommended default value of 1E-3 will be used for the dermal permeability of inorganic constituents.

8.2.4.5 Incidental/Direct Ingestion of Ground Water/Surface Water

Residents may be exposed to ground water via direct ingestion. Direct contact with surface waters while swimming or exploring could also result in the inadvertent ingestion of small amounts of water. Intakes associated with ingestion of water will be evaluated using the following equations (U.S. EPA, December 1989):

$$Intake_{wi} = (C_{wi})(IR_w)(EF)(ED)\,/(BW)(AT) \quad \textit{for groundwater}$$

$$Intake_{wi} = (C_{wi})(CR)(ET)(EF)(ED)\,/(BW)(AT) \quad \textit{for surface water}$$

where:

$Intake_{wi}$	=	intake of chemical "i" from water (mg/kg/day)
C_{wi}	=	concentration of chemical "i" in water (mg/L)

IR_w	=	ingestion rate for ground water (L/day)
CR	=	contact rate for surface water (L/hr)
ET	=	exposure time for surface water (hr/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yrs x 365 days/yr

The same exposure times, frequencies, and durations used to assess dermal exposure to water will be used to estimate intakes for ingestion of water.

8.2.4.6 Inhalation of Volatiles in Ground Water

Ground water exposure may also result in an inhalation exposure. This exposure route will be evaluated for residential receptors only who may be exposed while showering, bathing, washing dishes, etc. Inhalation exposures will be estimated using a mass transfer model, developed specifically for this exposure route, in combination with an air intake estimation model. The mass transfer model accounts for inhalation that occurs during a shower and after a shower while the receptor remains in the closed bathroom. The method employed is as follows (U.S. EPA, December 1989; Foster and Chrostowski, 1987):

$$Intake_{si} = (S)(IR_{sh})(K)(EF)(ED) / (BW)(AT)(R_a)(CF)$$

$$K = D_s + \frac{\exp(R_a \times D_t)}{R_a} - \frac{\exp R_a \times (D_s - D_t)}{R_a}$$

where:

$Intake_{wi}$	=	intake of chemical "i" from water via inhalation (mg/kg/day)
S	=	volatile chemical generation rate (µg/m^3-min-shower)
IR_{sh}	=	inhalation rate (L/min)
EF	=	exposure frequency (showers/yr)
ED	=	exposure duration (yrs)
BW	=	body weight (kg)

AT	=	averaging time or period of exposure (days)
R_a	=	air exchange rate (min^{-1})
K	=	mass transfer coefficient (min)
D_s	=	shower duration (min)
D_t	=	total time in bathroom (min)
CF	=	conversion factor (1E+6 µg-L/mg-m^3)

The volatile chemical generation rate will be estimated using the Foster and Chrostowski mass transfer model, which is based on two-phase film theory. The model employs contaminant-specific mass transfer coefficients, Henry's Law constants, droplet diameter, drop time, viscosity, temperature, etc. Calculations of the shower model will be provided in the appendices to the site-specific risk assessments.

8.2.4.7 Summary of Exposure Parameters

A summary of the exposure input parameters for all exposure pathways are presented in Table 8-3 for the identified potential receptor groups at SWMU 2. In general, standard default parameters (U.S. EPA, March 1991), which combine mid-range and upper-end exposure factors, will be used to assess RME conditions. CTE will be assessed primarily by the use of mid-range exposure factors presented in current risk assessment guidance (U.S. EPA, May 1989 and May 1993). These input parameters may be updated according to new risk assessment guidance, as it becomes available.

8.2.5 Exposure to Lead

The equations and methodology presented in the previous section cannot be used to evaluate exposure to lead because of the absence of published dose-response parameters. Exposure to lead will be assessed using the latest version of the U.S. EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead (U.S. EPA, February 1994). This model is designed to estimate blood levels of lead in children (under 7 years of age) based on either default or site-specific input values for air, drinking water, diet, dust, and soil exposure.

Studies indicate that infants and young children are extremely susceptible to adverse effects from exposure to lead. Considerable behavioral and developmental impairments have been noted in children with elevated blood lead levels. The threshold for toxic effects from this chemical is believed to be in the range of 10 µg/dL to 15 µg/dL. Blood lead levels greater than 10 µg/dL are considered to be a "concern."

For SWMU 2, the IEUBK Model for lead will be used to address exposure to lead in children when detected ground water and surface water concentrations exceed the 15 µg/L Federal Action Level promulgated under the Safe Drinking Water Act and when detected soil and sediment concentrations exceed the OSWER soil screening level of 400 mg/kg for residential land use (U.S. EPA, July 1994a). Average chemical concentrations, as well as default parameters for some input parameters, will be employed. Estimated blood lead levels and probability density histograms will be presented as support documentation for this analysis and appended to the site-specific risk assessment.

Adult exposure to lead in soil will be quantified by the model provided by the U.S. EPA's Technical Review Workgroup for Lead (U.S. EPA, December 1996). In this model, adult exposure to lead in soil is addressed by an evaluation of the relationship between the site soil lead concentration and the blood lead concentration in the developing fetuses of adult women. The adult lead model will generate a spreadsheet for each exposure scenario evaluated (i.e., workers and adult residents). The spreadsheets will calculate a range of 95th percentile fetal blood lead concentrations from central estimates of blood lead concentrations in pregnant adult women. The spreadsheets also calculate 95th percentile blood lead concentrations in fetuses born to women exposed to lead in soil.

No models are currently available to evaluate the periodic exposure of adolescent trespassers to lead. Therefore, the results of the IEUBK Model for children will be used to qualitatively assess exposure of this receptor. Essentially, the qualitative discussion will cite that potential adverse effects from exposure to lead are expected to be of a lesser magnitude for adolescent trespassers than for children.

8.3 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to identify the potential health hazards and adverse effects in exposed populations. Quantitative estimates of the relationship between the magnitude and type of exposures and the severity or probability of human health effects will be defined for the identified COPCs. Quantitative toxicity values determined during this component of the risk assessment will be integrated with outputs of the exposure assessment to characterize the potential for the occurrence of adverse health effects for each receptor group.

The toxicity value used to evaluate noncarcinogenic health effects is the Reference Dose (RfD). Carcinogenic effects are quantified using the Cancer Slope Factor (CSF).

8.3.1 Toxicity Criteria

Oral and inhalation RfDs and CSFs to be used in the site-specific risk assessments for SWMU 2 will be obtained from the following primary literature sources:

- Integrated Risk Information System (IRIS)
- Annual Health Effects Assessment Summary Tables (HEAST)
- NCEA Superfund Health Risk Technical Support Center

Although RfDs and CSFs can be found in several toxicological sources, U.S. EPA's IRIS on-line database is the preferred source of toxicity values. This database is continuously updated and values presented have been verified by U.S. EPA RfD and Carcinogenic Risk Assessment Verification Endeavor (CRAVE) work groups. The U.S. EPA Region 9 PRG tables and Region 3 Risk-Based Criteria tables will also be used as a source of toxicity criteria. Toxicity criteria for dye constituents will be developed, if necessary, by the U.S. EPA.

8.3.1.1 Toxicity Criteria for Dermal Exposure

RfDs and CSFs found in literature may be expressed as administered doses; therefore, these values are considered to be inappropriate for estimating the risks associated with dermal routes of exposure. Oral dose-response parameters based on administered doses must be adjusted to absorbed doses before the comparison to estimated dermal exposure intakes is made. Because this information is not always readily available, all oral dose-response parameters will be adjusted.

The adjustment to an absorbed dose will be made using chemical-specific absorption efficiencies published in available guidance [i.e., IRIS, Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles, etc.] and the following equations:

$$RfD_{dermal} = (RfD_{oral})(ABS_{GI})$$

$$CSF_{dermal} = (CSF_{oral})(ABS_{GI})$$

where:

ABS_{GI} = absorption efficiency in the gastrointestinal tract

Absorption efficiencies used in the risk assessments will reflect the U.S. EPA's current dermal assessment guidance (U.S. EPA, November 1998).

8.3.1.2 Toxicity Criteria for Chromium

Toxicity criteria are available for different forms of chromium, which is considered to be more toxic in the hexavalent state. Because there is no evidence to support the conclusion that hexavalent chromium is present at the sites, speciation analyses will not be completed for SWMU 2. Risks associated with this chemical will be assessed by assuming that 10 percent of the reported total chromium result is attributable to hexavalent chromium, while 90 percent of the total chromium result is comprised of trivalent chromium. This assumption is based on published toxicological information (ATSDR, 1991).

8.3.2 Toxicity Profiles

Toxicological profiles for each COPC will be presented as an appendix to the risk assessment. These brief profiles present a summary of the current available literature on the carcinogenic and noncarcinogenic health effects associated with human exposure to COPCs.

8.4 RISK CHARACTERIZATION

Potential risks (noncarcinogenic and carcinogenic) for human receptors resulting from the exposures outlined in the exposure assessment are quantitatively determined during the risk characterization component of the Baseline Human Health Risk Assessment.

A summary and interpretive discussion of the quantitative risk estimates will be provided in the text of the site-specific risk assessments. During the interpretive risk discussion, COPCs that contribute significantly to elevated risks will be identified as "risk drivers" or Chemicals of Concern (COCs). All the numeric estimates of risk will be contained in the risk assessment spreadsheets, which will be appended to the assessment as support documentation.

8.4.1 Quantitative Analysis

Quantitative estimates of risk will be calculated according to risk assessment methods outlined in U.S. EPA guidance (U.S. EPA, December 1989). Lifetime cancer risks will be expressed in the form of dimensionless probabilities, referred to as incremental cancer risks (ICRs), based on CSFs. Noncarcinogenic risk estimates will be presented in the form of HQs that are determined through a comparison of intakes with published RfDs.

ICR estimates are generated for each COPC using estimated exposure intakes and published CSFs, as follows:

$$ICR = (\text{Estimated Exposure Intake})(CSF)$$

If the above equation results in an ICR greater than 0.01, the following equation will be used:

$$ICR = 1\text{-}[\exp(\text{-Estimated Exposure Intake})(CSF)]$$

An ICR of 1E-6 indicates that the exposed receptor has a one-in-one-million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons.

As mentioned previously, noncarcinogenic risks will be assessed using the concept of HQs and HIs. The HQ for a COPC is the ratio of the estimated intake to the RfD, as follows:

$$HQ = (\text{Estimated Exposure Intake}) / (RfD)$$

An HI will be generated by summing the individual HQs for all COPCs. The HI is not a mathematical prediction of the severity of toxic effects and therefore is not a true "risk"; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

8.4.1.1 Comparison of Quantitative Risk Estimates to Benchmarks

To interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates will be compared to typical benchmarks. Calculated ICRs will be interpreted using the U.S. EPA's "target range" (1E-4 to 1E-6), while HIs will be evaluated using a value of 1.0.

The U.S. EPA has defined the range of 1E-4 to 1E-6 as the ICR "target range" for most hazardous waste facilities addressed under RCRA. Individual or cumulative ICRs greater than 1E-4 will not be considered as protective of human health, while ICRs less than 1E-6 will be regarded as protective.

An HI exceeding unity (1.0) indicates that there may be potential noncarcinogenic health risks associated with exposure. If an HI exceeds unity, a segregation of target organs effects associated with exposure to

COPCs will be performed. Only those chemicals which affect the same target organ(s) or exhibit similar critical effect(s) will be regarded as truly additive. Consequently, it may be possible for a cumulative HI to exceed 1.0, but no adverse health effects are anticipated if the COPCs do not affect the same target organ or exhibit the same critical effect.

8.4.2 Qualitative Analysis

As mentioned previously, a qualitative evaluation of risk will be made for several exposure situations.

- The soil inhalation pathway (Section 8.2.4) will be initially evaluated by a comparison of maximum site soil concentrations to U.S. EPA Generic SSLs for transfers from soil to air. If the maximum site concentration exceeds the SSL for a chemical, a quantitative analysis of this exposure pathway will be performed.

- Known dye constituents will be evaluated qualitatively if toxicity criteria for these compounds could not be developed.

- If a compound is identified as an unknown dye constituent during laboratory analysis, a qualitative evaluation of this chemical will be conducted.

8.5 UNCERTAINTY ANALYSIS

The goal of the uncertainty analysis is to identify important uncertainties and limitations associated with the Baseline Human Health Risk Assessment. Uncertainties related to each component of the assessment (i.e., data evaluation, exposure assessment, toxicity assessment, and risk characterization) will be presented. In addition, the effect of a particular uncertainty on the outcome of the assessment (i.e., risk estimates) will also be indicated, where possible. The following subsections present an overview of uncertainties which may be addressed in the risk assessment uncertainty section.

8.5.1 Uncertainty in Data Evaluation

This section may discuss uncertainties in the risk assessment associated with the analytical data and data quality. This may also involve a discussion of uncertainty in the COPC selection process, the inclusion or exclusion of COPCs in the risk assessment on the basis of background concentrations, the uncertainty in COPC screening levels, and the omission of constituents for which health criteria are not available.

8.5.2 Uncertainty in the Exposure Assessment

This section will include a discussion of the following: assumptions related to current and future land use; the uncertainty in exposure point concentrations, for example, the use of maximum concentrations to estimate risks; uncertainty in the selection of potential receptors and exposure scenarios; and uncertainty in the selection of exposure parameters (RME vs. CTE). If predictive models are used in the risk estimation, the uncertainty associated with the model and modeling parameters will be evaluated.

8.5.3 Uncertainty in the Toxicity Assessment

The uncertainties inherent in RfDs and CSFs and use of available criteria will be discussed. A discussion of the uncertainty in hazard assessment, which deals with characterizing the nature and strength of the evidence of causation, or the likelihood that a chemical that induces adverse effects in animals will also induce adverse effects in humans, will be provided. This section will also discuss uncertainty in the dose-response evaluations for the COPCs which relates to the determination of a CSF for the carcinogenic assessment and derivation of an RfD or reference concentration (RfC) for the noncarcinogenic assessment. In addition, a discussion of the uncertainty in the toxicity of specific constituents, such as PAHs, arsenic, chromium, aluminum, iron, and copper, will be presented, if applicable.

8.5.4 Uncertainty in the Risk Characterization

This section will discuss the uncertainty in risk characterization which results primarily from assumptions made regarding additivity/synergism of effects from exposure to multiple COPCs affecting different target organs across various exposure routes. The risk assessment will discuss the uncertainty inherent in summing risks for several substances across different exposure pathways.

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TABLE 8-1

FORMAT OF COPC SELECTION SUMMARY TABLE
SWMU 2
NSWC CRANE, INDIANA

Chemical	Frequency of Detection	Range of Detection	Location of Maximum Detection	Risk-Based COC Screening Level	Other Health-Based Criteria	Attributable to Background?	Selected as COC?	Rationale
All positively detected chemicals presented.	Presented as the number of positive detections divided by the total number of sample results. Sample results qualified as rejected during data validation are not included in the total sample count. Only the "original" of a field duplicate sample pair will be used as the concentraton value at a given point.	Positive results qualified as rejected during data validation are not presented. Sample results qualified as rejected during data validation are not included in the range. Only the "original" of a field duplicate sample pair will be used as the concentraton value at a given point.	The sampling data associated with the maximum detection may be appended if an extensive amount of historical data is available.	Direct exposure criteria developed using current U.S. EPA Region 9 PRG guidance.	Soil and tap water ingestion, SSLs for transfers from soil to air, and SSLs for transfers from soil to groundwater will be used, in addition to Federal drinking water standards.	Yes or No identification.	Yes or No identification.	Indicates decision process. Will typically be presented as references, such as "ASL" above screening level, "BSL" below screening level, etc.

TABLE 8-2

EXPOSURE ROUTES FOR QUANTITATIVE EVALUATION
SWMU 2
NSWC CRANE, INDIANA

Receptors	Exposure Routes[1]
Adolescent Trespassers (6 to 17 Years)	• Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface) • Surface Water/Sediment Dermal Contact • Surface Water/Sediment Ingestion
Maintenance/Occupational Workers	• Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface)
Construction Workers	• Soil Dermal Contact (surface and subsurface) • Soil Ingestion (surface and subsurface) • Inhalation of Air/Dust/Emissions (surface and subsurface)
Adult Recreational Users	• Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface) • Surface Water/Sediment Dermal Contact • Surface Water/Sediment Ingestion
Residents (Adult/Children)	• Direct Ingestion of Ground Water • Ground Water Dermal Contact (showering/bathing) • Inhalation of Volatiles in Ground Water (showering/bathing)

1 Because a mult-layered cap system is in place at SWMU 2, exposure pathways for soil will only be considered to be complete if dye contamination is found outside the limits of the cap.

TABLE 8-3

SUMMARY OF EXPOSURE ASSUMPTIONS
SWMU 2
NSWC CRANE, INDIANA
PAGE 1 OF 4

Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Adolescent Trespasser (6 to 17 Years)	EF (days/yr)	52	26	Professional judgment; 1 day/week for the RME and 1 day/every other week for the CTE.
	ED (yrs)	11	11	Adolescents from age 6 to 17 evaluated.
	ET (hours/day) and t_{event} (hr/event)	4	2	Professional judgment.
	BW (kg)	43	43	Average age-specific value (U.S. EPA, May 1989).
	SA (cm^2/day) and A (cm^2)	3,820	3,100	25 percent of the total body surface area will be assumed to be available for soil, sediment, and surface water contact. CTE and RME areas represent the mean of 50th and 95th percentile values for ages 6 to 17, respectively, as provided in Table 6-6 of the Exposure Factors Handbook (U.S. EPA, August 1997).
	IR_S (mg/day)	100	50	Assumed similar to adult exposure (U.S. EPA, May 1993).
	IR_a (m^3/hour)	1.9	1.9	Recommended short-term heavy activities rate for children (U.S. EPA, August 1997; Table 5-23).
	EV (events/day)	1	1	Professional judgment.
	CR (L/hr)	0.05(1) 0.01(2)	0.05(1) 0.01(2)	Intake rates for exposure to surface water during wading (U.S. EPA, November 1995).
Maintenance/ Occupational Worker	EF (days/yr)	24 (maintenance)	12 (maintenance)	Professional judgment for maintenance worker; 2 days/month for the RME and 1 day/month for the CTE.
	ED (yrs)	25	9	Convention for RME (U.S. EPA, March 1991); 50th percentile time at one residence for CTE (U.S. EPA, May 1989).
	ET (hours)	8 (air)	8 (air)	Standard default (U.S. EPA, March 1991).
	BW (kg)	70	70	U.S. EPA, May 1993.

TABLE 8-3

SUMMARY OF EXPOSURE ASSUMPTIONS
SWMU 2
NSWC CRANE, INDIANA
PAGE 2 OF 4

Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Maintenance/ Occupational Worker (Continued)	SA (cm^2/day)	2,830	2,300	Surface area of the hands and forearms measured in men assumed to be available for soil contact . The RME and CTE values represent the 95th and 50th percentile areas of the hands and forearms (U.S. EPA, August 1997, Table 6-2).
	IR_S (mg/day)	100	50	U.S. EPA, May 1993.
	IR_a (m^3/hour)	2.5 (maintenance)	2.5 (maintenance)	For maintenance workers, recommended short-term heavy activities rate for outdoor workers (U.S. EPA, August 1997; Table 5-23).
Construction Worker	EF (days/yr)	10	10	Professional judgment. Short-term, relatively un-intrusive activities are anticipated; a 2 week, 5 days/week project.
	ED (yrs)	1	1	Estimated length of construction project (professional judgment).
	BW (kg)	70	70	U.S. EPA, May 1993.
	SA (cm^2/day)	5,800	5,000	Recommended values for adult skin surface area assumed to be available for soil contact (U.S. EPA, August 1997; Table 6-16).
	IR_S (mg/day)	480	240	Convention for the RME (U.S. EPA, March 1991). CTE is assumed to be one-half the RME value.
	IR_a (m^3/hour)	2.5	2.5	Recommended short-term heavy activities rate for outdoor workers (U.S. EPA, August 1997; Table 5-23).
Adult Recreational User	EF (days/yr)	52	26	Professional judgment; 1 day/week for the RME and 1 day/every other week for the CTE.
	ED (yrs)	30	9	U.S. EPA, May 1993. Assumed length of residence for an adult living near the facility.
	ET (hours/day) and t_{event} (hr/event)	4	2	Professional judgment.
	BW (kg)	70	70	U.S. EPA, May 1993.

TABLE 8-3

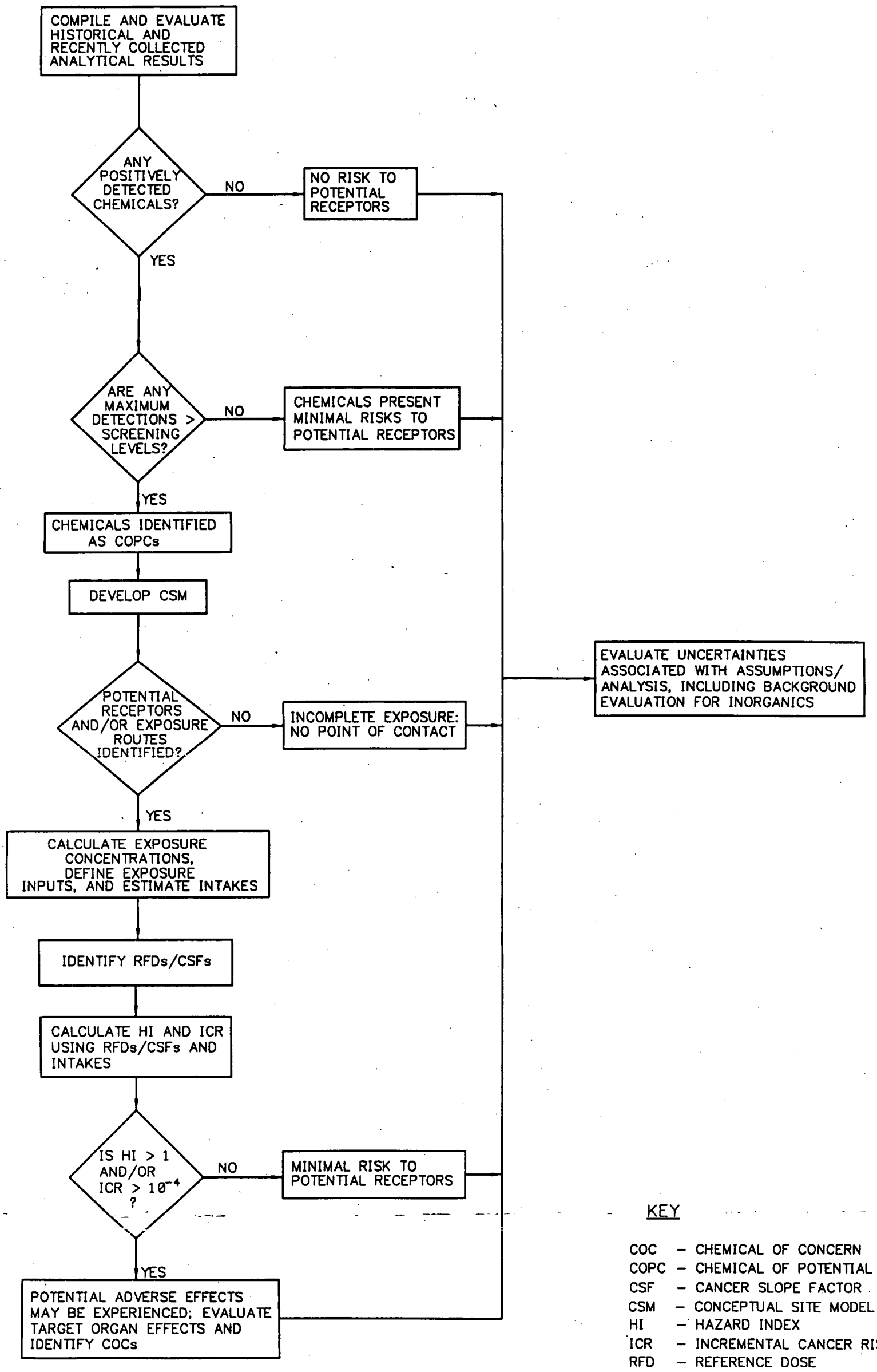
SUMMARY OF EXPOSURE ASSUMPTIONS
SWMU 2
NSWC CRANE, INDIANA
PAGE 3 OF 4

Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Adult Recreational User (Continued)	SA (cm^2/day)	9,190	7,770	Feet, lower legs, hands, and arms of adult male assumed to be available for sediment contact. The RME and CTE values represent the 95th and 50th percentile areas of the feet, lower legs, hands and arms (U.S. EPA, August 1997, Table 6-2).
	IR_S (mg/day)	100	50	Based on U.S. EPA, May 1993.
	IR_a (m^3/hour)	1.6	1.6	Recommended short-term moderate activities rate for adults (U.S. EPA, August 1997; Table 5-23).
	EV (events/day)	1	1	Professional judgment.
	CR (L/hr)	0.05(1) 0.01(2)	0.05(1) 0.01(2)	Intake rates for exposure to surface water during wading (U.S. EPA, November 1995).
Resident (Adult/Child)	EF (days/yr or showers/yr)	350	234	U.S. EPA, May 1993. One shower assumed to be taken per day.
	ED (yrs)	24(1) 6(2)	7(1) 2(2)	U.S. EPA, May 1993.
	t_{event} (hr/event)	0.25	0.167	15 min/event for RME and 10 min/event for CTE (U.S. EPA, January 1992).
	BW (kg)	70(1) 15(2)	70(1) 15(2)	U.S. EPA, May 1993.
	SA (cm^2/day)	5,800(1) 2,000(2)	5,000(1) 1,745(2)	Recommended values for adult skin surface area assumed to be available for soil contact (U.S. EPA, August 1997). Child CTE and RME areas represent 25% of the total body area, as provided in Table 6-6 of the Exposure Factors Handbook (U.S. EPA, August 1997).
	IR_a (m^3/hr) (showering)	0.6	0.6	For all age groups while showering (U.S. EPA, December 1989).
	IR_W (L/day)	2(1) 1.5(2)	1.4(1) 0.66(2)	USEPA, May 1993 for adult exposure. U.S. EPA, August 1997, Table 3-30 for child exposure.

TABLE 8-3

SUMMARY OF EXPOSURE ASSUMPTIONS
SWMU 2
NSWC CRANE, INDIANA
PAGE 4 OF 4

BW	Body Weight
CR	Contact Rate (for surface water ingestion)
ED	Exposure Duration
EF	Exposure Frequency
ET	Exposure Time
EV	Event Frequency
IR_a	Inhalation Rate
IR_S	Soil Ingestion Rate
IR_w	Groundwater Ingestion Rate
SA	Skin Surface Area available for Contact



KEY

COC – CHEMICAL OF CONCERN
COPC – CHEMICAL OF POTENTIAL CONCERN
CSF – CANCER SLOPE FACTOR
CSM – CONCEPTUAL SITE MODEL
HI – HAZARD INDEX
ICR – INCREMENTAL CANCER RISK
RFD – REFERENCE DOSE

DRAWN BY KW DATE 4/20/99	SUMMARY OF HUMAN HEALTH RISK ASSESSMENT PROCESS NSWC CRANE, INDIANA	CONTRACT NO. 7141	
CHECKED BY DATE		APPROVED BY DATE	
COST/SCHED–AREA		APPROVED BY DATE	
SCALE NOT TO SCALE		DRAWING NO. FIGURE 8–1	REV. 0

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9.0 ECOLOGICAL RISK ASSESSMENT METHODOLOGY

The goal of the Screening-Level Ecological Risk Assessment (SERA) will be to identify the chemicals detected at concentrations that exceed the COPC screening levels, the locations of these exceedances, and the need for further investigation and/or remedial action at SWMU 2 at NSWC Crane. This SERA will provide information to scientists and managers that will enable them to conclude either that ecological risks at the site are most likely negligible, or that further information is necessary to evaluate potential ecological risks at the site. The SERA methodology used at NSWC Crane will follow the guidance presented in the Department of Navy Environmental Policy Memorandum 97-04, Use of Ecological Risk Assessments (May 16, 1997), Chief of Naval Operations Letter 5090 Ser N453E/9U 59 5335 (April 5, 1999), Navy Policy for Conducting Ecological Risk Assessment, Final Guidelines for Ecological Risk Assessment (U.S. EPA, 1998a) and the Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (U.S. EPA, June 1997). A schematic diagram of the general risk assessment process is provided in Figure 9-1.

This SERA will consist of the first two of eight steps required by the Environmental Protection Agency (EPA) guidance (EPA, 1997 and 1998) and the Navy Policy for Conducting Ecological Risk Assessments (Navy, 1999). Figure 9-1 present these steps in relation to the EPA process that will be used at NSWC Crane.

The first two steps are the screening-level assessment. Step 3a is the first step of the Baseline Ecological Risk Assessment and consists of retaining the list of COPCs that were retained following the SERA. Note that the Step 3a evaluation will be included as an attachment to the SERA. Steps 3b through 7 are conducted if additional evaluations or investigations are necessary. Finally, Step 8, Risk Management, is incorporated throughout the ERA process, in cooperation with the Region 5 Biological Technical Assistance Group (BTAG).

9.1 PROBLEM FORMULATION

Problem formulation is the first step of an SERA. It results in three products (U.S. EPA, 1998a):

- Assessment endpoints that adequately reflect management goals and the ecosystems they represent.

- Conceptual models that describe the key relationships between a stressor and assessment endpoint or between several stressors and assessment endpoints.

- An analysis plan.

Problem formulation includes identifying the following:

- Ecosystems potentially at risk.
- Source and stressor characteristics.
- Exposure characteristics.
- Ecological effects.

The problem formulation process enables the risk assessor to identify the ecological resources to be protected (known as assessment endpoints); the measurements to be used to evaluate risks to those resources (known as measures of effects); and the chemicals, geographic areas, and environmental media relevant to the risk assessment.

9.1.1 Ecological Setting and Potential Ecological Receptors at NSWC Crane

Eighty percent of NSWC Crane's 63,000 acres is classified as Central Hardwoods Forest of the United States (NEESA, 1983). In addition, some agricultural fields are in various stages of succession. Openings on dry upland sites contain almost pure stands of grasses with some clumps of woody plants such as persimmon, sassafras, and sumac. Wetter sites have river birch, willow, sycamore, and cottonwood. Hillside communities have mostly hickory, white and black oak, red maple, sugar maple, tulip poplar, ash, and beech (NEESA, 1983).

The great variety of habitats at NSWC Crane (i.e., many stages of forest succession, streams, ponds, Lake Greenwood, grassy open spaces) lead to a high diversity of animal species (NEESA, 1983). Some of these species include (but are not limited to) mammals such as white-tailed deer, beaver, coyote, hawks, red fox, rabbits, raccoons, mice; birds such as ducks, geese, wild turkey, bobwhite quail, red-tailed hawks, and American robins; and various amphibians, reptiles, fish, and invertebrates. The threatened and endangered Indiana Bat may be a potential receptor at SWMU 2.

The bird population includes a number of Threatened, Endangered, or Species of Special Concern that use the site as their home range. These species include the bald eagle, osprey, sharp-skinned hawk,

red-shouldered hawk, broad-winged hawk, black and white warbler, hooded warbler, and the worm-eating warbler (B&R Environmental, 1997).

Six main creeks receive drainage in five separate drainage basins at NSWC Crane: Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, and Seed Tick Creek. Sulfur Creek receives drainage from SWMU 2. Many smaller streams/creeks and drainage ditches also are located at the facility, along with several small man-made ponds and one large lake (Lake Greenwood). Lake Greenwood is the source of potable water for NSWC Crane, however, Lake Greenwood is not impacted by site activities at SWMU 2. Surface water from the facility eventually discharges to the east fork of the White River, which is located south of the facility.

Because of the large numbers of ecological receptors present at the site, it is not feasible to evaluate potential risks to all of them. Therefore, surrogate species will be selected to represent various trophic levels and feeding preferences if it is necessary to conduct food chain modeling. These surrogate species will be selected after the site visit and after discussions with state and Federal regulators.

9.1.2 Potential Sources of Contamination and Associated Exposure Pathways

SWMU 2 was identified at NSWC Crane as an area potentially warranting further investigation. A limited variety of chemicals were potentially released at this site; constituents include dyes and potentially inorganics. Specific information for SWMU, including a site description and detected chemicals of interest, was provided in Section 5.0 of this Work Plan.

Chemicals released either to surface or subsurface soils could potentially migrate downward to the shallow aquifer, and south/southwest into Little Sulphur Creek. Although the major springs at the site are located in the valleys below the Dye Burial Grounds, an additional ground water seep with intermittent flow was identified on the southwest slope of the site. Although most ecological receptors would not directly contact the ground water while it is in the ground, they may be exposed to chemical contaminants after the ground water discharges to a surface water body, or to the surface via springs or seeps in the area. Surface runoff from the Dye Burial Grounds is rapid, leaving the site in drainage channels that head at the edge of the ridges. Contaminants in surface soil may become suspended or dissolved in surface water runoff and eventually reach Little Sulphur Creek via overland flow. Ecological receptors could potentially be exposed to chemical contaminants via direct contact and ingestion of water form seeps and/or Little Sulphur Creek.

9.1.3 Ecological Effects

The results of the surface soil, surface water, and sediment sampling for SWMU 2 will be presented in the RFI/Risk Assessment Report. Physical and chemical characteristics of contaminants may affect their mobility, transport, and bioavailability in the environment. These characteristics include the organic carbon partition coefficient, octanol water partition coefficient, and vapor pressure. These characteristics will be summarized for the contaminants that are detected in the various media, as appropriate.

In addition to the above physical and chemical characteristics, the SERA specifically uses plant, invertebrate, and small mammal bioaccumulation factors (BAFs) to predict contaminant loading in plants, invertebrates, small mammals, and bioconcentration factors to predict concentrations in aquatic organisms. The following list presents the source of the BAFs and bioconcentration factors that will be used in the SERA:

- Plant BAFs - Organics: Toxicity and Chemical-Specific Factors Database (ORNL, 1998a)
- Plant BAFs - Inorganics: Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants (ORNL, 1998b)
- Soil Invertebrate BAFs - PCBs and Inorganics: Development and Validation of Bioaccumulation Models for Earthworms (Sample et al., 1998a)
- Sediment Invertebrate BAFs - PCBs and Inorganics: Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation (ORNL, 1998c).
- Small Mammal BAFs – Inorganics: Development and Validation of Bioaccumulation Models for Small Mammals (Sample et al., 1998b).
- Aquatic Bioconcentration Factors – Organics and Inorganics: Various Sources

Some of the BAFs presented in the documents listed previously estimate the tissue concentrations in dry weight. These values must be converted to wet weight for use in exposure estimation in the food chain models by multiplying the BAF by the proportion of dry matter content of the organism (Sample et al., 1997). The following table presents the proportion of dry matter that will be used to adjust the BAFs, if necessary (Sample et al., 1997).

Food Type	Percent Water Content	Percent Dry Weight
Aquatic Invertebrates (isopods, amphipods)	71-80	20-29
Terrestrial Invertebrates (earthworms)	84	16
Mammals (mice, voles, rabbits)	68	32
Terrestrial Plants (monocots-young grass)	70-88	12-30

Other plant, invertebrate, and small mammal BAFs obtained from the literature also may be used for contaminants that are not listed in the above reference sources. Contaminants that do not have BAFs will be assigned a default value of 1.

9.1.4 Assessment Endpoints

An assessment endpoint is the ecological component of value that is to be protected. Three criteria are used to select appropriate assessment endpoints: (1) ecological relevance, (2) susceptibility to known or potential stressors, and (3) relevance to management goals (U.S. EPA, 1998a). The assessment endpoint must in some way be relevant to the ecosystem that is being evaluated (i.e., contribute to the food base, provide habitat, etc.). The assessment endpoint also must be susceptible to the stressor. Otherwise, potential effects to the ecosystem cannot be determined. Finally, the assessment endpoint must be relevant to management goals and be socially important. The assessment endpoints are as follows:

- Effects on longevity, reproduction, and/or growth of plants and invertebrates from exposure to site-related contaminants in the surface soil.
- Effects on longevity, reproduction, and/or development of terrestrial birds and mammals from exposure to site-related contaminants in the surface soil, surface water and sediment.
- Effects on longevity and other life processes (e.g., growth, feeding rates, behavioral changes) of benthic macroinvertebrates from exposure to site-related contaminants in the sediment.
- Effects on longevity and other life processes (e.g., growth, feeding rates, behavioral changes) of aquatic organisms from exposure to site-related contaminants in the surface water.

9.1.5 Conceptual Model

A conceptual model in problem formulation is a written description and visual representation of predicted relationships between ecological entities and the stressors to which they may be exposed (U.S. EPA, 1998a). The conceptual model consists of two primary components: (1) predicted relationships among stressor, exposure, and assessment endpoint response; and (2) a diagram that illustrates the relationships (U.S. EPA, 1998a). The following risk hypotheses describe these relationships and are evaluated as part of this SERA:

- Contaminants in the surface soil at the site will not cause an increase in mortality to plants and earthworms/invertebrates.

- Contaminants in the surface soil at the site will not cause an increase in mortality, decrease in reproduction, and/or developmental effects in birds and mammals.

- Contaminants in the surface water or sediment impacted by the site will not cause an increase in mortality to benthic macroinvertebrates and fish, or an increase in mortality, decrease in reproduction, and/or developmental effects to piscivorous wildlife.

The primary source of the contamination at SWMU 2 was identified based on past operational practices. The primary stressors are contaminants in the surface soil, surface water, sediment, and ground water. Because ecological receptors are not directly exposed to contaminants in the ground water, the secondary stressors are contaminants in the surface water and sediment. The primary receptors for contaminants in the surface soil will be plants and invertebrates, while the secondary receptors will be birds and mammals. Figure 9-2 presents the conceptual site model.

9.1.6 Measures of Effects

Measures of effects are measures of biological effects (e.g., reproduction, development) that are used to evaluate the assessment endpoints and risk hypotheses. The following measures of effects will be used to evaluate the assessment endpoints and risk hypotheses in this SERA:

- Soil screening levels - Survival, reproduction, and/or growth of plants and soil invertebrates will be evaluated by comparing the measured concentrations of chemicals in the surface soil to screening levels designed to be protective of ecological receptors.

- No Observed Adverse Effects Levels (NOAELs) and Lowest Observed Adverse Effects Levels (LOAELs) for surrogate wildlife species - Mortality, reproductive, and/or developmental effects of birds and mammals will be evaluated by comparing the ingested dose from contaminants in the surface soil, plants, invertebrates, and/or small mammals, to these levels. The concentrations in the plants, invertebrates, and small mammals will be predicted from available BAFs or using a default value of 1.

- NOAELs and LOAELs for surrogate wildlife species - Mortality, reproductive, and/or developmental effects of birds and mammals will be evaluated by comparing the ingested dose from contaminants in the surface water, sediment, invertebrates, and/or fish, to these levels. The concentrations in the invertebrates and fish will be predicted from available BAFs or using a default value of 1.

- Sediment screening levels - Mortality and other adverse effects (e.g., those on growth, feeding rates, behavioral change) of benthic macroinvertebrates will be evaluated by comparing the measured concentrations of chemicals in the sediment to screening levels designed to be protective of ecological receptors.

- Surface water screening levels - Mortality and other adverse effects (e.g., those on growth, feeding rates, behavioral change) of aquatic organisms will be evaluated by comparing the measured concentrations of chemicals in the surface water to screening levels designed to be protective of ecological receptors.

The above measures of effects may be modified based on the results of the site visit and discussions with state and Federal regulators.

9.2 ANALYSIS PHASE

The analysis phase is the step between the problem formulation and the risk characterization. This phase consists of the selection of COPCs, characterization of exposure, and characterization of ecological effects.

9.2.1 Selection of Contaminants of Potential Concern

The first step in the analysis phase will be to select COPCs by comparing the maximum detected contaminant concentrations in the surface water, sediment, and surface soil samples to U.S. EPA Region 5 EDQLs (U.S. EPA, Region 5, April 1998). The following items summarize the procedures that will be used in each of the SWMU-specific SERAs to select COPCs. Calcium, magnesium, potassium, and

sodium will not be retained as COPCs in any medium because of their relative low toxicity to ecological receptors and their high natural variability in concentrations. They are not expected to be related to site activities. Contaminants without EDQLs will be retained as COPCs but only evaluated qualitatively. If a chemical is not detected in any of the samples in a particular media, and the reporting limit exceeds the EDQL, the chemical will not be quantitatively carried through the risk assessment as a COPC. However, the chemical, its reporting limit, and the EDQL will be summarized in a table and qualitatively discussed in the uncertainty analysis section. If a chemical is detected in at least one sample, one-half of the reporting limit will be substituted for the non-detects for calculating summary statistics (e.g., mean concentrations).

Dye compounds that are tentatively identified during analysis will not be used quantitatively during the risk assessment. These results will be discussed qualitatively in the uncertainty section of the risk assessment. The uncertainty associated with omitting the compound from a quantitative risk assessment will be discussed.

Surface Water and Sediment for Benthic Macroinvertebrates, Fish, and Terrestrial Wildlife

1. Inorganic and organic contaminants that do not exceed EDQLs will not be retained as COPCs.
2. Inorganic contaminants that do not exceed the maximum upstream concentrations will not be retained as COPCs.

Surface Soil for Invertebrates, Plants, and Terrestrial Wildlife

1. Inorganic and organic contaminants that do not exceed EDQLs will not be retained as COPCs.
2. Inorganic contaminants that do not exceed the site-specific background concentrations will not be retained as COPCs.

Contaminants that are retained as COPCs will be further evaluated in Step 3a using additional toxicity data and other factors in a lines-of-evidence approach to determine potential impacts to the ecological receptors. The following sections present the additional data sources that will be used to evaluate the COPCs.

9.2.2 Characterization of Exposure

This section describes the potential or actual contact or co-occurrence of the contaminants with the receptors to determine their exposure dose.

Terrestrial soil invertebrates and plants are exposed to contaminants in the surface soil through direct contact and/or ingestion. Maximum and average soil concentrations will be compared to the surface soil screening values to determine potential risk to these species because receptors that are not mobile (i.e., plants) may be exposed to maximum concentrations. Others (i.e., earthworms) will be exposed to an average concentration as they move through the soil.

Total exposure of the terrestrial receptors to the COPCs in the soil will be determined by estimating the daily doses in mg/kg/day using exposure equations. The contaminant concentrations in the surface soil, surface water, and sediment are used to calculate the chronic daily intake (CDI) doses. The following equation presents a generic food chain model that will be modified based on the surrogate species that are selected for the food chain model, if necessary:

$$CDI = \frac{[(Cc * BAF * IR) + (Cc * Is)]H}{BW}$$

where:

CDI	=	Chronic Daily Intake (mg/kg-day)
Cc	=	Contaminant concentration in surface soil, surface water, or sediment (mg/kg)
BAF	=	Bioaccumulation factor (unitless)
IR	=	Ingestion Rate (kg/day)
Is	=	Rate of incidental surface soil ingestion or sediment (kg/day)
H	=	Contaminated area/home area range area ratio (unitless)
BW	=	Body weight (kg)

Two food chain models will be used for each species. The first model will be very conservative using the following assumptions:

- 95 percent UCL soil, surface water, or sediment concentration.
- Lowest receptor body weight.

- Highest receptor ingestion rate [The food ingestion rates are presented as g/g-day in U.S. EPA (1993a). The highest ingestion rate will be multiplied by the highest body weight to obtain the maximum daily ingestion rate].
- Receptors spend 100 percent of their time at the site.

The second model will be more realistic using the following assumptions:

- Average soil, surface water, or sediment concentration.
- Average receptor body weight.
- Average receptor ingestion rate [The food ingestion rates are presented as g/g-day in U.S. EPA (1993a). The average ingestion rate will be multiplied by the average body weight to obtain the average daily ingestion rate].
- Receptor's home range taken into account.

The exposure assumptions (i.e., ingestion rate, body weight) will be obtained from the Wildlife Exposure Factors Handbook (U.S. EPA, 1993a), or other sources if necessary.

The lower bound of the threshold effects is based on consistent conservative assumptions and NOAEL toxicity values (U.S. EPA, 1997). This bound will present the highest potential risks. The upper bound is based on observed impacts or predictions that ecological effects could occur and is developed using consistent assumptions, site-specific data, LOAEL toxicity values, or an impact evaluation (U.S. EPA, 1997). This bound will present the average potential risk. Both the upper and lower bounds will be evaluated in this SERA to present the overall range of potential risks.

9.2.3 Characterization of Ecological Effects

The following sections present the toxicological data that will be used to characterize the ecological effects of the COPCs.

9.2.3.1 Terrestrial Plants and Invertebrates

Risks to the terrestrial plants and invertebrates from the COPCs will be evaluated by comparing the contaminant concentrations in the surface soil to various soil standards/benchmark values. These screening values will be designated as Surface Soil Screening Levels (SSSLs). Currently, neither Indiana nor U.S. EPA has developed ecological SSSLs. The following list presents the SSSLs that have been

developed by a few groups/agencies. The paragraphs following this list discuss the SSSLs in more detail:

- Dutch Intervention Values and Target Values – Soil Quality Standards (MHSPE, 1994)
- Canadian Soil Quality Guidelines (CCME, 1997)
- Oak Ridge National Laboratory Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision (Efroymson et al., 1997a)
- Oak Ridge National Laboratory Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (Efroymson et al., 1997b)

The Intervention Values and Target Values – Soil Quality Standards were developed by the Netherlands Ministry of Housing, Spatial Planning, and Environment (MHSPE), Department of Soil Protection and will be referred to as the Dutch Screening Values (MHSPE, 1994). The Dutch Screening Values for surface soil consist of Target Values and Intervention Values. The Target Values are the soil quality levels that are ultimately desired (MHSPE, 1994). The values for heavy metals, arsenic, and fluoride were derived from analysis of field data from relatively pollution-free rural areas. The Intervention Values indicate the "concentration levels of the contaminants in the soil above which the functionality of the soil for human, plant, or animal life is seriously impaired or threatened" (MHSPE, 1994). The "ecotoxicological effects are quantified in terms of the concentrations in the soil at which 50% of the species actually (or potentially) occurring may undergo adverse effects" (MHSPE, 1994). The following equation is used to determine the criteria that indicate the need for further investigation (MHSPE, 1994):

$$\text{Criteria} = (\text{Intervention Value} + \text{Target Value})/2$$

The Canadian Soil Quality Guidelines were developed by the Canadian Council of Ministers of the Environment (CCME, 1997). They are derived using toxicological data to determine the threshold level for key receptors (CCME, 1997). The values are calculated for four land uses: agricultural, residential/parkland, commercial, and industrial. Exposure from direct soil contact is used to derive guidelines for the residential/parkland, commercial, and industrial land uses (CCME, 1997). However, the soil guidelines for the agricultural land use incorporates direct soil contact as well as soil and food ingestion (CCME, 1997). A more detailed discussion of the derivation of the soil quality guidelines is

presented in A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 1996).

The Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision (Efroymson et al., 1997a) and the Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (Efroymson et al., 1997b) were developed by the Oak Ridge National Laboratory (ORNL). These benchmarks were intended to be used as screening values and, as such, may be overly conservative. They are based on a 20 percent reduction in growth, reproduction, or activity (for invertebrates) or growth and yield (for plants) as the threshold for significant effects (Efroymson et al., 1997a, b).

Additional sources of toxicity data from the literature may be used to evaluate potential risks to soil flora and invertebrates from contaminants in the surface soil for contaminants that are not evaluated in the above documents.

9.2.3.2 Terrestrial Wildlife

Most of the above-mentioned additional surface soil standards/benchmark values are not designed to screen out risks to terrestrial wildlife ingestion of the soil, plants, invertebrates, small mammals, or fish. Therefore, in addition to comparing the soil concentrations to toxicity values for terrestrial invertebrates and plants, a terrestrial intake model will used to estimate the exposure of the COPCs to terrestrial receptors.

Risk to terrestrial receptors to the COPCs in the soil will be determined by estimating the CDI (see Section 9.2.2) and comparing the CDI to Terrestrial Reference Values (TRVs) representing acceptable daily doses in mg/kg/day. The TRVs will be developed from NOAELs or LOAELs obtained from wildlife studies, if available. The majority of the TRVs will most likely come from the ORNL Toxicological Benchmarks for Wildlife: 1996 Revision (Sample et al., 1996). Toxicity data in the ATSDR toxicity profiles and IRIS printouts will be utilized, when necessary.

Appropriate scaling factors to convert a NOAEL from one species to a NOAEL for another species will be agreed on by state and Federal regulators prior to preparing the SERA. If a subchronic study is used to develop the TRV, the final value will be multiplied by a factor of 0.1 to account for uncertainty between subchronic and chronic effects. Also, if a LOAEL study is used to develop the NOAEL TRV, then the LOAEL will be multiplied by a factor of 0.1 to obtain the NOAEL.

9.2.3.3 Surface Water

Water Quality Standards (WQS) for surface water have been developed for Indiana (IDEM, 1998). These are the primary enforceable surface water standards for the site. In addition, the U.S. EPA has established AWQC for a few contaminants. Other, non-regulatory surface water screening values will be used to evaluate the surface water data that do not have WQS or AWQC. All will be collectively referred to as surface water screening levels (SWSLs) in this SERA work plan. The following presents the SWSLs that will be used in this evaluation:

1. Indiana Water Quality Standards (IDEM, 1998)
2. Ambient Water Quality Criteria (U.S. EPA, 1986)
3. "Eco Update-Ecotox Thresholds" (U.S. EPA, 1996)
4. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, 1996 Revision (Suter and Tsao, 1996)

The Indiana WQS are the concentrations of toxic substances that will not result in acute or chronic toxicity to aquatic life. All of the WQS used in this SERA will be based on total recoverable metals in accordance with the Indiana WQS (IDEM, 1998).

The AWQC were developed by the U.S. EPA to provide states with guidance for developing their own criteria. These values are set to protect the majority of aquatic organisms from adverse impacts from contaminants in the surface water.

The publication "ECO Update-Ecotox Thresholds" was prepared by U.S. EPA for use as benchmark screening values in the first step of a baseline risk assessment (U.S. EPA, 1996). Most of the surface water thresholds for the contaminants that are evaluated in this SERA are based on Suter and Mabrey (1994) in the Ecotox Thresholds. Because Suter and Mabrey (1994) has been updated, Suter and Tsao (1996) values will be used when the Ecotox Thresholds were based on the Suter and Mabrey (1994) data. The Suter and Tsao (1996) benchmarks were calculated using Tier II methodology as described in the U.S. EPA's Proposed Water Quality Guidance for the Great Lakes System (U.S. EPA, 1993b). Tier II values are developed so that aquatic benchmarks could be established with fewer data than are required for the U.S. EPA AWQC.

Both the acute and chronic SWSLs will be used to evaluate the COPCs to determine potential impacts in a weight-of evidence approach.

9.2.3.4 Sediment

Indiana has not established sediment-screening levels for any contaminants, and the U.S. EPA has established sediment-screening levels for only a few contaminants. Therefore, other, non-regulatory sediment-screening levels will be used to evaluate the sediment data. Sediment-screening levels based on freshwater studies will be used where available. The following list presents the sediment-screening levels that will be used in this evaluation. The paragraphs following this list discuss the sediment-screening levels in more detail:

1. Eco Update-Ecotox Thresholds (U.S. EPA, 1996)

2. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (OMOE, 1993)

3. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments (Long et al., 1995)

4. Revised Region III BTAG Screening Levels (U.S. EPA, 1995)

The sediment Ecotox Thresholds include draft U.S. EPA Sediment Quality Criteria (SQC) that have been established for five contaminants (acenaphthene, dieldrin, endrin, fluoranthene, and phenanthrene), Sediment Quality Benchmarks (SQB) that have been established using equilibrium partitioning, and Effects Range-Low values from Long et al. (1995). The SQC and SQBs Ecotox Thresholds are based on an assumption of 1 percent organic carbon (10,000 mg/kg TOC). An SQC document for metals also is due out in the summer of 1999. These documents will be utilized if they are available when the SERA is prepared.

The Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (OMOE, 1993) are based on freshwater studies. The OMOE guidelines establish three effects levels, as follows:

- ***No Effect Level:*** Sediment will not affect fish or sediment-dwelling organisms. In addition, no transfer through the food chain and no effect on water quality is expected.

- ***Lowest Effect Level:*** Sediment is considered marginally polluted but will not affect the majority of sediment-dwelling organisms.

- ***Severe Effect Level:*** Sediment is considered highly polluted and likely to affect the health of sediment-dwelling organisms.

The Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments (Long et al., 1995) will be used if no freshwater data are available because they are generally accepted by many state agencies and U.S. EPA regions, even though they are based primarily on estuarine and marine studies. Long et al. (1995) establishes three effects levels, as follows:

- ***Below Effects Range-Low (ER-L):*** Minimal-effects range (adverse effects would be rarely observed);

- ***Between ER-L and Effects Range-Median (ER-M):*** Possible-effects range (adverse effects would occasionally occur); and

- ***Above the ER-M:*** Probable-effects range (adverse effects would probably occur).

The Region III Biological Technical Assistance Team (BTAG) screening levels will be used if no other data are available. Some of their levels are based on less established and accepted methods than the above-referenced levels.

Contaminants that exceed the SSLs also will be compared to background contaminant levels developed in the Sediment Background Concentration Distributions of 172 Potential Pollutants in Indiana (Wente, 1994) document. The term "background" was interpreted in that document as "the concentration that would be present in the absence of any particular pollutant source." Background in that document was not meant to represent the concentrations of pollutants in the absence of all anthropogenic pollutant sources. The background data were given as a mean and as a 95th percentile value for each contaminant. The inorganic background data were further divided assuming no spatial variability and on a per county basis. IDEM indicated in a personal communication that they typically use the 95th percentile number as a flag when a site may be contaminated. These background values will not be used to select COPCs or predict risk. They will be used as another piece of information in the weight-of-evidence approach for evaluating the sediments.

9.3 RISK CHARACTERIZATION

The risk characterization is the final phase of a risk assessment characterization that compares the exposure to the ecological effects. It is at this phase that the likelihood of adverse effects occurring as a result of exposure to a stressor will be evaluated.

An HQ approach will be used to characterize the risk to terrestrial receptors. This approach characterizes the potential effects by comparing exposure concentration with the effects data. The HQ for terrestrial plants and invertebrates will be calculated as follows:

$$HQ = \frac{C_{ss}}{SSSL}$$

where:

HQ = Hazard Quotient (unitless)

C_{ss} = Contaminant concentration in surface soil (µg/kg or mg/kg)

SSSL = Plant or Invertebrate Screening Level in Soil (µg/kg or mg/kg)

The HQ for the terrestrial wildlife model will be calculated as follows:

$$HQ = \frac{CDI}{TRV}$$

where:

HQ = Hazard Quotient (unitless)

CDI = Chronic Daily Intake Dose (mg/kg-day)

TRV = Terrestrial Reference Value (NOAEL or LOAEL) (mg/kg-day)

The HQ for the aquatic receptors will be calculated as follows:

$$HQ = \frac{C_{sw}}{SWSL} \text{ or } \frac{C_{sd}}{SSL}$$

where:

HQ = Hazard Quotient (unitless)

C_{sw} = Contaminant concentration in surface water (µg/L)

C_{sd} = Contaminant concentration in sediment (µg/kg or mg/kg)

SWSL = Surface Water Screening Level (µg/L)

SSL = Sediment Screening Level (µg/kg or mg/kg)

An HQ of greater than "unity" will be considered to be indicative of potential risk. Such values do not necessarily indicate that an effect will occur but only that a lower threshold has been exceeded.

Four terrestrial wildlife HQs will be calculated in the SERA to present the range of risks using the following: (1) $NOAEL_{max}$ (HQ using maximum exposure and NOAEL), (2) $LOAEL_{max}$ (HQ using maximum exposure and LOAEL), (3) $NOAEL_{avg}$ (HQ using average exposure and NOAEL), and (4) $LOAEL_{avg}$ (HQ using average exposure and LOAEL). The $NOAEL_{max}$ will be considered the lower bound of the threshold effects because it will be based on conservative assumptions and NOAEL toxicity values. The $LOAEL_{avg}$ will be considered the upper bound of the threshold effects because it will be based on less conservative assumptions, site-specific data (i.e., home range compared to area of SWMU), and LOAEL toxicity values.

9.4 UNCERTAINTY ANALYSIS

Uncertainties are associated with most steps of an SERA, from selecting endpoints, collecting data, and evaluating toxicity. The following sections describe some of the sources of uncertainty that may be associated with this SERA.

9.4.1 Endpoints

Measures of effects are used to evaluate the assessment endpoints that are selected for the SERA. For this SERA, the measures of effects are not the same as the assessment endpoints. Therefore, the measures are used to predict effects to the assessment endpoints by selecting surrogate species that will be evaluated. For example, a decrease in reproduction of a robin is used to assess a decrease in the reproduction of the song bird population. However, predicting a decrease in reproduction to a robin may either under- or overprotect the song bird population resulting from differences in ingestion rates, toxicity, food preferences, etc., between different bird species.

Several endpoints will not be quantitatively evaluated in this SERA. Risks to burrowing animals will not be quantitatively evaluated because the methods for quantifying risks to these species have not been well developed. In addition, risks to reptiles and amphibians will not be quantitatively evaluated because exposure factors are not established for most species, and toxicity data are very limited. However, risks to reptiles and amphibians will be qualitatively evaluated as part of the SERA.

9.4.2 Exposure Characterization

The contaminant dose to terrestrial wildlife is calculated using an equation that incorporates ingestion rates, body weights, BAFs, and other exposure factors. These exposure factors are obtained from literature studies or predicted using various equations. Ingestion rates and body weights vary between species, especially between species inhabiting different areas. For example, the food ingestion rate for the robin was calculated as 0.89 g/g-day in California and 1.52 g/g-day in Kansas (U.S. EPA, 1993a). Therefore, there is uncertainty in applying exposure factors from the literature to the species at NSWC Crane.

Bioaccumulation of contaminants into various biological media (i.e., plants, invertebrates, fish, small mammals) depends on characteristics of the media such as pH, organic carbon, etc. Therefore, actual BAFs at the site may be different than the ones used in the SERA which were obtained from the literature.

There is uncertainty in the chemical data collected at the site. Sampling programs are frequently biased toward locations that have a higher expectation of being contaminated. Therefore, the concentrations do not actually represent the site, but they represent the higher concentrations at a site. As such, predicted exposure doses probably will be higher than actual exposure doses.

Finally, under the conservative scenario, terrestrial wildlife are assumed to live and feed only at the site or only in the portion of a water body affected by the site. These assumptions will tend to overpredict risk because it is unlikely that most receptors will obtain all their food from within the site boundaries and from the most contaminated areas. Risk also may be overpredicted in the average scenario, where home range is taken into account because of the biased sampling in the most contaminated areas.

9.4.3 Ecological Effects Data

There is uncertainty in the ecological toxicity value comparison. The AWQC developed by the U.S. EPA in theory protect 95 percent of the exposed species. Therefore, some sensitive species may be present at the site that are not protected by the use of these criteria. There also may be situations where the SWSLs are overpredictive of risk if the sensitive species used to develop the criteria are not present. Finally, with the exception of hardness for a few metals, the SWSLs do not account for site-specific factors such as TOC or pH that may affect toxicity.

Potential adverse impacts to aquatic receptors from constituents in the sediment are evaluated by comparing the COPC concentration in the sediment to screening values. The SSLs have more

uncertainty associated with them than do the SWSLs for the following reasons: (1) the procedures for developing them are not as well established so screening values have been developed using different methodologies, and (2) there are less sediment toxicity data than surface water toxicity data. Sediment characteristics (i.e., pH, acid volatile sulfide, TOC) also will have a large impact on the bioavailability and toxicity of constituents. Finally, screening values based on equilibrium partitioning have uncertainty associated with Log K_{ow} values; the assumed relationship between K_{ow} and K_{oc}, and the assumption that pore water exposure is the most important route for sediment-dwelling organisms.

Potentially adverse impacts to terrestrial plants and invertebrates from constituents in the surface soil are evaluated by comparing the COPC concentration to surface soil screening values. The SSSLs are similar to the sediment screening values in that they are less established than the SWSLs. Fewer studies and less data are available for establishing SSSLs than SSLs, and many of the SSSLs are based on the results of only a few studies. In addition, the SSSLs are based on different end points depending on the preference of the agency that developed them. Therefore, they have more uncertainty than surface water and sediment screening levels.

The NOAELS and LOAELs that were selected for the wildlife endpoint species likely will be based on species other than the end point species (i.e., rats, mice, ducks). There is uncertainty in the application of a toxicity data across species because the contaminant may be more or less toxic to the end point species than it was to the test study species.

The toxicity of chemical mixtures is not well understood. All the toxicity information used in the SERA for evaluating risk to the ecological receptors is for individual chemicals. Chemical mixtures can affect the organisms very differently than the individual chemicals because of synergistic or antagonistic effects.

Finally, toxicological data for a few of the COPCs are limited or do not exist. Therefore, there is uncertainty in any conclusions involving the potential impacts to ecological receptors from these constituents.

9.4.4 Risk Characterization

Unacceptable risks are possible if an HQ is greater than or equal to unity. However, the magnitude of effects to ecological receptors cannot be inferred based on the magnitude of the HQ. Rather, an HQ greater than 1.0 simply indicates that the dose used to derive the toxicity reference value was exceeded. Finally, there is uncertainty in how the predicted risks to a species at the site translate into risk to the population in the area as a whole.

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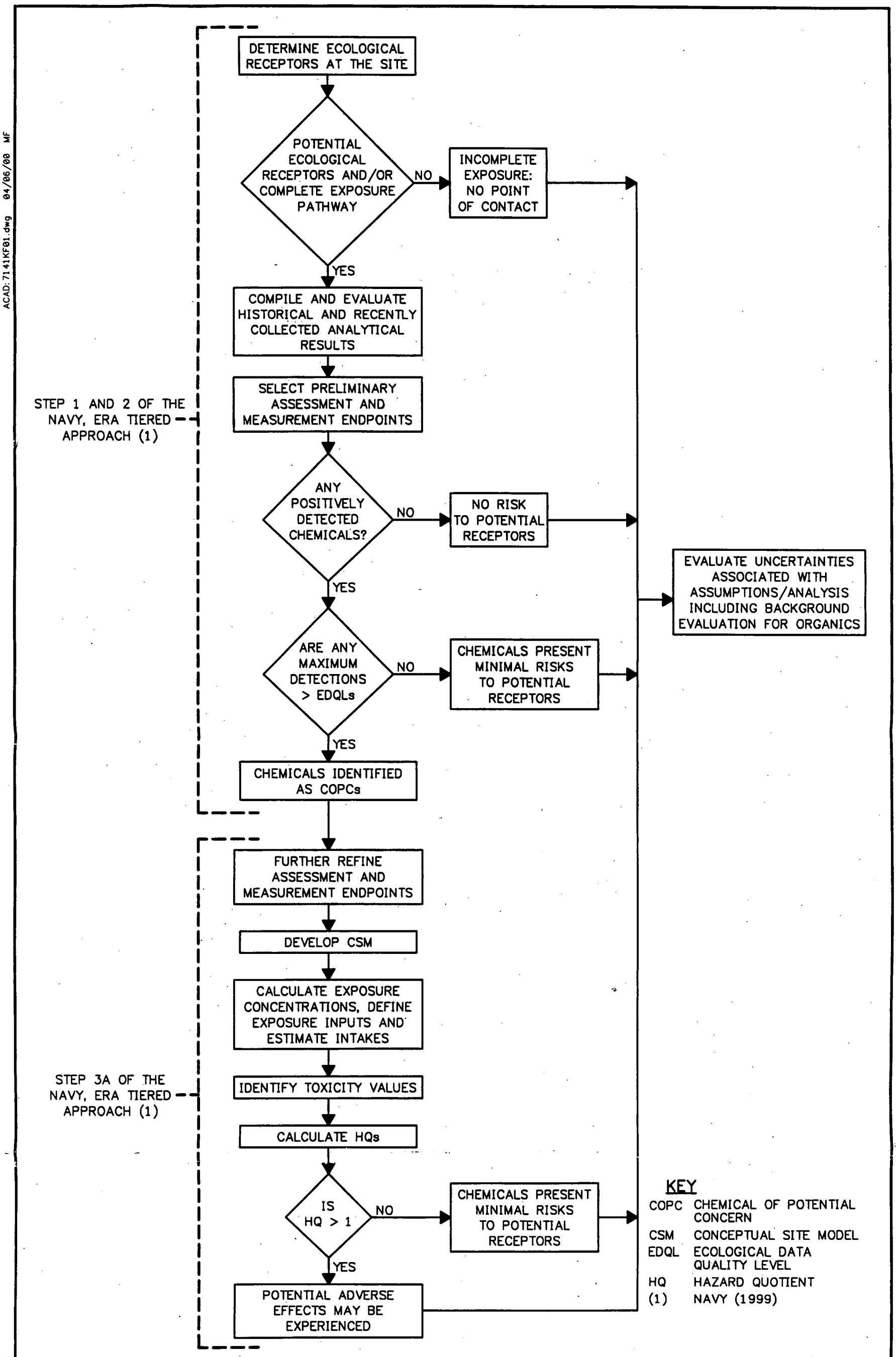

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CHECKED BY DATE		APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 9-1	REV. 0

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

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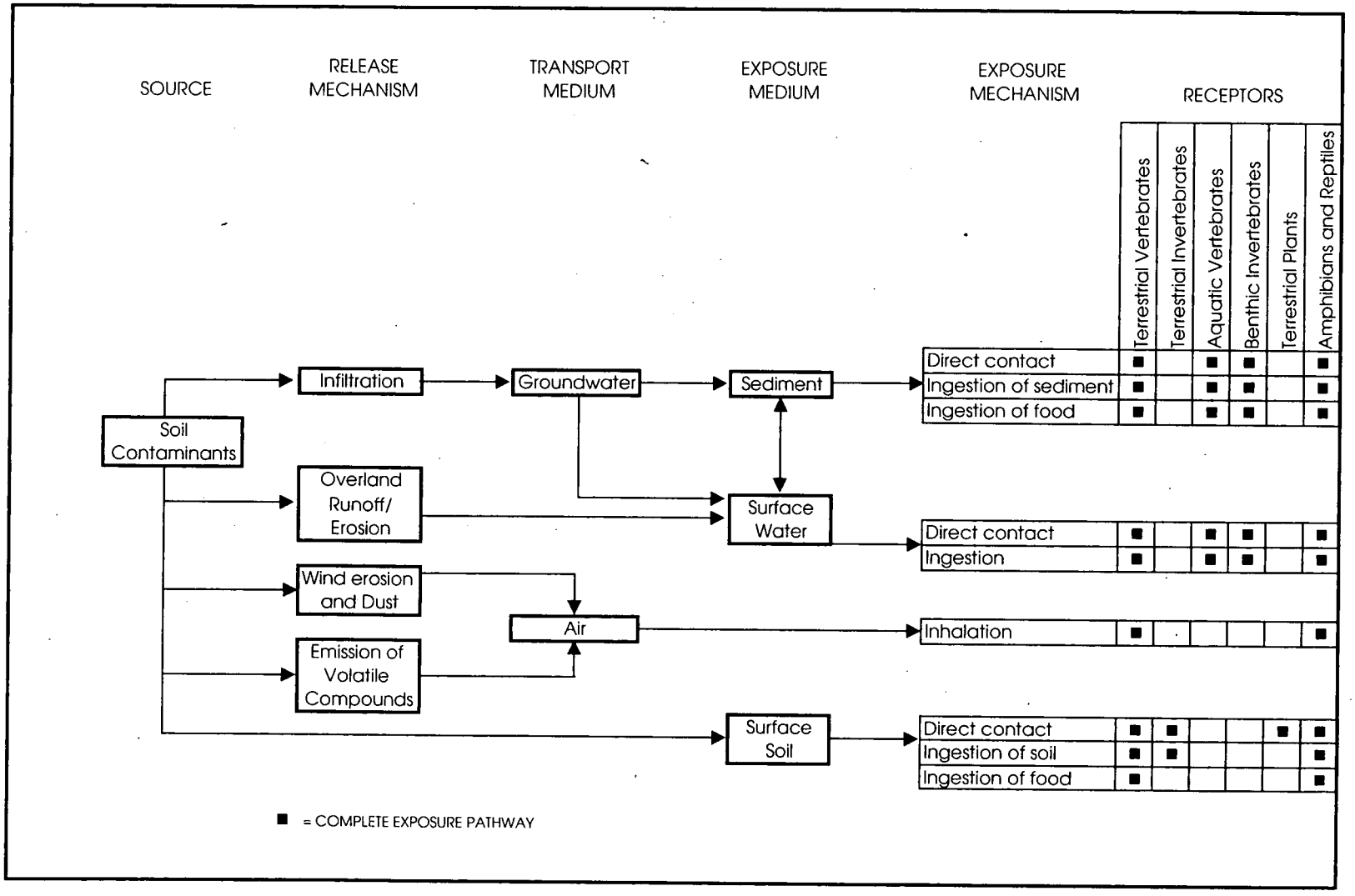
FIGURE 9-2

ECOLOGICAL CONCEPTUAL SITE MODEL
DYE BURIAL GROUNDS
NSWC CRANE, CRANE, INDIANA



10.0 CORRECTIVE MEASURES STUDY WORK PLAN

10.1 PURPOSE

This section of the Work Plan describes the procedures that will be followed and documentation required for the CMS for the SWMU 2 - Dye Burial Grounds at NSWC Crane. The CMS portion of this work plan was developed to meet the requirements of the NSWC Crane RCRA Part B Permit and is in accordance with RCRA Corrective Action Plan – Final (U.S. EPA, 1994) and IDEM guidance (IDEM, February 1998).

The CMS Report for SWMU 2 will incorporate the results of the RFI Report to develop and evaluate potential corrective measures for addressing risks to human health and the environment. Data collected during the RFI will be used to evaluate the effectiveness of the Interim Measures (multi-layer cap system to prevent rainfall infiltration) and determine those exposure pathways that should be addressed by corrective measures.

10.2 SCOPE

The CMS Report for the Dye Burial Grounds will consist of the following elements:

- Introduction/Purpose – The purpose of the document and a summary description of the project will be provided.

- Description of Current Conditions – A brief summary/discussion of site conditions, which could significantly affect the evaluation and selection of a corrective measures alternative, will be presented.

- Development of Corrective Action Objectives (CAOs) – Media- and chemical-specific CAOs will be developed that are protective of human health and the environment. The conclusions of the RFI report will identify the media to be addressed in the CMS and CAOs will be developed for these media. CAOs are developed based on media cleanup standards that consist of federal and state promulgated standards, background concentrations, and human health and ecological risk-based concentrations developed in accordance with the U.S. EPA risk assessment guidance. CAOs will be established in conjunction with U.S. EPA Region 5 and IDEM.

- Identification, Screening, and Development of Corrective Measure Alternatives – Potentially applicable technologies that may be used to achieve the CAOs for each affected medium will be

identified. Technologies will be screened to eliminate those that may prove to be unfeasible to implement given existing waste and site-specific conditions. Technologies that pass the screening step will be assembled into alternatives that have the potential to meet the CAOs for each medium. Each alternative will consist of an individual technology or a combination of technologies.

Identification and screening of alternatives will not be conducted for the source area (landfill). Remedies for consideration for the source area will consist of the no-action alternative (evaluation of the existing multi-layer cap) and containment (supplements to the existing interim measures containment).

- Evaluation of Corrective Measures Alternatives – Corrective measures alternatives will be evaluated in accordance with the following nine evaluation criteria: (1) protection of human health and the environment; (2) attainment of media cleanup standards; (3) control of releases from the source; (4) compliance with applicable waste management standards; (5) long-term reliability and effectiveness; (6) reduction in the toxicity, mobility, or volume of waste through treatment; (7) short-term effectiveness; (8) implementability; and (9) cost.

- Recommendation of a Final Corrective Measures Alternative – Based on the evaluation of alternatives, a final corrective measures alternative will be recommended for SWMU 2. Corrective actions recommended will be consistent with, and as stringent as, those required under 329 IAC 3.1-9-1 (40 CFR 264.100).

10.3 REPORTING

An internal draft, draft, and final CMS Report will be prepared documenting the development and evaluation of correction measures alternatives and the identification of a recommended alternative. The internal draft version of the CMS Report will be submitted for SOUTHDIV and NSWC Crane review and comment. Resolution of comments will occur via a teleconference. Once the comments have been discussed/resolved, a Draft CMS Report will be submitted to U.S. EPA and IDEM for their review and comment. A comment response letter will be prepared to address regulatory concerns. Once the comments have been discussed/resolved, a Final CMS Report will be prepared and submitted.

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Field Sampling Plan
for
RCRA Facility Investigation, Corrective Measures Study, and Risk Assessment
at
Solid Waste Management Unit 2 - Dye Burial Grounds

Naval Surface Warfare Center Crane Division
Crane, Indiana

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

Contract Task Order 0010

May 2001

TABLE OF CONTENTS

SECTION **PAGE NO.**

ACRONYMS **3**

1.0 INTRODUCTION **1-1**
1.1 INTRODUCTION 1-1
1.2 PROJECT ORGANIZATION AND RESPONSIBILITIES 1-3
1.2.1 Project Organization 1-3

2.0 FIELD OPERATIONS **2-1**
2.1 GENERAL FIELD OPERATIONS 2-1
2.1.1 Mobilization/Demobilization 2-1
2.1.2 Site Restoration 2-1
2.2 SUBSURFACE INVESTIGATIONS 2-2
2.2.1 Soil Boring Installation 2-2
2.2.2 Borehole and Sample Logging 2-3
2.2.3 Borehole Abandonment 2-4
2.3 MONITORING WELL CONSTRUCTION AND INSTALLATION 2-4
2.3.1 Monitoring Well Construction 2-5
2.3.2 Monitoring Well Development 2-6
2.3.3 Monitoring Well Protection 2-6
2.4 GENERAL SAMPLING OPERATIONS 2-7
2.4.1 Ground Water Sampling 2-7
2.4.2 Soil Sampling 2-9
2.4.3 Surface Water Sampling 2-10
2.4.4 Sediment Sampling 2-11
2.5 SAMPLE HANDLING, PACKAGING, AND SHIPPING 2-11
2.6 FIELD SAMPLE DOCUMENTATION 2-12
2.7 QUALITY CONTROL (QC) SAMPLES 2-12
2.8 FIELD MEASUREMENTS 2-14
2.8.1 Equipment Calibration 2-14
2.8.2 Field Instrument Preventive Maintenance Procedure/Schedule 2-14
2.9 FIELD CORRECTIVE ACTION 2-15
2.10 SURVEYING 2-17
2.11 DECONTAMINATION 2-17
2.11.1 Major Equipment 2-17
2.11.2 Sampling Equipment 2-18
2.12 INVESTIGATION-DERIVED WASTE (IDW) HANDLING 2-18
2.13 SITE MANAGEMENT AND FACILITY SUPPORT 2-19
2.14 RECORD KEEPING 2-20

3.0 SITE-SPECIFIC FIELD SAMPLING PLANS **3-1**
3.1 SWMU 2 – DYE BURIAL GROUNDS 3-1
3.2 SWMU 2 SURFACE AND SUBSURFACE SOIL SAMPLING 3-1
3.3 SWMU 2 MONITORING WELL INSTALLATION 3-3
3.4 SWMU 2 GROUND WATER SAMPLING 3-3
3.5 SWMU 2 SURFACE WATER AND SEDIMENT SAMPLING 3-4

REFERENCES **R-1**

TABLE OF CONTENTS (Continued)

ATTACHMENT

A **FIELD FORMS**
B **SITE-SPECIFIC STANDARD OPERATING PROCEDURES**

TABLES

NUMBER **PAGE NO.**

2-1 Summary of Sample Analyses, Bottle Requirements, Preservation Requirements, and Holding Times, Soil/Sediment Samples 2-21
2-2 Summary of Aqueous Sample Analyses, Bottle Requirements, Preservation Requirements, and Holding Times, Groundwater and Surface Water Samples 2-22
3-1 Soil and Sediment Samples 3-7
3-2 Field Sample Summary - Soil/Sediment 3-10
3-3 Existing Monitoring Well Data for SWMU-2 3-11
3-4 Groundwater and Surface Water Samples for SWMU-2 3-12
3-5 Field Sample Summary - Groundwater and Surface Water 3-15

FIGURES

NUMBER **PAGE NO.**

2-1 Typical Stick-Up Construction Unconfined Aquifer Monitoring Well 2-23

ACRONYMS

ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
ºC	Degree Celcius
CEC	Cation Exchange Capacity
CMS	Corrective Measures Study
CoC	Chain-of-Custody
CTO	Contract Task Order
DI	Deionized
DO	Dissolved Oxygen
DPT	Direct-Push Technology
DQO	Data Quality Objective
FOL	Field Operations Leader
FSP	Field Sampling Plan
FTMR	Field Task Modification Record
HPLC	High-Liquid Performance Chromatography
HSA	Hollow Stem Auger
IAC	Indiana Annotated Codes
IAS	Initial Assessment Study
I.D.	Identification
ID	Inside Diameter
IDW	Investigation-Derived Waste
IRA	Interim Remedial Action
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NGVD	National Geodetic Vertical Datum
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Units
ORP	Oxidation-Reduction Potential
PID	Photoionization Detector
PM	Project Manager
PPE	personal protective equipment
PVC	Polyvinyl Chloride
QA	Quality Assurance

QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPM	Remedial Project Manager
SOP	Standard Operating Procedure
SOUTH DIV	U.S. Navy Southern Division Naval Facilities Engineering Command
SWMU	Solid Waste Management Unit
TLC	Thin Layer Chromatography
TOC	Total Organic Carbon
TOM	Task Order Manager
TSS	Total Suspended Solids
TtNUS	Tetra Tech NUS
U.S. EPA	U.S. Environmental Protection Agency
USCS	Unified Soil Classification System
WES	Waterways Experiment Station

1.0 INTRODUCTION

1.1 INTRODUCTION

This comprehensive Field Sampling Plan (FSP) describes the sampling and analysis procedures to be used for the Resource Conservation and Recovery Act (RCRA) Facility Investigation, Corrective Measures Study (CMS) and Risk Assessment. These tasks are to be conducted by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0010 at the Naval Surface Warfare Center (NSWC) Crane Division, Crane, Indiana (see Figure 1-1 in Work Plan). These activities will be conducted in accordance with applicable RCRA Corrective Action requirements as identified in the RCRA Part B Permit issued to NSWC Crane by U.S. Environmental Protection Agency (U.S. EPA) Region 5.

In 1989 NSWC Crane was given a final RCRA Part B Permit. The permit contained corrective action requirements to be performed at its solid waste management units (SWMUs) identified in the Initial Assessment Study (IAS), including requirements for RCRA Facility Investigations (RFIs) to be performed at its hazardous waste disposal units. The U.S. Army Corp of Engineers (U.S. ACE) Waterways Experiment Station (WES) installed eight exploratory borings and monitoring wells in August and September 1981 at SWMU 2 - Dye Burial Grounds and provided a report in April 1982 (Dunbar 1982). The Dunbar report was included as an appendix in the Phase III RFI. A Phase II RFI began at the Dye Burial Grounds in January 1987. The Draft Report for this investigation was submitted to the U.S. EPA on March 4, 1991. A Phase III RFI groundwater release characterization began in October 1990, with the Draft RFI Phase III report submitted to U.S. EPA Region 5 on June 1, 1994. In addition, an RFI Interim Measures Geophysical Investigation was conducted at the Dye Burial Grounds in January 1991 to delineate the boundaries of the burial trenches and identify buried anomalies, with the report submitted to U.S. EPA on June 14, 1991. WES recommended remedial measures in a report by Glynn et al. (1995). Based on these studies, a Work Plan for Interim Measures Cleanup at SMWU 2 was prepared on August 7, 1997, and a cap installed at the Dye Burial Grounds. The Final Draft Interim Measures Completion Report for the Construction of Cap System at SWMU 2 was submitted in April 1999.

Conclusions on the nature and extent of contamination at SWMU 2 were drawn from these studies. The objective of this field investigation is to obtain sufficient information to perform an RFI, a CMS and human health and screening-level ecological risk assessments for SWMU 2. Conclusions from the risk assessments will be used in the risk management evaluation and CMS to determine if further activities are warranted at the site.

This FSP specifies requirements for any fieldwork that may be undertaken at the NSWC Crane facility under this CTO and serves as a complete guide for use in the field by all field investigation team members. This investigation will comply with applicable Indiana, U.S. Southern Division Naval Facilities Engineering Command (SOUTHDIV), and U.S. EPA regulations and guidance.

The field investigation at the NSWC Crane facility will consist of the following tasks:

- Mobilization/demobilization
- Field equipment maintenance
- Drilling
  - Installation of soil borings
  - Installation of permanent monitoring wells (only if warranted)
- Soil sampling
  - Surface soil sampling
  - Subsurface soil sampling
- Ground water sampling
  - New permanent monitoring wells (only if warranted)
  - Existing permanent monitoring wells
- Surface water/sediment sampling
- Field survey of springs, seeps and outcrops
- Equipment decontamination
- Ground water level measurements
- Investigation-derived waste handling and disposal
- Site restoration

This FSP consists of three sections. Section 1.0 presents an introduction to the sampling and analysis plan. Section 2.0 describes the field operations, investigation tasks, environmental sampling and analytical procedures, waste handling, site management and facility support, and record keeping. Section 3.0 details the site-specific field sampling plan. Site-specific Field Forms and Standard Operating Procedures (SOPs) for the proposed activities are included in Attachments A and B, respectively, of this FSP.

1.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

TtNUS will be responsible for the implementation of the project, including the field inspection and implementation of all sampling activities. Personnel from the Navy will be actively involved in the investigation planning and will coordinate with personnel from TtNUS in a number of areas.

1.2.1 Project Organization

The key organizations and personnel involved in the investigation, as well as the chain of communication and responsibility of the project personnel, are described in Section 2.0 of the Work Plan.

2.0 FIELD OPERATIONS

2.1 GENERAL FIELD OPERATIONS

This section presents sampling operations, procedures, and proper documentation for the field operations to be performed for the RFI, CMS and risk assessment for SWMU 2 at NSWC Crane, Indiana.

2.1.1 Mobilization/Demobilization

Following approval of this FSP, TtNUS will begin mobilization activities. In addition to this FSP, all field team members will review the planning documents [Work Plan, Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP)] prior to the start of project activities. In addition, a field team orientation meeting will be held by the Field Operations Leader (FOL) to ensure that personnel are familiar with the scope of the field activities. The FOL will coordinate the mobilization activities upon arrival at the facility.

Before the initiation of fieldwork, the FOL will arrive at the site to begin on-site mobilization activities. These activities will include coordination with base personnel and the clearing of drilling locations with the proper utilities. Equipment required for the field activities may be shipped from the TtNUS Pittsburgh warehouse or other environmental rental companies to the site. After field activities are completed, the FOL will be responsible for the demobilization of all equipment and the field office.

All site preparation will be coordinated through NSWC Crane personnel. When necessary, temporary barriers and traffic control will be provided at drilling locations as a safety precaution.

Additional details regarding responsibilities and authorities of key personnel are presented in Section 2.0 of the Work Plan.

2.1.2 Site Restoration

All site restoration activities will be performed by TtNUS and its subcontractors. Site restoration may include, but is not limited to, regrading areas where drilling activities are performed, and asphalt and concrete replacement where necessary.

2.2 SUBSURFACE INVESTIGATIONS

2.2.1 Soil Boring Installation

Drilling of deep boreholes for soil sampling and monitoring well installation, if warranted, will be accomplished using the direct-push and/or hollow-stem auger methods. The drilling method selected will depend on the type of samples being collected at a location, boring depths, and site characteristics. Whenever possible, hand augers will be used for the collection of shallow soil samples for analytical and lithologic descriptive purposes. Mechanized augers mounted on a skid-steer may be utilized to advance hand auger boreholes Hollow-stem auger techniques will be used to enlarge these borings to allow for the installation of monitoring wells. All borings for soil sampling will be drilled in accordance with CTO 10 SOP 2-7 and logged in accordance with CTO 10 SOP 2-14, both contained in Attachment B.

2.2.1.1 Hand Auger

Hand augers may be used to collect soil samples at shallow depths less than 5 feet. If necessary, a skid-steer with a mounted auger attachment may be used to facilitate the advancement of the hand auger boreholes. The ridgetop soils have a hard fragipan at 3 to 5 feet which may be difficult to auger by hand. Soil samples for laboratory analysis will not be collected from the mechanized auger flights. Borings will be advanced by hand until refusal, then a mechanized auger can overdrill past the obstruction and hand augering resumed. The advantage of this method is the lower cost and relative ease, when compared to mobilizing a drill or push rig. Disadvantages include the production of soil cuttings which must be disposed properly and the mechanized augers must be decontaminated which requires clean transport to and from a relatively permanent decon station and increased decon fluids.

2.2.1.2 Direct-Push Drilling

The direct-push technology (DPT) involves pushing sampling tools hydraulically or mechanically downward into the ground to a desired depth. A primary advantage of DPT over conventional drilling techniques is that DPT generates little or no drill cuttings. Disadvantages include limited penetration depth of 15 to 40 feet and small sample volume.

2.2.1.3 Hollow-Stem Auger Drilling

The hollow-stem auger drilling technology with split-spoon sampling may also be used for soil sampling. The hollow-stem augers are advanced to a depth immediately above the sample depth. A split-spoon sampler is driven through the auger by means of a drill rig-mounted hammer weighing 140 pounds falling

30 inches for each blow (standard penetration test). The interval at which a split-spoon sample is collected will be based on the specific purpose or needs of the sampling effort. As mentioned above, it is anticipated that the hollow-stem auger technique will be used to enlarge direct-push or hand auger borings to allow for the installation of permanent monitoring wells. In this case, split-spoon samples will not be collected.

2.2.2 Borehole and Sample Logging

All hand auger, direct-push, and/or split-spoon samples collected from soil borings will be monitored immediately upon opening of the sample tool by passing a photoionization detector (PID) along the sample's length. These readings will be recorded on the boring log. Soil samples collected for chemical analysis should be done in accordance with the procedures outlined in Section 2.4.2.

A lithologic description of each soil sample and a complete log of each boring should be maintained by the TtNUS geologist in accordance with CTO 10 SOP 2-14, contained in Attachment B. At a minimum, the boring log will contain the following information:

- Well identification (if applicable)
- Boring identification
- Name of geologist logging the boring
- Name of drilling contractor
- Sample numbers and types
- Sample depths
- Standard penetration test data
- Sample recovery/sample interval
- Soil density or cohesiveness
- Soil color
- Unified Soil Classification System (USCS) material description
- Location of boring
- Drilling and well construction problems/deviations from project-specific FSP.

In addition, depths of changes in lithology, sample moisture observations, depth to water, presence of organic vapor [i.e., photoionization detector (PID) readings], visual observance of dyes, drilling methods, and total depth of each borehole are included on each log, as well as any other pertinent observations. An example of the boring log form is included in Attachment A. The driller will prepare a separate written

boring log for each boring drilled. The driller's boring log and/or a daily record of drilling activities are submitted to the field geologist at the conclusion of the daily field activities.

2.2.3 Borehole Abandonment

Once a boring is drilled to the desired depth, if it is not to be converted to a monitoring well, then it will be backfilled. It should be noted that the soil borings installed for soil sampling will not be converted into monitoring wells. Therefore, all soil borings installed for soil sampling will be backfilled. Borings with standing water will be backfilled using a tremie pipe from the bottom up to the ground surface with a cement-bentonite slurry. Dry boreholes will be backfilled with bentonite chips and hydrated per manufacturer's specifications, typically using 1 gallon of water per 1 foot of bentonite in an 8-inch hole. A standard batch of slurry consists of approximately one 94-pound bag of cement, 5 percent by weight (5 pounds) bentonite powder, and 6.5 to 7 gallons of potable water.

2.3 MONITORING WELL CONSTRUCTION AND INSTALLATION

As explained in Section 5.5.2.2 of the Work Plan, ground water samples will be collected from existing wells in two phases. In the first phase, ground water samples will be collected from wells located in and close to the burial trenches. The second round of samples will be from wells surrounding the site. If these sampling events from existing wells fail to delineate constituents in the ground water, new wells may be installed.

If new well installation is required, the hollow-stem auger drilling method will be used for the installation of groundwater monitoring wells in overburden materials. This method will be implemented as a dry drilling method for the project. During all overburden drilling, continuous split-spoon sampling and borehole logging will be performed unless a DPT or hand auger boring is converted to a well using hollow-stem auger.

Soil drilling using the hollow-stem auger method will be accomplished using a truck-mounted CME-55 auger rig, or equivalent, of sufficient size and power that will advance augers to the anticipated maximum drilling depth. The total depth of each borehole will be dictated by the depth where the water table is encountered. After the hollow-stem augers have been advanced to the designated depth below the water table at each borehole location, a 2-inch inside diameter Schedule 40 polyvinyl chloride (PVC) ground water monitoring well will be installed.

When bedrock is encountered and soil borings cannot be continued using hollow-stem auger drilling, drilling and sampling will be performed using a diamond bit corer. An NX-sized core barrel will be used and core samples will be collected and logged according to CTO 10 SOP 2-8, contained in Attachment B. Once bedrock is reached, casing (typically steel or Schedule 80 PVC) is grouted in place to seal off the surface and drilling is continued to the desired depth. When the total depth of the well is reached, the borehole will be reamed to allow installation of a 2-inch-diameter monitoring well.

Well construction and drilling methods will be performed in accordance with SOUTHDIV Monitoring Well Design, Installation, Construction, and Development Guidelines (Southern Division Naval Facilities Engineering Command, 1997). All monitoring wells will be installed in a manner consistent with 310 Indiana Annotated Code (IAC) 16-8-3 and the Army Corps of Engineers, Waterways Experiment Station by a water well driller licensed by the State of Indiana.

2.3.1 Monitoring Well Construction

Monitoring wells will be constructed of 2-inch inside diameter (ID), Schedule 40 PVC and flush-joint, factory-slotted well screen. Well screens will be approximately 10 feet in length, with exact lengths based on the geologist's interpretation of the lithology. The well screens will have a slot size of 0.010 inch and be supplied with a PVC end cap. Five-foot-long well screens may be used where a shorter screened interval is desired or where total well depths are less than 10 feet below ground surface (bgs), based on site conditions determined during the investigation. The numbers and locations of wells at SWMU 2 are described in Section 3.3. Once the screen and the riser pipe are in place, the annulus of the boring will be backfilled with clean silica from the bottom of the boring to 1 to 2 feet above the top of the well screen. A bentonite pellet seal (minimum 2-foot thickness) will then be installed and allowed to hydrate per the manufacturer's recommendations. The remainder of the annulus of the borehole (from the bentonite seal to the ground surface) will be grouted by pumping a cement/bentonite slurry through a tremie pipe until the grout reaches the level where the concrete apron will be placed. The depths of the backfill materials will be constantly monitored during the installation of the monitoring well using a weighted stainless steel or plastic tape to ensure that no bridging of the sand pack or bentonite occurs during the installation process. Indiana State well installation requirements in 310 IAC 16 and the Army Corps of Engineers, Waterways Experiment Station well installation procedures will be followed for all well installation activities. Well construction logs, as presented in Attachment A, will be completed for all wells.

When installing wells into aquifers below confining layers, telescope well or double well construction will be used to avoid cross contamination between the shallow and deeper aquifers. Steel surface casing with a sufficient diameter to install a multiple cased well will be installed at least 4 feet into the confining layer

underlying the shallow aquifer and pressure grouted in place with a cement-bentonite slurry. After the grout is allowed to cure for a minimum of 24 hours, a smaller diameter hollow-stem auger will be advanced through the center of the steel casing and through the aquifer to be monitored.

2.3.2 Monitoring Well Development

All existing wells to be sampled as part of this investigation will be redeveloped, and all newly installed monitoring wells will be developed no sooner than 24 hours after installation to remove fine material from around the well screen. Wells will be developed by bailing and surging and/or by pumping as determined by the field geologist. Recharge rates will be noted. Measurements of pH, temperature, specific conductance, and turbidity will be collected after each well casing volume and recorded on a well development form, which is provided in Attachment A. The wells will be developed until three consecutive readings are within the following criteria: pH +/- 0.1 standard units, temperature +/- 3% degree Celcius (°C), specific conductance +/- 3% milliSiemens per centimeter (mS/cm), and turbidity less than 10 Nephelometric Turbidity Units (NTU). If water quality parameters do not stabilize after five well volumes have been removed, then the site geologist will document the event, and development will be considered complete. Development water will be containerized into appropriate containers and discharged into the NSWC Crane permitted sanitary sewer system, pending approval based on a review of required analysis. All well development will be performed in accordance with CTO 10 SOP 2-8 which is provided in Attachment B.

2.3.3 Monitoring Well Protection

Once the monitoring well is completed and the annulus is grouted to the surface, a large diameter steel (or Schedule 80 PVC) protective casing with a locking cap will be cemented in place over the riser pipe of each well. This stick-up type protective casing will extend approximately 2.5 feet above and below the ground surface, and a drain hole will be cut or drilled into the protective casing approximately 6 inches above the ground surface. Figure 2-1 illustrates typical well construction details for overburden wells with stick-up type well protection. A 3-foot-square and 1- to 2-foot deep concrete apron will be cemented in place around the well casing, and three to four safety yellow barrier posts (nominal 4-inch-diameter, 7-foot-long steel pipe filled with concrete) will be cemented at the four corners of the concrete apron, as directed by TtNUS personnel.

To maintain well security, all wells will be locked using locks that are keyed alike.

2.4 GENERAL SAMPLING OPERATIONS

This section presents the sampling methodology for all groundwater, surface soil, subsurface soil, surface water, and sediment sampling activities to be performed at SWMU 2, NSWC Crane, Indiana. Site-specific sample locations and analytical requirements including field test methods for these samples will be detailed in Section 3.0. Summaries of sample containers, sample volume, preservation requirements, and analytical methodology are provided in Tables 2-1 for solid matrices and 2-2 for aqueous media.

2.4.1 Ground Water Sampling

Ground water samples will be collected and submitted for fixed-base laboratory analyses from new (if warranted) and existing monitoring wells at NSWC Crane. The specific wells that will be sampled are outlined in the site-specific FSP (Section 3.0). If warranted, new wells will be installed and sampled. The objective of this section is to provide guidance for the proper use of sampling equipment and proper techniques for ground water sample collection. All ground water sampling will be conducted in accordance with the requirements of the project-specific Work Plan and QAPP and in accordance with CTO 10 SOP 2-4, contained in Attachment B.

2.4.1.1 Water Level Measurements

Water level measurements will be collected in all wells at SWMU 2 every sampling event before purging and sampling activities are conducted, to provide information regarding ground water flow patterns and flow gradients across the site. Each round of water level measurements will be obtained within a 24-hour period.

Measurements will be taken with an M-scope (electrical water-level indicator) or other approved instruments, using the top of the well riser as the reference point for determining depths to water. All measurements will be taken in accordance with CTO 10 SOP 2-2, contained in Attachment B. A notch will be used at the top of the PVC riser pipe to ensure that measurements are taken consistently between measuring events. A mark will be made on the casing if a notch or surveyed reference point is not visible. Water-level measurements will be recorded to the nearest 0.01 foot in the appropriate field logbook and on a ground water-level measurement form, included in Attachment A.

2.4.1.2 Well Purging

Purging will be accomplished using low-flow techniques in accordance with CTO 10 SOP 2-3. The low-flow procedures are based on the 1996 paper entitled "Low-Flow (Minimal Drawdown) Groundwater

Sampling Procedures," EPA/540/S-95/504 (Puls, R.W., and M.J. Barcelona, 1996). Low-flow purging and sampling is being implemented because this method will provide the least disturbance to the surrounding formation (i.e., less turbulence in sampling and hence less turbidity) and will allow for a more representative sample to be collected. Field measurements of pH, temperature, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, and water levels are taken during the purging process. Techniques for the measurement of these parameters and procedures for the operation of the water quality meter are found in CTO 10 SOP 2-15.

Wells will be purged prior to sampling using a peristaltic pump or bladder pump depending on well depths. Surface-type pumps (peristaltic pumps) will use disposable Teflon-lined tubing that will be either washed and disposed as trash (see Section 2.12) or left in the wells for reuse. Submersible pumps (bladder pumps) will require decontamination between each well.

Upon opening the well cap, a PID reading of air within the riser pipe will be taken prior to purging to determine appropriate personal protective equipment (PPE). Following collection and recording of the PID reading, the water level and the total depth of the monitoring well will be measured to within 0.01 foot accuracy from the marked location on the top of the well riser pipe using an electronic water-level indicator (M-scope). Water levels will be monitored every 5 to 10 minutes as purging occurs.

Initially, the pumping rate will be set at approximately 0.1 liters per minute, or lower if possible. If little or no drawdown occurs, the pumping rate may be increased to a maximum of 0.4 liters per minute. The pumping rate will be reduced if turbidity is greater than 10 NTUs after all field parameters have stabilized. The pumping rates will be adjusted to prevent drawdown from exceeding 0.3 feet during purging. If ground water is drawn down below the pump intake, purging will cease, and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the work day. If possible, samples will be collected from these wells within the same 8-hour workday. During purging, water quality parameters (pH, turbidity, specific conductance, temperature, ORP, and DO) will be measured and recorded every 5 to 10 minutes using a multi-parameter analyzer (see CTO 10 SOP 2-15). Stabilization of the above parameters is defined as follows:

- Temperature $\pm$ 3%
- pH $\pm$ 0.1 standard units
- Turbidity < 10 NTUs
- Specific conductance $\pm$ 3%
- DO $\pm$ 10%.

Well purging will continue until all parameters have stabilized and the minimum purge volume (stabilized well volume plus the extraction tubing volume) has been removed. If the parameters have not stabilized within 4 hours or three well volumes have been purged, this information will be recorded and sampling will begin.

Purge water will be containerized into appropriate containers and discharged into the NSWC-permitted sanitary sewer system pending approval based on a review of required analyses.

2.4.1.3 Sampling of Monitoring Wells

All monitoring wells should be sampled using low-flow purging and sampling techniques. Sample handling and custody procedures are presented in Sections 2.5 and 2.6.

Monitoring wells will be sampled using the same pump (peristaltic or bladder) and tubing used during well purging. Immediately following the purging process and before sampling, the temperature, pH, specific conductance, DO, ORP, and turbidity of the water sample will be measured and recorded on the Groundwater Sample Log Sheet (included in Attachment A). If the last turbidity measurement prior to the commencement of sampling showed turbidity to be greater than 10 NTUs, then filtered aliquots of ground water will be collected and analyzed for dissolved metals, in addition to the total metals aliquot.

All sample containers should be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. Samples for dye and metals analyses will be collected first. Immediately after collection, these samples will be sealed and placed in a cooler containing ice at 4°C. Subsequently, samples to be analyzed in the field for the potential of natural attenuation will be collected.

2.4.2 Soil Sampling

Soil samples for two different purposes will be collected. The first set of soil samples will be collected to confirm that the visual appearance of dyes guiding excavation during interim measures was sufficient to identify the vertical extent of dye contaminated soils. These samples will be collected at the depth of excavation as determined in the field by a change in soil texture, structure or soil horizons between backfill and natural soil.

The second set of soil samples will be collected to confirm that excavation during interim measures was sufficient to identify the horizontal extent of dye contaminated soils. Samples will be collected at two intervals. A surface sample from the 0 to 2 ft. interval will be collected. A subsurface sample at a depth

greater than 2 ft. will be collected. The exact depth will be determined in the field at the interface of the backfilled material and the natural soil.

2.4.2.1 Surface Soil Sampling

Surface soil samples will be collected from the ground surface to a maximum depth of 2 feet using direct-push, split-spoon sampling techniques, or using a single-use, dedicated plastic trowel or stainless steel hand auger. Upon sample retrieval, all samples obtained will be monitored with a PID and then collected for lithologic and chemical analysis. Samples to be analyzed for dye parameters will be collected first. Samples for inorganic parameters (metals, etc.) will be collected from 0 to 1 foot bgs. All samples will be placed in a cooler containing ice at 4°C immediately after collection. Before samples are collected, all pertinent ambient conditions and field data are recorded in the field logbook and on the soil sample log sheet (included in Attachment A) as described in Section 2.6. For additional guidance regarding surface soil sampling, refer to CTO 10 SOP 2-7, contained in Attachment B.

2.4.2.2 Subsurface Soil Sampling

Subsurface soil samples will be collected from soil borings using direct-push 4-foot core samplers, 2-foot split-spoon samplers, or hand auger buckets, as appropriate. All subsurface soil sampling will be done in accordance with CTO 10 SOP 2-7, contained in Attachment B. Selection of the intervals for subsurface soil sampling is based on the physical observation of a change from backfill to native soil. All samples collected from the borehole will be immediately screened with a PID and visually scanned for dye staining before collection for lithologic and/or chemical analysis, as appropriate. Borehole locations are described in the site-specific FSP outlined in Section 3.2.

Soil to be analyzed will be mixed or composited over a specified 2-foot interval, placed into the required containers, immediately sealed, and placed in a cooler containing ice at 4°C. The 4-foot-long clear plastic sleeves inside of the direct-push samplers will be disposed of as described in Section 2.12. If used, split-spoon samplers and hand auger buckets will be decontaminated between sample collection as described in Section 2.11.2. All pertinent field data are recorded on a soil sample log sheet (included in Attachment A) and in the field logbook.

2.4.3 Surface Water Sampling

Surface water samples including springs, seeps, and drainageways will be collected from the locations described in the site-specific sampling plan (Section 3.0) and submitted to a fixed-base laboratory. The objective of this section is to present the proper use of sampling equipment and proper techniques for

sample collection. All surface water sampling will meet the requirements of the project Work Plan and QAPP and CTO 10 SOP 2-5, contained in Attachment B.

At each sampling location, surface water samples will be collected before sediment samples, at midstream, just below the water surface. The water may be sampled with any type of clean stainless-steel pitcher, jar, or extra unpreserved clean glass sample bottle supplied by the laboratory. Filtered and unfiltered surface water will be collected for metals analysis. For filtration of surface water samples, unpreserved polyethylene bottles may be used to transfer samples. Immediately after collection, samples will be sealed and placed in a cooler containing ice at 4°C.

A sampling location description will be completed for each sampling point on the sample log sheet (Attachment A), either during an initial survey or at the time of sample collection. However, field measurements, including DO, ORP, pH, specific conductance, temperature, and turbidity, will be taken at the time of sampling. Techniques for measurement of water quality parameters are explained in CTO 10 SOP 2-15.

2.4.4 Sediment Sampling

Sediment samples will be collected from the locations described in the site-specific FSPs (Section 3.0) and submitted to a fixed-base laboratory. The objective of this section is to present the proper use of sampling equipment and proper techniques for sample collection. All sediment sampling will meet the requirements of the project Work Plan, QAPP, and CTO 10 SOP 2-6, contained in Attachment B.

After surface water samples have been collected, sediment will be sampled in the same vicinity, but only in a depositional area. Depositional areas will have slowly moving water and predominantly fine (clay and silt) particles. Sediment samples will be restricted to the aerobic zone, up to a maximum depth of 6 inches. (The anaerobic zone may be characterized by darker colors and sulfide odor.) Any sampler is suitable that can be decontaminated and that does not disturb the surface fines when sampling. Immediately after collection, all samples will be placed in a cooler containing ice at 4°C.

2.5 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Sample handling includes the field-related considerations concerning the selection of sample containers, preservatives, allowable holding times, and analyses requested. Sample nomenclature is addressed in CTO 10 SOP 2-10 (Attachment B). Sampling containers will be wrapped in plastic bubble wrap to minimize the possibility of breakage and secured in a sealed "Ziploc"-type plastic bag. The secured

sample containers will then be placed in a sturdy cooler lined with a large plastic garbage bag. The cooler will be packed with a noncombustible, cushioning material (vermiculite or bubble wrap) to minimize container breakage. Samples will be cooled with bagged ice placed around the shoulders of the sample containers. A temperature blank will be placed in the cooler before shipment. The inside plastic bag liner will be sealed with a knot and the chain-of-custody (CoC) form will be sealed in a "Ziploc"-type plastic bag and taped to the inside of the cooler lid. The cooler will be sealed according to CTO 10 SOP 2-12 (Attachment B).

Details concerning sample containers, volume requirements, preservatives, allowable holding times, and analyses requested are summarized in Tables 2-1 for soil and sediment samples and 2-2 for ground water and surface water samples.

2.6 FIELD SAMPLE DOCUMENTATION

Sample documentation consists of the completion of CoC forms and matrix-specific sample log sheets. CoC forms are discussed in Section 5.0 of the QAPP. Additionally, CoC forms are explained in CTO 10 SOP 2-11 (Attachment B). The sample log sheets contain information such as container source and description; sample type; and time, date, and method of sample collection. Any problems or unusual circumstances encountered during sample collection are noted on the form. Sample log sheets are sequentially numbered and placed in a sample logbook. Examples of sample log sheets for the various media are contained in Attachment A.

All samples collected at SWMU 2, NSWC Crane will be properly labeled with a sample label affixed on the sample container. Detailed information to be written on the sample labels is outlined in CTO 10 SOP 2-10 (Attachment B).

2.7 QUALITY CONTROL (QC) SAMPLES

In addition to calibration of field equipment and appropriate documentation, QC samples are collected or generated during environmental sampling activities. QC samples include field duplicates, ambient condition blanks, equipment rinsate blanks, and source water blanks. Each type of field QC sample, as well as additional sample aliquots needed to accommodate laboratory QC analyses, are explained in detail in the comprehensive QAPP (Section 8.0). These types of QC samples are briefly described below.

- Field Duplicates. Field duplicates are two samples collected either (1) independently at a sampling location in the case of groundwater and surface water, or (2) as a single sample split into two portions

in the case of soil or sediment. Field duplicates are used to assess the overall precision of the sampling and analysis program. Duplicates will be analyzed for the same parameters in the laboratory and will be labeled such that the identify of the duplicate is unknown to the laboratory (CTO 10 SOP 2-10 provided in Attachment B summarizes sample nomenclature procedures). Field duplicates will be collected at a frequency of one per 10 samples per matrix for all laboratory parameters and for field parameters obtained using field test kits.

- Ambient condition blanks. Ambient condition blanks consisting of analyte-free water will be submitted to the laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Ambient blanks are not collected using the same sampling equipment as the field sample, but are collected while at the field sampling site by placing analyte-free water directly into the same type of container (preserved and stored in the same manner) as the field samples. Ambient blank samples are analyzed to check for background contamination at the facility (e.g., vapors, dust, or exhaust fumes that are part of normal operations at the site) that may cause sample contamination. The exposure of the ambient blank to ambient conditions should be similar to the ambient exposure of the field samples. Ambient blanks will be collected based on conditions at the time of sampling at the discretion of the FOL, with a minimum of one ambient blank being collected during this investigation.

- Equipment Rinsate Blanks. Equipment rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through or over sample collection equipment after decontamination and before use. One rinsate blank will be collected per each type of sampling equipment used (i.e., bailer, split-spoon samples, hand tools, etc.) per day that sampling is conducted. At least one equipment rinsate blank will be collected per day, per sampling event. A sampling event is matrix-specific; therefore, an equipment rinsate blank must be collected for each matrix sampled. However, if pre-cleaned, dedicated, or disposable sampling equipment is used, one rinsate blank will be collected as a "batch blank." Rinsate blanks are analyzed for the same chemical constituents as the associated environmental samples.

- Source water blanks. Source water blanks are obtained by sampling the analyte-free water and/or potable water source(s) used for decontamination of sampling equipment. If applicable, source water blanks are used to determine whether the analyte-free water or the potable water (used for steam cleaning) may be contributing to sample contamination. If nondedicated bailers/bladder pumps are used for existing wells or if new wells are installed, one source water blank will be collected for each source of water used for decontamination.

- Matrix Spikes. Matrix spikes (MS) are investigative samples analyzed to provide information about the effect of the sample matrix on the analytical process. All matrix spikes are performed in duplicate (Matrix Spike Duplicate - MSD). MS samples will be collected at a frequency of 1 per every 20 samples. MS samples are not applicable for field parameters.

2.8 FIELD MEASUREMENTS

Field measurements will be recorded during field sampling operations. Ambient air quality will be measured using a PID. Ambient air quality measurements include monitoring of organic vapors in the breathing zone during intrusive field investigation activities and monitoring of organic vapors emanating from site sources such as soil samples and well casings. Water quality parameters, including water temperature, pH, turbidity, specific conductance, ORP, and DO will be obtained using a multi-parameter water quality meter. Water-level measurements will be obtained using an electronic water-level indicator. Natural attenuation parameters, including ferrous iron, carbon dioxide, DO, alkalinity, nitrate, nitrite, hydrogen sulfide, and sulfide, will be measured in the field using field test kits.

CTO 10 SOPs 2-13, 2-15, 2-2, and 2-16 (included in Attachment B) provide information regarding use of the PID, water quality meter, water level indicator, and field test kits, respectively.

2.8.1 Equipment Calibration

As a rule, instruments used in the field will be calibrated daily prior to use. These instruments will be calibrated according to manufacturer's specifications. Field equipment calibration is documented on an Equipment Calibration Log (included in Attachment A).

Calibration of the water quality meter is described in CTO 10 SOP 2-15 (Attachment B). CTO 10 SOP 2-13 (Attachment B) addresses calibration of the PID.

2.8.2 Field Instrument Preventive Maintenance Procedure/Schedule

The field instruments for this project include the PID and the water quality meter. Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturer.

An appropriate maintenance check is performed on each piece of equipment daily, during calibration. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument is removed from service

until the defective parts are repaired or replaced. The maintenance schedule and procedures for the PID are indicated in CTO 10 SOP 2-13 (Attachment B).

Maintenance of the water quality meter is addressed in CTO 10 SOP 2-15 (Attachment B). Critical spare parts will be kept on site to reduce downtime. Spare parts for the water quality meter include batteries and a membrane kit (membranes and a bottle of solution). Spare parts for the PID include batteries, inlet filters, and UV light sources. Backup instruments and equipment will be available on site or within 1 day via overnight courier to avoid delays in the field schedule.

2.9 FIELD CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or "out of quality control" performance that can affect data quality.

Corrective action in the field could result when the sample network is changed (i.e, more/less samples, sampling locations other than those specified, etc.), and sampling procedures and/or field analytical procedures require modification. Project personnel will be responsible for reporting all suspected technical or QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the FOL or designee. The TOM will be responsible for assessing the suspected problems in consultation with the project QA/QC Manager and making a decision based on the potential for the situation to affect the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the TOM.

The FOL will be responsible for ensuring that corrective action for nonconformances is initiated by:

- Evaluating all reported nonconformances
- Controlling additional work on nonconforming items
- Determining disposition or action to be taken
- Maintaining a log of nonconformances
- Reviewing nonconformance reports and corrective action taken
- Ensuring nonconformance reports are included in the final site documentation in project files.

If appropriate, the FOL will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include the following:

- Repeat the measurement to check the error
- Check for all proper adjustments for ambient conditions such as temperature
- Check the batteries
- Check the calibration
- Re-calibrate
- Replace the instrument or measurement devices
- Stop work (if necessary).

The FOL or designee is responsible for all site activities. In this role, the FOL at times is required to adjust the site programs to accommodate site-specific needs. When it becomes necessary to modify a program, the following field change procedure must take place:

- The responsible person notifies the FOL of the anticipated change.

- The FOL notifies the TOM of the need for the change.

- If necessary, the TOM discusses the change with the pertinent individuals [e.g., the Navy Remedial Project Manager (RPM), TtNUS Quality Assurance Manager (QAM)]. Verbal or written approval or denial of the proposed change is then given to the FOL.

- If acceptable, the FOL then documents the change on a Field Task Modification Record (FTMR) form (included in Attachment A). The FTMR form documents the need for the change from original procedures outlined in the FSP, when the change was made, and how the change was made.

- The FOL forwards the FTMR to the TOM at the earliest convenient time (e.g., end of the work week).

- The TOM signs the form and distributes copies to the Navy RPM, TtNUS QAM, FOL, and project file. The RPMs will be notified whenever program changes are made in the field.

- A copy of the completed FTMR is attached to the field copy of the affected document.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected because of unapproved or improper use of approved methods. The TtNUS QAM will

identify deficiencies and recommend corrective action to the TOM. Implementation of corrective actions will be performed by the TtNUS field investigation team as directed by the FOL. Corrective action will be documented in QA reports distributed to the entire project management.

Corrective actions will be implemented and documented in the field logbook. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by the Navy and U.S. EPA RPMs.

2.10 SURVEYING

All new monitoring wells, soil borings, surface soil locations, surface water, and sediment sample locations associated with this sampling event will be surveyed. The top of the riser pipe (where the uncapped well riser is notched), the top of the protective casing, and the ground surface elevation at each monitoring well location will be surveyed to within 0.01 foot vertical accuracy. For all other locations mentioned, the ground surface elevation will be surveyed to the nearest 0.10 foot. Vertical elevations will be referenced to the 1988 National Geodetic Vertical Datum (NGVD88). Existing survey monuments around NSWC Crane will be used as reference points. Horizontal locations of samples, borings, and wells will be surveyed to Indiana State Plane coordinates within the nearest 0.10 foot and referenced to the 1983 North American Datum (NAD83).

2.11 DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated before beginning work, during drilling and sampling activities, and at the completion of the project. This equipment includes drilling rigs, down-hole tools, augers, well casing and screens, and soil and water sampling equipment.

2.11.1 Major Equipment

All downhole equipment, including downhole drilling tools, are cleaned with high-pressure hot water, between boreholes, whenever the drilling rig leaves the drill site prior to completing a boring, and at the conclusion of the drilling program.

Well casing and screens, if not supplied at the site in certified clean packaging, will be cleaned with high-pressure hot water before installation into the borings.

All decontamination activities will take place at a predetermined area within the NSWC facility. Additional requirements for drilling equipment decontamination are found in CTO 10 SOP 2-9 (Attachment B).

2.11.2 Sampling Equipment

All nondedicated reusable sampling equipment used for collecting samples will be decontaminated both before field sampling and between samples. This equipment includes hand augers, trowels, split-spoon samplers, mixing bowls, clamshell dredges, and hollow sample tubes. The following decontamination steps will be taken:

- Potable water, phosphate-free detergent wash (scrub if necessary)
- Potable water rinse
- Deionized (DI) water rinse
- Isopropanol (only if oily soil conditions are encountered)
- DI water rinse
- Air dry (if possible)
- Wrap in aluminum foil (if not to be used immediately)

Additional guidance for decontamination is supplied in CTO 10 SOP 2-9 (Attachment B).

Disposable equipment used for sampling activities will be decontaminated using detergent wash and potable water rinse, placed in plastic garbage bags, and discarded in dumpsters on the NSWC Crane facility in accordance with procedures described in Section 2.12 of this FSP.

Field analytical equipment such as pH, conductivity, and temperature probes will be rinsed with analyte-free water. Water level measurement devices will also be rinsed with analyte-free water.

2.12 INVESTIGATION-DERIVED WASTE (IDW) HANDLING

It is anticipated that this investigation will generate five types of potentially contaminated residues or investigation-derived waste (IDW):

- Personal protective equipment (PPE)
- Ground water sample tubing and DPT sample liners
- Well development and purge fluids
- Equipment decontamination fluids
- Waste cuttings from drilling activities

IDW will be handled as described below:

PPE, Tubing, and DPT Sample Liners - All PPE, tubing, and DPT sample liners will be decontaminated and double-bagged and placed in trash receptacles at the facility.

Well Development and Purge Fluids - All well development and purge fluids will be collected and stored on-site in a 300- or 500-gallon plastic holding tank. The development and purge fluids will be discharged to the NSWC Crane permitted sanitary sewer system. Discharge will occur at a manhole designated by NSWC Crane.

Drilling Equipment Decontamination Fluids - All drilling equipment decontamination fluids will be combined with well development and purge fluids and handled in the same manner as described for well development and purge fluids.

Equipment Decontamination Fluids - All sampling decontamination fluids will be combined with well development and purge fluids and handled in the same manner as described for well development and purge fluids.

Waste Cuttings and Rock Cores from Drilling Activities - For each boring, the cuttings obtained will be scanned for VOCs. If all readings from these screening instruments are at background levels, the soil cuttings from soil borings will be spread on the ground adjacent to the borehole. Borings which contain contaminated cuttings will be backfilled with bentonite pellets or a cement/bentonite slurry.

Contaminated cuttings from borings will be placed in black plastic trash bags (or directly in drums if larger quantities), labeled, and then placed in 55-gallon sealable drums. The bags will be tagged and the drums will be clearly labeled regarding the dates, locations and depths from where the soils originated, and the personnel (including phone number) placing the cuttings in the drum. When analytical results are received back from the laboratory concerning contaminant concentrations in the soil samples, decisions will be made as to how to dispose of the soil materials.

2.13 SITE MANAGEMENT AND FACILITY SUPPORT

The FOL will be designated as the lead in coordinating all day-to-day activities during the investigation. The FOL is responsible for ensuring that all field team members (including subcontractors) are familiar with the FSP and site-specific HASP. Additionally, the FOL will be responsible for all sampling operations,

QA/QC, field documentation requirements, and field change orders. The FOL will also regularly report to the TOM regarding the status of fieldwork and any problems that may occur.

All site preparation, mobilization/demobilization, and sampling activities will be coordinated through NSWC Crane personnel.

2.14 RECORD KEEPING

Various hardcover, bound record books will be maintained for each field activity in accordance with CTO 10 SOP 2-11 (Attachment B). The Master Site Logbook serves as the overall record of field activities. Information recorded daily in the Master Site Logbook includes daily field activities, weather conditions, identity of and arrival and departure times of personnel, management issues, etc. Various field notebooks will also be maintained. For example, the geologist supervising drilling operations may also maintain a field notebook.

The FOL is responsible for the maintenance and security of all field records. Eventually, all field records (CoCs, sample log sheets, logbooks, and notebooks) will be docketed and incorporated in the central project file.

The FOL is also responsible for initiation and completion of FTMR forms (Attachment A). These FTMRs are specific forms initiated when a change to or deviation from procedures provided for in the project planning documents occurs. The procedure for requesting and recording field changes is outlined in Section 2.9.

TABLE 2-1

SUMMARY OF SAMPLE ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
SOIL/SEDIMENT SAMPLES
SWMU 2, NAVAL SURFACE WARFARE CENTER
CRANE DIVISION
CRANE, INDIANA

Parameter	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]	Analytical Methodology[2, 3]
Appendix 9 Metals	Wide-mouthed jar; Teflon-lined cap	8 oz.[4]	Cool to 4°C	Within 180 days; mercury within 28 days	SW-846 Method 6020; Mercury - SW-846 Method 7470A
Metals (Al, Ca, Fe, Mg, Mn, K, Na)	Wide-mouthed jar; Teflon-lined cap	8 oz.[4]	Cool to 4°C	180 days	SW-846 Method 6010B
Dyes	Wide-mouthed jar; Teflon-lined cap	8 oz.[5]	Cool to 4°C	Extraction 14 days; analysis within 40 days of extraction	Quantitative and Qualitative Screening Methods under development by Crane Lab
pH	Wide-mouthed jar; Teflon-lined cap	8 oz.[4]	Cool to 4°C	Analyze as soon as possible	SW-846 Method 9045C
Cation Exchange Capacity (CEC)	Wide-mouthed jar; Teflon-lined cap	8 oz.[4]	Cool to 4°C	Not specified	SW-846 Method 9081
Total Organic Carbon (TOC)	Wide-mouthed jar; Teflon-lined cap	8 oz.[4]	Cool to 4°C	28 days [6]	U.S. EPA 415.1
Grain Size	Wide-mouthed jar; Teflon-lined cap	8 oz.	Cool to 4°C	Not specified	
Bulk Density	Wide-mouthed jar; Teflon-lined cap	8 oz.	Cool to 4°C	Not specified	

1 All holding times are from date of collection.
2 U.S. EPA, 1986. Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd ed, including updates.
3 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes.
4 Metals and inorganic parameters can be analyzed from one 8-oz. jar – one extra jar is required for MS/MSD.
5 Dyes – Two extra jars are required for MS/MSD.
6 Not specified in analytical method. Holding time is based on requirement for aqueous matrices.

Al Aluminum
Ca Calcium
Fe Iron
Mg Magnesium
Mn Manganese
K Potassium
Na Sodium

TABLE 2-2

SUMMARY OF SAMPLE ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES GROUND WATER AND SURFACE WATER SAMPLES SWMU 2, NAVAL SURFACE WARFARE CENTER CRANE DIVISION CRANE, INDIANA

Parameter	Sample Container	Container Volume	Preservation[1]	Maximum Holding Time[2]	Analytical Methodology[3, 4]
Appendix 9 Metals (total and dissolved)[5]	Polyethylene bottle, plastic cap, plastic liner	(2)1000 mL[6, 7]	HNO_3 to pH < 2	Within 180 days; mercury within 28 days	SW-846 Method 6020; Mercury - SW-846 Method 7470A
Metals (Al, Ca, Fe, Mg, Mn, K, Na) total and dissolved[5]	Polyethylene bottle, plastic cap, plastic liner	(2)1000 mL[6]	HNO_3 to pH < 2	180 days	SW-846 Method 6010B
Dyes	Amber glass, Teflon-lined cap	(3) 1000 mL[8]	Cool to 4°C, dark	Extraction 7 days; analysis within 40 days of extraction	Quantitative and Qualitative Screening Analytical Methods under Development by Crane Lab.
Total Suspended Solids (TSS)	Polyethylene bottle, plastic cap, plastic liner	250 mL	Cool to 4°C	Analyze 7 days	U.S. EPA Method 160.2
Total Organic Carbon (TOC)	Polyethylene bottle, plastic cap, plastic liner	250 mL	Cool to 4°C	Analyze 7 days	U.S. EPA 415.1
Hardness	Polyethylene bottle, plastic cap, plastic liner	250 mL	Cool to 4°C	Analyze 7 days	Standard Method 2340B

1 HNO_3 = Nitric Acid
2 All holding times are from date of collection.
3 U.S. EPA, 1986. Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd ed, including updates.
4 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes.
5 Total and dissolved for surface water only.
6 Two 1000-mL bottle of unfiltered ground water will provide sufficient sample volume for the analysis for Appendix 9 metals (total) and miscellaneous metals (total). Likewise, two 1000-mL bottle of filtered ground water will provide sufficient sample volume for the analysis for Appendix 9 metals (dissolved) and miscellaneous metals (dissolved).
7 One additional 1000-mL bottle is required for samples designated for MS/MSD analysis (minimum 1 in 20 samples).
8 Four additional 1000-mL bottles are required for samples designated for MS/MSD analysis (minimum 1 in 20 samples).

Al Aluminum
Ca Calcium
Fe Iron
Mg Magnesium
Mn Manganese
K Potassium
Na Sodium

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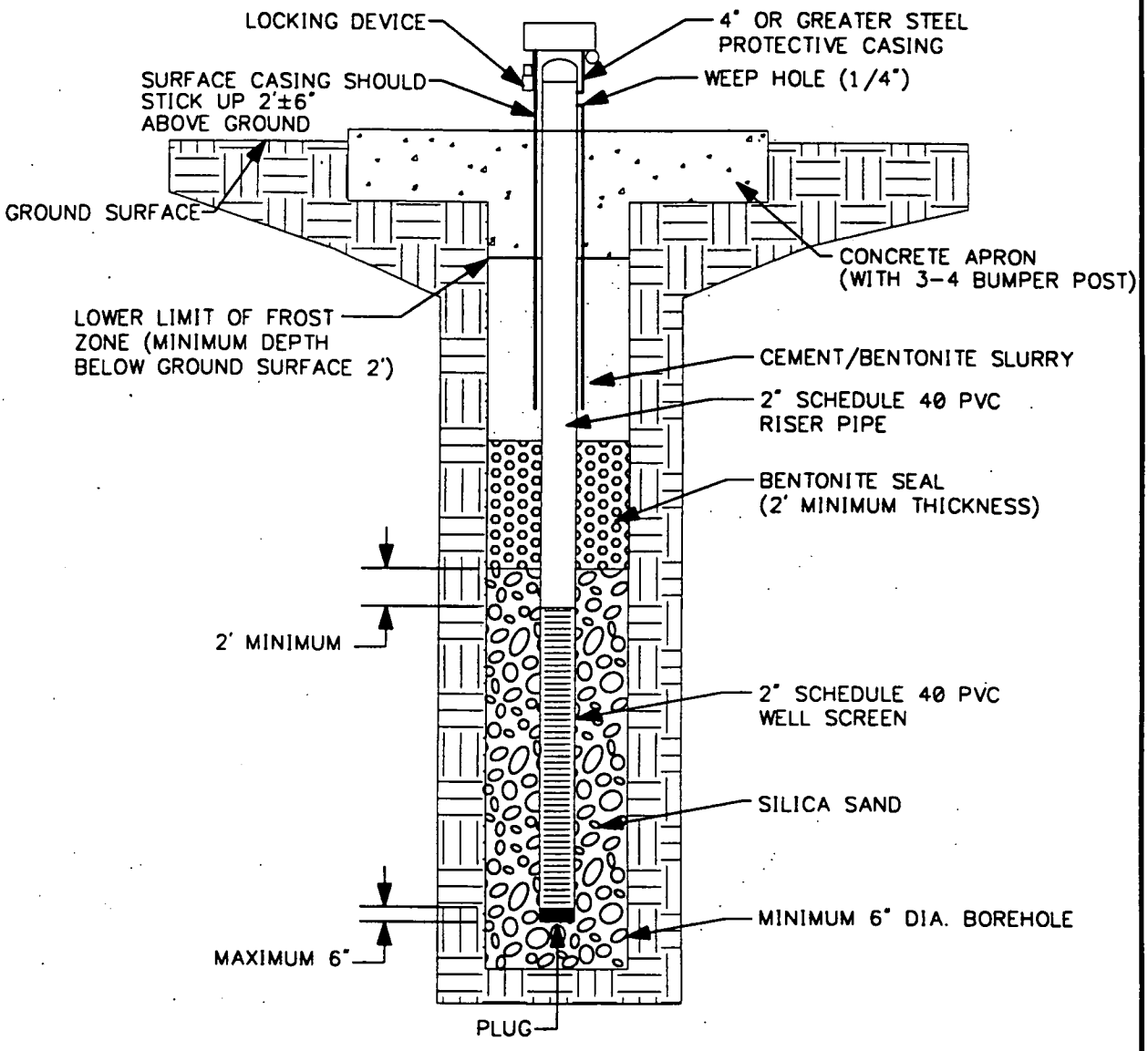

DRAWN BY KW DATE 5/6/99	DEPARTMENT OF THE NAVY SOUTHERN DIV FACILITIES ENGINEERING COMD	TYPICAL STICK-UP CONSTRUCTION UNCONFINED AQUIFER MONITORING WELL NAVAL SURFACE WARFARE CENTER CRANE DIVISION CRANE, INDIANA	CONTRACT NO. 7141
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 2-1 REV. 0

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

3.0 SITE-SPECIFIC FIELD SAMPLING PLANS

3.1 SWMU 2 – DYE BURIAL GROUNDS

Background information about Dye Burial Grounds, including a site description and summary of previous investigations, can be found in Section 5.0 of the Work Plan, which also includes a detailed description of the proposed investigation for SWMU 2. The objectives of the proposed investigation are as follows:

- To delineate nature and extent of contamination
- To obtain information to support a CMS
- To collect field and laboratory data needed to evaluate the potential risks for those human and ecological receptors identified in the CSM; and
- To confirm the presence or absence of residual contamination at locations subject to Interim Measures.

A summary of proposed sampling activities at Dye Burial Grounds to meet these objectives is presented in Table 5-8 of the Work Plan and summarized below. Figures 5-12, 5-13, and 5-14 of the Work Plan show proposed sampling locations at SWMU 2 for soil, ground water, and surface water/sediment, respectively. Sample containers, preservation requirements, and holding times are provided in Tables 2-1 and 2-2 of this FSP.

3.2 SWMU 2 SURFACE AND SUBSURFACE SOIL SAMPLING

The purpose of soil samples collected is two fold: 1) samples to confirm that the visual appearance of dyes guiding excavation during Interim Measures was sufficient to identify vertical extent and 2) samples to confirm that excavation during Interim Measures was sufficient to identify the horizontal extent of dye contaminated soils.

Soil samples will be collected for horizontal confirmation of Interim Measure excavation at 2 intervals in 13 locations. A surficial soil sample will be collect in the 0 to 2 ft. interval. A subsurface sample will be collected at a depth greater than 2 ft. The exact sampling location and depth will be determined in the field by identifying the interface between backfilled and natural soil horizons.

Seven soil samples will be collected within the boundaries of the previously excavated areas during interim measures activities. These samples will be collect at depths just below the previous depth of excavation to confirm the vertical approach used during interim measures soil removal. The sampling depth will be identified in the field at the interface between backfilled and natural soil horizons.

Section 2.4.2 describes specific procedures for collecting subsurface soil samples. Tables 3-1 and 3-2 present summaries of soil samples to be collected at SWMU 2, including numbers and types of QA/QC samples. .

Twenty soil borings will be installed by DPT, hollow-stem auger, or hand augering at SWMU 2, including:

- Thirteen soil borings will be installed to confirm the horizontal extent of dye-impacted soils around previously excavated areas. Samples will be collected in 13 locations just outside the previously excavated areas. A surface soil (0 to 2 ft. interval) and subsurface soil (> 2 ft.) sample will be collected from each boring. These samples will be analyzed for metals and dyes. The confirmation soil borings may be installed by hand augers and may not require drill or push rig mobilization. Expedited dye analyses will be performed and if present at a location, a 10-meter grid will be established around the point and additional borings will be drilled. If no dye is present, it will be assumed that the Interim Measures identified and removed all impacted soils.

- Seven soil borings will be installed to confirm that the depth of the Interim Measures excavation, which was based on the visual observation of dyes, removed all impacted subsurface soil. These samples will be collected inside the previously excavated areas but outside the cap and at the depth of excavation as identified in the field by the interface of backfill and native soil. Four soil borings are proposed for the northern area of the site and three for the southwest area. These samples will be analyzed by a quantitative analysis. The depth of these soil borings may be beyond the capability of hand augering and require mechanized drilling or push equipment. If no dyes are present, it will be assumed that Interim Measures excavation removed all impacted soils outside the cap.

Specific techniques for collecting subsurface soil samples are described in Section 2.4.2.2. Quantitative analytical parameters for surface and subsurface soil samples include:

- Dyes
- Appendix 9 metals
- Miscellaneous metals (Al, Ca, Fe, Mn, Mg, K, Na).

In addition, the seven confirmation soil samples collected to confirm the vertical extent of dye contamination within the previously excavated areas will be analyzed for Cation Exchange Capacity (CEC), grain size analysis, bulk density, pH, and Total Organic Carbon (TOC).

3.3 SWMU 2 MONITORING WELL INSTALLATION

SWMU 2 has 43 monitoring wells (Table 3-3) and nine will be sampled during the first round of sampling. An additional 20 monitoring wells may be sampled during a second round of ground water sampling. All ground water samples will be analyzed quantitatively. If the analytical results from these ground water samples fail to delineate the extent of ground water contamination, new wells may be installed. A total of three new monitoring wells (in one location) may be installed during a third round to further delineate the extent of impact (see Figure 5-18 in the Work Plan). The new wells are expected to be installed in the north east area of SWMU 2 to define the upper Pennsylvanian aquifer. Available well construction information is presented in Table 3-3. The anticipated depths of the new monitoring wells are not expected to exceed depths of existing wells.

3.4 SWMU 2 GROUND WATER SAMPLING

A total of nine ground water samples will be collected during the first round of sampling, and 20 ground water samples will be collected during the second round (see Figure 5-13 in the Work Plan). If warranted, the new well location will be designated 02T01, 02T01P2 and 02T01P3. Monitoring well development and ground water purging and sampling procedures are described in Sections 2.3.2, 2.4.1.2, and 2.4.1.3, respectively. Tables 3-4 and 3-5 present summaries of ground water and surface water samples to be collected at SWMU 2, including numbers of QA/QC samples.

Fixed-base laboratory analytical parameters for ground water samples at SWMU 2 include:

- Dyes
- Appendix 9 Metals
- Miscellaneous metals (Al, Ca, Fe, Mn, Mg, K, Na).
- TOC
- Chloride
- Sulfate
- Total Suspended Solids (TSS)

Field parameters to be measured for ground water samples at SWMU 2 include:

- DO
- ORP
- pH
- Specific conductance
- Temperature
- Turbidity
- Ferrous Iron
- Carbon dioxide
- Sulfide
- Alkalinity
- Nitrate
- Nitrite
- Hydrogen sulfide

3.5 SWMU 2 SURFACE WATER AND SEDIMENT SAMPLING

A total of 10 surface water and 10 sediment sample sets will be collected.

- Six surface water and co-located sediment samples will be collected from drainageways and tributaries that lead to Little Sulphur Creek. The purpose of this sampling is to evaluate surface water runoff from the site and subsequent deposition to sediment. These samples will be analyzed by quantitative laboratory methods.

- Four surface water samples and four co-located sediment samples will be collected from seeps or springs near the site. The purpose of these samples is to check for past surface water transport. These surface water and sediment samples will undergo quantitative laboratory analysis. The exact locations to be sampled will be determined by a site visit.

Specific collection procedures for surface water and sediment samples are described in Sections 2.4.3 and 2.4.4, respectively. Tables 3-1 and 3-2 present summaries of sediment samples to be collected, and Tables 3-4 and 3-5 present summaries of surface water samples to be collected at SWMU 2, including numbers and types of QA/QC samples.

Fixed-base laboratory parameters to be quantitatively analyzed for surface water/sediment samples include:

- Dyes
- Appendix 9 metals (total and dissolved for surface water samples)
- Miscellaneous metals (Al, Ca, Fe, Mn, Mg, K, Na) (total and dissolved for surface water samples).
- TSS (surface water only)
- TOC (surface water only)
- Hardness (surface water only)

Field parameters to be measured for surface water samples at Dye Burial Grounds include:

- DO
- ORP
- pH
- Specific conductance
- Temperature
- Turbidity.

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TABLE 3-1

SOIL AND SEDIMENT SAMPLES
SWMU 2 - DYE BURIAL GROUND
NSWC CRANE, INDIANA
PAGE 1 OF 3

Sample/ Boring No.	General Location	Sample Depth	Analyses			
			Dyes	App. 9 Metals	Al, Ca, Fe, Mn, Mg, K, Na	Misc.
SURFACE/SUBSURFACE SOIL						
02SB01	Northern Area Inside Waste Disposal Area.	TBD(1)	X	X	X	(2)
02SB02	Northern Area Inside Waste Disposal Area.	TBD(1)	X	X	X	(2)
02SB03	North East Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X	X	(2)
02SB04	Northern Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB05	North West Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB06	Central Area Inside Waste Disposal Area.	TBD(1)	X	X	X	(2)
02SB07	Central Area Inside Waste Disposal Area.	TBD(1)	X	X	X	(2)
02SB08	Central Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB09	Central Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB10	Central Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X	X	(2)
02SB11	Central Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB12	Southwest Area Inside Waste Disposal Area.	TBD(1)	X	X	X	(2)
02SB13	Southwest Area Inside Waste Disposal Area.	TBD(1)	X	X	X	(2)

TABLE 3-1

SOIL AND SEDIMENT SAMPLES
SWMU 2 - DYE BURIAL GROUND
NSWC CRANE, INDIANA
PAGE 2 OF 3

Sample/ Boring No.	General Location	Sample Depth	Analyses			
			Dyes	App. 9 Metals	Al, Ca, Fe, Mn, Mg, K, Na	Misc.
02SB14	Southwest Area Inside Waste Disposal Area.	TBD(1)	X	X	X	(2)
02SB15	Southwest Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X	X	(2)
02SB16	Southwest Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB17	Southwest Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB18	Southwest Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB19	Southwest Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
02SB20	Southwest Area Outside Waste Disposal Area.	0-2 feet	X	X		
		TBD(1)	X	X		
SEDIMENT						
02SD01	Sediment from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	-	X	X	X	
02SD02	Sediment from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	-	X	X	X	
02SD03	Sediment from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	-	X	X	X	
02SD04	Sediment from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	-	X	X	X	

TABLE 3-1

SOIL AND SEDIMENT SAMPLES
SWMU 2 - DYE BURIAL GROUND
NSWC CRANE, INDIANA
PAGE 3 OF 3

Sample/ Boring No.	General Location	Sample Depth	Analyses			
			Dyes	App. 9 Metals	Al, Ca, Fe, Mn, Mg, K, Na	Misc.
02SD05	Sediment from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	-	X	X	X	
02SD06	Sediment from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	-	X	X	X	
02SD07	Spring/Seeps (3)	-	X	X	X	
02SD08	Spring/Seeps (3)	-	X	X	X	
02SD09	Spring/Seeps (3)	-	X	X	X	
02SD10	Spring/Seeps (3)	-	X	X	X	

1 Sample to be collected at interface of excavated backfill and native soil. See Section 3.2 for details.
2 CEC, TOC, pH, bulk denisty, and grain size to be collected for 30 percent of soil samples.
3 Samples are discretionary and contingent upon discovery.

Al	Aluminum
Ca	Calcium
Fe	Iron
Mn	Manganese
Mg	Mangensium
K	Potassium
Na	Sodium
CEC	Cation Exchange Capacity
TOC	Total Organic Carbon

TABLE 3-2

FIELD SAMPLE SUMMARY - SOIL/SEDIMENT
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA

Analysis	Methodology	Samples	Duplicates	Rinsate Blanks	Ambient Blanks	Matrix Spike/ Matrix Spike Duplicates	Total[1]
Sediment							
Dyes	Quantitative HPLC Method Developed by Crane Lab	10	1	1	TBD	1/1	14
Appendix 9 Metals	SW-846 Method 6020; Mercury - SW-846 Method 7470A	10	1	1	TBD	1	13
Miscellaneous Metals (Al, Ca, Fe, Mg, Mn, K, Na)	SW-846 Method 6010B	10	1	1	TBD	1	13
Surface/Subsurface Soil							
Dyes	Quantitative HPLC Method Developed by Crane Lab	33	4	3	TBD	2/2	44
Appendix 9 Metals	SW-846 Method 6020; Mercury - SW-846 Method 7470A	33	4	3	TBD	2	42
Miscellaneous Metals (Al, Ca, Fe, Mg, Mn, K, Na)	SW-846 Method 6010B	33	4	3	TBD	2	42
Total Organic Carbon (TOC)	U.S. EPA 415.1	10	NA	NA	NA	NA	10
Cation Exchange Capacity (CEC)	SW-846 Method 9081	10	NA	NA	NA	NA	10
pH	SW-846 Method 9045C	10	NA	NA	NA	NA	10
Grain Size	ASTM D422	10	NA	NA	NA	NA	10
Bulk Density	ASTM D2937	10	NA	NA	NA	NA	10

1 Totals do not include the number of ambient condition blanks.

TBD - To Be Determined. Number of samples will be determined on site depending on conditions during sampling.

NA - Not Applicable.

HPLC - High Performance Liquid Chromatography

Al - Aluminum
Ca - Calcium
Fe - Iron
Mg - Magnesium
Mn - Manganese
K - Potassium
Na - Sodium

TABLE 3-3

MONITORING WELL DATA FOR SWMU 2 -
DYE BURIAL GROUNDS
NSWC CRANE, INDIANA

Well Number	Date Installed	Depth (ft)	Elevation (ft NGVD)	Elevation Screen Top (ft NGVD)	Elevation Screen Bottom (ft NGVD)	Aquifer
02-01	26-Aug-81	33	740.85	722.65	713.05	UPPER PENN.
02-02	02-Sep-81	57.5	727.67	684.97	675.37	LOWER PENN.
02-05	05-Sep-81	68	741.28	688.08	678.58	LOWER PENN.
02-06	23-Sep-81	68	738.67	685.17	675.87	LOWER PENN.
02-07	24-Sep-81	60.3	730.86	685.06	676.86	LOWER PENN.
02-08	25-Sep-81	63.1	732.22	683.32	676.06	LOWER PENN.
02C09	23-Jan-87	180.5	740.36	570.86	560.86	BEECH CREEK
02C09P2	26-Jan-87	100	740.66	646.16	641.16	GOLCONDA
02C10	13-Feb-88	155.5	716.47	571.97	561.97	BEECH CREEK
02C10P2	16-Feb-88	75	716.39	652.39	642.39	GOLCONDA
02C10P3	22-Feb-88	40.2	716.36	682.16	677.16	LOWER PENN.
02C11	29-Feb-88	161.5	715.31	564.81	554.81	BEECH CREEK
02C11P2	02-Mar-88	83.3	715.36	643.06	633.06	GOLCONDA
02C11P3	05-Mar-88	44.8	715.66	676.86	671.86	LOWER PENN.
02C12	14-Mar-88	185.1	741.57	567.47	557.47	BEECH CREEK
02C12P2	21-Mar-88	106.7	741.82	646.12	636.12	GOLCONDA
02C12P3	18-Mar-88	37.5	741.83	710.33	705.33	UPPER PENN.
02C14	13-Apr-88	167.4	716.40	560	550	BEECH CREEK
02C14P2	15-Apr-88	87.9	716.43	639.53	629.53	GOLCONDA
02C14P3	19-Apr-88	50.6	716.26	676.66	666.66	LOWER PENN.
02C17	23-May-88	99.6	732.96	644.36	634.46	GOLCONDA
02C17P2	26-May-88	63.2	732.84	680.64	670.64	LOWER PENN.
02C17P3	27-May-88	28.1	733.38	710.28	705.28	UPPER PENN.
02C19	14-Jun-88	93.7	733.35	650.65	640.65	GOLCONDA
02C19P2	15-Jun-88	59.1	733.28	685.18	675.18	LOWER PENN.
02C19P3	16-Jun-88	19.2	733.63	720.43	715.43	UPPER PENN.

NGVD = National Geodetic Vertical Datum

TABLE 3-4

GROUND WATER AND SURFACE WATER SAMPLES
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 1 OF 3

Well/Sample Number(1)	General Location	Analyses				
		Dyes	App. 9 Metals	Al, Ca, Fe, Mg, Mn, K, Na	TOC, TSS, Sulfate, Chloride	TSS, Hardness
GROUND WATER - FIRST ROUND						
02-01	1981 WES well adjacent to trenches (UP)	X	X	X	X	
02-02	1981 WES well adjacent to trenches (LP)	X	X	X	X	
02-05	1981 WES LP background well (LP)	X	X	X	X	
02-06	1981 WES well adjacent to trenches (LP)	X	X	X	X	
02-07	1981 WES well adjacent to trenches (LP)	X	X	X	X	
02-08	1981 WES well adjacent to trenches (LP)	X	X	X	X	
02C10P3	1988 WES background well, north, Chandler Cemetery (LP)	X	X	X	X	
02C11P3	1988 WES well, westernmost (LP)	X	X	X	X	
02C12P3	1988 WES well, adjacent to 02-05 in LP (UP)	X	X	X	X	
GROUND WATER - SECOND ROUND						
02C09	1987 WES well, easternmost (BC)	X	X	X	X	
02C09P2	1987 WES well, easternmost (G/H)	X	X	X	X	
02C10	1988 WES well, north, Chandler Cemetery (BC)	X	X	X	X	
02C10P2	1988 WES well, north, Chandler Cemetery (G/H)	X	X	X	X	
02C11	1988 WES well, westernmost (BC)	X	X	X	X	
02C11P2	1988 WES well, westernmost (G/H)	X	X	X	X	
02C12	1988 WES well, adjacent to 02-05 in LP (BC)	X	X	X	X	
02C12P2	1988 WES well, adjacent to 02-05 in LP (G/H)	X	X	X	X	
02C13	1988 WES well, north (G/H)	X	X	X	X	
02C13P2	1988 WES well, north (LP)	X	X	X	X	

TABLE 3-4

GROUND WATER AND SURFACE WATER SAMPLES
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 2 OF 3

Well/Sample Number(1)	General Location	Analyses				
		Dyes	App. 9 Metals	Al, Ca, Fe, Mg, Mn, K, Na	TOC, TSS, Sulfate, Chloride	TSS, Hardness
GROUND WATER - SECOND ROUND (Continued)						
02C13P3	1988 WES well, north (UP)	X	X	X	X	
02C14	1988 WES well, southwest (BC)	X	X	X	X	
02C14P2	1988 WES well, southwest (G/H)	X	X	X	X	
02C14P3	1988 WES well, southwest (LP)	X	X	X	X	
02C17	1988 WES well, south central (G/H)	X	X	X	X	
02C17P2	1988 WES well, south central (LP)	X	X	X	X	
02C17P3	1988 WES well, south central (UP) - Background	X	X	X	X	
02C18	1988 WES well, south central (G/H)	X	X	X	X	
02C18P2	1988 WES well, south central (LP)	X	X	X	X	
02C18P3	1988 WES well, south central (UP)	X	X	X	X	
02C19	1988 WES well, north central (G/H)	X	X	X	X	
02C19P2	1988 WES well, north central (LP)	X	X	X	X	
02C19P3	1988 WES well, north central (UP)	X	X	X	X	
SURFACE WATER						
02SW01	Surface Water from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	X	X(2)	X(2)		X
02SW02	Surface Water from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	X	X(2)	X(2)		X
02SW03	Surface Water from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	X	X(2)	X(2)		X
02SW04	Surface Water from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	X	X(2)	X(2)		X

TABLE 3-4

GROUND WATER AND SURFACE WATER SAMPLES
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA
PAGE 3 OF 3

Well/Sample Number(1)	General Location	Analyses				
		Dyes	App. 9 Metals	Al, Ca, Fe, Mg, Mn, K, Na	TOC, TSS, Sulfate, Chloride	TSS, Hardness
SURFACE WATER (Continued)						
02SW05	Surface Water from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	X	X(2)	X(2)		X
02SW06	Surface Water from drainage areas or unnamed tributaries leading to Little Sulphur Creek.	X	X(2)	X(2)		X
02SW07	Seep/Spring Water (3)	X	X(2)	X(2)		X
02SW08	Seep/Spring Water (3)	X	X(2)	X(2)		X
02SW09	Seep/Spring Water (3)	X	X(2)	X(2)		X
02SW010	Seep/Spring Water (3)	X	X(2)	X(2)		X

1 New monitoring wells discretionary. If required one well location with three wells (02T01, 02T01P2, 02t01P3) will be sampled for same parameters as other wells.
2 Filtered and unfiltered surface water samples will be collected at all locations.
3 Samples are discretionary and contingent upon discovery.

TSS - Total suspended solids
Al - Aluminum
Ca - Calcium
Fe - Iron
Mg - Magnesium
Mn - Manganese
K - Potassium
Na - Sodium
TOC - Total organic carbon
UP - Upper Pennsylvanian
LP - Lower Pennsylvanian
BC - Beech Creek
G/H - Galconda/Haney

TABLE 3-5

FIELD SAMPLE SUMMARY - GROUND WATER/SURFACE WATER
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA

Analysis	Methodology	Samples	Duplicates	Rinsate Blanks	Ambient Blanks	Matrix Spike/ Matrix Spike Duplicates	Total[1]
Ground Water - First Round							
Dyes	Quantitative Method Developed by Crane Lab	9	1	1	TBD	1/1	13
Appendix 9 Metals	SW-846 Method 6020; Mercury - SW-846 Method 7470A	9	1	1	TBD	1	12
Miscellaneous Metals (Al, Ca, Fe, Mg, Mn, K, Na)	SW-846 Method 6010B	9	1	1	TBD	1	12
Total Organic Carbon	SW-846 Method 9060	9	1	NA	TBD	1	11
Total Suspended Solids	U.S. EPA Method 160.1	9	1	NA	TBD	1	11
Sulfate	SW-846 Method 9056	9	1	1	TBD	1	12
Chloride	SW-846 Method 9056	9	1	1	TBD	1	12
Field Parameters	Field Meter[2]	9	NA	NA	NA	NA	9
	Field Test Kits[3]	9	1	NA	NA	NA	10
Groundwater - Second Round							
Dyes	Quantitative Method Developed by Crane Lab	23	2	2	TBD	2/2	31
Appendix 9 Metals	SW-846 Method 6020; Mercury - SW-846 Method 7470A	23	2	2	TBD	2	29
Miscellaneous Metals (Al, Ca, Fe, Mg, Mn, K, Na)	SW-846 Method 6010B	23	2	2	TBD	2	29
Total Organic Carbon	SW-846 Method 9060	23	2	NA	TBD	2	27
Total Suspended Solids	U.S. EPA Method 160.1	23	2	NA	TBD	2	27
Sulfate	SW-846 Method 9056	23	2	2	TBD	2	29
Chloride	SW-846 Method 9056	23	2	2	TBD	2	29
Field Parameters	Field Meter[2]	23	NA	NA	NA	NA	23
	Field Test Kits[3]	23	2	NA	NA	NA	25
Surface Water							
Dyes	Quantitative Method Developed by Crane Lab	10	1	1	TBD	1/1	14
Appendix 9 Metals Total and Dissolved	SW-846 Method 6020; Mercury - SW-846 Method 7470A	20	2	2	TBD	2	26
Miscellaneous Metals (Al, Ca, Fe, Mg, Mn, K, Na) Total and Dissolved	SW-846 Method 6010B	20	2	2	TBD	2	26
Hardness	Calculation	10	NA	NA	NA	NA	10
Total Suspended Solids	U.S. EPA Method 160.2	10	NA	NA	NA	NA	10
Field Parameters	Field Meter[2]	10	NA	NA	NA	NA	10

1 Totals do not include the number of ambient condition blanks.

2 Field parameters to be measured by meter include temperature, pH, specific conductance, turbidity, oxidation-reduction potential, and dissolved oxygen.

3 Field parameters to be measured by field test kits include alkalinity, carbon dioxide, dissolved oxygen, ferrous iron, nitrate, nitrite, sulfide, and hydrogen sulfide.

TBD = To be determined. Number of samples will be determined on site depending on conditions during sampling.

NA = Not Applicable.

Al - Aluminum
Ca - Calcium
Fe - Iron
Mg - Magnesium
Mn - Manganese
K - Potassium
Na - Sodium

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ATTACHMENT A

FIELD FORMS

TABLE OF CONTENTS

DAILY ACTIVITIES RECORD
EQUIPMENT CALIBRATION LOG
MONITORING WELL INSPECTION SHEET
WATER LEVEL MEASUREMENT SHEET
LOW FLOW PURGE DATA SHEET
GROUND WATER SAMPLE LOG FORM
SURFACE WATER SAMPLE LOG SHEET
SOIL AND SEDIMENT SAMPLE LOG SHEET
CHAIN OF CUSTODY RECORD
BORING LOG
MONITORING WELL SHEET
BEDROCK MONITORING WELL SHEET, WELL INSTALLED IN BEDROCK
BEDROCK MONITORING WELL SHEET, OPEN HOLE WELL
CONFINING LAYER MONITORING WELL SHEET
MONITORING WELL DEVELOPMENT RECORD
INVESTIGATION DERIVED WASTE
FIELD TASK MODIFICATION REQUEST FORM

DAILY ACTIVITIES RECORD

PROJECT NAME: _____ PROJECT NUMBER: _____

CLIENT: _____ LOCATION: _____

DATE: _____ ARRIVAL TIME: _____

PERSONNEL: _____ DEPARTURE TIME: _____

CONTRACTOR: _____ DRILLER: _____

ITEM	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

COMMENTS: _____

_____

_____

_____

APPROVED BY:

_____ _____

REPRESENTATIVE DRILLER

DATE: _____

EQUIPMENT CALIBRATION LOG

INSTRUMENT NAME/MODEL : _____

MANUFACTURER : _____

PROJECT NAME : NSWC Crane

PROJECT NUMBER : CTO 48

CALIBRATION DATE	INITIAL SETTINGS	STANDARDS USED	PROCEDURE	ADJUSTMENTS MADE	FINAL SETTINGS	SIGNATURE	COMMENTS

MONITORING WELL INSPECTION SHEET

Well ID: _____

Time: _____ **Date:** _____ **Inspector's Name:** _____

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible			
Well security	Condition protective case, cap, lock			
Well pad	Concrete or gravel & condition			
Well seal	Condition of…			
Area Immediately around well pad	Record any evidence of/or standing water in area of well			
Dedicated sampling equipment	Condition of…			
PVC Riser	Condition of riser & survey reference point			

Comments:

Signature(s)_____

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

WATER LEVEL MEASUREMENT SHEET

Project Name: NSWC Crane
Location: Crane, IN
Weather Conditions: _____

Project No.: CTO 10
Personnel: _____
Measuring Device: _____
Remarks: _____

Well ID	Date	Time	Water Level *	Thickness of Free Product	PID Reading ppm		Comments
					RP	BZ	

* All measurements to the nearest 0.01 foot

Signature(s): _____

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC CRANE
PROJECT NUMBER: CTO 10

WELL ID.: _____
DATE: _____

Time (Hrs.)	Water Level (Ft. below TOC)	Pump Rate (mL/Min.)	pH (S.U.)	S. Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celcius)	ORP mV	Comments

SIGNATURE(S): _____

PAGE___OF___

GROUND WATER SAMPLE LOG FORM

Page___ of ___

Project Site Name: NSWC CRANE, IN
Project No.: CTO 0010

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

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	Odor
Time-Start: End:	Visual	Standard	mS/cm	Degrees C	NTU	mg/l	mV	
Method:								

PURGE DATA:

Date:	Total Well Depth (TD):	End Purge (hrs):
Method:	Static Water Level (WL):	Total Purge Time (min):
Well Casing: 2" PVC	Start Purge (hrs):	Total Vol. Purged (gal):
One Casing Volume(gal):		

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Time Collected

OBSERVATIONS / NOTES:

PID reading in PVC riser pipe = (ppm)

PID reading in Breathing Zone = (ppm)

Reaction of sample to preservative:

QA Samples Collected:

MS/MSD	Duplicate ID No.:

Signature(s):

SURFACE WATER SAMPLE LOG SHEET

Project Site Name: _____
Project No.: _____

[] Stream
[] Spring
[] Pond
[] Lake
[] Other: _____
[] QA Sample Type: _____

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

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

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Date:	Visual	Standard	mS/cm	Degrees C	NTU	mg/l	%	
Time:								
Depth:								
Method:								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

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

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

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

GRAB SAMPLE DATA:

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

COMPOSITE SAMPLE DATA:

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

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

CHAIN OF CUSTODY RECORD

PROJECT NO.:	SITE NAME:
SAMPLERS (SIGNATURE):	

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CON-TAINERS							REMARKS

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS:	

Order No. 70440 (0693)

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING NUMBER: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: _____

Drilling Area Background (ppm): ____

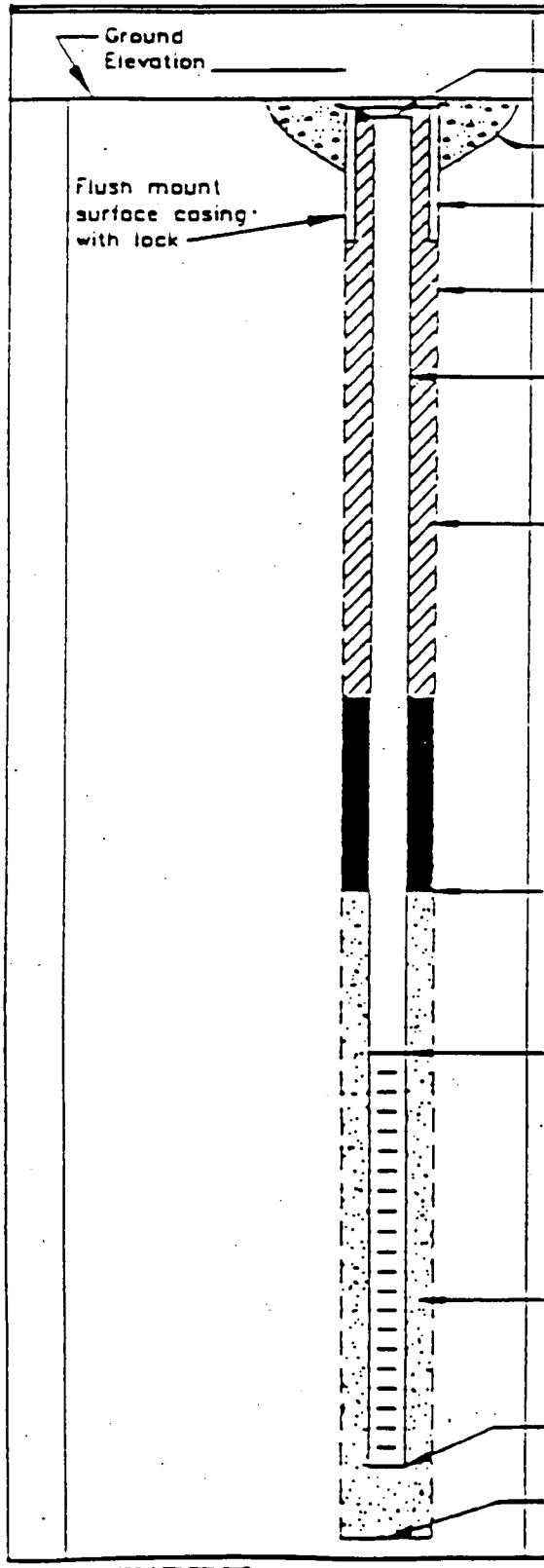
Converted to Well: Yes _____ No _____ Well I.D. #: _____

BORING NO.: _____

MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

TYPE OF PROTECTIVE CASING: _____

I.D. OF PROTECTIVE CASING: _____

DIAMETER OF HOLE: _____

TYPE OF RISER PIPE: _____

RISER PIPE I.D.: _____

TYPE OF BACKFILL/SEAL: _____

_____

DEPTH/ELEVATION TOP OF SAND: _____ / _____

DEPTH/ELEVATION TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK: _____

DEPTH/ELEVATION BOTTOM OF SCREEN: _____ / _____

DEPTH/ELEVATION BOTTOM OF SAND: _____ / _____

DEPTH/ELEVATION BOTTOM OF HOLE: _____ / _____

BACKFILL MATERIAL BELOW SAND: _____

ACFILE: U:70\GEOL\GBURD1.DWG

BORING NO.: _____

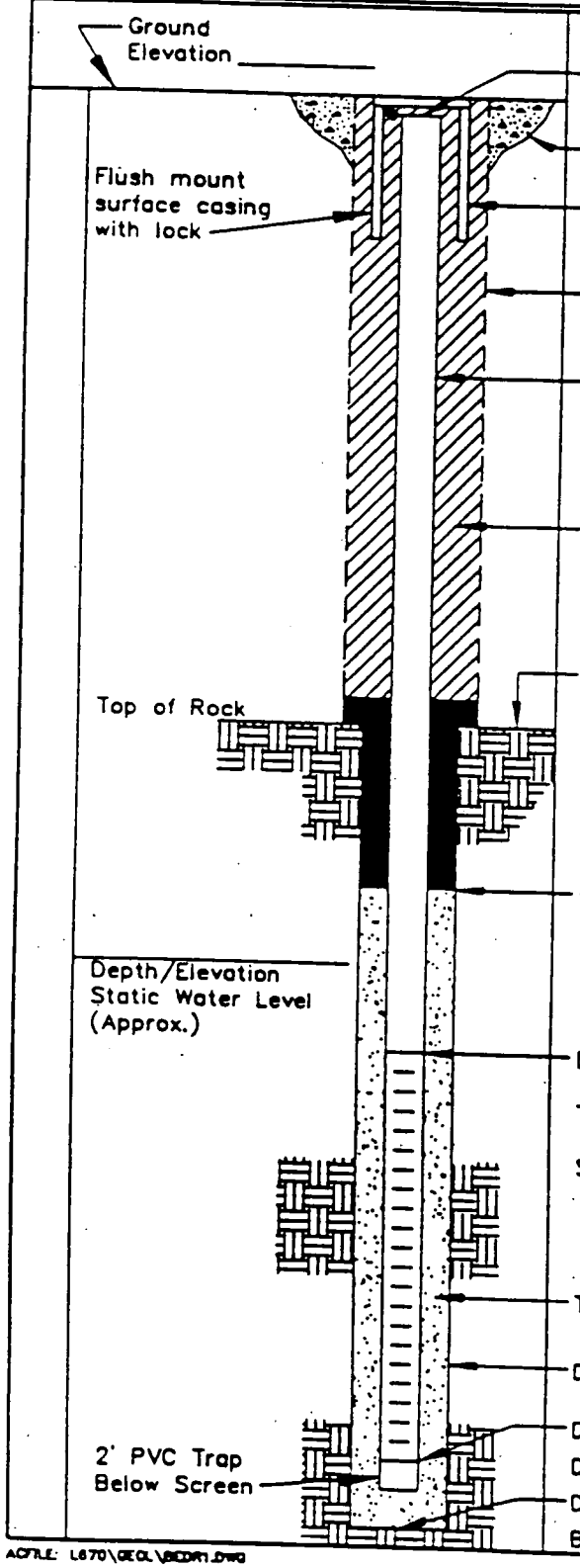
BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: _____ LOCATION: _____ DRILLER: _____

PROJECT NO.: _____ BORING: _____ DRILLING METHOD: _____

ELEVATION: _____ DATE: _____

FIELD GEOLOGIST: _____ DEVELOPMENT METHOD: _____



ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

TYPE OF PROTECTIVE CASING: _____

I.D. OF PROTECTIVE CASING: _____

DIAMETER OF HOLE: _____

TYPE OF RISER PIPE: _____

RISER PIPE I.D.: _____

TYPE OF BACKFILL/SEAL: _____

_____

DEPTH/ELEVATION TOP OF BEDROCK: _____ / _____

DEPTH/ELEVATION TOP OF SAND: _____ / _____

DEPTH/ELEVATION TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

TYPE OF SAND PACK: _____

DIAMETER OF HOLE IN BEDROCK: _____

DEPTH/ELEVATION BOTTOM OF SCREEN: _____ / _____

DEPTH/ELEVATION BOTTOM OF SAND: _____ / _____

DEPTH/ELEVATION BOTTOM OF HOLE: _____ / _____

BACKFILL MATERIAL BELOW SAND: _____

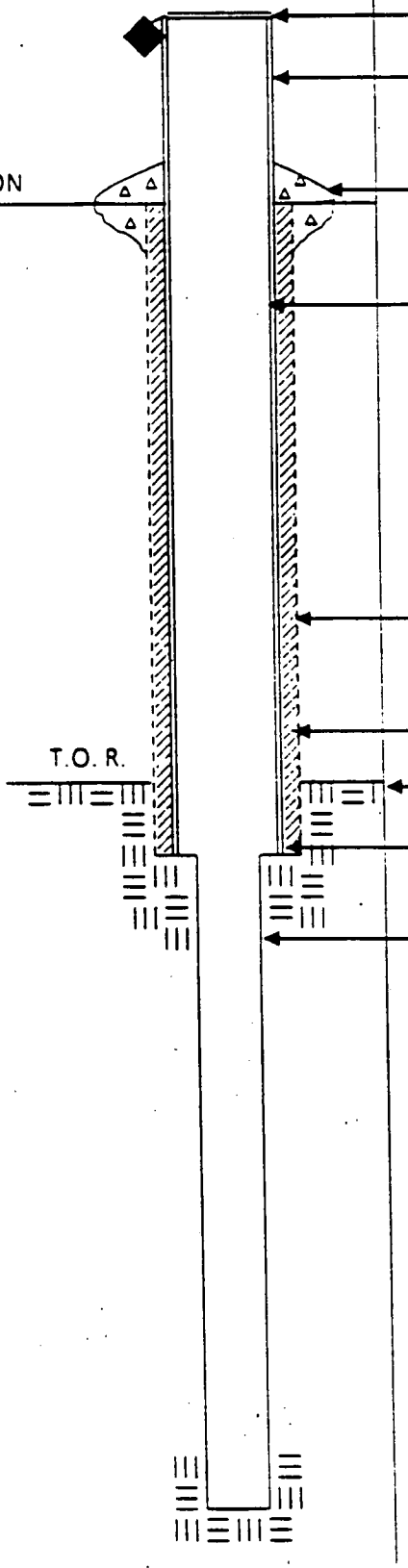
ACFILE: L670\GEOL\BCDR1.DWG

BORING NO.: _____

BEDROCK
MONITORING WELL SHEET
OPEN HOLE WELL

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF CASING: _____

STICK UP OF CASING ABOVE GROUND SURFACE: _____

TYPE OF SURFACE SEAL: _____

I.D. OF CASING: _____

TYPE OF CASING: _____

TEMP. / PERM.: _____

DIAMETER OF HOLE: _____

TYPE OF CASING SEAL: _____

DEPTH TO TOP OF ROCK: _____

DEPTH TO BOTTOM CASING: _____

DIAMETER OF HOLE IN BEDROCK: _____

DESCRIBE IF CORE / REAMED WITH BIT:

_____

_____

_____

DESCRIBE JOINTS IN BEDROCK AND DEPTH:

_____

_____

_____

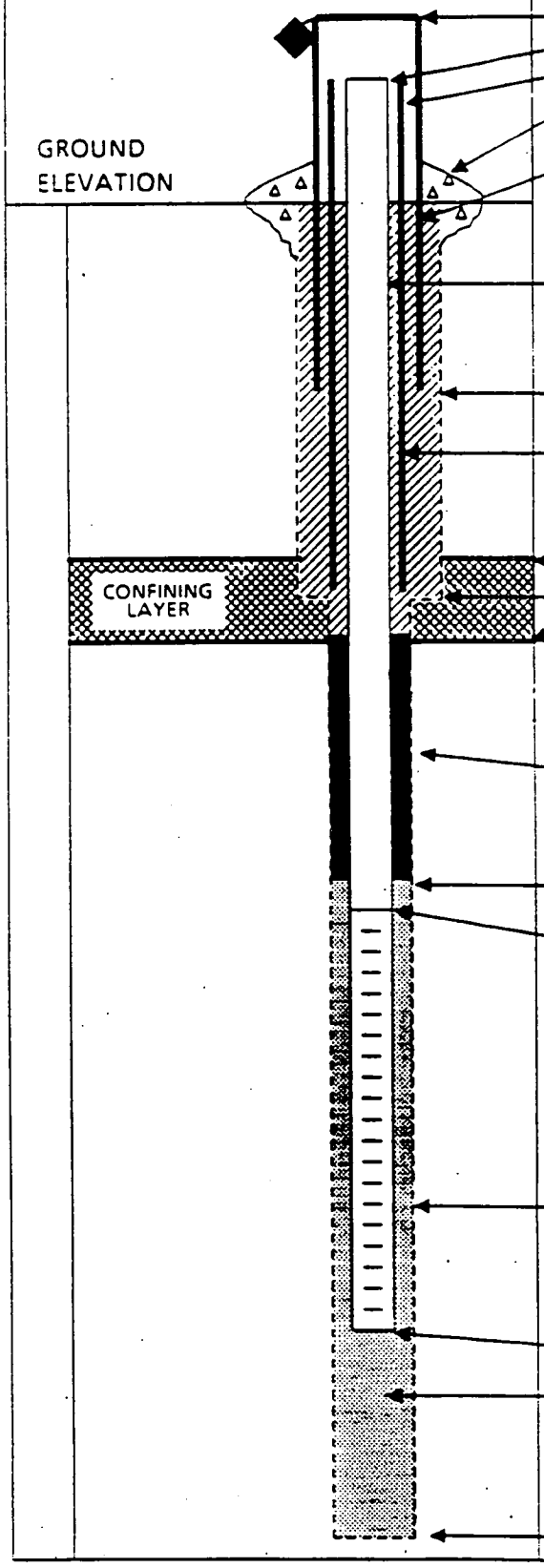
ELEVATION / DEPTH OF HOLE: _____ / _____

BORING NO.: _____

CONFINING LAYER
MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____
ELEVATION TOP OF PERM. CASING: _____
TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

PERM. CASING I.D. _____
TYPE OF CASING & BACKFILL: _____

ELEVATION / DEPTH TOP CONFINING LAYER: _____
ELEVATION / DEPTH BOTTOM OF CASING: _____
ELEVATION / DEPTH BOT. CONFINING LAYER: _____ / _____

ELEVATION / DEPTH TOP OF SEAL: _____ / _____
TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: _____ / _____
TYPE OF SCREEN: _____

TYPE OF SAND PACK: _____

BOREHOLE DIA. BELOW CASING: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____ / _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION / DEPTH OF HOLE: _____ / _____

MONITORING WELL DEVELOPMENT RECORD

Page ___ of ___

Well: _____
Site: _____
Date Installed: _____
Date Developed: _____
Dev. Method: _____
Pump Type: _____

Depth to Bottom (ft.): _____
Static Water Level Before (ft.): _____
Static Water Level After (ft.): _____
Screen Length (ft.): _____
Specific Capacity: _____
Casing ID (in.): _____

Responsible Personnel: _____
Drilling Co.: _____
Project Name: _____
Project Number: _____

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units ____)	Turbidity (NTU)	Remarks (odor,color,etc.)

Example IDW (drum) label

INVESTIGATION DERIVED WASTE

GENERATOR INFORMATION:

SITE _____ JOB NO. _____

LOCATION _____

DATE _____

DRUM# _____

CONTENTS _____

VOLUME _____

CONTACT _____

EMERGENCY PHONE NUMBER _____

TETRA TECH NUS
FIELD TASK MODIFICATION REQUEST FORM

Project/Installation Name _____ CTO & Project Number _____ Task Mod. Number _____

Modification To (e.g. Work Plan) _____ Site/Sample Location _____ Date _____

Activity Description: _____

Reason for Change: _____

Recommended Disposition: _____

Field Operations Leader (Signature) _____ Date _____

Approved Disposition:

Project/Task Order Manager (Signature) _____ Date _____

Distribution:

Program/Project File –
Project/Task Order Manager –
Field Operations Leader –

Other: _____

ATTACHMENT B

SITE-SPECIFIC STANDARD OPERATING PROCEDURES

ATTACHMENT B

STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

SOP Number	Title
CTO 10 SOP 2-1	INSPECTION OF EXISTING MONITORING WELLS
CTO 10 SOP 2-2	MEASUREMENT OF WATER LEVELS IN MONITORING WELLS
CTO 10 SOP 2-3	MONITORING WELL PURGING AND STABILIZATION
CTO 10 SOP 2-4	MONITORING WELL SAMPLING
CTO 10 SOP 2-5	SURFACE AND SPRING WATER SAMPLING
CTO 10 SOP 2-6	SEDIMENT SAMPLING
CTO 10 SOP 2-7	SURFACE AND SUBSURFACE SOIL SAMPLING
CTO 10 SOP 2-8	MONITORING WELL INSTALLATION AND WELL DEVELOPMENT
CTO 10 SOP 2-9	DECONTAMINATION OF FIELD SAMPLING EQUIPMENT
CTO 10 SOP 2-10	SAMPLE IDENTIFICATION NOMENCLATURE
CTO 10 SOP 2-11	SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES
CTO 10 SOP 2-12	SAMPLE PRESERVATION, PACKAGING, AND SHIPPING
CTO 10 SOP 2-13	USE OF PHOTOIONIZATION DETECTOR
CTO 10 SOP 2-14	BOREHOLE AND SOIL SAMPLE LOGGING
CTO 10 SOP 2-15	CALIBRATION, OPERATION, AND MAINTENANCE OF WATER QUALITY METER
CTO 10 SOP 2-16	FIELD TEST KIT ANALYSIS

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-1

INSPECTION OF EXISTING MONITORING WELLS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for the inspection of existing monitoring wells prior to sampling at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for inspection of existing monitoring wells.

Monitoring Well Inspection Sheet: A copy of the Monitoring Well Inspection Sheet can be found in Attachment A.

Writing Utensil with Indelible Ink

Bound Field Logbook

Disposable Medical Grade Gloves (e.g., Latex, Nitrile)

Well keys

3.0 INSPECTION PROCEDURES

3.1 Record the well identification (I.D.), date, and time on the Monitoring Well Inspection Sheet.

3.2 Record the condition of the well I.D. tag. Is the tag in place and legible?

3.3 Record the condition of the protective casing, caps, and lock. Has the casing, cap, and/or lock been tampered with? Has the well been damaged in any way or does it show signs of deterioration?

3.4 Record the condition of the concrete or gravel pad or collar. NSWC Crane wells will have either a concrete collar, concrete pad, or gravel pad. Check the condition of the pad or collar and note any changes. Are concrete pads/collars cracking or heaving? If a gravel pad is present, is there any erosion or plant growth in the pad area?

3.5 Record the condition of the cement seal surrounding the protective casing. Has the seal cracked or pulled away from the protective casing? Record any visible signs of deterioration in the area of the seal.

3.6 Record the presence of depressions and/or standing water around the casing or pad.

3.7 Unlock the well cap.

3.8 Inspect and record the condition of the polyvinyl chloride (PVC) riser pipe and the surveyed reference point. The surveyed reference point may be a V-notch on the top of the PVC riser pipe or just the top of the riser pipe.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-2

MEASUREMENT OF WATER LEVELS IN MONITORING WELLS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for determining water levels in monitoring wells at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for determining water levels in monitoring wells.

Ground Water Level Measurement Sheet: A copy of the Ground Water Level Measurement Sheet is included in Attachment A.

Bound Field Logbook

Writing Utensil

Photoionization detector (PID): The manual for the operation of the PID or flame ionization detector (FID) is found in the site-specific Health and Safety Plan (HASP).

Well key

Electronic water level indicator: The water level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot.

Decontamination supplies: CTO 10 SOP 2-9 describes decontamination procedures including decontamination supplies.

3.0 WATER LEVEL MEASUREMENT PROCEDURES

3.1 Check the operation of the electronic water level indicator.

3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water Level Measurement Sheet.

3.3 Unlock the well and remove the well cap.

3.4 Place the well cap on a clean piece of plastic.

3.5 Check the well for the presence of organic vapors in the 2-inch polyvinyl chloride riser pipe as follows:

1. Calibrate the PID or FID in accordance with the calibration procedures described in CTO 10 SOP 2-13.

2. Insert the PID or FID sample inlet straw approximately 3 inches into the riser pipe.

3. Record the PID or FID reading on the Ground Water Level Measurement Sheet. If the reading is below concentrations specified in the site-specific HASP, proceed to step 3.6. If the reading is above the concentration specified in the HASP, measure the concentration in the breathing zone. If the concentration in the breathing zone is below the concentration specified in the HASP, proceed to step 3.6. If the reading is above the specified concentration, allow the riser pipe to ventilate for 10 minutes and repeat the measurement of breathing zone concentrations until the concentrations fall below the level specified in the HASP before proceeding to step 3.6.

3.6 Insert the water level meter probe into the riser pipe. (The probe must be decontaminated before use according to the procedures in CTO 10 SOP 2-9.)

3.7 Slowly lower the probe into the well riser pipe until an audible and/or visible signal is produced, indicating contact with the water surface.

3.8 Read the ground water level measurement from the top of the inner casing at the surveyed reference point to the nearest 0.01 foot.

3.9 Record the water level measurement on the Ground Water Level Measurement Sheet.

3.10 Wind the meter cable measuring tape back onto the spool.

3.11 Replace the well cap and lock.

3.12 Decontaminate the meter's probe following the procedures outlined in CTO 10 SOP 2-9.

3.13 Containerize any decontamination fluids and personal protective equipment in accordance with the procedures described in Section 2.12 of this approved Field Sampling Plan.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-3

MONITORING WELL PURGING AND STABILIZATION

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for well purging and stabilization utilizing low-flow techniques. Low-flow purging and stabilization techniques will be used for ground water sampling at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow purging.

Low Flow Purge Data Sheet: A copy of this form is included in Attachment A.

Ground Water Sample Log Form: A copy of this form is included in Attachment A.

Bound Field Logbook

Photoionization detector (PID): The manual for the operation of the PID is found in the Health and Safety Guidance Manual and in CTO 10 SOP 2-13.

Well key

Electronic water level indicator: The water level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot. Procedures for operation of the water level indicator are found in CTO 10 SOP 2-2. The vendor should also supply a general instructions manual.

Multiple parameter water quality meter: This unit measures and displays field parameters measured in the field including pH, dissolved oxygen, turbidity, oxidation-reduction potential (ORP), temperature, and

specific conductance. Procedures for measurements of field parameters and the operation and calibration of the water quality meter are found in CTO 10 SOP 2-15. The vendor should also supply a general instructions manual for this unit.

Flow-through cell adapter for water quality meter

Purge water containers: Plastic containers with lids.

Graduated cylinder and stopwatch: Used to calculate flow rate.

Decontamination supplies: CTO 10 SOP 2-9 describes required decontamination supplies.

Disposable Medical-grade gloves (e.g., Latex, nitrile)

Pump: Peristaltic pump requires 12-volt battery (car or NiCd) as a power source, silicone tubing, and Teflon-lined tubing. Bladder pump requires compressed nitrogen as a power source and an electronic programmable controller (Model 400).

3.0 PUMP SELECTION FOR PURGING AND SAMPLING MONITORING WELLS

Ground water monitoring wells will be purged and sampled using one of two pumping methods. Either a peristaltic pump or bladder pump will be used for all monitoring well purging and sampling. The method chosen will be based on the depth below ground surface (bgs) to water, and the recharge rate of the well. For a monitoring well having a depth to water equal to or greater than 20 feet bgs, a bladder pump will be used. For a monitoring well having a depth to water of less than 20 feet bgs and a recharge rate greater than 150 mL per minute, a peristaltic pump will be used. Prior to purging and sampling, all monitoring wells will be developed; the recharge rate for each well will be determined during well development.

3.1 Peristaltic Pump Method

Insert a new section of medical-grade silicone tubing (approximately 18 inches in length) into the pump head, following the pump operation manual. Obtain the total depth of the well and screen length. Wear clean, disposable surgical gloves while handling the tubing. Measure the appropriate length of Teflon-lined polyethylene tubing and insert the tubing inlet (bottom of pump tubing) to the center of the saturated well screen. Insert the Teflon-lined polyethylene tubing into the silicone tubing. Proceed to Section 4.0.

3.2 Bladder Pump Method

Obtain the total depth of the well and screen length. Calculate the length of tubing needed to position the inlet screen of the pump at the center of the saturated well screen. Wear clean, disposable surgical gloves while handling the pump assembly and tubing. Measure the appropriate length of Teflon-lined polyethylene pump tubing and attach it to the bladder pump, examine all fittings and connections for tightness.

Insert the pump into the polyvinyl chloride riser pipe of the well. While holding the tubing, slowly lower the pump, taking care not to kink the pump tubing. When the tubing is inserted to its complete length, suspend the pump and tubing assembly on the top of the riser pipe using the attached well cap assembly. The manual for the operation of the controller should be supplied by the vendor. Proceed to Section 4.0.

4.0 PROCEDURES FOR WELL PURGING

4.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate water quality meter according to manufacturer's requirements and CTO 10 SOP 2-15.

4.2 Follow steps 3.1 through 3.9 in CTO 10 SOP 2-2 to obtain a static water level measurement of the well to be purged. Record the information on the Ground Water Sample Log Form and the Low Flow Purge Data Sheet. Leave the water level meter suspended in the well casing.

4.3 Calculate one well casing volume as follows:

1. Obtain the total depth of the well.

2. Using the static water level determined in step 3.2 and the total depth of the well, calculate the well casing volume using the following formula:

$$V = (0.163)(T)(r^2)$$

where:

V	=	Static casing volume of well in gallons.
T	=	Length of water table in feet (linear feet of water).

0.163	=	A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.
R	=	Inside radius of the well casing in inches

Bladder Pump only, steps 4.4 and 4.5; if peristaltic pump, proceed to step 4.6

4.4 Connect the pump controller to the well pump air supply (at the well cap) by following the instructions in the pump control manual (a copy of the manual will be supplied by the vendor.) The pump controller must be turned off when being connected.

4.5 Connect the nitrogen cylinder to the pump controller. The nitrogen cylinder valve must be closed and the regulator line pressure set at zero pounds per square inch (PSI) when being connected.

4.6 Following the instructions found in the water quality meter manual, connect the flow-through cell to the pump discharge line.

4.7 Place the discharge tubing from the flow-through cell to direct the purge water discharge into the graduated cylinder or purge-water container.

4.8 Following the instructions in the pump manual, start pumping water from the well.

4.9 Start with the initial pump rate set at approximately 0.1 liters/minute. Use the graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 foot during purging. If no drawdown is noted, the pump rate may be increased (to a maximum of 0.4 liters/minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 Nephelometric Turbidity Units (NTUs). If ground water is drawn down to the pump intake or the top of the well screen (if the static water level is above the screen), purging will cease and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be collected from these wells within the same workday and no later than 24 hours after the start of purging.

The time to sample any given well will vary greatly due to the many variables associated with low flow purging and sampling:

- Stabilization of parameters
- Possible drawdown
- Analytical requirements
- Varying quality assurance sample requirements
- Variable pump rates

Normally, the time from the start of purging to the end of sampling will be between 1.5 and 4.0 hours.

4.10 Measure the well water level using the water level meter every 5 to 10 minutes. Record the well water level on the Low Flow Purge Data Sheet.

4.11 Record on the Low Flow Purge Data Sheet every 5 to 10 minutes the water quality parameters (pH, specific conductance, temperature, turbidity, ORP, and dissolved oxygen) measured by the water quality meter. Clean the flow-through cell as needed during purging (e.g., when fluctuating turbidity readings are observed and confirmed by collection of a turbidity sample before the cell for comparison). If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low Flow Purge Data Sheet.

4.12 Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

4.13 During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles would be an indication that connections are not tight. If bubbles are observed, check for loose connections.

4.14 Stabilization is achieved and sampling can begin when a minimum of one casing volume has been removed and three consecutive readings, taken at 5- to 10-minute intervals, are within the following limits:

- pH ± 0.1 standard units
- Specific conductance ± 3%
- Temperature ± 3%

- Turbidity less than 10 NTUs
- Dissolved oxygen ± 10%

If the above conditions have not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-4

MONITORING WELL SAMPLING

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for monitoring well sampling. Low-flow sampling techniques will be used for ground water sampling at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells.

Ground Water Sample Log Form: A copy of this form can be found in Attachment A.

Bound Field Logbook

Labeled sample containers: See CTO 10 SOP 2-10 for sample identification procedures.

Tag for each sample container

Peristaltic Pump or Bladder Pump: See CTO 10 SOP 2-3, Section 3.0 for pump selection.

Peristaltic Pump

- 12-volt Battery: A 12-volt battery (car or NiCd) may be used as a power source for the peristaltic pump.

- Tubing: A length of flexible silicone tubing will be used in the pump and connected to Teflon-lined tubing cut to the depth of the well (may be left in well for reuse).

Bladder Pump

- **Electronic Programmable Controller, Model 400:** The programmable controller regulates the dedicated bladder pump. The vendor should supply a manual for the operation of the controller.

- **Cylinder of compressed nitrogen with regulator**: Compressed gas is the power source for the bladder pump.

Plastic storage bags

Shipping containers

3.0 MONITORING WELL SAMPLING PROCEDURES

3.1 Prior to sampling the well, the inspection procedures described in CTO 10 SOP 2-1, the water level measurements described in CTO 10 SOP 2-2, and the well purging procedures described in CTO 10 SOP 2-3 must be completed. Samples are identified by an alpha-numeric naming convention described in CTO 10 SOP 2-10. Initiate sampling when the well is stabilized in accordance with CTO 10 SOP 2-3.

3.2 Record the sample start time (using military time) on the Ground Water Sample Log Form.

3.3 With the pump continuing to run, disconnect the flow-through cell from the pump discharge tube and immediately start filling sample bottles directly from the pump discharge. Allow the pump discharge to flow gently down the inside of the container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled.

3.4 Cap each container immediately after filling.

3.5 Record the sample time on the Ground Water Sample Log Form, the sample tag, and the sample label. Additional sample documentation is discussed in CTO 10 SOP 2-11.

3.6 Secure the associated tag to each sample container.

3.7 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.

3.8 Repeat steps 3.3 through 3.7 for each sample container collected.

3.9 The pump rate should not be adjusted after sampling has begun. If it becomes necessary to adjust the pump rate, document the change on the Ground Water Sample Log Form.

3.10 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. Table 2-2 of this approved Field Sampling Plan includes information on preservation requirements. All samples will be collected in the following sequence (where applicable):

- Dyes
- Appendix 9 metals
- Miscellaneous Metals
- Miscellaneous Parameters

3.11 Types of sample containers, sample volume, preservation requirements, and holding times are summarized in Table 2-2 of this Field Sampling Plan. All sample containers will be supplied by the laboratory, and the laboratory will pre-preserve all sample containers, where appropriate.

3.12 The process for sampling and analyzing for natural attenuation parameters is located in SOP 2-16.

3.13 After completion of sample collection: if using a peristaltic pump properly dispose of pump tubing (if necessary) and filter following Section 2.12 Investigation-Derived Waste Handling in the Field Sampling Plan; for bladder pump remove pump from well and decontaminate following the procedures in CTO 10 SOP 2-9. Replace the outer protective well cap and lock the well.

3.14 All equipment should be cleaned and packed into the sample vehicle, along with the sample cooler for transport.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-5

SURFACE AND SPRING WATER SAMPLING

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for surface and spring water sampling. Surface water sampling will be collected from streams, seeps, and springs at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for surface water and spring sampling.

Surface Water Sample Log Sheet: A copy of this form is included in Attachment A.

Bound Field Logbook

Tags for each sample container

Multi-parameter water quality meter: The water quality meter is used for the measurement of dissolved oxygen, pH, specific conductance, temperature, turbidity, and oxidation-reduction potential. The procedures for the operation and calibration of this meter are found in CTO 10 SOP 2-15. The vendor should supply a manual for general instructions.

Dedicated/disposable sample containers: Dedicated/disposable sample containers are used to fill sample containers and transport sample(s) to a pump for filtering if dissolved samples are required.

Labeled sample containers: See CTO 10 SOP 2-10 for sample identification procedures.

0.45-micron filter assembly: These are single-use filters used to filter samples. The filters are discarded after one use.

Peristaltic pump + power source + tubing

Silicon tubing

Transfer bottles used during filtration (wide-mouth bottles may be advantageous for transfer in extremely low flow situations)

Plastic storage bags

Shipping containers

3.0 SURFACE AND SPRING WATER SAMPLING PROCEDURES

3.1 The same methods will be used to collect surface water samples from streams, seeps, or springs. Sampling will start at the downstream location and proceed to the farthest upstream location. Reference figures are included in the Field Sampling Plan for approximate sample locations.

3.2 Gently remove any leaves or twigs that have accumulated in the sample pool area.

3.3 Estimate the flow rate of the stream in gallons per minute (gpm). This is an estimate only. Round the flow rate to the nearest 5 gallons and record this number on the Surface Water Sample Log Sheet. Note if base (low) flow or storm (high) flow and record on form.

3.4 Record the sample time (using military time) on the Surface Water Sample Log Sheet and sample container labels and sample tags. Complete sample documentation of field activities in accordance with CTO 10 SOPs 2-10 and 2-11.

3.5 Obtain measurements of dissolved oxygen, pH, specific conductance, temperature, turbidity, and oxidation-reduction potential using the multi-parameter water-quality meter. Procedures for obtaining these measurements and the operation of the water quality meter are located in CTO 10 SOP 2-15. Suspend the meter into the sample pool. After the meter has stabilized (approximately 1 to 2 minutes), record the readings on the Surface Water Sample Log Sheet.

3.6 If the sample can be obtained from the shore, begin sampling using a dedicated, clean, unpreserved, 1-liter collection bottle supplied by the laboratory. Hold the collection bottle at a 45-degree angle and lower it to approximately half the sample pool depth. With the mouth of the

bottle facing upstream, fill the collection bottle with water, being careful not to disturb the sediment.

3.7 If the sample cannot be obtained from the shore, carefully step into the water downstream of the sample location. Make certain that any disturbed sediment clears from the water before sampling. Begin sampling using a dedicated, clean, unpreserved, 1-liter collection bottle supplied by the laboratory. Obtain the sample upstream of your location. Hold the collection bottle at a 45-degree angle and lower it to approximately half the sample pool depth. With the mouth of the bottle facing upstream, fill the collection bottle with water, being careful not to disturb the sediment.

3.7 Transfer the contents of the collection bottle to the sample container and cap the sample container. Note, the unpreserved, one-liter collection bottle is needed for streams and surface water locations with low flow and/or shallow depths that would prevent the complete filling of the sample container. Depending on site conditions, the sampler may use either direct fill and/or a sample collection bottle.

3.9 Affix the sample label to the sample container and, using a wire tie, secure the corresponding tag to the neck of the sample container.

3.10 Place the tagged sample container into a plastic storage bag and then place the plastic storage bag holding the sample container into a cooler containing ice.

3.11 Repeat steps 3.4 through 3.10 until all of the sample bottles have been filled.

3.12 All samples will be collected into pre-preserved bottles (if required for preservation) supplied by an approved laboratory. Table 2-2 of this approved Field Sampling Plan includes information on the preservative and bottle requirements. All samples will be collected in the following sequence (where applicable):

- Dyes
- Appendix 9 and Miscellaneous Metals (total)
- Appendix 9 and Miscellaneous Metals (dissolved)
- Miscellaneous Parameters

Samples for field analysis may be collected at any time.

3.13 Fill two 1-liter unpreserved polyethylene bottles. Use these bottles to transfer sample for field filtering. Set up a peristaltic pump (see vendor-supplied manual) for filtering of the dissolved metals (Appendix 9 and miscellaneous) samples. Using dedicated and disposable silicone tubing and a 0.45-micron filter, place the intake tubing from the pump into the transfer bottle with the filter attached to the discharge end and start the pump. Pre-rinse the filter with approximately 100-mL of sample water prior to filling the sample containers.

3.14 All samples will be collected into pre-preserved bottles (if required for preservation) supplied by an approved laboratory. Table 2-2 of this approved Field Sampling Plan includes information on preservative requirements.

3.15 Obtain measurements of dissolved oxygen, pH, specific conductance, temperature, turbidity, and oxidation-reduction potential using the multi-parameter water quality meter. Suspend the meter into the sample pool. After the meter has stabilized (approximately 1 to 2 minutes), record the readings on the Surface Water Sample Log Sheet.

3.16 Clean all equipment, and load the equipment and the sample cooler in the sample vehicle for transport.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-6

SEDIMENT SAMPLING

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for sediment sampling at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for sediment sampling.

Soil and Sediment Sample Log Sheet: A copy of this form is included in Attachment A.

Bound Field Logbook

Tags for each sample container

Stainless steel and/or disposable plastic trowels

Survey stakes and flagging: Used to mark sampling locations after completion of sampling.

Labeled sample containers: See CTO 10 SOP 2-10 for sample identification procedures.

Plastic storage bags

Shipping containers

SEDIMENT SAMPLE LOCATION SELECTION

Sediment samples are usually collected at the same verticals at which water samples are collected. The shape, flow pattern, depth, and water circulation patterns must all be considered when selecting sediment sample locations. In streams, areas likely to have sediment accumulation (e.g., bends, behind boulders, quite shallow areas, or very deep, low-velocity areas) will be sampled while areas likely to show net erosion (e.g., high-velocity, turbulent areas) and suspension of fine solid materials, will be avoided. In general, bed sediments composed of fine-grained materials with lower porosity and greater surface area available for adsorption are more desirable for sample selection. Bottom sediments (especially fine-grained materials) may act as a sink or reservoir for adsorbing heavy metals and organic contaminants (even if water column concentrations are below detection limits). Therefore, it is important to minimize the loss of low-density "fines" during the sampling process.

3.0 SEDIMENT SAMPLING PROCEDURES

3.1 Wearing clean disposable, surgical gloves and using a sampling trowel clear any accumulated vegetative matter from the sample area. Using the trowel to scoop the sediment into the labeled sample container, carefully decant any water that may have accumulated in the sample container.

3.2 Record the sample time (using military time) on the Soil and Sediment Sample Log Sheet and sample container labels and tags. Complete sample documentation of field activities in accordance with CTO 10 SOPs 2-10 and 2-11.

3.3 Secure the tag to the neck of the sample container using a wire tie.

3.4 Place the tagged sample container into a plastic storage bag and then place the plastic storage bag holding the sample container into a cooler containing ice.

3.5 Using an indelible marker write the sample identification on a survey stake, and drive the stake into the ground at the sample location.

3.6 All samples will be collected into bottles supplied by an approved laboratory. Table 2-1 of this approved Field Sampling Plan includes information on the bottle requirements. All samples will be collected in the following sequence (where applicable):

- Dyes
- Appendix 9 Metals

- Miscellaneous Metals
- Miscellaneous Parameters

3.7 Clean all equipment, and load the equipment and the sample cooler in the sample vehicle for transport.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-7

SURFACE AND SUBSURFACE SOIL SAMPLING

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for surface and subsurface soil sampling using direct push technology (DPT), split-barrel or hand auger at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil

Disposable Medical-Grade Gloves (i.e. latex, nitrile)

Boring Log

Soil and Sediment Sample Log Sheet

Stainless-steel mixing bowls

Stainless-steel trowel or soup spoon

EnCore Handle and Sampler

Required sample containers with appropriate preservative: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory.

Required Decontamination Materials

Bentonite Chips

Custody Seals

Chain of Custody Records

Required Personal Protective Equipment

Photoionization Detector (PID)

Wooden Stakes or Pin Flags

Sealable Polyethylene bags

Heavy-Duty Cooler

Ice

3.0 SOIL COLLECTION

Non-volatile soil samples may be collected as either grab or composite samples. A non-volatile sample includes all other chemical parameters (e.g., dyes, metals, etc.) and those engineering parameters that do not require undisturbed soil for their analysis. A composite sample exists as a combination of more than one sample at various depths, which is homogenized and treated as one sample. A grab sample is collected at one location and at one specific time. The non-volatile soil sample is thoroughly mixed in a stainless steel or disposable, inert plastic tray, using a stainless steel trowel or other approved tool, then transferred into the appropriate sample container(s). Headspace is permitted in a non-volatile soil sample container to allow for sample expansion.

4.0 SURFACE SOIL COLLECTION

The simplest, most direct method of collecting surface soil samples for subsequent analysis is by use of a stainless steel trowel. When acquiring surface soil samples, the following procedure will be used:

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

2. Using a decontaminated stainless steel trowel, collect surface soil from indicated soil interval and transfer into a clean decontaminated stainless steel or disposable, inert plastic tray for mixing.

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

4. Affix a sample label to each container. Be sure to fill out each label carefully and clearly.

5. Proceed with the handling and processing of each sample container.

5.0 SOIL SAMPLING USING A HAND AUGER

A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e., cylinders 6-1/2 inches long and 2-3/4 inches, 3-1/4 inches, and 4 inches in diameter), a series of extension rods (available in 2 foot, 3 foot, 4 foot, and 5 foot lengths), and a cross-handle. The hand auger can be used in

a wide variety of soil conditions. It is limited in depth of boring by texture of soil, layers of rock, or collapse of borehole by saturated conditions.

A larger diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then withdrawn. A mechanized/motorized auger may be used to reach deep soil intervals, if required. Note changes in the color, texture, or odor of the soil. Before the desired depth is reached, a clean decontaminated hand auger bucket bit may be lowered down the hole, and turned to the desired depth where the sample is collected.

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

- Complete hand auger assembly (including clips to attach auger bucket and handle to extension)
- Stainless steel mixing bowls
- The equipment listed under Section 2.0 of this procedure

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

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

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

- Begin augering by turning the "T" handle in a clockwise fashion, thus turning the auger bit until the bucket bit is advanced approximately 6 inches into the soil. Remove the bucket from the borehole, empty the contents and repeat, adding additional rod extensions as necessary to reach the desired depth. Note (in a field notebook or on standardized data sheets) any changes in the color, texture, or odor of the soil.

- After reaching the desired depth, slowly and carefully withdraw the bucket from the borehole.

- Remove the soiled bucket bit from the rod extension and replace it with another properly decontaminated bucket bit.

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

- Slowly turn the apparatus until the bucket is full.

- Discard the top of core (approximately 1 inch), which represents any loose material collected by the bucket bit before penetrating the desired sample depth.

- Utilizing the hand trowel, remove the sample material from the bucket bit into a properly decontaminated stainless steel mixing bowl.

- Screen the auger interval for volatiles with a PID and thoroughly homogenize the entire sample interval prior to filling the sample containers.

- Log the recovered sample on the Boring Log sheet (provided in Attachment A of the FSP).

- If additional sample volume is required, auger adjacent to the initial boring and composite/mix soil from the same interval.

- Fill out a Soil and Sediment Sample Log Sheet (found in Attachment A of the FSP) and sample labels and tags (according to CTO 10 SOP 2-11), making sure that the appropriate fields are filled out completely and legibly, and affix them to the sample bottle.

- Proceed with handling each sample container.

- Repeat for all samples to be collected.

Once sampling has been completed, backfill the hole with bentonite chips.

6.0 SOIL SAMPLING WITH A HOLLOW STEM AUGER AND A SPLIT-BARREL SAMPLER

A split-barrel (split-spoon) sampler consists of a heavy stainless steel sampling tube that can be split into halves to reveal the soil sample. Carbon steel split spoons should not be used for soil sampling. A drive head is attached to the upper end of the tube and serves as a point of attachment for the drill rod. A removable tapered nosepiece/drive shoe attaches to the lower end of the tube and facilitates cutting. A basket-like sample retainer can be fitted to the lower end of the split tube to hold loose, dry soil samples in the tube when the sampler is removed from the drill hole. This split-barrel sampler is attached to a drill rod and forced into the ground by means of a 140-pound or larger casing driver.

The following equipment is used for obtaining a split-barrel sample:

- Drilling equipment (provided by subcontractor)
- Stainless steel split-barrel samplers (OD 2 inches, ID 1-3/8 inches, and either 20 inches or 26 inches long)
- Drive weight assembly, 140-pound weight, driving head and guide permitting free fall of 30 inches.
- Stainless steel mixing bowls
- Equipment listed under Section 2.0 of this procedure

The drilling subcontractor will usually provide the recovered spoon or barrel to the sampler, and the following steps will be used to collect the soil sample:

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

- Utilizing the hand trowel, remove the sample material from the split-barrel sampler (except for the small portion of disturbed soil usually found at the top of the core sampler), and place the soil into a properly decontaminated stainless steel mixing bowl. Thoroughly homogenize the sample material prior to filling the sample containers.

- If additional sample volume is required, auger an additional boring adjacent to the initial borehole and composite/mix the same interval. Do not collect soil for chemical analysis from the mechanized/motorized auger flights.

- Once sampling has been completed, the hole is backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch is used to cap holes through paved or concrete areas. All holes will be finished smooth to existing grade.

- Affix a sample label with a wire tie to the neck of each container. Be sure to fill out each label carefully and clearly.

- Proceed with the handling and processing of each sample container.

7.0 DIRECT PUSH TECHNOLOGY (DPT)

DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional drilling equipment. DPT typically utilizes hydraulic pressure and/or percussion hammers to advance the sampling tools. A primary advantage of DPT over conventional drilling techniques is that DPT results in the generation of little or no drill cuttings.

Equipment needed for conducting DPT probing for soil sampling includes, but is not limited to, the following:

- 4-foot X 1.5-inch diameter macro-core sampler
- Probe sampling adapters
- Roto-hammer with 1.5-inch bit
- Acetate liner for soil sampler
- Steel drive points
- Geoprobe AT-660 Series Large Bore Soil Sampler, or equivalent
- Equipment listed in Section 2.0 of this procedure

There are several methods for the collection of soil samples using DPT probing equipment. The most common method is explained in the following section. Variations of the following method may be conducted upon approval of the Project Manager.

- Macro-core samplers fitted with detachable steel drive points are driven into the ground using hydraulic pressure. If there is concrete or pavement over a sampling location, a Roto-hammer is used to drill a minimum 1.5-inch-diameter hole through the surface material.

- The sampler is advanced continuously in 4-foot intervals. No soil cuttings are generated because the soil is displaced within the formation.

- The sampler is retracted from the hole, and the 4-foot continuous sample is removed from the outer coring tube. The sample is contained within an acetate liner.

- Log the sample on the Boring Log Sheet (Attachment A of the FSP). Note: The DPT macro-core sampler is 4 feet in length and sample length is 1 foot. Use an engineer's tape to measure for sample intervals.

- The acetate liner is cut lengthwise to field screen the sample with a real-time air monitoring instrument. Visually observe the sample for staining, assess moisture content, and, if sampling criteria are met, mix and transfer the sample to sample containers for laboratory analysis.

- If additional sample volume is required, push an additional boring adjacent to the first and composite/mix the same interval.

Once sampling has been completed, backfill the hole with bentonite chips or bentonite cement grout, depending upon project requirements. All holes will be finished smooth to existing grade.

8.0 RECORDS

The appropriate sample log sheet must be completed by the site geologist/sampler. All soil sampling locations must be documented by tying in the location of two or more nearby permanent landmarks (building, telephone pole, fence, etc.) and will be noted on the appropriate sample log sheet, site map, or field notebook. Boreholes will be logged by the field geologist in accordance with CTO 10 SOP 2-14.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-8

MONITORING WELL INSTALLATION AND WELL DEVELOPMENT

1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper monitoring well design, installation, and development. The methods described herein are specific for monitoring well construction at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds. Guidelines by South Division, Naval Facilities Engineering Command, (South Div NavFac, 1997) should be consulted as should State of Indiana regulatory requirements in Article 16 Water Well Drillers of Chapter 310 of the Indiana Annotated Codes (310 IAC 16).

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

It should be noted that it is not anticipated that any wells will need to be installed for SWMU 2. One well cluster (i.e., 3 wells) are proposed if ground water results fail to describe ground water conditions.

2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The driller may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

Field Geologist - The field geologist supervises and documents well installation and construction performed by the driller, and insures that well construction is adequate to provide representative ground water data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

Site Safety Officer – The Site Safety Officer is responsible for clearing the drill site for underground and overhead utilities or other potentially hazardous obstructions.

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

- Health and safety equipment as required by the Site Safety Officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineer's rule, electronic calculator, clipboard, mirror and flashlight for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).

4.0 WELL DESIGN

The objectives for each monitoring well and its intended use are clearly defined in Table 5-8, Summary of Objectives/Proposed Sampling for SWMU 2 (Work Plan). The objectives of monitoring well locations are to evaluate ground water quality of various locations in relation to their historical extent of contamination or to determine horizontal migration from surficial to deeper aquifers in geological strata of interest.

Present siting of monitoring wells will be confirmed after a preliminary estimation of the ground water flow direction. In most cases, ground water flow and potential well locations have been determined through the review of geologic data and the site terrain. In addition, data from existing monitoring wells in the area were used to determine the ground water flow direction.

Well construction is tailored to the specific objective of the monitoring well. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. The decision concerning the monitored interval and well depth is based on the following (and possibly other) information:

- Historical information on the construction of existing adjacent wells.
- Historical geologic logs describing the depth, thickness and uniformity of the water-bearing zone or strata of interest.
- The presence and location of contaminants encountered during drilling.

- Whether the purpose of the installation is for evaluating the ground water quality of the uppermost surficial aquifer or if a particular stratigraphic zone is being investigated.

In most situations depending on the purpose of the well and the site conditions, monitored intervals are 10 feet and will be installed with approximately 7 feet of the screen located below the water table. Shorter screen lengths (5 feet) are usually required where shallow surficial aquifers are being monitored. Bottoms of well screens should be placed a minimum of 6 inches but no more than 3 feet above the bottom of the drilled borehole.

All monitoring wells will be constructed of Schedule 40, flush-joint threaded, 2-inch inside diameter (ID) polyvinyl chloride (PVC) riser pipe and flush-joint threaded, factory-slotted well screen with a threaded end cap. The well screens will be factory slotted to 0.010-inch size. Each section of well casing and screen will be National Sanitation Foundation approved. Well screens will be 10 feet long, but may be longer or shorter based on the subsurface conditions encountered. A PVC cap will be placed on the bottom and is also flush threaded. Thermoplastic pipe will comply with American Society for Testing and Materials (ASTM) F-480 (1981). Other means of joining casings using glue, gaskets, pop rivets, or screws are not allowed.

The screen will pass no more than 10 percent of the pack material, or in-situ aquifer material. The field geologist will specify the combination of screen slot size and sand pack, which will be compatible with the water-bearing zone, to maximize ground water inflow and minimize head losses and movement of fines into the wells.

The hollow-stem auger dry drilling method may be used to install monitoring wells. The augers may have a 4.25-inch ID and create a 9.5-inch borehole. The use of drilling fluids will not be permitted. Split-spoon samples may be collected in accordance with ASTM specification D1586-84. Split-spoon samplers will be of 2-inch or 3-inch diameter and 2-foot minimum length. Samples will typically be collected continuously to the water table or as determined by the field geologist. Every effort will be made to achieve maximum recovery of sample material during split-spoon sampling, including use of traps as needed.

Monitoring wells will be installed through the augers immediately upon completion of each well boring. A clean silica sand pack will be installed trough the augers as they are removed from the boring. Clean silica sand of U.S. Standard Sieve Size No. 20 to 40 will be used. The sand pack will be extended from 0.5 foot below the well screen to 2.0 feet above the top of the well screen. A minimum 2-foot-thick bentonite pellet seal will be installed above the sand pack and allowed to hydrate as per the manufacturer's recommendations. Only 100 percent, certified pure, sodium bentonite will be used for well

construction. The depths of backfill materials will be constantly monitored during well installation using a weighted stainless steel or fiberglass tape measure. The remaining annulus above the hydrated bentonite seal will be backfilled to the surface using a tremie pipe, with a 20:1 cement/bentonite grout. A maximum of 10 gallons of water per 94-pound bag of Type 1 cement will be used. The grout mixture should be blended in an aboveground rigid container or mixer to produce a thick, lump-free mixture.

As required in the Navy Guidelines, a minimum 1-foot-thick secondary filter pack will be used to prevent intrusion of the bentonite seal into the primary filter pack. Uniformly graded fine sand with 100 percent by weight passing the No. 30 U.S. Standard sieve and less than 2 percent by weight passing the 200 U.S. Standard sieve should be used as a secondary filter pack.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets extending to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward, to prevent bridging and to provide a better seal. However, in shallow boreholes that do not collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

When the well is completed and grouted to the surface, a protective steel surface casing is placed over the top of the well. The finished well casing will extend at least 2 feet above the ground level and, if located in a floodplain, must be at least 2 feet above the elevation of the regulatory flood or be equipped with a watertight cap. This casing will have a cap that can be locked to prevent vandalism. A vent hole will be provided in the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water that may enter the annulus during well development, purging, or sampling.

4.1 Monitoring Wells in Unconsolidated Sediments

After the borehole are drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing and continue as the

temporary casing is withdrawn from the borehole. In the case of hollow-stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe is lowered into the borehole, all pipe and screen sections should be measured with an engineer's rule to ensure proper placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe is lowered through the temporary casing, the sand pack can be installed. A weighted tape measure must be used during the installation procedure to carefully monitor installation progress. The sand is slowly poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater than 1 foot above the bottom of the casing), bridging between the temporary casing, and riser pipe may occur. Centralizers may be used at the geologist's discretion, one above and one below the screen, to ensure enough annular space for sand pack placement.

After the sand pack (primary and secondary) is installed to the desired depth (at least 1 foot above the top of the screen), then the bentonite pellet seal (or equivalent) can be installed in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack. Pellets should be added slowly and their fall monitored closely to ensure that bridging does not occur.

The cement-bentonite grout is then mixed and either poured or tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed.

4.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between aquifers. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large-diameter boring through the upper aquifer, 1 to 5 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting a large diameter casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for installation of the monitoring well as detailed for overburden monitoring wells (with the exception of not using a temporary casing during installation). Sufficient time (determined by the field geologist) must be allowed for setting of the grout prior to drilling through the confined layer.

4.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5-10 feet into the bedrock. A casing (typically steel but Schedule 80 polyvinyl chloride may be used) is installed and either pressure grouted or tremie grouted in place. After the grout has cured, a smaller diameter boring is continued into the bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. However, if a screen is to be used, then the casing that is installed through the overburden and into the bedrock does not require grouting and can be installed temporarily until final well installation is completed.

5.0 WELL DEVELOPMENT METHODS

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. The development of newly installed wells shall not occur until at least 24 hours after the well has been installed and grouted. This time is required so that grout in the annulus can set and harden. Wells are typically developed until all fine material and drilling water are removed from the well. Sequential measurements of pH, conductivity, and temperature taken during development may yield information (stabilized values) regarding whether sufficient development has been performed. Development should proceed until criteria are met as stated in Navy Guidelines.

A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is aggressively moved up and down within the well screened interval of the to agitate the water, causing it to move in and out of the screen. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers: solid and valved. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Development should proceed until the following criteria are met:

1. The well water is clear to the unaided eye AND

2. A minimum removal of five times the standing water volume in the well (to include the well screen and casing plus saturated borehole annulus, assuming 30 percent annular porosity) OR

3. When pH measurements remain constant within 0.1 Standard Units and conductivity and temperature vary no more than plus or minus 3 percent for at least three consecutive readings. Turbidity may also show stabilization and ideally be below 10 Nephelometric Turbidity Units (NTUs).

If for any reason the above criteria cannot be met, the site geologist should document the event in writing and consult with the Task Order Manager regarding an alternate plan of action.

Well development must be completed at least 24 hours before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to sufficiently equilibrate to their new environment and for that new environment to re-stabilize after the disturbance of drilling.

6.0 RECORDS

A critical part of monitoring well installation is recording of significant details and events in the site logbook, on field forms, and in a field logbook. The geologist must record the exact depths of significant hydrogeological features, screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (see Attachment A in the FSP) will be completed, ensuring the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials will be recorded. Additional information will include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. Documentation is very important to prevent problems involving questionable sample validity.

The quantities of sand, bentonite, and grout placed in the well are also important. The geologist will calculate the annular space volume and have an idea of the quantity of material needed to fill the annular space. Any problems with rig operation or downtime will be recorded and may affect the driller's final fee.

Details of borehole and soil sample logging are contained in CTO 10 SOP 2-14, and field documentation procedures are outlined in CTO 10 SOP 2-11.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-9

DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

1.0 PURPOSE

The purpose of this procedure is to provide guidelines regarding the appropriate procedures to be followed when decontaminating drilling equipment, soil and sediment sampling equipment, surface water sampling equipment and monitoring well sampling equipment at Solid Waste Management Unit (SWMU) 2 – Dye Burial Grounds.

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED EQUIPMENT/SUPPLIES

Liquinox - A brand of phosphate-free laboratory-grade detergent.

Deionized Water - Deionized (analyte free) water is tap water that has been treated by passing through a standard deionizing resin column. Deionized water should contain no detectable heavy metals or other inorganic compounds at or above the analytical detection limits for the project.

Potable Water - Tap water used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Solvent - The solvent of choice is pesticide-grade Isopropanol. Solvents should not be used on PVC equipment or well construction materials.

Gloves - Disposable medical-grade (e.g., latex, nitrile)

Brushes, containers/buckets, paper towells, etc.

3.0 PROCEDURES

To ensure that analytical chemical results reflect actual contaminant concentrations present at sampling locations, the various drilling equipment, and chemical sampling and analytical equipment used to acquire the environmental sample must be properly decontaminated. Decontamination minimizes the potential for cross-contamination between sampling locations, and the transfer of contamination off site.

3.1 DRILLING EQUIPMENT

Prior to the initiation of a drilling program, all drilling equipment involved in field sampling activities shall be decontaminated by steam cleaning at a predetermined area. The steam cleaning procedure shall be performed using a high-pressure spray of heated potable water producing a pressurized stream of steam. This steam shall be sprayed directly onto all surfaces of the various equipment which might contact environmental samples. The decontamination procedure shall be performed until all equipment is free of all visible potential contamination (dirt, grease, oil, noticeable odors, etc.). In addition, this decontamination procedure shall be performed at the completion of each sampling and/or drilling location, including soil borings, installation of monitoring wells, test pits, etc. Such equipment shall include drilling rigs, backhoes, downhole tools, augers, well casings, and screens. Downhole equipment, however, must always be steam-cleaned between borings. Where PVC well casings are to be installed, decontamination is not required if the manufacturer provides these casings in factory-sealed, protective plastic sleeves (so long as the protective packaging is not compromised until immediately before use). Guidance to be used when decontaminating drilling equipment shall include:

As a general rule, any part of the drilling rig, which extends over the borehole, shall be steam cleaned.

All drilling rods, augers, and any other equipment, which will be introduced to the hole, shall be steam cleaned.

The drilling rig, all rods and augers, and any other potentially contaminated equipment shall be decontaminated between each well location to prevent cross contamination of potential hazardous substances.

Prior to leaving at the end of each work day and/or at the completion of the drilling program, drilling rigs and transport vehicles used onsite for personnel or equipment transfer shall be steam cleaned, as practicable. A drilling rig left at the drilling location does not need to be steam cleaned until it is finished drilling at that location.

3.2 DECONTAMINATION PAD CONSTRUCTION

The steam cleaning area shall be designed to contain decontamination wastes and waste waters and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided which is connected to a holding facility. A shallow aboveground tank may be used or a pumping system with discharge to a waste tank may be installed.

In certain cases such an elaborate decontamination pad is not possible. In such cases, a plastic lined pad with a collection system may serve as an adequate decontamination area. Alternately, a lined sloped pad with a collection pump installed at the lower end may be permissible. The location of the steam cleaning area shall be onsite in order to minimize potential impacts at certain sites.

3.3 GROUND WATER SAMPLING EQUIPMENT

When aquiring environmental samples from monitoring wells at NSWC Crane, several types of sampling devices may be employed. The type of sampling equipment used, depending on well depth, water level, and/or cost will be a peristaltic pump, bladder pump, or bailer (stainless steel or Teflon).

3.3.1 Sampling Equipment

Before the initial sampling and after each successive sampling point, sampling equipment (augers, split spoons, bowls, soup spoons, bailers, etc.) must be decontaminated. The following steps are to be performed when sampling for organic and inorganic contaminants:

- Potable water rinse
- Liquinox detergent wash-Includes scrubbing of the equipment with a scrub brush (may be required if the sample point is heavily soiled with heavy or extremely viscous materials)
- Potable water rinse
- Deionized water rinse
- Pesticide-grade isopropanol (only when oily soil conditions are encountered)
- Copious Deionized water rinse
- Air dry

Only reagent grade or purer solvents are to be used for decontamination. When solvents are used, the sampling equipment must be thoroughly dry before using to acquire the next sample.

In general, specially purchased pre-cleaned disposable sampling equipment is not decontaminated (nor is an equipment rinsate blank collected) so long as the supplier has provided certification of cleanliness. If decontamination is performed on several pieces of equipment at once (i.e., in batches), equipment not immediately used may be completely wrapped in aluminum foil (shiny-side toward equipment) and stored for future use. When batch decontamination is performed, one equipment rinsate is generally collected from one of the pieces of equipment belonging to the batch before it is used for sampling.

3.3.2 Sampling Pumps

Sampling pumps are low volume (less than 0.5 gpm) pumps. These include peristaltic and bladder pumps. If these pumps are used for sampling from more than one sampling point, they must be decontaminated prior to initial use and after each use.

The following procedures shall be adhered to when decontaminating sampling pumps:

Bladder pumps- Each of the liquid factions are to be pumped through the system. The amount of pumping is dependent upon the size of the pump and the length of the intake and discharge tubing.

Peristaltic pumps- All contamination is confined to the tubing, therefore the tubing is discarded and replaced with new tubing.

3.4 OTHER SAMPLING EQUIPMENT

Field tools such as trowels and mixing bowls are to be decontaminated in the same manner as described in Section 3.3.1 of this SOP.

3.5 WATER LEVEL INDICATORS

Water level indicators that come into contact with groundwater must be decontaminated using the following steps:

Rinse with potable water
Rinse with deionized water

3.6 PROBES

Probes (e.g., pH or specific-ion electrodes, geophysical probes, or thermometers) which would come in direct contact with the sample, will be decontaminated using the procedures specified above unless

manufacturer's instructions indicate otherwise (e.g., dissolved oxygen probes). Probes that contact a volume of groundwater not used for laboratory analyses can be rinsed with deionized water. For probes which make no direct contact, (e.g., OVA equipment) the probe is self-cleaning when exposure to uncontaminated air is allowed and the housing can be wiped clean with paper-towels or a cloth wetted with alcohol.

4.0 WASTE HANDLING

For the purposes of these procedures, contaminated materials are defined as any byproducts of field activities that are suspected or known to be contaminated with hazardous substances. These byproducts include such materials as decontamination solutions, purge water, soil cuttings, well-development fluids, and spill-contaminated materials. All of the above wastes will be handled following the procedures outlined in section 2.12 of the FSP.

As a general policy, it is wise to select investigation methods that minimize the generation of contaminated spoils and investigation derived wastes. Handling, decontaminating and disposing of potentially hazardous spoils and wastes can be dangerous and expensive. Until sample analysis is complete, it is assumed that all produced materials are suspected of contamination from hazardous chemicals and require containment.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-10

SAMPLE IDENTIFICATION NOMENCLATURE

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management at the Naval Surface Warfare Center Crane (NSWC). The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by site, location or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of identification and direct link to site and year

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Pen with indelible ink
Sample tags
Sample container labels

3.0 SAMPLE IDENTIFICATION NOMENCLATURE

3.1 Monitoring Samples

All monitoring samples collected at NSWC Crane will be properly labeled with a sample label affixed to the sample container and a tag tied around the neck of the container. Each sample will be assigned a unique sample tracking number. The sample tracking number will consist of a four or five segment alphanumeric code that identifies the sample's associated solid waste management unit (SWMU) or associated site, sample type, location, and, for aqueous samples where applicable whether a sample is filtered and/or the

sample round number. For soil and sediment samples the final four tracking numbers will identify the depth at which the sample was collected.

The alphanumeric coding to be used in the NSWC Crane sample system is explained in the diagram and the subsequent definitions:

NN	AA	A or N 2 to 5 characters	NN and/or A Aqueous only	NNNN Soils and Sediment Only
SWMU or Site Number	Sample Type	Location	Round Identifier and/or filtered	Depth Interval

Character Type:

A = Alpha

N = Numeric

SWMU or Site Number:

02 = Dye Burial Grounds (SWMU 2)

Sample Type:

GW = Ground water sample

SD = Sediment sample

SW = Surface water sample

SB = Soil boring sample

SS = Surface soil sample

Field sampling operations for the above SWMU is currently in progress as is expected to take place. For future SWMUs or site numbers refer to the appropriate planning documents for the proper numbers.

Location:

The sample location code is the well number, the soil sample location sediment sample location, or the stream sample location (i.e., surface water, springs, or seeps. Existing well numbers are used when unique. New wells will be designated by a "T" for Tetra Tech NUS and, followed by a MW for permanent monitoring wells, TW for temporary wells, etc. and numbered sequentially, by SWMU, beginning with zero one (MWT01). Well clusters, two or more wells in close proximity, will be designated with the letter P followed by the number 2, 3, 4 etc. The number signifies the well's depth in relation to other wells in that cluster. This two-digit code will follow the well identification. Using well T02 as an example, of a three well cluster, the well identification will be as follows:

T02	=	The deepest well in the cluster.
T02P2	=	Intermediate well.
T02P3	=	Shallowest well in the cluster.

Note: To keep the sample identification nomenclature to a minimum numbers of characters and to avoid redundancy, MW (monitoring well) is used for text, figures and tables and replaced with GW (groundwater) in the sample identification, example MWT01 would be GWT01.

Round Identifier:

A two digit round identifier will be used to tract the number of aqueous samples (GW, SW) taken from a particular aqueous sample location. The first sample collected from a location will be assigned round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Filtered:

Water samples that are field filtered (dissolved analysis) will be identified with an "F" in the last code section. No entry in this segment signifies an unfiltered (total) sample.

Depth Interval, Soil and Sediment only:

The depth code is used to note the depth, below ground surface (bgs), at which a soil or sediment sample is collected. The first two numbers of the four number code specify the top interval and the third and fourth specify the bottom, feet bgs (soil) inches bgs (sediment) of the sample. The depths will be noted in whole numbers only, further detail if needed will be recorded on the sample log sheet, boring log, log book, etc.

Depth (for soils, in feet bgs):

0002 = soil collected from 0 to 2 foot bgs

0204 = soil collected from 2 to 4 feet bgs

0810 = soil collected from 8 to 10 feet bgs, etc.

Depth (for sediments, in inches bgs):

0006 = sediment collected from 0 to 6 inches bgs

0612 = sediment collected from 6 to 12 inches bgs

3.1.1 Examples of Sample Nomenclature

The ground water sample collected from existing monitoring well 02-01 at the Dye Burial Grounds for a filtered sample would be designated as 02GW01 F.

The ground water sample collected from existing monitoring well 02C20P2 for an unfiltered sample would be designated as 02GWC20P2.

The unfiltered ground water samples collected from a new monitoring well 02T01 at the Dye Burial Grounds would be designated as 02GWT01.

A surface water sample collected from drainage way point 01 at the Dye Burial Grounds for an unfiltered sample would be designated as 02SW01.

A surface soil sample collected from soil boring 01 in the Dye Burial Grounds at the 0-2 foot interval would be designated 02SS010002.

A subsurface soil sample from the same boring 01 at an interval of 4-5 feet bgs would be designated as 02SB010405.

A sediment sample collected from drainage way location 01 at an interval of 0 to 6" would be designated as 02SD010006.

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

Field QA/QC samples are described in the approved Field Sampling Plan and QAPP. They will be designated using a different coding system. The QC code will consist of a three- to four-segment alphanumeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

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

The QC types are identified as:

TB = Trip Blank

RB = Rinsate Blank (Equipment Blank)

FD = Field Duplicate

AB = Ambient Conditions Blank

SB = Source Water Blank

The sampling time recorded on the chain-of-custody form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

3.2.2 Examples of Field QA/QC Nomenclature

The first duplicate of the day for a filtered ground water sample collected on June 3, 2001, would be designated as FD06030101F.

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

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-11

SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for sample custody and documentation of field sampling and field analyses activities at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 FIELD FORMS LIST

The following logbooks, forms, labels, and tags are required.

Site Logbook
Field Logbook
Sample labels and tags
Chain-of-Custody
Custody seal
Boring Log
Monitoring Well Inspection Sheet
Water Level Measurement Sheet
Low Flow Purge Data Sheet
Ground Water Sample Log Form
Surface Water Sample Log Sheet
Equipment Calibration Log
Soil and Sediment Sample Log Sheet

3.0 PROCEDURES

This section describes custody and documentation procedures. All entries made into the logbooks, custody documents, logs, and log sheets described in this SOP must be made in indelible ink (black is

preferred). No erasures are permitted. If an incorrect entry is made, the entry will be crossed out with a single strike mark, initialed, and dated.

3.1 Site Logbook

The Site Logbook is a hardbound, paginated, controlled-distribution record book in which all major on-site activities are documented. At a minimum, the following activities/events will be recorded (daily) in the Site Logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day
- Sample pickup information
- Health and safety issues
- Weather conditions

The Site Logbook is initiated at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each Site Logbook:

- Project name
- Project number
- Book number
- Start date
- End date

Information recorded daily in the Site Logbook need not be duplicated in other field notebooks, but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). At the completion of each day's entries, the Site Logbook must be signed and dated by the Field Operations Leader.

Upon completion of the fieldwork or when completely filled, the Site Logbook is stored in the NSWC Crane records repository.

3.2 Field Log Books

The Field Logbook is a separate dedicated notebook used by field personnel, as needed, to document the activities in the field. This notebook is hardbound and paginated.

Upon completion of the fieldwork or when completely filled, Field Logbooks are stored in the NSWC Crane records repository.

3.3 Sample Label and Tag

Adhesive sample container labels must be completed and applied to every sample container. A second, identical adhesive sample label will be completed and affixed onto a tag that will be attached to the neck of the sample container. Once the laboratory receives the sample, the tag will be removed from the sample container and returned to the Task Order Manager. Sample tags will be stored in the NSWC Crane records repository.

3.4 Chain-of-Custody Form

The Chain-of-Custody (COC) is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. Each COC form is numbered. This form must be used for any samples collected for laboratory chemical analysis. The original (top) signed copy of the COC form will be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. Once the samples are received at the laboratory, the sample custodian checks the contents of the cooler against the enclosed COC. Any problems are noted on the enclosed COC form (discrepancies between the sample labels, tags, COC form, etc.) and will be resolved through communication between the laboratory point-of-contact and the task manager. The COC form is signed and retained by the laboratory and becomes part of the sample's corresponding analytical data package.

Each COC form is placed into a binder and stored in the NSWC Crane records repository. Attachment A of the FSP contains an example COC form.

3.5 Custody Seal

The Custody Seal is an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. The Custody Seals are signed and dated by the samplers and affixed across the

opening edges of each cooler (four seals per medium to larger coolers; two seals per smaller cooler) containing environmental samples. The laboratory sample custodian will examine the Custody Seal for evidence of tampering and will notify the task manager if evidence of tampering is observed.

3.6 Equipment Calibration Log

The Equipment Calibration Log is used to document calibration of measuring equipment (e.g., multi-parameter water quality meter) used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

Each Equipment Calibration Log is placed into a binder and stored in the NSWC Crane records repository. Attachment A contains an example Equipment Calibration Log sheet.

A preprinted, fill-in the blank type, field form will be used to document each field task (e.g., drilling, surface water sampling, sediment sampling). Examples of all field forms can be found in Attachment A.

3.7 Monitoring Well Inspection Form

The Monitoring Well Inspection Form is used to document the inspection of existing monitoring wells in accordance with CTO 10 SOP 2-1.

3.8 Water-Level Measurement Form

The Water Level Measurement Form is used to document the determination of water levels in monitoring wells in accordance with CTO 10 SOP 2-2.

3.9 Low-Flow Purge Data sheet

The Low-Flow Purge Data Sheet is used to document field measurements made while purging wells to stabilization in accordance with CTO 10 SOP 2-3.

3.10 Ground Water Sample Log Sheet

The Ground Water Sample Log Sheet is used to document the samples taken from a monitoring well at the end of low-flow well purging. This sheet is used in conjunction with CTO 10 SOP 2-4.

3.11 Surface Water Sample Log Sheet

The Surface Water Sample Log Sheet is used to document the samples collected from surface waters. This sheet is used in conjunction with CTO 10 SOP 2-5.

3.12 Boring Log

The Boring Log is used to document lithology encountered during advancement of the boring. This sheet is used in conjunction with the borehole advancement procedures outlined in CTO 10 SOP 2-8 and the lithologic documentation process outlined in CTO 10 SOP 2-14. Attachment A of the FSP contains an example Boring Log sheet.

3.13 Soil Sample Log Sheet

The Soil and Sediment Sample Log Sheet is used to document the samples taken from each boring. Attachment A contains an example Soil and Sediment Sample Log Sheet.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-12

SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for sample preservation, packaging, and shipping to be used in handling environmental samples obtained for chemical analysis at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Shipping labels
Custody seals
Chain-of-custody (COC) forms
Sample containers with preservatives: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory.
Sample shipping containers (coolers): All sample shipping containers are supplied by the laboratory.
Packaging material: Bubble wrap, ZipLoc® bags, strapping tape, etc.
Temperature Blank

3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

3.1 Tables 2-1 and 2-2 of this Field Sampling Plan (FSP) establish requirements for sample preservation. The laboratory provides sample containers that are certified clean for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped at 4°C ±2°C. This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

3.2 The sampler will maintain custody of the samples until the samples are relinquished to another custodian or to the common carrier.

3.3 Check that the sample container is properly identified on the label and tag, the lid securely fastened, and the container sealed in a ZipLoc® bag.

3.4 Place the sample container into a bubble wrap shipping bag and seal the bag using the self-sealing, pressure-sensitive tape supplied with the bag.

3.5 Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut. If the cooler is questionable for shipping, the cooler must be discarded.

3.6 Place the sample container into a shipping cooler in an upright position (all containers will be upright for shipment). Continue filling the cooler with samples and packing material until the cooler is full and the movement of the sample containers is limited.

3.7 Place a temperature blank in the cooler.

3.8 Fill the voids in between the bubble wrap shipping bags with ice and continue filling the cooler with ice to the top, using a minimum of eight pounds of ice for a medium-size cooler.

3.9 Complete a COC form. List on the COC form each sample bottle contained in the cooler. Include the air bill number on the COC form. Use a ballpoint pen and make sure that all of the carbon forms are legible.

3.10 Place the original (top) signed copy of the COC form inside a large ZipLoc® bag. Tape the bag to the inside of the lid of the shipping cooler.

3.11 Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (a total of four signed custody seals must be used per cooler). Cover the custody seal with the last wrap of tape. This will provide a tamper-evident custody seal system for the sample shipment.

3.12 Affix a shipping label to the top of the cooler containing all of the shipping information. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments. Include the air bill number on the COC.

3.13 All samples will be shipped to the laboratory no more than 72 hours after completion of sampling. Under no circumstances will sample holding times be exceeded for hold times (see Tables 2-1 and 2-2 of this FSP).

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-13

USE OF PHOTOIONIZATION DETECTOR

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for the use, maintenance, and calibration of the photoionization detector (PID) at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds. The Photovac 2020 Photoionization Air Monitor will be used for the risk assessment investigation. The procedures for its use are discussed in detail in the following sections.

The Naval Surface Warfare Center (NSWC) Environmental Protection Department must approve any deviations from this procedure.

2.0 GLOSSARY

Electron volt (eV) - A unit of energy equal to the energy acquired by an electron when it passes through a potential difference of 1 volt in a vacuum. It is equal to $1.602192 \pm 0.000007 \times 10^{-19}$ volts.

Intrinsically Safe (I.S.) - Based on wiring, configuration, design, operation, gasketing, and construction, this instrument may be employed within locations in which flammable gases and/or vapors may exist.

Ionization Potential (I.P.) - The energy required to remove an electron from a molecule yielding a positively charged ion and a negatively charged free electron. The instrument measures this energy level.

Photoionization Detector (PID) - PID employed as general reference to air monitors of this type. The PID detection method employs ultraviolet (UV) radiation as an energy source. As air and contaminants are drawn through the ionization chamber, the UV light source causes the contaminant with ionization potentials equal to or less than the UV source to break into positive and negatively charged ions. The created ions are subjected to an electrostatic field. The voltage difference is measured in proportion to the calibration reference and the concentration of the contaminant.

UV Radiation - UV is the energy source employed by the instrument to ionize collected sample gas streams. The UV lamp source is required to be equal to or greater than the ionization potential of the substance drawn through the instrument to create separate ionized species.

3.0 REQUIRED EQUIPMENT

Pen
Equipment Calibration Log
Photoionization Detector
Calibration Gas (usually isobutylene/air mixture)

4.0 PROCEDURES

4.1 Principle of Operation

The Photovac portable photoionizer detects the concentration of many organic compounds (and a few inorganic compounds). The basis for detection of this instrument is the ionization of components of captured gaseous streams. The incoming gas molecules are subjected to UV radiation, which is energetic enough to ionize many gaseous compounds. Molecules are transformed into charged-ion pairs, creating a current between two electrodes. Each molecule has a characteristic ionization potential, which is the energy required to remove an electron from the molecule, yielding a positively charged ion and the free electron. The instrument measures this energy level.

This instrument measures the concentration of airborne photoionizable gases and vapors and automatically displays and records these concentrations. It does not distinguish between individual substances. Readings displayed represent the total concentration of all photoionizable chemicals present in the sample. This instrument is factory set to display concentration in units of ppm or mg/m^3. The meter display updates itself once per second.

The Photovac 2020 also performs short-term exposure limit (STEL), time-weighted average (TWA) and PEAK calculations. Any of these results can be viewed, but only one mode may be viewed at a time.

The Photovac 2020 has six keys for alphanumeric entry and for accessing multiple functions. The keys are used to set up and calibrate the 2020. This allows the concentration data to be manipulated in various ways.

All information entered with the keys and stored in the 2020's memory is retained when the instrument is switched off. The clock and calendar continue to operate and do not need to be set each time the 2020 is turned on.

4.1.1 Displays

The 2020 has a meter display for reporting detected concentration and a display used to display status information and guide one through configuration options. All functions of the 2020 will be controlled or reported using one of these displays.

4.1.1.1 Meter Display

The meter display is a 4-digit display. It will always be used for reporting detected concentration. When the detector and pump are off, the meter display will be blank.

To accommodate the range of concentrations that the 2020 can detect, the meter reading will be reported using one of two resolutions. A resolution of 0.1 will be used for concentrations below 100 ppm, and a resolution of 1 will be used for concentrations above 100 ppm.

4.1.1.2 Status Display

The status display is a 2-line by 16-character display. The top line is used to display status information and to prompt for information. The bottom line is used for soft key names. Up to three names can be displayed for the three soft keys. If a name does not appear for a soft key, then the soft key has no associated function.

4.1.2 Keys

4.1.2.1 Fixed Keys

The three round keys below the soft keys each have a fixed function. The first key is the ON/OFF key, the middle key is the EXIT key, and the last key is the ENTER key.

The ON/OFF key is used both to turn power on to the 2020 as well as to turn the power off. To turn on the 2020, press the ON/OFF key. To turn the power off, press the ON/OFF key and hold it down for 2 seconds, and then release it. This is done to prevent accidental power off.

The EXIT key provides a way of returning to the default display. In the functional map, the soft keys allow you to advance and the EXIT key provides a way to go back. If you are at the initial entry of the menu, EXIT will return you to the default display.

The ENTER key has a context sensitive function. When operating or navigating through the function map, the ENTER key is used to exit the functions and return to the default display. When entering data such as a name, number, date, or time, ENTER is used to confirm the entry.

4.1.2.2 Soft Keys

The three soft keys on the 2020 are located directly below the status display. Each key has varying functions for configuring the 2020, editing the data logger, and controlling the display. Since only three soft keys are available, each function is broken down into a path.

4.1.2.3 Entering Text With the Soft Keys

For all information that must be entered, the left, center, and right soft keys correspond to the up, down, and right arrow.

The up and down arrows are used to change the character highlighted by the cursor. The right arrow is used to advance the cursor to the next character on the right. When the cursor is advanced past the right-most character, it wraps around to the first character again. To accept the changes, press the ENTER key. To ignore the change, press EXIT.

Formatting characters, such as the colon (:) in the time, the decimal (.) in a concentration, and the slash (/) in the date are skipped when advancing the cursor.

All inputs are an eight-character input, which is displayed on the right side of the top line of the status display. The prompt, describing the input, occupies the left half of the top line. The soft keys are defined on the bottom line of the status display.

4.2 Default Display

The meter display shows the detected concentration. The resolution of the display changes with the magnitude of the reading. A reading of 0 to 99.9 will be displayed with a resolution of 0.1 ppm or mg/m^3. A reading greater than 99.9 will be shown with a resolution of 1 ppm or mg/m^3. The meter will display concentrations up to 2000 ppm or 2000 mg/m^3.

The status display is used to display the instrument status, date, time, units, and active soft keys.

The default display provides the following information: instrument status, current detected concentration, time, date, and measurement units. The status display toggles between showing time and units and then the date.

When the display mode is MAX, the date and time correspond to the date and time the MAX concentration was recorded. In TWA mode, the time represents the number of hours and minutes during which the TWA has been accumulating. For PEAK and STEL monitoring, the date and time correspond to the current date and time.

4.3 Monitoring

4.3.1 Instrument Status

The instrument status is shown on the left of the first line of the status display and on the Table and Graph outputs. Each status has a priority assigned to it. If more than one status is in effect, then the status with the highest priority is displayed until the condition is corrected or until the option is turned off.

4.3.2 Alarms

While operating the instrument, any one of three alarm conditions can occur. To accurately identify the source of the alarm, each type of alarm has been given a unique status.

In addition to the status, the 2020 also has an audible alarm and a visual alarm LED. To conserve power, the 2020 alternates between these two alarm indicators, rather than operating both concurrently. Different alarms are identified by the frequency at which the 2020 alternates as follows: PEAK alarm-5 times per second; STEL alarm-2.5 times per second; and TWA alarm-1.25 times per second.

The left soft key is used for acknowledging alarms and is named "Ack." If no alarm exists, then the "Ack" key is not shown. To clear the alarm, press the "Ack" key. Once acknowledged, the alarm indicators are cleared. The alarm status will remain until the alarm condition clears.

The 2020 updates the peak concentration once every second. Following every update, the peak concentration is compared to the peak alarm level and, if exceeded, an alarm is triggered.

If 15-minute average exceeds the selected STEL, a STEL alarm is generated.

The TWA alarm is generated when the current average of concentration, since the TWA was last cleared, has exceeded the TWA exposure limit.

During calibration, all alarms are disabled. Once the calibration is complete, the alarms are re-enabled.

4.4 STEL, TWA, MAX, and PEAK Operation

The 2020's meter display can be configured to show one of four values: STEL, TWA, MAX, or PEAK.

4.4.1 Short-term Exposure Limit (STEL) Mode

The STEL mode displays the concentration as a 15-minute moving average. The 2020 maintains 15 samples, each representing a 1-minute averaging interval.

Once every minute, the oldest of the 15 samples is replaced with a new 1- minute average. This moving average provides a 15-minute average of the last 15 minutes with a 1-minute update rate. Since the average is calculated using 15 one-minute averages, the meter display will only update once every minute.

STEL is set to zero each time the instrument is turned on. Since STEL is a 15-minute moving average, there is no need to clear or reset the STEL.

STEL calculations are always being performed by the 2020. Display the results of the calculations by selecting STEL as the Display mode.

4.4.2 Time-weighted Average (TWA) Mode

The TWA accumulator sums concentrations every second until 8 hours of data have been combined. If this value exceeds the TWA alarm setting, a TWA alarm is generated. The TWA is not calculated using a moving average. Once 8 hours of data have been summed, the accumulation stops. To reset the TWA accumulator, press the "Clr" key.

This sum will only be complete after 8 hours, so the meter displays the current sum divided by 8 hours. While you are in TWA mode, the time on the status display will show the number of minutes and hours of

data that TWA has accumulated. When this reaches 8 hours, the 2020 stops accumulating data and the TWA is complete.

TWA calculations are always being performed by the 2020. Display the results of the calculations by selecting TWA as the Display mode.

4.4.3 MAX Mode

The MAX mode displays the maximum signal, with the date and time that it was recorded. The 2020 continues to log data according to the selected averaging interval, but only the maximum detected concentration is displayed on the meter display.

The right soft key is used to clear the meter when displaying MAX. The "Clr" key only affects the reading that the meter is displaying for example, if the MAX reading is displayed and "Clr" is pressed, only the MAX value is cleared. The TWA is still accumulating in the background.

4.4.4 PEAK Mode

The PEAK mode displays the current detected concentration. The reading is updated once a second. In the background, the 2020 data logger is sampling the concentration and measuring minimum, maximum, and average concentrations for the selected averaging interval. At the end of every interval, one entry is placed in the data logger until the data logger is full. Typical application concerning the use of this instrument is operated in this mode. Operation within the other specialized modes are the responsibility of the Site Safety Officer.

4.5 Set Functions

Set functions are used to set up the 2020. Three functions that can be set on the 2020 are Pump, Clock, and Calibration.

4.5.1 Pump

The Pump function is used to control the pump. After selecting Set Pump, the 2020 responds by displaying the new pump status.

The detector is also turned off when the pump is turned off. This prevents the detector from being damaged when there is no sample flowing through the detector.

When the pump and the detector are off, the meter display will be blank. Turn the pump and detector off when concentration measurements are not necessary, and the 2020 will only be used for reviewing data or generating reports. By operating the instrument with the pump and detector off when not needed, the lives of the battery and UV lamp will be conserved.

1. Press the ENTER key. The top line of the status display changes to "Select?". The bottom line displays three soft key names: "Set," "Log," and "Disp."

2. Press the soft key below "Set."

3. The names of the soft keys change to reflect the Set options. The display now shows three devices which can be set: "Clock," "Pump," and "Cal." Press the "Pump" key.

4. The 2020 turns the pump off. If the pump was off, pressing "Pump" will turn the pump on.

5. A message will be displayed to show the status of the pump. The 2020 reverts back to the previous menu after a few seconds.

6. To return to the default display, press the ENTER key.

4.5.2 Clock

The Clock function is used to set both the current date and time.

1. Press the ENTER key.

2. Press the "Set" key.

3. When the names of the soft keys change, press the "Clock" key.
   The up and down arrows are used to change the character underlined by the cursor. The right arrow is used to advance the cursor to the next character on the right. When the cursor is advanced past the right-most character, it wraps around to the first character again.
   Formatting characters, such as the colon (:) in the time and the slash (/) in the date are skipped when advancing the cursor.

4. Use the "arrow keys" to enter the correct time. The time is formatted as Hour:Minute:Second.

5. Press the ENTER key to confirm the time and move to the date option.

6. When setting the date, the 2020 prompts for the current date formatted as Year/Month/Day. Use the "arrow keys" to enter the correct date.

7. Press the ENTER key to confirm the date and return to the Set options. Wait for the display to timeout or press ENTER to return to the default display.

4.5.3 Calibration (Cal)

Cal allows one to set up and calibrate the 2020. There are three options under the Cal function: "Zero," Span," and "Mem."

A calibration memory consists of a name, a response factor, and PEAK, TWA, and STEL alarm levels.

The "Zero" and "Span" keys are covered in detail in the manufacturer's operations manual for the instrument.

To edit the calibration memory, select "Mem" and then "Chng." The 2020 prompts with two new soft keys: "User" and "Lib."

4.5.4 Library (Lib)

Library selections simplify Cal Memory programming and provide standard response factors for approximately 70 applications. "Lib" allows one to select an entry from a pre-programmed library. The name, response factor, and three alarm levels are all set from the library. To select a library entry to program the selected Cal Memory:

1. Select "Set," "Cal," "Mem," "Chng," and "Lib."

2. Use the "Next" and "Prev" keys to scroll through the list. See the manufacturer's manual Appendix 8.7 for a list of the library entries.

4.6 <u>Preparing for Field Operation of the Photovac 2020</u>

Turning the 2020 On

1. Turn the 2020 on by pressing the ON/OFF key.

2. The 2020 will display the software version number. Wait for the 2020 to proceed to the default display.

3. Allow 10 minutes for the instrument to warm up and stabilize.

4. Press the Enter Key. The default display will provide three soft key selections: "Set," "Log," and "Display."

5. Press "Set." From this option three other soft key selections will be offered: "Pump," "Clock," and "Cal."

6. Press "Cal." This will begin the calibration sequence. The first selection is to Zero the instrument.

7. Press Enter, zeroing will begin. (Note: When employing zero gas attach and activate zero gas supply at this time.)

8. The next selection offered will be Span. Press Enter, then the concentration will be requested. The isobutylene calibration gas employed under general service will be marked on the side of the container. Use the soft keys to toggle into position and to log the concentration. Once the concentration is logged, press "Enter." The direction or status display will indicate spanning. Hook up the span gas with a regulator to the Photovac 2020, and open it to supply enough flow to elevate the flow rate indicator to the green indicator line (1/8 inch from the rest position).

9. Once spanning is complete, the alarms which have been disabled during calibration will activate, indicating that calibration is complete.

10. Document this calibration procedure using an Equipment Calibration Log (included in Attachment A in the FSP).

This instrument is ready for general purpose application.

Calibration is to be performed daily or prior to each use in accordance with this section.

4.7 Maintenance and Calibration Schedule

Function	Frequency
Routine calibration	Prior to each use
Factory inspection and calibration	Once a year, or when malfunctioning
Wipe down the outer casing of the unit	After each use
Clean UV light source	Every 24 hours of operation
Sample inlet filter	Change on a weekly basis or as required by level of use
Battery charging	After each use
Clean ionization chamber	Monthly

4.7.1 Cleaning the UV Light Source Window

1. Turn the FUNCTION switch to the OFF position. Use the 2020 multi-tool and remove lamp housing cover.

2. Tilt the lamp housing with one hand over the opening, and slide the lamp out of the housing.

3. The lamp window may now be cleaned with any of the following compounds using lens paper:
   a. 11.7 eV Lamp - Dry Aluminum Oxide Powder (3.0 micron powder)
   b. High Performance Liquid Chromatography Grade Methanol - All other lamps

4. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Replace O-ring as necessary, reinstall lamp housing cover, and tighten using the 2020 multi-tool. (Do not over tighten).

5. Recalibrate in accordance with Section 4.6.

4.7.2 Cleaning the Ionization Chamber

1. Turn the FUNCTION switch to the OFF position and remove the lamp housing cover and lamp in accordance with Section 4.7.1.

2. Using a gentle jet of compressed air, gently blow out any dust or dirt.

3. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Replace O-ring as necessary, reinstall lamp housing cover, and tighten using the 2020 multi-tool. (Do not over tighten).

4. Recalibrate in accordance with Section 4.6.

4.8 Instrument Advantages

The Photovac 2020 is easy to use in comparison to many other types of monitoring instrumentation. Its detection limit range is in the low parts-per-million range. Response time rapidly reaches 90 percent scale of the indicated concentration (less than 3 seconds for benzene). This instrument's automated performance covers multiple monitoring functions simultaneously, incorporating data logging capabilities.

4.9 Limitations of the Photovac 2020 Photoionization Monitor

- Since the 2020 is a nonspecific total gas/vapor detector, it cannot be used to identify unknown chemicals; it can only quantitate them in relationship to a calibration standard (relative response ratio).

- For appropriate application of the 2020, ionization potentials of suspected contaminants must be known.

- Because the types of compounds that the 2020 can potentially detect are only a fraction of the chemicals possibly present at a hazardous waste site or incident, a background or zero reading on this instrument does not necessarily signify the absence of air contaminants.

- The 2020 instrument can monitor only certain vapors and gases in air. Many nonvolatile liquids, toxic solids, particulates, and other toxic gases and vapors cannot be detected.

- PIDs are generally not specific. Their response to different compounds is relative to the calibration gas used. This is referred to as relative response ratio. Instrument readings may be higher or lower than the true concentration. This can be an especially serious problem when monitoring for total contaminant concentrations if several different compounds are being detected at once.

- The 2020 is a small, portable instrument which cannot be expected to yield results as accurately as laboratory instruments.

4.9.1 Variables Affecting Monitoring Data

Monitoring a hazardous waste site environment can pose a significant challenge in assessing airborne concentrations and the potential threats to site personnel. Several variables may influence both dispersion and the instrument's ability to detect actual concentrations. Some of the variables which may impact these conditions are as follows:

- Temperature - changes in temperature or pressure will influence volatilization and affect airborne concentrations. Additionally, an increase or decrease in temperature ranges may have an adverse effect on the instrument's ability to detect airborne concentrations.

- Humidity - excessive levels of humidity may interfere with the accuracy of monitoring results.

- Rainfall - through increased barometric pressure and water may influence dispersion pathways affecting airborne emissions.

- Electromagnetic interference - high voltage sources, generators, and other electrical equipment may interfere with the operation and accuracy of direct-reading monitoring instruments.

5.0 SHIPPING

The Photovac 2020 may be shipped as cargo or carried on as luggage providing there is no calibration gas cylinder accompanying the kit. When shipping or transporting the calibration gas, a Hazardous Airbill must be completed.

6.0 REFERENCES

Photovac 2020 Photoionization Monitor User's Manual, 1995.

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-14

BOREHOLE AND SOIL SAMPLE LOGGING

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the standard procedure and technical guidance on borehole and sample logging at Solid Waste Management Unit (SWMU) 2 - Dye Burial Grounds.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 FIELD FORMS AND EQUIPMENT

Knife
Ruler (marked in tenths and hundredths of feet)
Boring Log
Writing utensil
Munsell Soil Color Book

3.0 RESPONSIBILITIES

A field geologist/engineer is responsible for supervising all boring activities and assuring that each borehole is properly and completely logged.

4.0 PROCEDURES FOR BOREHOLE AND SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 <u>USCS Classification</u>

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Table 1.

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TABLE 1

FIELD IDENTIFICATION SYSTEM FOR SOIL SEPARATES

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

FIELD IDENTIFICATION PROCEDURES

(Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights

COARSE-GRAINED SOILS More Than Half of Material is LARGER Than No. 200 Sieve Size			GROUP SYMBOL	TYPICAL NAMES
GRAVELS (50%(+)>1/4"Ø	CLEAN GRAVELS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
	GRAVELS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
SANDS 50%(+)<1/4"Ø	CLEAN SANDS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see MCL)	SM	Silty sands, poorly graded sand-silt mixtures.
		Plastic fines (for identification procedures, see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.

FINE-GRAINED SOILS More Than Half of Material is SMALLER Than No. 200 Sieve Size	FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)				GROUP SYMBOL	TYPICAL NAMES
	Identification Procedures on Fraction Smaller than No. 40 Sieve Size					
		DAY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)		
SILTS AND CLAYS Liquid Limit <50	None to Slight	Quick to Slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
	Medium to High	None to Very Slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	Slight to Medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
SILTS AND CLAYS Liquid Limit >50	Slight to Medium	Slow to None	Slight to Medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
	High to Very High	None	High		CH	Inorganic clays of high plasticity, fat clays.
	Medium to High	None to Very Slow	Slight to Medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example, GW-GC, well graded gravel-sand mixture with clay binder.

All sieve sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS	
DESIGNATION	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT
Very Loose	0-4
Loose	5-10
Medium Loose	11-30
Dense	31-50
Very Dense	Over 50

CONSISTENCY OF COHESIVE SOILS			
CONSISTENCY	UNC COMPRESSIVE STRENGTH (TONS/SQ. FT.)	STANDARD PENETRATION RESISTANCE-BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very Soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb.
Medium Stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb.
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Very Stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail.
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail.

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils shall be divided into rock fragments, sand, or gravel. The terms sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4 inch-1/2 inch)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

4.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Table 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Table 2.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Table 1).

TABLE 2

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample. The sample will be broken in half and the thumb pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. One of the other methods will be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in Table 2.

4.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., "sandy")	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil "wet" if rolling it in the hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

4.6 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features

4.7 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, the following table will be used.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Clay	CL	inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays,
	CH	inorganic clays of high plasticity, fat clays
	OH	organic clays of medium to high plasticity, organic silts
Silt	ML	inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
	OL	organic silts and organic silty clays of low plasticity
	MH	inorganic silts, micaceous or diatomaceous fine sand or silty soils
Sand	SW	well graded sands, gravelly sands, little or no fines
	SP	poorly graded sands, gravelly sands, little or no fines
	SM	silty sands, sand-silt mixtures
	SC	clayey sands, sand-clay mixtures

STANDARD OPERATING PROCEDURE

CTO 10 SOP 2-15

CALIBRATION, OPERATION, AND MAINTENANCE OF WATER QUALITY METER

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for the calibration, operation, and maintenance of the Water Quality Meter used to measure groundwater (purge and development) and surface water field parameters and for the documentation of that calibration and maintenance.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 FIELD FORMS AND EQUIPMENT LIST

The following logbooks, forms, equipment and supplies are required.

Site Logbook
Equipment Calibration Log sheet
YSI Model 610-D and Sonde, multi-parameter, water quality meter with flow-through cell
Equipment manual
Calibration kit
Deionized water, paper towels, spray bottle, etc.

3.0 PROCEDURES

This section describes the calibration procedure for the YSI Model 610-D and Sonde (YSI). The meter is supplied with an instruction manual. Sections of this manual are listed in this SOP. The manual will be on-site and used as the calibration guidance document for the meter's calibration (page 29, Section 2.6 starts the calibration procedure). This procedure will list requirements for frequency of calibration and checks to be performed on the meter.

The YSI Model 610-D and Sonde is a multi-parameter, water quality meter that may be used to measure open water bodies (streams, ponds, springs etc.) with the probe guard installed. With the flow-through

cell attached, the meter can measure ground water directly from the well, via the pump discharge line prior to coming in contact with the atmosphere. The parameters measured by the YSI for this field effort include:

- Dissolved oxygen
- Specific conductance
- Temperature
- pH
- Oxidation-reduction potential (ORP)
- Turbidity

3.1 Measurement Techniques for Field Determination of pH

The following procedure is used for measuring pH (meter standardization is according to manufacturer's instructions):

- Check batteries and inspect the instrument prior to initiation of the field effort.

- Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.

- If applicable, make sure all electrolyte solutions with the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).

- Following manufacturer's instructions for the YSI Model 610-D, calibrate on a daily use basis (or as recommended by manufacturer). Calibration procedures are duplicated in Section 5.0 of this procedure. Record all pertinent information on an Equipment Calibration Log sheet (see Attachment A of the FSP).

- Immerse the electrode(s) in the sample, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.

- Read and record the pH of the sample to the nearest 0.01 standard unit. Also record the sample temperature.

- Rinse the electrode(s) with deionized water.

- Store the electrode(s) in an appropriate manner when not in use.

3.2 Measurement Techniques for Specific Conductance

- Check batteries and inspect the instrument before going to the field.

- Calibrate on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions which are for the YSI Model 610-D are duplicated in Section 5.0 of this procedure. Record all pertinent information on an Equipment Calibration Log sheet located in Attachment A of the FSP. Potassium chloride solutions with a specific conductance closest to the values expected in the field will be used for calibration. Table 1 (at the end of this SOP) provides guidance in this regard.

- Rinse the cell with one or more portions of the sample to be tested or with deionized water.

- Immerse the electrode in the sample and measure the conductivity. Adjust the temperature setting to the sample temperature (if applicable).

- Read and record the results in a field logbook or sample log sheet.

- Rinse the electrode(s) with deionized water.

3.3 Measurement Techniques for Dissolved Oxygen Determination

- Check batteries and calibrate the equipment before going to the field.

- Condition the probe in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

- Calibrate the instrument in the field according to manufacturer's recommendations or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubilities as a function of temperature and salinity (Table 2 at end of this SOP).

- Record all pertinent information on an Equipment Calibration Log sheet located in Attachment A of the FSP.

- Rinse the probe with deionized water.

- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells can be moved up and down.

- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.

- Rinse the probe with deionized water.

- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Take special care during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

3.4 Measurement Techniques for Oxidation-Reduction Potential

- Check batteries and calibrate the equipment before going to the field.

- Check that the platinum probe is clean and that the platinum bond or tip is unoxidized. If dirty, polish with emery paper or, if necessary, clean the electrode using aqua regia, nitric acid, or chromic acid, in accordance with manufacturer's instructions.

- Thoroughly rinse the electrode with deionized water.

- Verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of the test solution is altered. The ORP will increase when the pH of the test solution decreases, and the ORP will decrease if the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added (i.e., pH is raised), thus indicating the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with

the manufacturer's instructions. If the ORP does not respond as above when the caustic is added, the electrodes will be cleaned and the above procedures repeated.

- After the assembly has been checked for sensitivity, wash the electrodes with three changes of water or by means of a flowing stream of deionized water from a wash bottle. Place the sample in a clean container and insert the electrodes. Set temperature compensator throughout the measurement period. Read the millivolt potential of the solution, allowing sufficient time for the system to stabilize and reach temperature equilibrium. Measure successive portions of the sample until readings on two successive portions differ by no more than 10 mV. A system that is very slow to stabilize properly will not yield a meaningful ORP. Record all results in a field logbook or sample log sheet, including ORP (to nearest 10 mV), sample temperature, and pH at the time of measurement.

3.5 Measurement Techniques for Turbidity

The steps involved in taking turbidity measurements are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instruments before going to the field.
- Check the expiration date of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer's instructions, and record all pertinent information on an Equipment Calibration Log sheet located in Attachment A of the FSP
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the probe in the sample and measure the turbidity. The reading must be taken immediately as suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.
- Read and record the results in a field logbook or sample log sheet. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.

4.0 DOCUMENTATION

Follow the procedure in CTO 10 SOP 2-11 for documentation of calibration. An example of an Equipment Calibration Log sheet can be found in Attachment A of the FSP.

5.0 CALIBRATION

All of the above parameters must be calibrated prior to the start of each field effort. After this initial calibration the YSI will be checked each day that it is used. If the check shows any out-of-spec readings, the parameters will be calibrated. Meter specifications can be found in the equipment manual, starting on page 248. Calibrations and checks will be documented in the site logbook and on the Equipment Calibration Log sheet. An example of this form can be found in Attachment A of the FSP. The name, lot number, and expiration date for all calibration, buffers, and standards used will be recorded on the Equipment Calibration Log sheet. The meter's model, serial number, and name of rental company will also be recorded on the Equipment Calibration Log sheet.

Tips for Good Calibration

- The dissolved oxygen calibration is a water-saturated air calibration. Make certain to loosen the calibration cup seal to allow pressure to equilibrate before calibrating.
- Make certain that sensors are completely submersed in solution and readings are stable when calibration values are entered.
- Use a small amount of calibration solution (previously used solution may be used, then discarded for this purpose) to pre-rinse the sonde.
- Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.
- Make sure to rinse and dry the probe between calibration solutions. This will reduce carry-over contamination and increase the accuracy of the calibration.

6.0 MAINTENANCE

The YSI will be rented for the duration of the brief field effort. Therefore, little field maintenance will be required. For any maintenance other than the routine, cleaning, calibrating, or battery charging, the YSI should be returned to the vender and a replacement sent to the job site.

Procedures for cleaning the probe during normal maintenance are:

- Rinse probe thoroughly with potable water.
- Wash in a mild solution of Liquinox and water, wiping with paper towels and/or cotton swabs.

- Rinse and soak in deionized water.
- If stronger cleaning is required, consult the equipment manual.

7.0 METER STORAGE

For this field effort, the meter storage will be short term (i.e., overnight or between work shifts, 4-day break). During these breaks the meter will be placed on charge. One-half inch of tap or distilled water will be placed in the meter's calibration cup and the cup threaded onto the sonde. The key for short-term storage of probes is to use a minimal amount of water so that the calibration cup will remain at 100 percent humidity. The water level has to be low enough so that none of the probes are actually immersed. Proper storage of the sonde between usage will extend its life and will also insure that the unit is ready for use as quickly as possible in the next application.

Multi-parameter short-term storage key points:

- Use enough water to provide humidity, but not enough to cover the probe surfaces.
- Make sure the storage vessel is sealed to minimize evaporation.
- Check periodically to make certain that water is still present.

Note: Reagents that are used to calibrate and check the YSI may be hazardous. Review Health and Safety Plan, Attachment A of the equipment manual, and Material Safety Data Sheets, all of which are on file in the field trailer.

TABLE 1

SPECIFIC CONDUCTANCE OF 1 MOLAR KCl AT VARIOUS TEMPERATURES[1]

Temperature (°C)	Specific Conductance (umhos/cm)
15	1,147
16	1,173
17	1,199
18	1,225
19	1,251
20	1,278
21	1,305
22	1,332
23	1,359
24	1,368
25	1,413
26	1,441
27	1,468
28	1,496
29	1,524
30	1,552

[1] Data derived from the International Critical Tables 1-3-8.

TABLE 2

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY
PAGE 1 OF 2

Temperature (°C)	Dissolved Oxygen (mg/L)					
	CHLORIDE CONCENTRATION IN WATER					Difference/ 100 mg Chloride
	0	5,000	10,000	15,000	20,000	
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.016
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008
25	8.4	8.0	7.6	7.2	6.7	0.008
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008

TABLE 2

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY PAGE 2 OF 2

Temperature (°C)	Dissolved Oxygen (mg/L)					
	CHLORIDE CONCENTRATION IN WATER					Difference/ 100 mg Chloride
30	7.6	7.3	6.9	6.5	6.1	0.008
	0	5,000	10,000	15,000	20,000	
31	7.5					
32	7.4					
33	7.3					
34	7.2					
35	7.1					
36	7.0					
37	6.9					
38	6.8					
39	6.7					
40	6.6					
41	6.5					
42	6.4					
43	6.3					
44	6.2					
45	6.1					
46	6.0					
47	5.9					
48	5.8					
49	5.7					
50	5.6					

NOTE: In a chloride solution, conductivity can be roughly related to chloride concentration (and therefore used to correct measured dissolved oxygen concentration) using Table 1.

STANDARD OPERATING PROCEDURE
CTO 10 SOP 2-16
FIELD TEST KIT ANALYSIS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for the field chemical analysis of parameters in ground water using field test kits. The following parameters are included in this SOP:

- Alkalinity
- Dissolved Carbon Dioxide
- Dissolved Oxygen
- Ferrous Iron
- Nitrite
- Nitrate
- Sulfide
- Hydrogen Sulfide

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Field Chemical Analytical Log Form: A copy of the Field Chemical Analytical Log Form can be found in Attachment 1 of this SOP.

Field analytical test kits, methods, and reagents: The following table presents the required analytical test kits to be used for field analysis. Specific reagents and bottle requirements are included in each procedure. Current copies of the procedures will be maintained on-site during the field program. They will be accessible during use of the Field Test Kits.

Parameter	Make	Model	Method Number	Equipment/ Method Chemistry
Alkalinity	CHEMetrics	K-9810 K-9815 K-9820	ASTM D 1067-92	CHEMets vacuum vials/HCL Titrant w/pH indicator
Carbon Dioxide	CHEMetrics	K-1910 K-1920 K-1925	ASTM D 513-82	CHEMets vacuum vials/Rhodazine D and Indigo Carmine Sodium Hydroxide w/pH indicator
Dissolved Oxygen	CHEMetrics	K-7501 K-7512	ASTM D 5543-94	CHEMets vacuum vials/Rhodazine D and Indigo Carmine
Ferrous Iron	HACH	DR-850	HACH 8146	Colorimeter / 1,10 Phenanthrolein
Nitrite	HACH	DR-850	HACH 8507 Mod EPA 354.1	Colorimeter / Diazotization
Nitrate	HACH	DR-850	HACH 8192 Mod EPA 353.2	Colorimeter / Cadmium Reduction
Sulfide	HACH	DR-850	HACH 8131 EPA 376.2	Colorimeter / Methylene Blue
Hydrogen Sulfide	HACH	HS-C	HACH Proprietary/ Mod. SM 426C	Color Chart/ Effervescence through Sulfide reactive paper

3.0 FIELD ANALYTICAL PROCEDURES

3.1 GENERAL

The procedures for each of the individual analyses will be maintained in the field during the entire sampling program. The procedures give a detailed explanation on how to perform each particular method, and include information on sampling/storage, accuracy checks, interference, reagents, and apparatus.

3.2 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Accuracy checks shall be performed to check the performance of the reagents, the apparatus, and the analytical procedure. These accuracy checks include standard solutions, field duplicates, and reagent blank correction. The field test kit procedures detail how to perform each of the accuracy checks for each parameter.

Prior to analysis, the expiration dates of reagents will be checked. If the reagents have exceeded their shelf life, the reagents will be replaced. If deviations from the applicable analytical procedure are identified, the deviations will be corrected and the associated samples re-analyzed. If no problems are

identified with the reagents, apparatus, or procedures, interference may be present. Associated data will be qualified as estimated in the 'notes' section on the sample logsheet. Field duplicate results will be evaluated for relative percent difference (RPD). If the RPD exceeds 30 percent, the associated data will be qualified as estimated.

The following table describes the type and frequency of accuracy checks required for each parameter.

Parameter	Standard Solution	Field Duplicate	Reagent Blank Correction
Alkalinity	None	1 per 10	None
Carbon Dioxide	None	1 per 10	None
Dissolved Oxygen	None	1 per 10	None
Ferrous Iron	None	1 per 10	None
Nitrite	1 per round	1 per 10	1 per lot
Nitrate	1 per round	1 per 10	1 per lot
Sulfide	None	1 per 10	None
Hydrogen Sulfide	None	1 per 10	None

3.3 Sample Handling and Storage

Each of the field parameters requires slightly different sampling procedures and storage limitations. In order to compile these procedures and limitations into one location for reference in the field, the following table has been prepared that presents parameter-specific requirements for sampling and storage.

Parameter	Handling	Storage
Alkalinity	Avoid agitation and exposure to air	May hold for 1 hr. at 4°C with zero headspace; warm to room temperature before analysis.
Carbon Dioxide	Avoid agitation and exposure to air	May hold for 24 hr. at 4°C with zero headspace; warm to room temperature before analysis.
Dissolved Oxygen	Avoid agitation and exposure to air	Analyze immediately.
Ferrous Iron	Avoid agitation and exposure to air; filter if visibly turbid	Analyze immediately; keep out of sunlight.
Nitrite	Utilize standard sampling techniques	May hold for 24 hr. at 4°C; warm to room temperature before analysis.

Parameter	Handling	Storage
Nitrate	Utilize standard sampling techniques; filter if visibly turbid	May hold for 48 hr. at 4°C; warm to room temperature before analysis.
Sulfide	Avoid agitation and exposure to air	Analyze immediately.
Hydrogen Sulfide	Avoid agitation and exposure to air	Analyze immediately.

CTO-10 SOP 2-16

ATTACHMENT 1

FIELD CHEMICAL ANALYTICAL LOG FORM

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: NSWC Crane

Project No.: CTO 10

Sampled By:

Sample ID No.:

Sample Location:

Duplicate: ☐

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	ORP
Time:	(Visual)	(SU)	(mS/cm)	(°C)	(NTU)	(Meter, mg/l)	mV
Method:							

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Alkalinity:

Equipment: Chemetrics Test Kit

Analysis Time: _____

Range Used:	Range	Concentration ppm
☐	10 to 100 ppm	
☐	50 to 500 ppm	
☐	100 to 1000 ppm	

Concentration: _____ ppm

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Analysis Time: _____

Range Used:	Range	Concentration ppm
☐	10 to 100 ppm	
☐	100 to 1000 ppm	
☐	250 to 2500 ppm	

Concentration: _____ ppm

Notes:

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Analysis Time: _____

Range Used:	Range	Concentration ppm
☐	0 to 1 ppm	
☐	1 to 12 ppm	

Concentration: _____ ppm

Notes:

Hydrogen Sulfide:

Equipment: HACH HS-C

Analysis Time: _____

Concentration: _____ mg/L

Notes:

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: NSWC Crane

Project No.: CTO 10

Sampled By:

Sample ID No.:

Sample Location:

Duplicate: ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Ferrous Iron (Fe^{2+}):

Equipment: HACH IR-18C

Analysis Time:

Concentration: _____ mg/L

Sulfide (S^{2-}): Range 0-0.7 mg/L

Equipment: HACH DR-850 Colorimeter

Analysis Time: _____

Program No.: 93

Concentration: _____ mg/L

Filtered: ☐

Notes:

Nitrite (NO_2-N): Range 0-0.35 mg/L

Equipment: HACH DR-850 Colorimeter

Analysis Time: _____

Program No.: 62

Concentration: _____ mg/L

Notes:

Nitrate (NO_3-N):

Equipment: HACH DR-850 Colorimeter

Analysis Time: _____

Program No.: 55

Concentration: _____ mg/L

Nitrite Interference Treatment: ☐

Notes:

APPENDIX B

HEALTH AND SAFETY PLAN

Health and Safety Plan
for
RCRA Facility Investigation/Corrective Measures Study (RFI/CMS)
at
Solid Waste Management Unit 2 Dye Burial Grounds Naval Surface Warfare Center Crane Division
Crane, Indiana

Southern Division
Naval Facilities Engineering Command
Contract No. N62467-94-D-0888
Contract Task Order 0010

May 2001

HEALTH AND SAFETY PLAN
FOR
RCRA FACILITY INVESTIGATION/CORRECTIVE MEASURES STUDY (RFI/CMS)
AT
SOLID WASTE MANAGEMENT UNIT 2
DYE BURIAL GROUNDS

NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY CONTRACT

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

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NO. N62467-94-D-0888
CONTRACT TASK ORDER 0010

May 2001

PREPARED UNDER THE SUPERVISION OF:

Ralph Basinski 5/11/01

RALPH BASINSKI
TASK ORDER MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

APPROVED FOR SUBMITTAL BY:

Joseph Lefferg for 5/11/01

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

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION 1-1
1.1 KEY PROJECT PERSONNEL AND ORGANIZATION 1-2
1.2 SITE INFORMATION AND PERSONNEL ASSIGNMENTS 1-3

2.0 EMERGENCY ACTION PLAN 2-1
2.1 INTRODUCTION 2-1
2.2 EMERGENCY PLANNING 2-1
2.3 EMERGENCY RECOGNITION AND PREVENTION 2-2
2.4 SAFE DISTANCES AND PLACES OF REFUGE 2-3
2.5 DECONTAMINATION PROCEDURES/EMERGENCY MEDICAL TREATMENT 2-3
2.5.1 Emergency Medical Treatment 2-3
2.6 EMERGENCY ALERTING AND ACTION / RESPONSE PROCEDURES 2-7
2.7 PPE AND EMERGENCY EQUIPMENT 2-8
2.7.1 Fire Extinguishers 2-8
2.8 EMERGENCY CONTACTS 2-11
2.9 EMERGENCY ROUTE TO HOSPITAL 2-13
2.10 INJURY/ILLNESS REPORTING 2-16

3.0 SITE BACKGROUND 3-1
3.1 SITE HISTORY 3-1
3.2 SPECIFIC SITE TO BE INVESTIGATED – SWMU 2 3-1

4.0 SCOPE OF WORK 4-1
4.1 MONITORING WELL INSTALLATION 4-1
4.1.1 Continuous-Flight Hollow-Stem Auger Drilling 4-1
4.1.2 Direct-Push Technology 4-2
4.2 MONITORING WELL DEVELOPMENT/REDEVELOPMENT 4-2
4.3 MONITORING WELL SAMPLING 4-2
4.3.1 Natural Attenuation Sampling 4-3
4.3.2 Water Level Measurements 4-4
4.4 MULTI-MEDIA SAMPLING 4-5
4.4.1 Surface and Subsurface Well Samples 4-5
4.4.2 Surface Water, Seeps, and Sediments 4-5
4.5 GEOGRAPHICAL SURVEYING 4-5
4.6 DECONTAMINATION 4-6
4.6.1 Sampling Equipment 4-6
4.6.2 Heavy Equipment 4-6
4.7 IDW MANAGEMENT 4-7

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION 5-1
5.1 GENERAL SAFE WORK PRACTICES 5-1
5.2 DRILLING SAFE WORK PRACTICES 5-2
5.2.1 Before Drilling 5-2
5.2.2 During Drilling 5-3
5.2.3 After Drilling 5-3

TABLE OF CONTENTS (continued)

SECTION		PAGE
6.0	**HAZARD ASSESSMENT**	**6-1**
6.1	CHEMICAL HAZARDS	6-1
6.2	PHYSICAL HAZARDS	6-2
6.2.1	Slips, Trips, and Falls	6-2
6.2.2	Cuts or Other Injuries Associated with Hand Tool Use	6-3
6.2.3	Strains/Muscle Pulls	6-4
6.2.4	Ambient Temperature Extremes – Heat /Cold Stress	6-5
6.2.5	Heavy Equipment Hazards	6-5
6.2.6	Energized Systems	6-6
6.2.7	Vehicular and Foot Traffic Hazards	6-6
6.2.8	Noise in Excess of 85 dBA	6-7
6.3	NATURAL HAZARDS	6-8
6.3.1	Insect/Animal Bites and Stings, Poisonous Plants, etc.	6-8
6.3.2	Snakes and Other Wild Animals	6-11
6.3.3	Poisonous Plants	6-12
6.3.4	Inclement Weather	6-13
7.0	**AIR MONITORING**	**7-1**
7.1	TASKS TO BE CONDUCTED	7-1
7.2	ASSOCIATED HAZARDS	7-1
7.2.1	Chemical Contaminant Monitoring	7-2
7.3	INSTRUMENT MAINTENANCE AND CALIBRATION	7-4
8.0	**TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS**	**8-1**
8.1	INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING	8-1
8.1.1	Requirements for All Field Personnel	8-1
8.2	SITE-SPECIFIC TRAINING	8-1
8.3	MEDICAL SURVEILLANCE	8-3
8.3.1	Medical Surveillance Requirements for TtNUS Personnel	8-3
8.3.2	Requirements for All Field Personnel	8-3
8.4	SUBCONTRACTOR EXCEPTION	8-3
9.0	**SITE CONTROL**	**9-1**
9.1	EXCLUSION ZONE	9-1
9.2	SUPPORT ZONE	9-2
9.3	SAFE WORK PERMITS	9-2
9.4	SITE MAPS	9-2
9.5	BUDDY SYSTEM	9-4
9.6	MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS	9-4
9.7	COMMUNICATION	9-4
9.8	SITE VISITORS	9-4
9.9	SITE SECURITY	9-6
9.10	SANITATION AND BREAK AREAS	9-6
9.10.1	Toilets	9-6
9.10.2	Potable Water	9-6
9.10.3	Showers and Change Rooms	9-7
9.10.4	Break Areas	9-7

TABLE OF CONTENTS (continued)

SECTION **PAGE**

10.0 SPILL CONTAINMENT / CONTROL PROGRAM 10-1
10.1 SCOPE AND APPLICATION 10-1
10.1.1 IDW Management 10-1
10.1.2 Waste Storage 10-2
10.1.3 Resource Storage – Limited Fuel and Lubricant Storage 10-3
10.2 PERSONNEL TRAINING AND SPILL PREVENTION 10-4
10.3 SPILL PREVENTION AND CONTAINMENT EQUIPMENT 10-4
10.4 SPILL CONTAINMENT/CONTROL RESPONSE PLAN 10-5

11.0 CONFINED SPACE ENTRY 11-1

12.0 DRUM/UNIDENTIFIED CONTAINERS 12-1
12.1 INTRODUCTION 12-1

13.0 MATERIALS AND DOCUMENTS 13-1
13.1 MATERIALS TO BE POSTED AT THE SITE 13-1

14.0 GLOSSARY 14-1

ATTACHMENT I - DYE COMPOUNDS POTENTIALLY BURIED AT SWMU 2

ATTACHMENT II - UTILITY LOCATING AND EXCAVATION CLEARANCE

ATTACHMENT III - SAFE WORK PERMITS

ATTACHMENT IV - EQUIPMENT INSPECTION CHECKLIST

ATTACHMENT V - HOT WORK PERMIT

ATTACHMENT VI - HEARING CONSERVATION PROGRAM

ATTACHMENT VII - OSHA POSTER

TABLES

NUMBER **PAGE**

2-1 Emergency Reference Contacts 2-12

5-1 Tasks/Hazards/Control Measures Compendium 5-5

6-1 Chemical, Physical, and Toxicological Data 6-2

FIGURES

NUMBER **PAGE**

2-1 Emergency Response Protocol 2-5
2-2 Primary Hospital Route Map 2-14
2-3 Secondary Hospital Route Map 2-15
2-4 Injury/Illness Reporting Form 2-17

7-1 Documentation of Field Calibration 7-6

8-1 Site-Specific Training Documentation 8-2

9-1 Safe Work Permit 9-4

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 Number: 0010

Statement of Work 4, Revision B: Provide site investigation and reporting to determine the vertical and horizontal extent of contamination surrounding Solid Waste Management Unit (SWMU) 2, Dye Burial Grounds (DBG).

Proposed Dates of Work: 06/01/01 through 08/15/01

Application: This Health and Safety Plan (HASP) has been specifically written for site activities that are to be conducted at the Naval Surface Warfare Center (NSWC) Crane facility, located in Crane, Indiana. Activities to be conducted under this CTO 0010, Statement of Work 4, Revision B, include the following:

- Monitoring Well Installation/Development
- Multi-media sampling
  - Sample existing and new wells
  - Surface and subsurface soil sampling (Hollow Stem, Direct push, and hand augering)
  - Surface water and sediment sampling
  - Geographical Surveying

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

Modifications/Changes: The following conditions are considered sufficient basis for change and will serve as triggers to institute review and possible changes to this document

- The addition of activities outside of those specified in Section 3.0, Scope of Work.

- Task Modifications to those activities specified within Section 3.0, 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 Tetra Tech NUS and subcontractor employees engaged in on-site activities. Personnel assigned to these positions will exercise the primary responsibility for 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.

Tetra Tech NUS Task Order Manager (TOM) is responsible for the overall direction of health and safety for this project.

Project Health and Safety Officer (PHSO) is responsible for developing the HASP in accordance with applicable OSHA regulations.

Tetra Tech NUS 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.

Site Safety Officer (SSO) supports site activities by advising the FOL on all aspects of health and safety on-site.

CLEAN Health and Safety Manager monitors compliance with this document and approves all changes and modifications.

1.2 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: NSWC Crane

Address: Crane, Indiana

Client Contact: Mr. Thomas Brent

Phone Number: (812) 854-6160

Alternate Contact: Ms. Chris Freeman

Phone Number: (812) 854-4423

Project Team:

Tetra Tech NUS Personnel:	Discipline/Tasks Assigned:	Phone No.:
Ralph Basinski	Task Order Manager (TOM)	(412) 921-8308
Matthew M. Soltis, CIH, CSP	CLEAN Health and Safety Manager (HSM)	(412) 921-8912
Tom Dickson, CSP	Project Health and Safety Officer (PHSO)	(412) 921-8457
Keith Simpson	Field Operations Leader (FOL)	(412) 921-8131
TBD	Site Safety Officer (SSO)	
Tom Patton	Equipment Manager (Pittsburgh)	(412) 859-4670

Non-Tetra Tech NUS Personnel:	Affiliation/Discipline/Tasks Assigned:	Phone No.:
Laucks Testing	Analytical Laboratory	(206) 767-5060
NSWC Crane Laboratories	Analytical Laboratory	(812) 854-3143
TBD	Drilling Subcontractor	
TBD	Surveyor	
FedEx	Sample/Parcel Delivery	1(800)463-3339

Hazard Assessments (for purposes of 29 CFR 1910.132) and HASP preparation conducted by:
Thomas M. Dickson, CSP

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 emergency. Tetra Tech NUS will through necessary services provide 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

Note: Emergency support in the initial stages will only be provided to the capabilities of on-site personnel and available resources.

2.2 EMERGENCY PLANNING

Through the initial hazard/risk assessment effort, injuries or illnesses resulting from exposure to chemical or physical hazards or fire are the most probable emergencies that could be encountered during site activities.

To minimize and eliminate these potential emergency situations, emergency planning activities associated with this project include the following.

The SSO and/or the FOL are responsible for:

- Coordinating with NSWC Crane Emergency Services personnel to ensure that Tetra Tech NUS emergency action activities are compatible with existing facility emergency response procedures.
- Establishing and maintaining information at the project staging area (support zone) or Field Office for easy access in the event of an emergency. This information will include the following:
  - Chemical Inventory (used on-site), with Material Safety Data Sheets.
  - On-site personnel medical records (medical data sheets).
  - A logbook identifying personnel on site each day.

- 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 to provide early recognition and prevention, where possible.

It is understood that the use of two-way communication devices (cellular phones and radios) maybe used at the NSWC CRANE Facility providing such equipment is intrinsically safe and power output is under 5 watts.

2.3 EMERGENCY RECOGNITION AND PREVENTION

The primary focus of this section is the ability to recognize and control factors that could contribute to an emergency situation/condition. This will be accomplished in the following manner

The FOL, and/or the SSO, will preview all site work locations prior to committing people or resources. Their actions will be as follows:

- Identify, remove, and/or barricade and physical hazards within the estimated work area.
- Identify prevalent emergency conditions and their control measures and insure they are stated on the Safe Work Permits.
- Provide the necessary equipment to control potential emergencies (i.e., Safety Cans for flammable storage, Spill Containment Equipment, PPE, and Emergency Equipment such as Fire Extinguishers).
- Evaluate operations to ensure the necessary measures have been taken to prevent, control and/or minimize the impact of emergency situations/conditions.

Field Crew shall:

- Identify, remove, and/or barricade and physical hazards within the estimated work area.
- Follow the guidelines for control of emergency situations/conditions as stated on the Safe Work Permits.
- Prepare for Emergency Action by placing fire extinguishers, eyewashes, and first-aid kits where they are readily available.
- Report any potential emergency situations/conditions to the FOL and/or the SSO.

2.4 SAFE DISTANCES AND PLACES OF REFUGE

NSWC CRANE has identified the Ammunition Burning Grounds Office, adjacent to SWMU 2, as the primary Safe Place of Refuge. Tetra Tech NUS, Inc. and subcontractor personnel will report to this location and remain there in the event of an emergency at NSWC CRANE, outside of the Tetra Tech NUS operations.

- The FOL is responsible for selecting and identifying primary and secondary safe place of refuge locations within Tetra Tech NUS, Inc. operating areas. These are as follows:
  - Primary – Ammunitions Burning Grounds Office
  - Secondary – To be determined in the field by the FOL based on access, telephone communications point, and a location from which responding emergency services personnel can be directed (i.e., gate, intersection, etc.)

- During an evacuation, personnel reporting to the refuge location will remain there until directed otherwise by the Tetra Tech NUS FOL.

- The FOL or the SSO shall take a head count at this location, to account for, and to confirm the location of all site personnel. The site logbook will be used to take the head count. Emergency response personnel will be notified immediately of any unaccounted personnel.

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. Decontamination will not be performed, if the action that initiates an evacuation would further endanger the lives of workers if workers, were to perform decontamination procedures. However, it is unlikely that an evacuation would occur at this site which would require workers to evacuate the site without first performing decontamination procedures.

2.5.1 Emergency Medical Treatment

The FOL and/or the SSO should check to see, if the First-Aid Kits provided or purchased for use are stocked with the following suggested items.

Micro-Shield CPR Mouthpiece	Disposable Surgeons Masks	Ammonia Inhalant

Gauze Bandage	Triangular Bandage	Cold Packs
Gauze Pads	Adhesive Bandage	Adhesive Tape
Wound Towelettes	PVP Iodine Wipes	Antibiotic Cream
Burn Cream	Compression Bandage	Alcohol Prep Pads
Forceps		

In addition to the recommended above First-Aid Kit components, the following items are recommended in support of on-site activities.

1. Portable Eye Wash – Although the use and application is obvious, it is imperative that these units be available during monitoring well construction activities. Components of the well construction materials are corrosive in nature and if gotten into the eyes could damage the eyes if not flushed immediately.

Tetra Tech NUS and subcontractor personnel are only permitted to provide treatment to the general First-Aid Level or injuries not requiring follow-up treatment by a physician. This may include minor cuts, bruises, bee stings, scrapes, and minor irritation to the skin. This does not include second or third degree burns, lacerations requiring stitches, butterfly bandaging, sprains, and severe forms of heat stress. Personnel providing medical assistance are required to be trained in General First-Aid/CPR and the requirements of the Bloodborne Pathogen Standard 29 CFR 1910.1030.

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

(1) Notify the FOL and/or the SSO of the incident.
(2) Take the necessary precautions to prevent direct contamination of yourself with the injured person's body fluids.
   a) Use surgeons gloves to offer the first line of defense for handling cuts, abrasions, bites, punctures, etc. or any part of the injured person. The use of safety glasses and surgeons masks as necessary, if there is the potential for uncontrolled spread of body fluids.
   b) If it is necessary to provide Cardio-Pulmonary Resuscitation (CPR), use a CPR Micro-Shield Disposable mouthpiece.

If the emergency involves personnel exposures to chemicals, follow the steps provided in Figure 2-1.

FIGURE 2-1
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, being 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 (Monday through Friday 8:00 a.m. to 5:00 p.m.).

  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 2-1 (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: _____

2.6 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

There are several aspects associated with emergency alerting procedures that must be taken into account at NSWC Crane. These are as follows:

- Due to the physical setting (size and remoteness) of the sites where field activities will be conducted, readily available means of communication are not always available.

- In addition, again based on the size of the facility and location, there are limited cellular communication points on Base where a signal may be obtained. This also limits communication capabilities.

- Lastly, due to the schedule that Tetra Tech NUS, Inc. will work (10 days on; 4 days off) the potential exists for field personnel to be present during holidays, off days, and after hours. Primary safe places of refuge that would normally be accessed in the event of an emergency during normal working hours will be closed during these periods.

In order to overcome these restrictions, the Base Environmental Office will allocate a Public Works/Fire/Security Radio to be used in support of this field effort. This radio will be available 24/7 which will establish a direct link to security and emergency services.

If an emergency occurs at NSWC CRANE within the Tetra Tech NUS operations, 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 FOL (who will serve as the Incident Coordinator) what has occurred and as many details as possible.

- Have your partner evacuate non-essential persons from the incident scene, engage initial response measures given the emergency type (i.e., spill response, fire extinguisher, first-aid) .

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:

Primary Means of Notification

- Emergency Notification Radio - This radio will be available 24/7 which will establish a direct link to security and emergency services.

Secondary Means of Notification

- On base call 1333 or 3300 (Table 2-1) and report the emergency. Give the emergency operator the location of the emergency, the type of emergency, the number of injured, and a brief description of what occurred. Stay on the phone and follow the instructions given by the operator. The operator will then notify and dispatch the proper emergency response agencies. The Fire Dept. coordinates ambulatory service. They will provide emergency medical, ambulatory, hazardous materials response, and rescue.

  Note: On-base extensions 1333 and 3300 are the primary emergency phone numbers. From an NSWC Crane phone base extensions must be proceeded with "854". Off base numbers from a base phone can only be reached by dialing "990" or " 991" first. Furthermore, all emergencies should be subsequently reported to the Environmental office (x6160).

- Evacuate all Tetra Tech NUS and subcontractor personnel to the identified safe place of refuge. Conduct a head count of site personnel using the site logbook.

2.7 PPE AND EMERGENCY EQUIPMENT

A first aid kit(s), eye wash unit(s), and fire extinguisher(s) (strategically placed) will be maintained on-site and shall be immediately available for use in the event of an emergency. PPE levels will not exceed those items to be used in the completion of identified tasks.

2.7.1 Fire Extinguishers

As fires were identified as a potential emergency situation, the control measures employed are prevention and the ability to extinguish a fire that has started.

Prevention

- Storage - Use Safety Cans to store all flammable liquids.

- Dispensing - Never dispense gasoline into the gas tank, if the engine is still hot or running. This practice has been identified during well development and other tasks that employ gas powered pumps.

- Inspections - Ensure response equipment such as fire extinguishers and first-aid kits are stocked, inspected, operational, and readily available.

- Hot work – Ensure any hot work is performed in a location away from potential fuel sources and in a location approved by NSWC CRANE. Ensure the Fire Dept. also approves of the precautionary measures incorporated for this type of activity.

Note: A Hot Work Permit for any type of work that may generate a spark. Examples of this may include the operation of a steam cleaner, generators, power tools, etc. A Hot Work Permit is issued by the NSWC Crane Fire Department and can be obtained by calling (812) 854-1235. The following provisions will be necessary when supporting Hot Work Operations:

- A Fire Extinguisher meeting the following performance specifications – 20-A: 80-B:C minimum performance requirements established by NSWC Crane Fire Department.

- A Fire Watch – A person available during the execution of the permit manning the above designated extinguisher. This position shall be manned for during the execution of the Hot Work Permit and for up to 30-minutes thereafter.

- Hot Work Permit – In addition, to the requirements established by NSWC Crane Fire Department a Tetra Tech NUS, Inc. Hot Work Permit will be required to be completed in support of all spark and open flame activities conducted on this site. The Hot Work Permit and provisions for use are provided in Attachment

Fire Extinguishers Use/Application

All fire extinguishers supplied or purchased for use on the job-site will be mounted/placed in locations readily visible and accessible. Travel distance to obtain and employ the designated extinguisher will be no greater than 50 feet from the hazard area/location.

Inspection

- All fire Extinguishers maintained on the job site require a yearly inspection by a certified inspection service. This will be indicated by a dated inspection tag. New Extinguishers will not have an inspection tag. Therefore, one should be attached indicating date of purchase.

- Monthly visual inspections to ensure extinguishers are fully charged and no evidence of physical damage. This inspection should be documented on the tags attached to the extinguisher provided with the yearly inspection or the tag you have attached.

- Ensure the 5 or 12-year (Depending on Type of extinguisher) required hydrostatic inspections has not lapsed for dry chemical extinguishers (Note: Non-refillable extinguishers are exempt from this requirement.)

Note: All inspections and quick checks should be documented in the Project or Health and Safety Logbook, as applicable.

Fire Extinguisher Use

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) A Fire Extinguisher meeting the following performance specifications – 20-A: 80-B:C minimum performance requirements established by NSWC Crane Fire Department. If you will buy a Fire Extinguisher, this is the type recommended. Initial fire extinguisher support for operations outside of those specified for Hot Work are 2 1/2 to 5 lbs.
2) Determine whether the extinguisher is adequate for this fire.
3) If adequate, hold the extinguisher upright and pull the ring pin.
4) Stand back 10 feet and aim at base of fire. Be careful not to spread burning material with pressurized extinguishing material.
5) Squeeze lever; sweep extinguisher in a side-to-side motion at the base of the fire.

2.8 EMERGENCY CONTACTS

Prior to performing work at any of the sites, all personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. Table 2-1 provides a list of emergency contacts and their associated telephone numbers. This table must be posted on site where it is readily available to all site personnel.

TABLE 2-1

EMERGENCY REFERENCE CONTACTS

NSWC CRANE, Crane, Indiana

AGENCY	TELEPHONE
NSWC Emergency Fire and Security (The Fire Dept. Dispatcher will coordinate emergency services including on-base ambulance and security)	On base (812) 854-1333 (812) 854-3300 Non-Emergency (812) 854-1235
NSWC Ambulance	(812) 854-1333 (812) 854-3300 (812) 854-1100
Bloomington Hospital (Bloomington, Indiana)	(812) 336-9515
Bedford Medical Center(Bedford, Indiana)	(812) 279-6545
NSWC Medical Facility	(812) 854-1220
Poison Control Center	1-800-382-9097
National Response Center	1-800-424-8802
Base Contact – Thomas Brent Alternate – Ms. Chris Freeman	(812) 854-6160 (812) 854-4423
Utilities – Indiana Underground Plant Protection Services (One Call)	1(800)382-5544
Utilities – Public Works Dept.	(812) 854-6903
Task Order Manager Ralph Basinski	(412) 921-8308
CLEAN Health and Safety Manager, Matthew M. Soltis, CIH, CSP	(412) 921-8912
Project Health and Safety Officer, Tom Dickson	(412) 921-8457

NOTE: All emergency contacts to emergency services off base require the notification of NSWC CRANE Emergency Dispatch. Information to be provided will include the type and extent of the emergency and agencies notified.

2.9 EMERGENCY ROUTE TO HOSPITAL

Directions to the Bloomington Hospital*

Directions	Distance (Miles)
Exit NSWC Crane on H-45 through the Bloomington Gate. Follow Highway 45 North to Bloomington at Highway 45 and Highway 37.	30
Continue going straight over the overpass (Bloomfield Road). Follow Bloomfield Road North; this road turns into 2nd Street. Follow 2nd Street, hospital will be on the right (601 West 2nd Street)	8

Directions to the Bedford Medical Center*

Directions	Distance (Miles)
Exit the base on H-58, through the Bedford Gate. Head West on State Highway 158.	16.9
State Highway 158 becomes 16th Street upon entering the City of Bedford. The medical center is on the right shortly after Plaza Drive.	

NSWC Crane Gate, Hours of Operation

Bloomington Gate:	Open 24hours/day/7days/week
Crane Gate:	Open 24hours/day/7days/week
Bedford Gate:	Open Monday through Friday 0530-0830 and 1500 through 1800
Burn City Gate:	Open Monday through Friday 0530-0830 and 1430 through 1800
Dover Hill Gate:	Open Monday through Friday 0530-0830 and 1500 through 1800

***NOTE:** Maps indicating the preferred gate and travel routes from the site to the hospitals are provided as Figures 2-2 and 2-3.

FIGURE 2-2

Hospital Route Map (Bloomington Gate)

****Note: The Bloomington Gate is open 24 hours.**

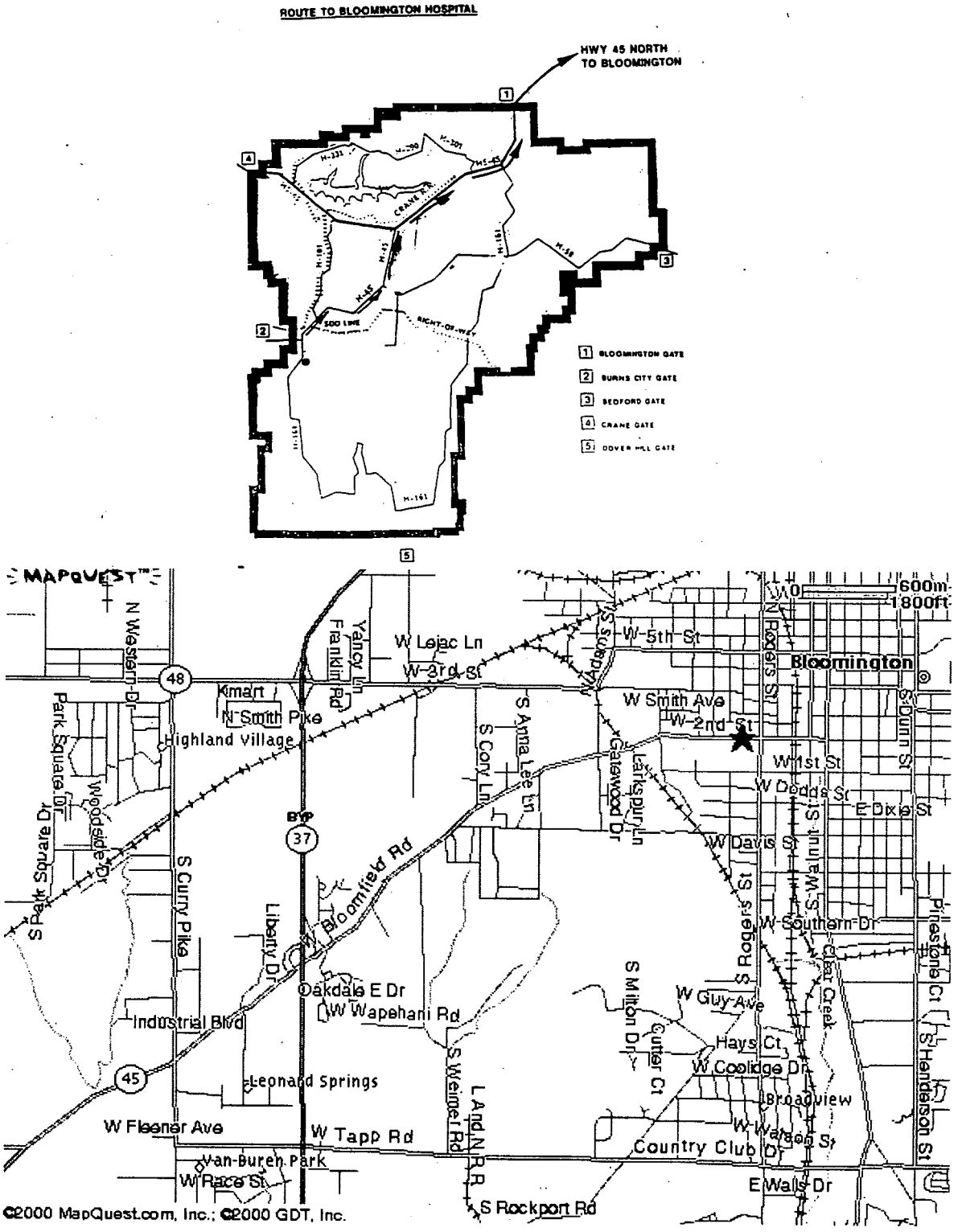
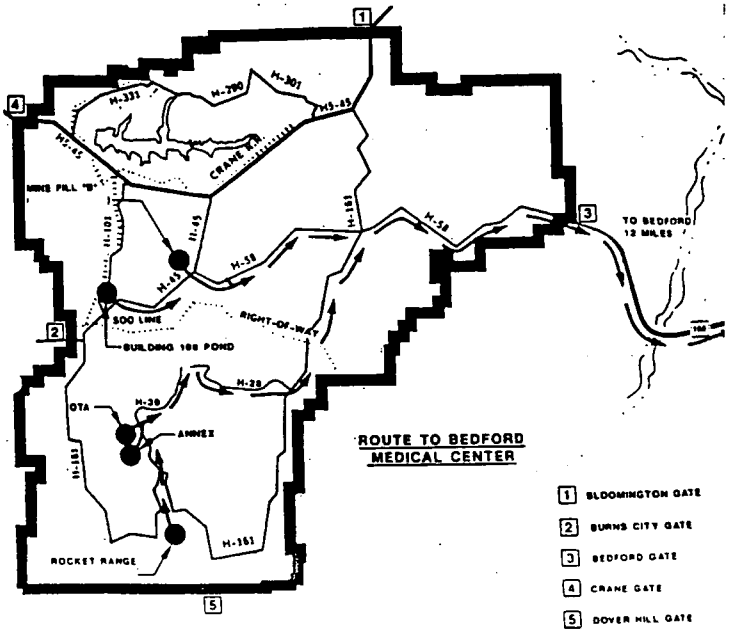
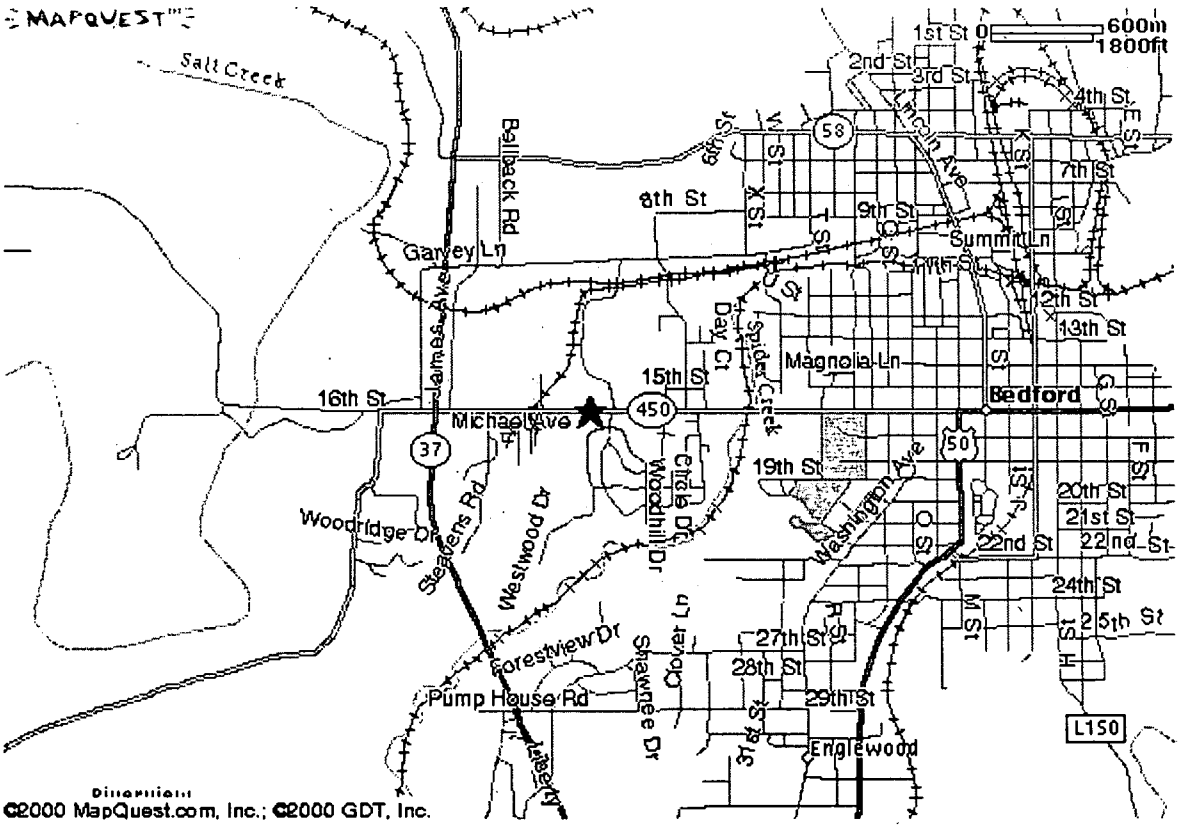


FIGURE 2-3

Hospital Route Map (Bedford Gate)

*Note: The Bedford Gate open only from 0600 – 0830 and 1500 – 1800 hours.





3.0 SITE BACKGROUND

This section provides information pertaining to NSWC Crane and the specific site that is to be investigated. This information will be revised, if additional information becomes available or if additional sites are added to the scope of work.

3.1 SITE HISTORY

NSWC Crane is located in Crane, Indiana approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky. The facility encompasses 98.2 square miles (62,832 acres) in Davies, Greene, Lawrence, and Martin Counties. It is located in a rural, sparsely populated area. The acreage surrounding the Base is either wooded or farmed land. The facility, originally called Naval Ammunition Depot (NAD), Burns City, was opened in 1941 to serve as an inland ammunition production and storage center. The Depot's name was changed to NAD, Crane in 1943. In 1975, the name was changed to Naval Weapons Support Center, Crane and in 1992, the name was again changed to Naval Surface Warfare Center, Crane. Today NSWC Crane's mission is to "provide quality and responsive engineering, technical and material support to the Fleet for combat subsystems, equipment and components, microelectronic technology, microwave components, electronic warfare, acoustic sensors tests, engineering pyrotechnics, small arms, electronic module test and system command." Under the Single Service Management Program, a segment of the Center's mission is to provide support (including environmental protection) to the Crane Army Ammunition Activity (CAAA). The Army is tasked with the production and renovation of conventional ammunition and related items, the performance of manufacturing, engineering, and product quality assurance to support production; and the storage, shipment, demilitarization, and disposal of conventional ammunition and related components. Because of the nature of the Army's operations, CAAA contributes significant financial support for the environmental program through an Inter-service Support Agreement.

3.2 SPECIFIC SITE TO BE INVESTIGATED – SWMU 2

The Dye Burial Ground (DBG) is located on the eastern section of the NSWC Crane facility, adjacent to the Ammunitions Burning Grounds (See SAP for Map and Location). The Initial Assessment Study (IAS) team reported in 1984 that an estimated 50,000 pounds of dye and dye contaminated materials were deposited in open trenches between 1952 and 1964. Materials reportedly deposited in the trenches included magnesium, boxes, dye contaminated rags, and approximately sixty (60) open drums of dye ("RCRA Facility Investigation, Phase III, Groundwater Release Characterization, SWMU 2/11 Dye Burial Grounds, Naval Surface Warfare Center Crane, Indiana: U.S. Army Corps of Engineers dated July 1998").

The specific contents of the DBG remain unknown. Attachment I provides the compounds that had existed and were identified as common categories and ingredients per the IAS report.

4.0 SCOPE OF WORK

The following activities have been identified in Statement of Work 4, Revision B, will be conducted under CTO 0010.

- Monitoring Well Installation/Development
- Multi-media sampling
  - Sample existing and new wells
  - Surface and subsurface soil sampling (Hollow Stem, Direct push, and hand augering)
  - Surface water and sediment sampling
- Survey Monitoring Well and sampling locations
- Decontamination
- IDW Management – Sample, transport, and dispose of IDW.

These tasks are discussed in detail below.

4.1 MONITORING WELL INSTALLATION

Currently, new monitoring wells are to be installed to close gaps in radial dispersion pathways of the groundwater. Monitoring wells are to be installed at varying depths clusters to determine the contamination levels at varying depths within the aquifer.

The installation of monitoring wells for this field effort may comprise multiple methods based on the function of the well and the established data quality objectives. Two primary methods to be employed at NSWC Crane are Hollow Stem Auger and Direct Push. These methods are summarized below.

4.1.1 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.

4.1.2 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 to 4-foot intervals for soil sample extraction. This activity establishes a pilot hole, and in some cases, remains open above the water table. For permanent well installation pre-constructed wells are inserted into the pilot hole created during soil sampling activity. In other applications, a well screen is used in the first interval of tooling. The tooling is advanced to the desired depth and the screen is deployed by knocking out a disposable drive tip. The well is extracted 2 to 3 feet exposing the screen for discreet sample collection.

4.2 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.

4.3 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.

In addition to the contaminant analysis for groundwater samples, aliquots may be removed for Natural Attenuation sampling purposes.

4.3.1 Natural Attenuation Sampling

Natural Attenuation Sampling uses a variety of testing mechanisms and reagents to measure the efficiency of degradation of contaminants within the hydrologic systems. This is accomplished through biodegradation, dispersion, dilution, sorption, volatilization and abiotic degradation mechanisms. This process utilizes chemical reagents to determine the geochemical properties of the sample substrate.

4.3.1.1 Dissolved Oxygen

Geochemical measurements of Dissolved Oxygen (DO) are made in the field using a high-resolution, low-range, test kit (HACH® Model OX-DT). The test kit for DO utilizes a digital titratrator and the azide modification of the Winkler methodology (Method 8215). The test involves chemical extraction using manganous sulfate, alkaline iodide-azide, and sulfamic acid. Titration is then performed using 0.02N sodium thiosulfate and a starch indicator solution.

4.3.1.2 Ferrous Iron

Geochemical measurements of dissolved ferrous iron (Fe^{2+}) are made in the field using a low-range, test kit (HACH® Model IR-18C). The test for Fe^{2+} involves colorimetric indication using a 1,10-phenanthroline indicator solution and ferrous iron reagent..

4.3.1.3 Hydrogen Sulfide

Geochemical measurements for dissolved hydrogen sulfide (H_2S) are made in the field using a low-range, test kit (HACH® Model HS-C). The test kit for H_2S utilizes a color chart and the effervescence of H_2S in the presence of sodium/potassium bicarbonate. The test involves colorimetric indication using copper sulfate test paper.

4.3.1.4 Carbon Dioxide

Geochemical measurements for dissolved carbon dioxide (CO_2) are made in the field using a low-range, test kit (HACH® Model CA-23). The test kit for CO_2 utilizes the drop-count titration method and involves colorimetric indication using sodium hydroxide and a phenolphthalein indicator solution.

4.3.1.5 Oxidation-Reduction Potential

The groundwater's oxidation-reduction potential (ORP), frequently referenced as REDOX or Eh, is analyzed by using a portable, water-quality probe (Hanna® Model CE). The probe is used in conjunction with a flow-through sample chamber to reduce sample aeration and contact with the atmosphere.

4.3.1.6 Sulfide

Hydrogen sulfide and acid soluble metal sulfides react with N,N-dimethyl-p-phenylenediamine oxalate to form methylene blue. The intensity of the color is directly proportional to the sulfide concentration. To a sample cell add 25 ml of sample and equal amount of demineralized water. To this add 1.0ml of sulfide reagent and mix (swirl); repeat adding 1.0 ml of sulfide reagent and mix. Zero Digital Colorimeter, add sample cell into Digital Colorimeter and read.

4.3.1.7 Alkalinity

In the alkalinity test the sample is titrated with sulfuric acid (H_2SO_4) to a colorimetric end point to a specific pH. This test employs a titration cartridge of sulfuric acid and a phenolphthalein and bromocresol indicator powder pillows. This test requires adding these reagents through titration or direct pour thereby resulting in a color change which is the final determinant of alkalinity.

4.3.1.8 Nitrate

Cadmium metal reduces nitrates presence in the sample to nitrites. The nitrite ion reacts in an acidic medium to form a pink colored product. This test involves mixing 30-ml sample with Nitrate Reagent Pillow to prepare a sample cell for colorimetric measurement.

4.3.1.9 Nitrite

Nitrite reacts with a sulfanilic acid to form a diazonium salt. The salt reacts in an acidic medium to form a pink colored product. This test involves mixing 30-ml sample with Nitrate Reagent Pillow to prepare a sample cell for colorimetric measurement.

4.3.2 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.

4.4 MULTI-MEDIA SAMPLING

4.4.1 Surface and Subsurface Soil Samples

Surface and Sub-surface soil samples will be collected utilizing a variety of techniques.

4.4.1.1 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.

4.4.1.2 Drill Rigs (Hollow-stem auger); Direct Push Technologies

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.

4.4.2 Surface Water, Seeps, 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

4.5 GEOGRAPHICAL SURVEYING

This activity is generally non-intrusive in nature, however limited brush removal may be required using chain saws, machetes, and brush hooks. The brush removal will facilitate lines of sight and passage routes for the equipment during the survey.

4.6 DECONTAMINATION

The equipment involved in the field activities for this investigation will be decontaminated prior to, during and after the sampling activities.

4.6.1 Sampling Equipment

All nondedicated 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
- Instrument scan – This will be performed after air drying to ensure all chemical solvents have been effectively removed. Positive results require re-rinsing and re-scan to ensure removal of the applicable chemical solvents.

4.6.2 Heavy Equipment

All non-dedicated heavy equipment (i.e. auger flights, split spoons, drive rods, etc.) will be decontaminated prior to use, 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
- Steam Cleaned
- Deionized (DI) water rinse
- Solvent rinse (Isopropanol)
- DI water rinse
- Air dry
- Instrument scan – This will be performed after air drying to ensure all chemical solvents have been effectively removed. Positive results require re-rinsing and re-scan to ensure removal of the applicable chemical solvents.

All non-direct contact equipment including truck bodies will be washed using soap and water and/or steam cleaned prior to use, between locations, and prior to exiting the site. These components as they never contact potential sampling media will not be required to undergo chemical decontamination.

4.7 IDW MANAGEMENT

This task includes the containerization, labeling, staging, monitoring, and final deposition of investigative derived wastes. It is anticipated that this investigation will generate five types of potentially contaminated residues or investigative derived wastes. IDW will be handled as described below:

PPE, tubing, and DPT Sample Liners – All PPE, tubing, and DPT sample liners will be decontaminated and double bagged and placed in the trash receptacles at the facility.

Monitoring Well Development and Purge Waters; Equipment (Heavy and Sampling) Decontamination Fluids – These fluids shall be collected and stored on site in a 300 or 500-gallon plastic holding tank. These fluids shall be discharged to a NSWC Crane permitted Sanitary Sewer system. Discharge shall occur at a manhole designated by NSWC Crane.

Wastes Cuttings and Rock Cores from Drilling Activities – For each boring, the cuttings obtained will be scanned for VOCs. If all readings obtained during the scan are at background levels, the soil cuttings shall be spread on the ground adjacent to the bore-hole from where they came.
Should readings above background be indicated, then the contaminated cuttings shall be containerized, labeled, and staged until analytical data indicating chemical contaminant concentrations. This information shall be used to determine the most appropriate route of disposal.

Containerization/Labeling/Staging

These activities are to be conducted as follows:

Containerization – Contaminated materials generated (soils) shall be collected and containerized in 55-gallon drums and staged in a centralized location.

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.

Final Deposition – Waste 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 Work Plan (WPA) and/or the Quality Assurance Plan (QAP). The above listing represents a summarization of the tasks as they apply to the scope and application of this HASP. If additional tasks are determined to be necessary, this HASP will be amended and a hazard evaluation of the additional tasks to be performed.

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION

Table 5-1 of this section serves as the primary portion of this HASP. This section identifies the tasks that are to be performed, the anticipated hazards, recommended control measures, air monitoring recommendations, required Personal Protective Equipment (PPE), and decontamination measures for each site task are discussed in detail. The FOL and/or the SSO will utilize these tables as the primary reference for completion of the Safe Work Permits.

5.1 GENERAL SAFE WORK PRACTICES

In addition to the task-specific work practices identified on Table 5-1, follow the safe work practices listed will be employed when conducting work involving known and unknown site hazards. These safe work practices establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations.

- Refrain from 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 by walking around puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on equipment. Do not place monitoring equipment on potentially contaminated surfaces.

- Be familiar with and adhere to all instructions in the site-specific HASP.

- Be aware 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.

- Use the "buddy system".

- Maintain visual contact with each other and with other on-site team members by remaining in close proximity in order 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 SAFE WORK PRACTICES

The following Safe Work Practices are to be followed when working in or around the Hollow Stem Drill Rig and/or Direct Push Drill Rig Operations.

5.2.1 Before Drilling

- Identify all underground utilities and buried structures before drilling. Use the Utility Locating and Excavation Clearance Standard Operating Procedure provided in Attachment II.

- All drill 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 IV. 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 drillers helper will establish an equipment staging and laydown 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

- 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 drill 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 auger flights and other heavy tooling.

- 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

- All equipment used within the exclusion zone will undergo a complete decontamination and evaluation by the SSO to determine 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 days activities. During fueling operations all equipment will be shutdown and bonded to the fuel provider.

- When not in use all direct push drill rigs will be shutdown, and emergency brakes set. All Hollow Stem Auger Drill Rigs will have their wheels chocked to assist in controlling movement.

- 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.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER – CRANE, INDIANA

Operation/Location	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

Mobilization/Demobilization
 	
This activity includes, but not limited to:
 	
- Equipment Preparation and Inspection
 	
- Resource acquisition and unpacking of supplies
 	
- Site clearance and preparation – Utility clearances, etc.
 	
- Establish and construct access routes to sample/work locations, where applicable.
 	
- Construct decontamination and IDW operation and storage facilities, as applicable.
	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 with each applicable chemical having 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 and the label) This list, which also includes quantities and storage locations will be maintained in a centralized location and made available upon request.
	
	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) Cuts and lacerations
	4) Pinches and compressions/Struck by
	5) Slips, trips, and falls
	6) Heavy equipment hazards (swinging booms, hydraulic lines, etc.)
	7) Vehicular and foot traffic
	
	Natural hazards:
	
	8) Ambient temperature extremes (heat/cold stress)
	9) Insect and animal bites and poisonous plants
	10) 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. Information on hazards and PPE will be communicated on the Safe Work Permit for this task. Any specific provisions recommended by the MSDS shall be in place (i.e., eye wash, fire extinguisher, specified PPE, etc.) prior to using the chemical substance.
		
		Physical hazards:
		2) **Lifting Hazards** – During mobilization/demobilization personnel are required to handle equipment, supplies, and resources in preparation for site activities. This hazard becomes more predominant in the early morning hours (prior to muscles becoming limber) and later in the day (as a result of fatigue). The following provisions shall be instituted in order to minimize hazards of this nature:
		- Use machinery or multiple personnel for heavy lifts.
		- Use proper lifting techniques such as
		  - Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are obtainable.
		  - 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 the 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
		- Your Overall physical condition
		
		3) **Cuts and lacerations** – To prevent cuts and lacerations associated with unpacking or packing equipment and supplies, during site preparation (clearing access routes), the following provisions are required:
		- Always cut away from yourself and others, then, if a knife slips, you will not impale yourself or others.
		- Do not place items to be cut in your hand or on your knee.
		- Change out blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments.
		If hand tools (brush hooks, machetes, etc.) are used to gain access to sample locations, the following precautions are recommended:
		- Insure handles are of good construction (no cracks, splinters, loose heads/cutting 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 and when carrying these items over rough or slippery terrain.
		- All personnel will maintain a 10-foot perimeter or greater around persons clearing brush and access paths to sample and/or well locations.
		
		4) **Pinches/Compressions/Struck By** - Do not modify tooling without manufacturer's expressed permission.
		- Keep any machine guarding in place, avoid moving parts.
		- Use tools or equipment where necessary to avoid placing hands in areas vulnerable to 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.
		
		5) **Preview work locations for unstable/uneven terrain**. It should be noted that this is not considered a predominant hazard at NSWC Crane. Take the following measures to minimize hazards of this nature
		- Cover, guard and barricade all open pits, ditches, and embankment, that impede upon the work area, as necessary.
		- As part of site control efforts fences shall be constructed to control and isolate traffic in the work area. Fences shall also be constructed isolating resource or staging areas.
		- The FOL and the SSO during site surveys and site preparation should identify these potential hazards.
		- All activities conducted greater than 6-feet above ground surface shall employ acceptable engineered fall protection (i.e. handrails and platforms) or accepted fall protection harnesses.
		
		6) **Heavy Equipment Hazards** - All equipment will be
		- Inspected in accordance with OSHA and manufacturer's design.
		- All equipment inspection will be documented on a Equipment Inspection Checklist as provided in (See Attachment IV).
		- Operated by knowledgeable operators and ground crew.
		
		7) **Vehicular and Foot Traffic Hazards** - As part of site preparation activities and zone construction, when preparing 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.
		- Heavy equipment patterns shall be isolated using fences or other suitable barricades from pedestrian pathways.
		- Bumpers or other suitable traffic stops shall be placed in areas where it is desired that traffic approaching an open excavation, embankment, or pits stops.
		- All self-propelled equipment shall be equipped with movement warning systems.
		- 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.
		(See Section 6.2.7 for more information)
		Natural hazards:
		
		8) **Ambient Temperature Extremes** - 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.
		
		9) **Insect/Animal Bites and Stings and Poisonous Plants** - To combat the potential impact of natural hazards, the following actions are recommended
		- Avoid nesting – Preview routes, avoid nests, 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. This is especially critical when clearing brush areas to gain access to sample locations.
		- 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.
		- Report potential hazards to the SSO.
		- As this activity may take personnel into areas of heavier vegetation, personnel should be cognizant of poison ivy, poison oak, and poison sumac in the area. See Section 6.3 for descriptions of these plants. Protective measures to be used to minimize hazards of this nature
		a) Avoid direct contact through the use of Tyvek coveralls, clothing, or barrier creams
		b) Wash after contact with cool water and mild soap.
		c) Wash equipment contaminated with the oils of these plants to avoid cross contamination.
		
		10) **Inclement Weather** - Suspend or terminate operations until directed otherwise by SSO.
		See Section 4.0 of the TtNUS Health and Safety Guidance Manual for additional information concerning natural hazards.
			Visual observation of work practices by the FOL and/or the SSO to minimize potential physical hazards (i.e., improper lifting, unsecured loads, cutting practices, etc.). Monitoring for chemical hazards are not required during this activity.	Level D - (Minimum Requirements)
				- Standard field attire (Sleeved shirt; long pants)
				- Safety shoes (Steel toe/shank)
				- *Leather gloves should be worn as necessary to protect the hands.*
				- *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 (At the direction of the FOL and/or the SSO).*
				
				As site conditions may change, the following equipment will be maintained during all on-site activities as prescribed in Section 2.0 of this HASP
				
				- Fire Extinguisher
				- First-aid kit
				
				Note: *The FOL and/or the SSO will determine the number of fire extinguishers and first-aid kits to be made available based on the number of operations to be conducted at any given time.*
					Not required.
					
					Good personal hygiene practices should be employed prior to breaks lunch or other period when hand to mouth contact occurs. This will minimize potential ingestion exposures.
					
					Site Preparation – A structured decontamination is not required for this activity. However, as some site preparation activities may require personnel to enter unimproved areas (heavy underbrush wooded areas) personnel should inspect themselves and one another for the presence of ticks when exiting wooded areas, grassy fields, etc. This action will be employed to assist in stopping the transfer of these insects into vehicles, homes, and offices.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER – CRANE, INDIANA

Task/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type/Action Levels	Personal Protective Equipment	Decontamination Procedures
Removal of Vegetation	***Chemical hazards:*** 1) Chemical hazards are anticipated to be minimal during any vegetation clearing in support of the surveying activity as the burial area currently has a cap. ***Physical hazards:*** 3) Rotating/cutting machinery 4) Noise 5) Biological hazards (Insect/animal bites and stings)	***Chemical hazards:*** 1) None anticipated in the areas where vegetation may need to be cleared to gain access. ***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 manufacturers design and documented as such using Equipment Inspection Checklist (See Attachment IV). - Only manufacturer approved parts may be used in repair of site equipment. - Operated by knowledgeable ground crew. - Restrictions at the operation (All personnel not directly supporting this clearance activity will remain at least 50 feet from the point of this operation). - Work areas will be kept clear of clutter. - Brush should be cut for lines of sight or passage through the area will be cut as close to the ground as possible to eliminate puncture and trip hazards. All brush should be cleared from the sight and/or walking path where persons will have to travel. - Brush hooks, machetes, chain saws should be kept sharp to provide ease of cutting. Broken or loose handles should be repaired prior to use. - Falling larger trees (>2inch girth) require two man operation. ***Chainsaw Operations*** Recommended Safe Work Practices: - Inspect the chainsaw prior to each use. Insure the blade is adjusted and sharp, and all parts are lubricated per the manufacturer's instruction. - Test all safety devices initially and then periodically to insure operational status. - When starting, place the chainsaw on the ground or some other firm surface. Place your foot in the hand guard at the rear of the saw, grip the top handle of the saw with one hand, pull the start cord with the free hand. Never attempt to start the saw free hand or by placing on your knee. - Never cut with tip of the chain saw blade. - Plan the cut. Know where the tree will fall. Have a clear escape plan when dropping trees greater than 2 inches in girth. - Preview the tree to be dropped. Often, red wasps will nest in hollowed out trunks and in tree tops. - Do not stand between falling trees and branches and fix items or other trees. - Do not cut over your head. - Do not cut materials other than wood with the chain saw. - Where prescribed safety equipment. - Monitor, the condition of the saw during use, make adjustments, as necessary. - When limbing a tree, to the extent possible cut from the other side of the trunk which will serve as a shield. - Be attentive as to which way the trunk may move when removing limbs, place yourself out of the anticipated pathway when cutting. - Be attentive to movement of the trunk as an indication of the stability of the tree and brush pile. - Keep the work area free from clutter to avoid potential slip, trip, and fall hazards. 4) Due to operations generated noise levels when using mechanical devices to clear vegetation, excessive noise control will be facilitated through the use of hearing protection. 5) **Insect/Animal Bites and Stings and Poisonous Plants** - To combat the potential impact of natural hazards, the following actions are recommended - Avoid nesting – Preview routes, avoid nests, 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. This is especially critical when clearing brush areas to gain access to sample locations. - 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. - Report potential hazards to the SSO. - As this activity may take personnel into areas of heavier vegetation, personnel should be cognizant of poison ivy, poison oak, and poison sumac in the area. See Section 6.3 for descriptions of these plants. Protective measures to be used to minimize hazards of this nature a) Avoid direct contact through the use of Tyvek coveralls, clothing, or barrier creams b) Wash after contact with cool water and mild soap. c) Wash equipment contaminated with the oils of these plants to avoid cross contamination.	**Based on historical information and the type of activities and the contaminants of concern, it is not anticipated that field crews associated with this task will be overexposed to any of the site contaminants.** 4) The SSO may perform noise dosimetry to ensure the operational activities, and any contributional levels associated with the operation do not surpass the noise attenuation factors associated with the hearing protection selected. This will be at his/her discretion.	The removal of vegetation is anticipated to be initiated in a modified Level D protection. Level D - (Minimum Requirements) For vegetation clearance activities: - Tyvek coveralls (Based on site conditions, time of the year, etc.) - Field attire (Long sleeve shirt; long pants) - Safety shoes (Steel toe/shank) - Safety glasses/chippers shield - Hardhat (when overhead hazards exists, or identified as a operation requirement) - Hearing protection - Work gloves - Chain saw chaps and screened face shield for the chain saw operator This HASP will serve as the primary reference for hazard control measures, however, as the Safe Work Permit (Attachment III) will incorporate site-specific conditions, it will take precedence over the HASP when conflict arises over the more conservative measures to be incorporated.	**Personnel Decontamination** It is not anticipated that site personnel engage in this task will encounter any of the associated site contaminants. Therefore, personnel decontamination will consist of - Equipment drop - Remove disposable outer protective garments as applicable - Wash hands and face, leave contamination reduction zone As this activity will have personnel entering and working in high brush, field personnel should perform a visual inspection of themselves and partners of their outer garments for ticks. A closer self inspection should be performed when showering for any vectors of this type which may have gotten under your clothing and attached to your body. Areas to check closely are those which are more moisture laden, inside socks, groin area, arm-pits, etc. See Section 4.0 of the Health & Safety Guidance Manual for additional information concerning this hazard. **Equipment Decontamination** All equipment employed will undergo a high pressure/ steam cleaning as a precautionary measure.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER - CRANE, INDIANA

Tasks/ Operation Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring–Types & Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO dictate.)*	Decontamination Procedures
Subsurface activities including: • Soil Boring activities • Installation of Monitoring Wells via hollow stem auger or direct push technologies • Hand auger	***Chemical hazards:*** 1) The potential chemical hazards exist at SWMU 2 in two different physical states, these are as follows: **Dyes and Dye Intermediates** – Examples of these types of substances have been provided in Section 6.1. In general these substances are anticipated to be in a particulate or particulate bound form. These substances generally exhibit low level toxicities and contact point irritation. Chronic exposure to some of the active ingredients have been shown to exhibit carcinogenic properties in test animals. In addition to the dyes, the following metals were detected in soils and groundwater: **Metals** - Antimony, arsenic, barium, beryllium, manganese, mercury, nickel, and lead. Volatile Organic Compounds (VOCs) - As part of the general screening process and IDW Management Plan soil cuttings will be scanned using a PID to determine if contaminants of this nature possibly exist. General categories of contaminants of this nature would include chlorinated solvents; petroleum products (Benzene, toluene, ethylbenzene, and xylenes); paint solvents and strippers. Materials such as these offer the greatest potential for exposure and are quite mobile in the environment. Health effects associated with compounds of this nature typically result in irritation at points of contact, central nervous system depression (dizziness, confusion, narcotic effects). Chronic exposure may result in dermatitis, chemical pneumonia (inhalation), and possible kidney and liver damage. It should be noted that these chronic exposures are not anticipated based on the short duration of the work and minimization of potential exposure. It is provided for informational purposes only. Section 6.1 provides limited information concerning the health effects of the major dye classes. Table 6-1 provides additional information about the metals identified as contaminants of concern. - Well construction materials 2) Transfer of contamination into clean areas or onto persons. ***Physical hazards:*** 3) Rotating equipment and moving machinery 4) Cuts and Lacerations Pinch/compression points 5) Strain/muscle pulls from heavy lifting 6) Vehicular and foot traffic 7) Slips, trips, and falls 8) Natural hazards (insect/animal bites or stings, poisonous plants, etc.) 9) Inclement weather including ambient temperature extremes. 10) Noise > 85 dBA 11) Energized systems	***Chemical hazards:*** 1) Use real-time air monitoring instrumentation (PID) and established action levels will be used to detect and identify exposures to VOCs. Appropriate safe work practices (See Section 5.1 and 5.2) and PPE to minimize the potential for exposure. The majority of the potential contaminants of concern (dyes and metals) are likely to be present in the form of particulates or bound to particulates. Real-time air monitoring instruments are ineffective for detecting these contaminants. Visual observation will be the most likely method of detection. Therefore, generation of dusts should be minimized to the greatest extent possible. If airborne dusts are observed, area wetting methods will be used. If area wetting methods are not feasible or are ineffective, task activities will be terminated to minimize exposure to excessive airborne dusts. Dusts concentrations are visible at 2 mg/m^3 concentrations. This level or concentration will provide ample opportunity to implement dust suppression methods to control airborne dusts prior to reaching levels where the potential for exposure could occur. - Review all MSDSs for well construction materials to be used. The primary concern (short term) is irritation of the eyes and skin (alkaline in nature). For this reason a portable eyewash should be made available for flushing eyes. Some of the dye materials that are to be investigated are used to make a variety of colored smokes for battlefield applications. The mechanism employed uses mechanical or thermal means to discharge/volatize the dye components into the atmosphere. From that point hydrolysis or hydration (dependent on dye type) reacts with the dye compounds to create the smoke and by products. Therefore, storage of free dye liquid product or solid dye product should be stored away from moisture to avoid reaction with atmospheric moisture. Once reaction occurs the smoke products recondensate to particulate form (smoke). Should this scenario be encountered move to an upwind location and allow the reaction to occur. 2) Decontaminate all equipment and supplies between sampling events as well as prior to leaving the site. ***Physical hazards:*** 3) All equipment to be used will be - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600, .601, .602), and manufacturers design. These inspections will be documented as such using Equipment Inspection Checklist (See Attachment IV). - Operated by knowledgeable or certified (as required) operators, and ground crew. - Only manufacturer approved equipment may be used in conjunction with equipment repair procedures (i.e., pins for auger flights etc.). In addition to the equipment considerations, the following standard operating procedures will be employed: - All personnel not directly supporting the drilling operation will remain at least the height of the mast plus 5 feet away from the point of operation. - All loose clothing/protective equipment, jewelry, and hair will be secured to avoid possible entanglement. - Hand signals will be established if communication through normal means is impeded due to noise or some other means of obstruction. This will be done, if necessary, prior to the commencement of drilling. - 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. - 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 direct push rig and support vehicles to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO. - The direct push rig and support vehicles will be moved no closer than 5-feet to unsupported side-walls of excavations and embankments. These and other Safe Work Practices are provided in Section 5.1 through 5.2.3. 4) **Cuts and Lacerations** - To prevent cuts and lacerations associated with extracting samples from the acetate liners of the Macro-Core Sampler during DPT operations, the following provisions are required: - Obtain and use the knife and acetate tube retention tub recommended by Geoprobe to prevent accidents of this nature. These items have been engineered to allow sample acquisition without putting the sampler at risk. - Always cut away from yourself and others, then, if a knife slips, you will not impale yourself or others. - Do not place items to be cut in your hand or on your knee. Change out blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments. 5) **Pinch and Compression Points** – The following provisions apply - Keep hands and feet away from pinch points. - Ensure stacked equipment is secured to avoid potential collapse and injury. 6) **Lifting Hazards** - Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques as described in mobilization/demobilization and Section 6.2.3. 6) **Vehicle and Foot Traffic** - Areas will be inspected prior to the movement of drill rigs and support vehicle to eliminate any physical hazards or conditions that may predispose an activity to a physical hazard. This will be the responsibility of the FOL and/or SSO. - Drill rigs and support vehicles will be moved no closer to banks, ditches, and other excavations than 3 feet unless the wall is supported. 7) **Slips, Trips, and Falls** - Preview work locations for unstable/uneven terrain. - Cover, guard and barricade all open pits, ditches, and embankment that encroach upon the area of operation, as necessary. - Ruts, roots, tools, and other tripping hazards should be eliminated approaching points of operation to minimize trips and falls when approaching operating/rotating equipment. - Maintain a clutter free work area. - As part of site control efforts construct fences or other means of demarcation (i.e. signs and postings) to control and isolate traffic in the work area. Demarcation is as necessary. See Section 6.2.1 for more information. 8) **Natural Hazards (Insect/animal bites/stings or poisonous plants** - Wear appropriate clothing and PPE. Avoid potential nesting areas and suspicious vegetation (poison ivy, poison oak, etc.). When feasible and necessary, use commercially available insect repellents. Refer to the Health and Safety Guidance Manual for additional information regarding ticks and Lyme's disease. Tape ankle and wrist areas to prevent tick, chiggers, etc. from getting under clothing and attaching to skin. Wear light colored clothing so that ticks and other insects can be easily visible. 9) **Ambient Temperature Extremes and Inclement Weather** - Suspend or terminate operations until directed otherwise by SSO. See Section 4.0 of the Health & Safety Guidance Manual for directions concerning heat/cold stress. 10) Wear hearing protection when working near operating machinery (Steam/pressure washer or Drill rig). 11) All subsurface activities will be proceeded by utility clearance using the Tetra Tech NUS Utility Locating and Excavating Clearance SOP. All subsurface activities will be accounted for using the Utility Clearance Form provided in Attachment II.	**It is generally anticipated that potential contaminant concentrations at outdoor locations will be below levels that could present a health hazard. However, as some of the materials may be unreacted in containers these substances present both a thermal hazard and an inhalation hazard.** A Photoionization Detector w/ 10.6 eV UV lamp source will be used as a general screening instrument for VOCs. The following guidance applies: Source (e.g., borehole) monitoring will be conducted periodically during intrusive work. The SSO will also monitor the breathing zone (BZ) of all potentially affected employees. Workers must evacuate to a safe area if sustained BZ concentrations exceed background measurements. General Categories of VOCs – Correction factors to be employed for general VOC Screening is 0.4. This represents general chlorinated solvents and BTEX compounds. Therefore multiply all results by the correction factor to obtained estimated concentration. **Action Level for Volatile Emissions:** Action level - 10 ppm in the workers breathing zone for no greater than 10 minutes duration, no more than 4 occurrences in a single day. Action levels of this level will protect personnel from achieving the most conservative TLV/TWA. Site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to the greatest extent possible to avoid inhalation of contaminated dusts or particulates. Dusts/particulates – All dust/particulate concentrations will be maintained to below visual recognition which is estimated at 2 mg/m^3. Concentration in excess of this action level require personnel to stop work, notify PHSO. As some of the compounds may react through hydrolysis or hydration the appearance of the signal smoke, this will serve as a primary indicator. The appearance of smoke within or eminating from the borehole will require all personnel to cease activities and move to an upwind refuge location until the reaction terminates. Noise monitoring will be conducted at the discretion of the PHSO and/or the SSO. Action Level - >85 dBA Participation in the Project Hearing Conservation Program. Hearing protection is required for this operation. Noise level measurements of greater than 105dBA will require the use of combination plugs and muff for noise protection. All sound level measurements and noise dosimetry should proceed in accordance with the project Hearing Conservation Program (See Attachment VI).	All soil boring operations will be initiated in Level D protection, including the following articles: *Sampler/Oversight Personnel* - Standard field dress (long pants, Sleeved shirts) - Steel toe safety shoes or work boots - Hard hat(when within 25-feet of the direct push rig or the height of the mast + 5-feet when near the HSA Rig) - Safety Glasses(when within 25-feet of the direct push rig or the height of the mast + 5-feet when near the HSA Rig) or when sampling) - Nitrile surgeon style inner gloves for sampling - Hearing protection (when within 25-feet of the direct push rig or the height of the mast + 5-feet when near the HSA Rig) - *Impermeable boot covers* - *Reflective vest for traffic areas* **Driller and Driller Helper** - Standard field attire including sleeved shirt and long pants - Safety shoes (Steel toe/shank) - Safety glasses - Nitrile inner and outer gloves - Hearing protection - Hard hat - Impermeable boot covers - Because heavier items such as MacroCore Samplers and auger flights must be handled close to the body because of their weight, Impermeable aprons are recommended for handling these items to prevent soiling work clothes As site conditions may change, the following equipment will be maintained during all on-site activities - Fire Extinguishers - First-aid Kit - Portable Eyewash **Note:** The Safe Work Permit(s) for this task (See Attachment III 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.	**Personnel Decontamination** - Will consist of a soap/water wash and rinse for outer protective equipment (boots, gloves, etc.) as applicable. This function will take place at an area adjacent to the soil boring or well installation operations bordering the support zone. This decontamination procedure for will consist of - Equipment drop - Soap/water wash and rinse of reusable PPE (outer gloves and outer boots), as applicable - Removal and disposal of disposable PPE, as applicable - Wash hands and face, leave exclusion zone perimeter To insure contaminants do not travel on equipment to other locations or onto clean persons the FOL and/or the SSO will perform a decontamination evaluation. This evaluation Will be completed as follows: For Persons – Visual For Equipment – Visual & Monitoring instrument scan.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER - CRANE, INDIANA

Tasks/Operation Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring – Types & Action Levels	Personal Protective Equipment *Italicized items will be employed as directed by the FOL and/or the SSO based on site conditions*	Decontamination Procedures
Multi-media sampling, including - Surface water – direct pour or pump - Ground water – Peristaltic or bladder pumps - Surface soils and Sediments – Trowel - Subsurface soils – hand auger, soil corers, and mechanized support. Protective measures as recommended her shall also apply to aquifer development, water level measurements, and hydraulic conductivity testing.	***Chemical hazards:*** 1) The potential chemical hazards exist at SWMU 2 in two different physical states, these are as follows: **Dyes and Dye Intermediates** – Examples of these types of substances have been provided in Section 6.1. In general these substances are anticipated to be in a particulate or particulate bound form. These substances generally exhibit low level toxicities and contact point irritation. Chronic exposure to some of the active ingredients have been shown to exhibit carcinogenic properties in test animals. In addition to the dyes, the following metals were detected in soils and groundwater: **Metals** - Antimony, arsenic, barium, beryllium, manganese, mercury, nickel, and lead. **Volatile Organic Compounds (VOCs)** - As part of the general screening process and IDW Management Plan soil cuttings will be scanned using a PID to determine if contaminants of this nature possibly exist. General categories of contaminants of this nature would include chlorinated solvents; petroleum products (Benzene, toluene, ethylbenzene, and xylenes); paint solvents and strippers. Materials such as these offer the greatest potential for exposure and are quite mobile in the environment. Health effects associated with compounds of this nature typically result in irritation at points of contact, central nervous system depression (dizziness, confusion, narcotic effects). Chronic exposure may result in dermatitis, chemical pneumonia (inhalation), and possible kidney and liver damage. It should be noted that these chronic exposures are not anticipated based on the short duration of the work and minimization of potential exposure. It is provided for informational purposes only. Section 6.1 provides limited information concerning the health effects of the major dye classes. Table 6-1 provides additional information about the metals identified as contaminants of concern. 2) Transfer of contaminants into clean areas or onto persons ***Physical hazards:*** 3) Slip, trip, and fall hazards 4) Strain/muscle pulls from manual lifting 5) Cuts and Lacerations 6) Ambient temperature extremes (heat/cold stress) 7) Site Characterization ***Natural hazards:*** 8) Animal and insect bites and encounters 9) Inclement weather	***Chemical hazards:*** 1) Employ real-time monitoring instrumentation, action levels, personal sampling, and identified PPE to identify, quantify, and control exposures to potentially contaminated media (e.g., air, water, soils). 2) Restrict the cross use of equipment and supplies between sampling locations without first going through a suitable decontamination. ***Physical hazards:*** 3) **Slip, Trip, and Fall Hazards** – These hazards shall be minimized by adherence to the practices listed below. This includes - Maintain proper housekeeping in all work areas. - Preview and inspect work areas to identify and eliminate slip, trip, or fall hazards. - Cover, guard, barricade, and or place warning postings over/at holes or openings that personnel may fall or step into. - For traversing steep, slippery, or sloped terrain establish rope ladders to control ascent and descent to sampling areas or use alternative pathways. - Use multiple persons and pack small loads to remote locations. 4) **Strain/Muscle Pulls from Manual Lifting** - Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques (See Lifting Mobilization/Demobilization, Page 1 of 6, Table 5-1 and Section 6.2.3). 5) **Cuts and Lacerations** – Employ the following measures to reduce and/or eliminate the potential for cuts and lacerations - Obtain and use the knife and acetate tube retention tub recommended by Geoprobe to prevent potential cuts and lacerations when accessing samples within MacroCore acetate liners. These items have been engineered to allow sample acquisition without putting the sampler at risk. - Select and secure the most favorable route to monitoring wells and sampling locations. - Previewing pathways - Where possible, remove or demarcate the physical hazards. - Inspect all cutting equipment to be used to clear access routes for defects. - When cutting items - always use a sharp knife and always cut away from your body. Do not place items to be cut in your opposite hand or on your knee. - Carry all glassware and items that present a potential for cuts, lacerations, or impalement such as machetes or brush hooks in protective packaging or sheathed to avoid breakage or exposure in the event of a slip, trip, and/or fall. See also Section 6.2.2 for more information. 6) **Ambient Temperature Extremes (Heat/Cold Stress)** - 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. 7) **Site Characterization** - 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. 8) **Animal and Insect Bites and Encounters** - To combat the potential impact of natural hazards, the following actions are recommended: - Avoid nesting – Preview routes, avoid nests, 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 working in snake infested areas personnel are directed to adhere to the following provisions: a. Leave snakes and animals alone, do not harass or try to capture. Contact the SSO for direction in the removal of animals and snakes within the confines of the work site. b. Snake chaps or high leather boots should be worn in unimproved or unmaintained areas on an initial sweep of the area, if you are unknowledgeable regarding nesting and habitat considerations for indigenous animals and reptiles. c. Keep hands and feet out of areas you cannot see. Exercise extreme care when lifting materials or debris providing ground cover as snakes and other animals prefer these areas to nest. d. Be cautious when moving debris or other structures, that may serve as a nest. Do not use your hands to separate debris piles. Use equipment (hand tools or heavy equipment, as available). - As this activity may take personnel into areas of heavier vegetation, samplers should be cognizant of poison ivy, poison oak, and poison sumac in the area. See Section 6.3.3 for descriptions of these plants. Protective measures to be used to minimize hazards of this nature a) Avoid direct contact through the use of Tyvek coveralls, clothing, or barrier creams b) Wash after contact with cool water and mild soap. c) Wash equipment contaminated with the oils of these plants to avoid cross contamination. 9) Suspend or terminate operations during electrical storms. Return to work when directed by the FOL and/or the SSO.	**It is anticipated that potential contaminant concentrations at outdoor locations will be below levels that could present a health hazard. Even once intrusive activities take place it is not anticipated that the contaminants in question would volatize at a significant rate to present a hazard to field crews without sufficient warning unless a container is struck.** A Photoionization Detector w/ 10.6 eV UV lamp source will be used as a general screening instrument for VOCs. The following guidance applies: Source (e.g., borehole) monitoring will be conducted periodically during intrusive work. The SSO will also monitor the breathing zone (BZ) of all potentially affected employees. Workers must evacuate to a safe area if sustained BZ concentrations exceed background measurements. General Categories of VOCs – Correction factors to be employed for general VOC Screening is 0.4. This represents general chlorinated solvents and BTEX compounds. Therefore multiply all results by the correction factor to obtained estimated concentration. **Action Level for Volatile Emissions:** Action level - 10 ppm in the workers breathing zone for no greater than 10 minutes duration, no more than 4 occurrences in a single day. Action levels of this level will protect personnel from achieving the most conservative TLV/TWA. Site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to the greatest extent possible to avoid inhalation of contaminated dusts or particulates. **Action Levels for Dusts/Particulates:** Dusts/particulates – All dust/particulate concentrations will be maintained to below visual recognition which is estimated at 2 mg/m^3. Concentration in excess of this action level require personnel to stop work, notify PHSO. As some of the compounds may react through hydrolysis or hydration the appearance of the signal smoke, this will serve as a primary indicator. The appearance of smoke within or eminating from the borehole will require all personnel to cease activities and move to an upwind refuge location until the reaction terminates.	Level D protection will be utilized for the following sampling activities Surface water, groundwater, and sediments Sampler/Oversight Personnel - Standard field dress (long pants, Sleeved shirts) - Steel toe safety shoes or work boots - Safety Glasses - Nitrile surgeon style inner gloves for sampling **When working Around the Drill Rigs** - Hard hat(when within 25-feet of the direct push rig or the height of the mast + 5-feet when near the HSA Rig) - Safety Glasses(when within 25-feet of the direct push rig or the height of the mast + 5-feet when near the HSA Rig) or when sampling) - Hearing protection (when within 25-feet of the direct push rig or the height of the mast + 5-feet when near the HSA Rig) - *Impermeable boot covers* - *Reflective vest for traffic areas* Protective Measures as specified for drilling and soil boring will be employed for all subsurface soil sampling. **Upgrades to Level C protection are not anticipated.** **Note:** The Safe Work Permit(s) for this task (See Attachment III) 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. This HASP will serve as the primary reference for hazard control measures, however, as the Safe Work Permit will incorporate site-specific conditions it will take precedence over the HASP when conflict arises over the more conservative measures.	**Personnel Decontamination** - This decontamination procedure for will consist of **Fixed Station:** - Equipment drop - Soap/water wash and rinse of reusable PPE (outer gloves and outer boots), as applicable - Removal and disposal of disposable PPE, as applicable - Wash hands and face, leave contamination reduction zone **Remote Sampling Locations:** - 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 sampling equipment will undergo a soap/water wash and rinse utilizing a suitable potable water source until visibly clean. Sampling equipment may also be steam cleaned. All chemical decontamination will proceed in accordance with the other site documents such as QA/QC and the Sampling Analysis Plan.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER - CRANE, INDIANA

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 a centralized location. 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 potential chemical hazards exist at SWMU 2 in two different physical states, these are as follows: **Dyes and Dye Intermediates** – Examples of these types of substances have been provided in Section 6.1. In general these substances are anticipated to be in a particulate or particulate bound form. These substances generally exhibit low level toxicities and contact point irritation. Chronic exposure to some of the active ingredients have been shown to exhibit carcinogenic properties in test animals. In addition to the dyes, the following metals were detected in soils and groundwater: **Metals** - Antimony, arsenic, barium, beryllium, manganese, mercury, nickel, and lead. Volatile Organic Compounds (VOCs) - As part of the general screening process and IDW Management Plan soil cuttings will be scanned using a PID to determine if contaminants of this nature possibly exist. General categories of contaminants of this nature would include chlorinated solvents; petroleum products (Benzene, toluene, ethylbenzene, and xylenes); paint solvents and strippers. Materials such as these offer the greatest potential for exposure and are quite mobile in the environment. Health effects associated with compounds of this nature typically result in irritation at points of contact, central nervous system depression (dizziness, confusion, narcotic effects). Chronic exposure may result in dermatitis, chemical pneumonia (inhalation), and possible kidney and liver damage. It should be noted that these chronic exposures are not anticipated based on the short duration of the work and minimization of potential exposure. It is provided for informational purposes only. Section 6.1 provides limited information concerning the health effects of the major dye classes. Table 6-1 provides additional information about the metals identified as contaminants of concern. It should be noted that in this process the majority of the materials (gross contamination) have been removed during removal of the equipment at the sample location. Contamination is expected to be minimal. 2) Decontamination fluids - Liquinox (detergent); isopropanol (decontamination solvent); diesel fuel (steam cleaner) ***Physical hazards:*** 3) Lifting (strain/muscle pulls) 4) Noise in excess of 85 dBA 5) Flying projectiles 6) Falling hazards 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 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) Insure wash and drying racks are of suitable construction to prevent heavier items such as push rod flights from falling during the decontamination 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. Monitoring instrumentation will be employed to determine if all of the decontamination solvent (isopropanol) has been removed through the rinse process. Any positive indication/results greater than background require the article that has been decontaminated to be re-rinsed and scanned again. If necessary this process should be repeated until no measurable indication of the decontamination solvent exists.	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. Impermeable aprons may be used instead of coveralls if they offer adequate protection against overspray and back splash. **For sampling equipment** (trowels, 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 III) 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 **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner or pressure washer. 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 cleaned/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 indicated within the 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
NAVAL SURFACE WARFARE CENTER - CRANE, INDIANA

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 The locations identified to be surveyed are predominantly located surrounding a capped area. These activities will take place over the cap and along the surrounding wooded areas. This area (the cap) is mowed periodically. This should minimize the necessity to cut clear lines from vertical and horizontal control monuments.	***Chemical hazards:*** 1) Significant exposure to site contaminants is anticipated to be unlikely given the nature of this task. ***Physical hazards:*** 2) Slips, trips, and falls 3) Struck by 4) Ambient temperature extremes (heat/cold stress) ***Natural hazards:*** 5) Inclement weather 6) Insect/animal bites or stings, poisonous plants, etc.	***Chemical hazards:*** 1) None anticipated ***Physical hazards:*** 2) 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.) 3) 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/cutting 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 >2-inch girth will be required to be dropped as part of this operation or that significant amount of clearing will be required. Therefore the use of chainsaws and chippers as well as other motorized equipment will not be addressed. 4) Ambient Temperature Extremes **(Inclement Weather)** – To minimize hazards of this nature, the following provisions shall be employed - Wear appropriate clothing for weather conditions. - Provide acceptable shelter and replacement liquids for field crews as relief from excessive ambient temperatures. - Under conditions of elevated temperatures allow for periods of acclimatization. ***Natural hazards:*** 5) Suspend or terminate operations until directed otherwise by SSO 6) To combat the potential impact of natural hazards, the following actions are recommended - Avoid nesting – Preview routes, avoid nests 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. - As this activity may take personnel into areas of heavier vegetation, samplers should be cognizant of poison ivy, poison oak, and poison sumac in the area. See Section 6.3 of this HASP for descriptions of these plants. Protective measures to be used to minimize hazards of this nature a) Avoid direct contact through the use of Tyvek coveralls, clothing, or barrier creams b) Wash after contact with cool water and mild soap. c) Wash equipment contaminated with the oils of these plants to avoid cross contamination. See Section 4.0 of the TtNUS Health and Safety Guidance Manual for additional information concerning natural hazards.	Air monitoring is not required given the unlikelihood that airborne contaminants will be present. The potential for exposure to site contaminants during this activity is considered minimal.	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 - Shoes rugged lug sole for traction - Work gloves shall be worn when clearing brush. - *Safety glasses, hard hats (if working near machinery, overhead hazards, or clearing brush)* - *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.* - *Reflective or blaze orange vests should be worn when working along traffic thoroughfares.* **Note:** The Safe Work Permit(s) for this task (See Attachment III) 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** - 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. In addition, early detection shall provide for early removal.

6.0 HAZARD ASSESSMENT

The following section provides information regarding the chemical, physical, and biological hazards associated with the NSWC CRANE Site and the activities that are to be conducted as part of the scope of work.

6.1 CHEMICAL HAZARDS

It should be noted the following information represents the types of dyes that could exist at the Dye Burial Grounds. This information was information gathered concerning the types employed at the facility during the Initial Assessment Survey (IAS). This is certainly, by no means implying that all of these substances were disposed of at this location. Information regarding the primary types of dyes which could be encountered during this field investigation effort are as follows:

Azo/aniline compounds – Acute reactions - These compounds generally have been shown to be primary. irritants at all points of contact. Prolonged contact has been shown to result in contact dermatitis, while others resulting in allergic reactions which become more evident on subsequent exposures. Systemically, the most toxic routes of exposure have been demonstrated to be through ingestion and inhalation resulting in headaches, nausea, vomiting, diarrhea, coughing, wheezing, and difficulty in breathing.
Chronic Exposure – Many of these dye components have been demonstrated to be cancer causing and reproductive toxins of varying degrees. Toxicity information has largely been generated through animal testing.

Anthraquinone compounds – While these substances have expressed limited evidence in laboratory animals concerning carcinogenicity, the evidence is not as overwhelming as that of the Azo/aniline compounds.

Quinoline compounds – Acute exposure – Symptoms include irritation at all points of exposure. Respiratory effects include coughing, difficulty in breathing, tightness of the chest, as well as a burning sensation in the lungs. Eye and skin irritation generally resulted in excessive tearing, runny nose, itchy red and dry skin. Gastro- and neurological disorders resulting from ingestion and inhalation were not significant. Testing has indicated that up to several hundred milligrams have been ingested without serious side effects. Chronically, carcinogenic activity has been reported in test animals, sufficient evidence in humans has not been substantiated.

Xanthene compounds – Primary irritants to the skin and eyes, some of which may be from mechanical irritation.

Auramine Compounds – These substances have been shown to effect exposure through inhalation and dermal contact. Systemically, auramine compounds can interfere with the red blood cells ability to carry oxygen. This can result in weakness, shortness of breath, and a bluish color to the fingernails, nose and lips. These substances have been shown to be irritating at all points of contact. Chronic effects include possible liver and kidney damage. Auramine is probably carcinogenic, however, this action may be a synergistic response with other substances. Extreme care should be exercised when handling these substances.

The contaminants selected for inclusion in Table 6-1 is based on information obtained from the most recent sampling event. This is the most recent information concerning contaminant levels in the soils and groundwater surrounding SWMU 2. With the exception of the dyes which is the focus of this investigation.

6.2 PHYSICAL HAZARDS

The following is a list of physical hazards that may be encountered at any of the sites identified above or may present during the performance of site activities associated with the scope of work.

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

6.2.1 Slips, Trips, and Falls

Conditions such as steep or slippery terrain, steps and/or heavy vegetation may create an increased potential for slip, trip, and fall hazards. This hazard is associated with all activities, however, most predominantly during mobilization during site preparation activities. The following measures shall be employed to minimize hazards of this nature:

- 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, and debris). This is especially critical around rotating and/or operating equipment.

- Stairways leading into trailers should be equipped with anti-slip treads to minimize the potential for slipping.

- Larger vehicles with elevated access ways will be equipped with hand holds, ladders, walkways (non-slip surfaces), guardrails.

- Erect barriers in areas of high fall probabilities.

- Keep aisle-ways and work areas clear of clutter and storage.

6.2.2 Cuts or Other Injuries Associated with Hand Tool Use

A number of accidents have been reported over the last few years regarding persons cutting themselves while extracting samples from within acetate lines used in MacroCore Samplers to be employed on these projects.

This activity has resulted in numerous cuts to hands and legs, as persons attempt to slice open the liners, while resting the liner in their opposite hand or on their leg.

To minimize this hazard, it is recommended that the knife system and acetate liner holder developed by Geoprobe be used. These items have been engineered to allow sample acquisition without putting the sampler at risk. In addition, the following safe work practices will assist in the minimization of this hazard:

- Always cut away from yourself and others, then, if a knife slips, you will not impale yourself or others.

- Do not place items to be cut in your hand or on your knee.

- Change out blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments.

- When cutting tools are not in use or are being transported to another area retractable blades should be retracted into the protective housing and sheaths should be placed on non-retractable blades to avoid inadvertent cuts and lacerations from exposed blades.

While this hazard are most predominantly associated with DPT activities, hazards of this nature should not be ruled out when associated with more mundane tasks such as

- Mobilization/demobilization
  - Cutting open and packing boxes and coolers
  - Clearing vegetation for such activities such as site preparation while accessing remote sample locations.
- Surveying – Clearing lines of site.

6.2.3 Strains/Muscle Pulls

Worker injuries resulting from improper manual material handling activities are easily prevented through observation of proper lifting and carrying methods. These types of injuries are not limited to merely the factor of the weight of the load. Other considerations include how many lifts will be involved (i.e., repetitive lifting of even small loads), the size, shape, and/or configuration of the load to be lifted, and whether or not the load will need to be lifted to another height or carried to another location. All workers involved with these types of activities are to be instructed by the SSO in the following manner:

- First estimate the weight and configuration of the load (i.e., is it bulky or hard to safely grasp/lift/control). If it appears to be too heavy or bulky to safely handle alone, either use a mechanical lifting device or obtain help from another employee to lift the load (Note: The use of mechanical lifting devises is ***always*** preferable over manual lifting).

- Bend at the knees (not at the waist) when attempting a lift.

- Ensure that a firm hold is obtained, and keep the load as close to the body as possible.

- Lift the load using your legs, and not the back.

- Avoid turning or twisting while holding a load.

- If the load is to be moved, preview the path of travel first to identify and eliminate any tripping hazards.
- Do not attempt to carry loads that obstruct the line of sight.
- When setting a load down, again use the leg muscles and do not bend at the waist.

Hazards of this nature are most predominant when:

- Mobilization/demobilization – Lifting and stocking heavy boxes and coolers
- Sampling Activities – Lifting and handling heavy coolers. Packing heavy coolers and IDW from remote locations and/or over uneven and slippery terrain.
- Drilling/Decontamination activities – When handling heavy auger flights
- IDW Management – When attempting to handle partially full/full containers of IDW.

6.2.4 Ambient Temperature Extremes - Heat/Cold Stress

Given the geographic location of the site, overexposure to ambient temperature extremes (heat/cold stress) may exist during performance of this work depending on the project schedule. Work performed when ambient temperatures exceed 70°F may result in varying levels of heat stress (heat rash, heat cramps, heat exhaustion, and/or heat stroke) depending on variables such as wind speed, humidity, and percent sunshine, as well as physiological factors such as metabolic rate and skin moisture content. Additionally, work load and level of protective equipment will affect the degree of exposure. Site personnel will be encouraged to drink plenty of fluids to replace those lost through perspiration. Fatal exposures to cold stress may also result from accidental exposures to low ambient temperatures as well as immersion into low temperature waters. Pain in the extremities and shivering are first signs of the potential on-set of cold stress. Adequate insulating layers of dry clothing, wind breaks where possible, and work-warm regimen to control the deleterious effects of cold stress. This is considered highly unlikely given the geographical location of the site and planned time frame for the work to be conducted.

Each of these physical hazards are 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.

6.2.5 Heavy Equipment Hazards (Pinch/compression points, rotating equipment, etc.)

Often the hazards associated with drilling operations are the most dangerous to be encountered during site activities. The SSO will thoroughly discuss safe drilling procedures during the pre-activities training session. All site personnel will sign the form in Figure 8-2 documenting that they received the training and

understand the procedures. Although this hazard has limited applications for direct push rigs, only when coring concrete and asphalt, the following rules will apply to all drilling operations:

- Each rig must be equipped with emergency stop devices which will be tested daily to ensure that they are operational.
- The driller may not leave the controls when any attachment and/or tooling are rotating.
- All equipment that is to be operated must first be closely inspected to ensure that adequate machine guarding is in place.
- No maintenance or other activities is to be performed on operating machines.
- All employees whose duties places them in proximity to moving machinery items are to avoid wearing jewelry, or have long (unrestricted) hair, or loose fitting clothing.
- The use of home-made or jury-rigged machine parts is strictly prohibited. All equipment parts must be manufacturer provided or approved.

6.2.6 Energized Systems (Contact with Underground or Overhead Utilities)

Underground utilities such as pressurized lines, water lines, telephone lines, buried utility lines, and high voltage power lines are known to be present throughout the facility. Clearance of underground and overhead utilities for each sample location will be coordinated with NSWC Crane personnel. All work must be consistent with the SOP for Utility Locating and Excavation Clearance (See Attachment II of this HASP). Additionally, drilling operations will be conducted at a safe distance (>20 feet) from overhead power lines. Whenever underground utilities are suspected to be close to subsurface sampling locations, the bore-hole will be advanced to a minimum of 5.0 feet with a hand auger prior to drilling. It should be noted that all pilot holes must represent the diameter of the intended down-hole tooling. Therefore, it may be necessary to advance multiple hand auger holes to cover an area sufficient in size of that representing an 8.25 inch auger flight. As built drawings may also be utilized for additional clarification. In certain cases, Base personnel may need to de-energize electrical cables using facility lockout/tagout procedures to insure electrical hazards are eliminated.

6.2.7 Vehicular and Foot Traffic Hazards

Many of the sites identified are located within remote areas they still are active. The movement of personnel and vehicles within these areas, culminated with normal operating traffic can result in

hazardous conditions. To minimize hazards of this nature, the following measures are recommended practices to be employed by site personnel.

- Where possible minimize U-turns and backing unless a spotter is used.

- Park unattended vehicles out of the way from delivery/operational traffic patterns.

- If work is to be conducted within a thoroughfare
  - Use signs, barricades, and flag persons, as necessary to control vehicle traffic.
  - Try to schedule work in public thoroughfares and in locations that will be impacted during hours of operation for off-hours when foot and vehicular traffic will be the lightest.
  - Notify Security and Base personnel through the use of the Base Paper when traffic restrictions are anticipated.

- Obey all traffic regulations as posted on NSWC Crane.

- Always wear a seat belt during vehicle and/or self-propelled equipment operation.

6.2.8 Noise in Excess of 85 dBA

Worker exposure to noise that can approach hazardous levels is a common potential hazard on most project work sites. All workers who must work in areas or who must perform operations where noise levels can approach an 8-hour time weighted average of 85 decibels on the A-weighted scale (dBA) must have received hearing conservation training within the past 12 month period. If personnel have not had this training within the last 12 months, the training will be provided by the SSO at the project site prior to participating in high noise level activities. On this project, this is a predominant hazard associated with the advancement of soil boring tooling using the percussion and/or weighted slide hammer and during decontamination activities when using steam/pressure washers.

As a general rule-of-thumb to prevent worker exposure to high noise levels, workers will be informed to observe the following:

> *If ambient noise levels are loud enough that they have to raise their voice in order to communicate with another person who is less than 2 feet away, hearing protection will be required. Also, if any existing base operations are posted as high noise areas or that hearing protection is required in that area, then that protection will be used.*

Note: The SSO may be required to perform quantitative measurements, in situations where noise dosimetry or monitoring data exists.

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. These are further culminated by vector transmission.

6.3.1 Insect/Animal Bites and Stings, Poisonous Plants, etc.

Insect/animal bites and stings are difficult to control given the climate and environmental setting of NSWC Crane. 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 that 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, inside sock cuffs, 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 any 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 with them at all times with the prescribed treatment for their specific allergy. In situations where severe reactions are anticipated, the FOL and/or the SSO should remove these persons from potential exposure or at a minimum communicate the necessary emergency action as described by the person's physician to their field team members.

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

6.3.1.1 Ticks

During warm months (spring through early fall), tick-borne Lyme Disease may pose a potential health hazard. The longer a disease carrying tick remains attached to the body, the greater the potential for contracting the disease. Wearing long sleeved shirts and long pants (tucked into boots and taped). As well as performing frequent body checks will prevent long term attachment. Site first aid kits should be equipped with a tick cup and rubbing alcohol to assist in tick removal. For information regarding tick removal procedures, and symptoms of exposure consult Section 4.0 of the HSGM.

Attention: Historically, instruction has been provided to utilize forceps for tick removal. Certain references sources currently exist with that direction provided. However, using forceps improperly may cause the tick to regurgitate body fluids as pressure is applied to the body during removal. In addition, the use of oils, Vaseline, alcohol, cigarettes, lighters will also cause the tick to expel body contents in response to these measures. Therefore, a tick cup is recommended for removal, as its design permits the cup to be placed under the body and slide forward using a narrowing groove to contain, then slide under the head of the tick to facilitate removal.

Control measures as described in Section 6.3.1 will be employed to minimize this hazard.

6.3.1.2 Mosquito-Borne Illness

The Indiana Department of Health is urging people to take precautions to avoid potentially dangerous mosquitoes. Mosquitoes in Indiana may carry diseases including St. Louis encephalitis, Eastern equine encephalitis, La Crosse encephalitis and West Nile virus.

Mosquitoes become infected after biting infected birds. The symptoms for mosquito-borne illnesses may include headache, moderate to high fever, stiff neck and confusion. In serious cases coma, seizures or

paralysis can result. Symptoms usually appear between 5 to 15 days after exposure to infected mosquitoes. Mosquito-borne illnesses may be mild or serious and can lead to death.

West Nile Virus

Encephalitis is an inflammation of the brain and can be caused by bacteria and viruses. West Nile encephalitis is caused by a virus transmitted to humans by mosquitoes. West Nile virus is commonly found in Africa, West Asia, and the Middle East. It is closely related to St. Louis encephalitis virus found in the United States. The West Nile-like virus that has been found in United States is genetically related to West Nile virus, but because of genetic differences it may be a new subtype of West Nile virus.

The mosquito becomes infected by feeding on birds infected with the West Nile virus. Infected mosquitoes then transmit the West Nile virus to humans and animals when biting (or taking a blood-meal). West Nile encephalitis is NOT transmitted from person-to-person. There is no evidence that a person can get the virus from handling live or dead infected birds. However, avoid bare-handed contact when handling any dead animals, including dead birds. Ticks have not been implicated as vectors of West Nile-like virus.

Mild infections are common and include fever, headache, and body aches, often with skin rash and swollen lymph glands. More severe infection is marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, occasional convulsions, paralysis and, rarely, and death (especially in the elderly and very young). The incubation period of West Nile encephalitis is usually 3 to 12 days. There is no specific therapy or vaccine against West Nile encephalitis.

No cases have previously been reported in the U.S. prior to September 1999 (in New York). To date seven deaths in New York have been attributed to West Nile Virus.

Eastern Equine Encephalitis (EEE)

Eastern Equine Encephalitis is spread to horses and humans though the bite of an infected mosquito. The mosquito becomes infected after biting an infected bird. EEE can cause severe complications and even death. Symptoms for EEE in humans begin with high fever, chills, soar throat, nausea and vomiting. The illness can affect the central nervous system, cause sudden fever, severe headache, mental confusion, seizures and coma. Symptoms usually appear between 5 to 15 days after exposure to infected mosquitoes.

Precautions include:

- Limit outdoor activities during peak mosquito times – at dusk and dawn.
- Avoid standing water
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Apply insect repellent according to manufacturers instruction to exposed skin. An effective repellent will contain 20% to 30% DEET (N,N-diethyl-meta-toluamide). Avoid products containing more than 30% DEET.
- Spray clothing with repellents containing permethrin or DEET, mosquitoes may bite through thin clothing.

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.

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.

- Leave snakes and animals alone, do not harass or try to capture. Contact the SSO for direction in the removal of animals and snakes within the confines of the work site.

- Snake chaps or high leather boots should be worn in unimproved or unmaintained areas on an initial sweep of the area, if you are unknowledgeable regarding nesting and habitat considerations for indigenous animals and reptiles.

- Keep hands and feet out of areas you cannot see. Exercise extreme care when lifting structure providing ground cover as snakes and other animals prefer these areas to nest.

- Be cautious when moving debris or other structures, that may serve as a nest. Do not use your hands to separate debris piles. Use equipment (hand tools or heavy equipment, as available).

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.

6.3.3 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 or moving through 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.

Each of these physical hazards is discussed in the Health and Safety Guidance Manual. Additionally, information on these physical hazards and their associated control measures are discussed in Table 5-1 of the site specific HASP.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
PAGE 1 OF 4

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Antimony	7440-36-0	Particulate form - unable to be detected by PID/FID.	Air sample using particulate filter; acid desorption; atomic absorption spectrometry PeCam Sampling and analytical protocol shall proceed in accordance with NIOSH Method #261.	OSHA/NIOSH/ACGIH: 0.5 mg/m³ IDLH: 50 mg/m³	Metallic taste resulting from exposure. **Recommended Air Purifying Cartridges:** Protect from dusts, fumes, and mists use HEPA filters. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact.	**Boiling Pt:** 2975°F; 1635°C **Melting Pt:** 1166°F; 630°C **Solubility:** Insoluble **Flash Pt:** Nonflammable **LEL/LFL:** Nonflammable **UEL/UFL:** Nonflammable NOTE: This substance is nonflammable but may present a moderate explosion hazard when airborne dusts of an adequate concentration are exposed to flames. **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg @ 1627°F; 886 °C **Specific Gravity:** 6.684 @ 77°F; 25°C **Incompatibles:** Acids, oxidizers, halogens **Appearance and odor:** silvery gray, lustrous metal	This substance is considered a poison by ingestion, irritating to the skin and mucous membranes causing inflammation to the nose,mouth, and throat. Chronic exposure may result in some forms of dermatitis. Ingestion may result in a metallic taste, vomiting, colic, and diarrhea. Chronic exposure may result in addition to those stated above indigestion, loss of appetite and weight, and diarrhea. Sores in the mouth along with a sore throat help distinguish this form of poisoning from other forms of metallic poisoning such as lead and arsenic. Inhalation at excessive concentrations may result in difficulty in breathing, headaches and a bloody discharge from the nose, and chemical pneumonitis.
Arsenic	7440-38-2	Particulate form - This substance is unable to be detected by PID/FID.	Air sample using a particulate filter; acid desorption; AAS detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7300.	OSHA: Organic compounds 0.5 mg/m³ Inorganic compounds 0.01 mg/m³ NIOSH: (Ceiling) 0.002 mg/m³ ACGIH: 0.2 mg/m³ IDLH: 5 mg/m³ as arsenic	No identifiable warning properties to indicate presence and thereby detection. **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. This substance may be presented as a pesticide, therefore a cartridge suitable for pesticides (MSA-GMP). **Recommended Gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** sublimation @ 1134°F; 612°C **Melting Pt:** 1497°F; 814°C @ 36 atm **Solubility:** Insoluble in water;soluble in nitric acid **Flash Pt:** Nonflammable, however, airborne in the form of a dust this substance will support combustion **LEL/LFL:** Nonflammable **UEL/UFL:** Nonflammable **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg @ 372°C (sublimes) **Specific Gravity:** 5.73 **Incompatibilities:** Oxidizers, halogens,zinc, lithium, azides, and acetylides **Appearance and odor:** Gray to black, brittle, crystalline, amorphous, odorless.	Overexposure to this substance through inhalation or ingestion may result in ulceration of the nasal septum, GI disturbances resulting in violent purging and vomiting, hoarse voice, sore throat, excessive salivation, peripheral neuropathy (numbness and burning sensations beginning at the extremities followed by motor weakness), respiratory irritation leading to possible pulmonary edema. Skin or eye contact may result in irritation, conjunctiva, dermatitis, and hyperpigmentation (darkening of the areas exposed) of the skin. This substance has been judged to be a Human carcinogen by NTP, and IARC.

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Barium	7440-39-3 as Ba 10022-31-8 as Ba $(NO_3)_2$ 10361-37-2 as Ba Cl_2	Particulate form - This substance is unable to be detected by PID/FID.	Air sample using particulate filter; water desorption; AAS detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7056.	OSHA; NIOSH; ACGIH: 0.5 mg/m³ IDLH: 50 mg/m³	No identifiable warning properties to indicate presence and thereby detection. **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 2984°F; 1640°C (decomposes) **Melting Pt:** 1337°F; 725°C **Solubility:** Varies between compounds 9/38% **Flash Pt:** Not available (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** 10 mmHg @ 1920°F 1049°C **Specific Gravity:** 3.5 **Incompatibilities:** Acids, oxidizers **Appearance and odor:** Silver to white, odorless	Overexposure to this substance results in the solubilization in the water or stomach acids. Symptoms include vomiting, colic, diarrhea (watery sometimes bloody), slow to irregular pulse, transient hypertension, convulsive tremors, and muscular paralysis resulting in stiffness immobility, leg cramps, twitching, and impairment of speech and swallowing. Overexposure to some compounds via inhalation may result in respiratory distress, dyspnea, and baritosis (a benign pneumoconiosis). Direct contact to the skin or eyes may result in irritation.
Beryllium	7440-41-7 as Be	Particulate form - This substance is unable to be detected by PID/FID.	Air sample using a particulate filter; acid desorption; AAS/GF detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7102.	OSHA: 0.002 mg/m³, (Ceiling) 0.005 mg/m³ NIOSH: 0.0005 mg/m³ ACGIH: 0.002 mg/m³	No identifiable warning properties to indicate presence and thereby detection. **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 5378°F; 2970°C **Melting Pt:** 2332°F; 1278°C **Solubility:** Insoluble **Flash Pt:** Not available (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** 0 mmHg **Specific Gravity:** 1.85 **Incompatibilities:** Halocarbons, strong oxidizers, acids and caustics **Appearance and odor:** gray to white hard light metal, brittle	Overexposure to this substance may result in respiratory symptoms including difficulty in breathing, coughing, rales, chest pain, possibly pulmonary edema, weakness, fatigue, headache, weight loss. Direct contact may result in irritant action on the skin (dermatitis), eyes (conjunctivae), and mucous membranes. This substance has been identified as a potential human carcinogen.
Cadmium	7440-43-9	Particulate Form - Unable to be easily detected by PID or FID.	Air sample using a mixed cellulose-ester filter / acid desorption and analysis by atomic absorption-flame. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7300 or #7048.	OSHA: 2 µg/m³ (0.002 mg/m³) ACGIH: 0.01 mg/m³ (total particulate); 0.002 mg/m³ (respirable particulate) IDLH: 9 mg/m3 (as cd)	The use of an air purifying, full face-piece respirator with a high efficiency particulate air filter for concentrations up to 0.25 mg/m³. **Recommended Gloves:** This is in particulate form. Therefore any glove suitable to prevent skin contact.	**Boiling Pt:** 1412°F; 767°C **Melting Pt:** 610°F; 321°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg @ 741°F; 394° C **Specific Gravity:** 8.65 @ 90°F; 32°C **Incompatibilities:** Strong oxidizers, elemental sulfur, selenium, tellurium, zinc, nitric acid, and hydrazoic acid **Appearance and Odor:** Metal: Silver-white, blue-tinged lustrous, odorless solid. Fume: yellow-brown, finely divided particulate dispersed in air.	Overexposure to this substance may result in irritation to the respiratory tract, dyspnea, tightness in the chest, coughing, possibly pulmonary edema. Overexposure to fumes causes symptoms characteristic of the flu (headaches, chills, muscle aches, nausea, vomiting, diarrhea). Chronic exposure may result in damage to the lungs, kidneys and liver. This substance has been identified as a confirmed animal; potential human carcinogen by IARC and NTP.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Chromium Compounds	7440-47-3 (Element)	Not detectable by PID. Not detectable by FID.	Air sample using mixed cellulose -ester filter; acid desorption and analysis by atomic absorption. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7024.	OSHA & NIOSH: (Chromium II, III) 0.5 mg/m³ (Chromium VI) 0.1 mg/m³ (Ceiling) ACGIH: 0.5 mg/m³ (Chromium II, III compounds), 0.05 mg/m³ (Chromium VI compounds) IDLH: 30 mg/m³ (Chromium VI compounds)	The use of a air purifying, full face-piece respirator with a high efficiency particulate filter for concentrations up to 0.1 mg/m³. **Recommended Gloves:** This is in particulate form. Therefore any glove suitable to prevent skin contact.	**Boiling Pt:** 4788°F; 2642°C **Melting Pt:** 3452°F; 1900°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** Not available **Vapor Pressure:** 0 mmHg **Specific Gravity:** 7.14 **Incompatibilities:** Strong oxidizers, peroxides, and alkalis **Appearance and Odor:** Appearance and odor vary depending upon the specific compound.	Health hazards are characterized normally through chronic exposure manifesting as histologic fibrosis of the lungs and ulceration of the nasal septum and skin. IARC, NTP and ACGIH list various chromium compounds as possessing carcinogenic properties.
Lead	7439-92-1	Particulate form - Unable to be detected by either PID or FID.	Air sample using a mixed cellulose ester filter; or HNO_3 or H_2O_2 desorption; or Atomic absorption detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7082 or #7300.	OSHA: 0.05 mg/m³ ACGIH: 0.15 mg/m³ NIOSH: 0.10 mg/m³ IDLH: 100 mg/m³ as lead	The use of a air purifying, full-face respirator with high efficiency particulate air filter for up to 2.5 mg/m³. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 3164°F; 1740°C **Melting Pt:** 621°F; 327°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** Not available **Vapor Pressure:** 0 mmHg **Specific Gravity:** 11.34 **Incompatibilities:** Strong oxidizers, peroxides, sodium acetylide, zirconium, and acids **Appearance and Odor:** Metal: A heavy ductile, soft gray solid.	Overexposure to this substance via ingestion or inhalation may result in metallic taste in the mouth, dry throat, thirst, Gastrointestinal disorders (burning stomach pain, nausea, vomiting, possible diarrhea sometimes bloody or black, accompanied by severe bouts of colic), CNS effects (muscular weakness, pain, cramps, headaches, insomnia, depression, partial paralysis possibly coma and death. Extended exposure may result in damage to the kidneys, gingival lead line, brain, and anemia.
Manganese	7439-96-5 as Mn	Particulate form - This substance is unable to be detected by PID/FID.	Air sample using particulate filter; acid desorption, ICP detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7300.	OSHA: Ceiling 5 mg/m³ as a fume 1 mg/m³ NIOSH: 1 mg/m³ for dust and fume; 3 mg/m³ as a STEL ACGIH: 5 mg/m³ for dust; 1 mg/m³ for fume IDLH: 500 mg/m³	No identifiable warning properties to indicate presence and thereby detection. **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 3452°F; 1900°C **Melting Pt:** 2300°F; 1260°C **Solubility:** Insoluble **Flash Pt:** Not available (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals. This substance is considered a combustible solid.) **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg @ 2358°F; 1292°C **Specific Gravity:** 7.20 **Incompatibilities:** Strong oxidizers, halogens, and nitrates. Will react with water to produce hydrogen gas. **Appearance and odor:** Silvery solid or reddish-gray, odorless	Overexposure to this product may result in Central Nervous System and pulmonary effects by inhalation. Symptoms may include disturbances in gait and speech, sleepiness, mental confusion, stolid, masklike face, muscular twitching varying from tremors to coarse rhythmical movements of the extremities accompanied by cramps. Symptoms are described as postencephalitic Parkinsonism. Additionally dry throat, tightness in the chest, dyspnea, rales, flu-like symptoms low back pain, and vomiting.

CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Nickel	7440-02-0	Particulate form - This substance is unable to be detected by PID/FID.	Air sample using particulate filter; acid desorption; ICP detection. Sampling and analytical protocol shall proceed in accordance with NIOSH Method #7300.	OSHA: as Ni metal and insoluble compounds 1 mg/m³ NIOSH: 0.015 mg/m³ ACGIH: 0.05 mg/m³ IDLH: 10 mg/m³	No identifiable warning properties to indicate presence and thereby detection. **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This material is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 4946°F; 2730°C **Melting Pt:** 2651°F; 1455°C **Solubility:** Insoluble acid **Flash Pt:** Not available(Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** 1 mmHg @ 3290°F; 1810°C **Specific Gravity:** 8.90 **Incompatibilities:** Strong acids, halogens, sulfur, wood and other combustibles, nickel nitrate, and oxidizers **Appearance and odor:** Silvery white, hard, malleable ductile metal, odorless	Symptoms of overexposure to this product may include headaches, vertigo, delirium, extreme weakness, GI disturbance and pain including nausea vomiting and diarrhea, coughing, hyperpnea, cyanosis, weakness, allergic dermatitis, nickel itch, pulmonary asthma, chest pains tightness, dyspnea, dry cough, and conjunctivitis. This substances has been identified as a Human carcinogen by NTP and IARC.

7.0 HAZARD MONITORING

Direct reading instruments will be used as a general screening device at the site to detect and evaluate the presence of site contaminants and other potentially hazardous conditions.

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.

7.1 TASKS TO BE CONDUCTED

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

- Monitoring Well Installation and subsurface soil sampling [Hollow Stem and Direct Push Technologies (DPT)]
- Multi-media Sampling – Surface soils; groundwater; sediments
- Decontamination activities

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.

    - Hollow Stem Auger Drill Rigs (During well installation) - Noise levels range from 87 to 92 dBA-Time Weighted Average (TWA)

    - DPT - driving temporary wells and soil cores. Noise levels range from 90 to 102 dBA-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. Depending on the type of generators used determines the noise levels. The Honda Generators emit approximately 82 to 88 dBA. The older models (Generac) emit approximately 89 – 94 dBA TWA.

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

The decision to proceed with noise monitoring will be at the discretion of the PHSO and the SSO. This decision will based on the necessity to quantify noise levels associated with a particular type of rig or equipment or the necessity to perform noise level quantification to insure the hearing protection devices selected attenuation capabilities are sufficient for those noise levels produced.

If monitoring is to be conducted it will be done so with the Metrosonics dB-307 Noise Dosimeter/or Equivalent. 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.

7.2.1 Chemical Contaminant Monitoring

Previous chemical contaminant information indicates relatively low levels of volatile organic compounds in the groundwater. Historical information regarding groundwater contamination has been gathered and the maximum positive detection's have been identified. This information has been used to determine potential worker exposure during tasks such as soil boring and groundwater sampling. Under current considerations, it is not anticipated that these contaminants will present a significant exposure threat based on reported concentrations and typical concentrations seen base wide. Based on the application of this hazard monitoring, which is general screening, the following represent general categories of compounds that air monitoring will be used to detect, if encountered.

Chlorinated solvents

Perchloroethylene	0.6 correction factor
Trichloroethylene	0.4 correction factor
Dichloroethane	Not detectable with 10.6 eV Lamp
Dichloroethylene	0.9 correction factor

Petroleum products

Diesel Fuel	0.4 correction factor
Jet Fuels	0.4 correction factor (average)
Waste Oils	Generally Not detectable with 10.6 eV Lamp
Benzene	0.5 correction factor
Toluene	0.5 correction factor
Xylene	0.4 correction factor

Paint Thinners/Strippers and Solvents

Stoddard Solvent	0.7 correction factor
Mineral Spirits	0.7 correction factor
Turpentine	0.4 correction factor

These substances represent more mobile substances (those with an increased exposure potential from all routes).

Dyes and Intermediates

Basic dye classes are comprised of pigments, which are organic and inorganic solids within a vehicle or substrate. Based on the physical properties of these substances (A solid and/or bound to a particulate crystalline structure) it is not practical to employ hand-held screening instruments in their detection. Detection of the presence of these materials in the field shall be based on visual identification. This exploits the nature of the substance based on their absorption of coloring or the scattering of light.

Most of the toxicity information available on these substances are based on acute oral toxicity involving ingestion, the most feasible route of exposure.

The use of real-time monitoring instrumentation outside of general screening is not practical. It is recommended that the instruments still be used as a general screen for possible pockets of contamination that may exist at higher concentrations and are more readily detectable.

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

- Soil boring

Chemical air monitoring will be performed by the SSO using a photo-ionization detector (PID) as a primary screening instrument. Instruments will be used primarily to monitor source points and worker breathing zone areas, while observing instrument action levels.

Action levels are discussed in Table 5-1 as they may apply to a specific task or location. The relative response ratio/correction factor for the compounds in question that can be detected is as follows:

Chlorinated solvents as well as petroleum products correction factor is approximately 40%. Therefore, results obtained on these instruments should be multiplied by 0.4 to obtain actual values. For example:

10 ppm (instrument reading) x 0.4 (correction factor) = 4.0 ppm (adjusted value)

Paints, strippers, and solvents correction factor is approximately 70%.

10 ppm (instrument reading) x 0.7 (correction factor) = 7.0 ppm (adjusted value)

Note: Relative response ratio provided is in comparison to equal concentrations of the reference gas Isobutylene.

Note: Caution should be used when employing correction factors regarding the accuracy. A plus/minus of 25% should be incorporated as a buffer to the conservative.

Prior to the commencement of any field activities, the background levels of the site must be determined and noted. Daily background readings will be taken away from any areas of potential contamination. These readings, any influencing conditions (i.e., weather, temperature, humidity) and site location must be documented in the field operations logbook or other site documentation (e.g., sample log sheet).

7.3 INSTRUMENT MAINTENANCE AND CALIBRATION

Hazard monitoring instruments will be maintained and pre-field calibrated by the TtNUS Equipment Manager or commercial supplier. 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 (for example, the PID must be field calibrated daily and an additional field calibration must be performed at the end of each day to determine any significant instrument drift). 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

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 efforts must be documented. Figure 7-1 is provided for documenting these calibration efforts. 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, supplier)
- Any relevant comments or remarks

All monitoring instrumentation used at NSWC CRANE must be intrinsically safe due to ammunition/pyrotechnic handling activities.

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 is included to specify 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 entail 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 8-2 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.

FIGURE 8-1

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potentially hazardous nature of performing investigation activities at NSWC CRANE, and that I have received site-specific training, that included the elements presented below:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- The contents of the health and safety plan
- The use and application of the Safe Work Permit
- Emergency action/response procedures (evacuation and assembly points)
- Review contents of relevant Material Safety Data Sheets
- Review of relevant NSWC CRANE and United States Navy policies and procedures

I further state that I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction.

I further state by the presence of my signature below that the date of my training (introductory, refresher, and supervisory, as applicable) and my medical surveillance requirements are accurate and correct to the best of my knowledge.

Name/Signature	40-Hour Introductory Hazardous Waste Site Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Surveillance (Date)	Other (First-Aid/CPR, Driller's Certification, Etc.) (Date)

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 that the persons listed have had physical examinations under this program within the past 12 months (or a letter indicating from their Primary Health Care provider indicating a specified frequency, up to every 2 years) and when that exam occurred, and that they 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. 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. Additionally, support or restoration services may be exempt

from these training and medical surveillance requirements. **Use of this Subcontractor Exception is strictly limited to the authority of the CLEAN Health and Safety Manager.**

9.0 SITE CONTROL

This Section outlines the means by which Tetra Tech NUS will delineate work zones and use these work zones in conjunction with engineering, administrative, PPE, decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site and to remove personnel from inherent physical hazards. It is anticipated that a two zone approach will be used during work at this site; an exclusion zone, and a support zone. It is also anticipated that this control measure will be used to control access to the work areas, thereby restricting the general public and facility personnel to protect individuals who are not cleared to enter by way of training and/or medical surveillance qualifications.

9.1 EXCLUSION ZONE

The exclusion zone will be considered those areas of active operations plus an established safety zone depending on the task. The following represent the exclusion zone boundaries for the following identified tasks:

- Hollow Stem Auger Drill Rig - Monitoring Well Installation – The boundary perimeter will be established by determining the height of the mast, plus five feet. Therefore, if it is a 35-foot mast plus 5 feet equals a 40-foot boundary surrounding the point of operation.

- DPT – Minimum 25-feet from the point of operation

- Well Development – 10 feet surrounding the well head and discharge point.

- Groundwater sampling – 10 feet surrounding the well head or the collection receptacle.

- Surface/subsurface soils, surface water, sediments – 5 feet surrounding the sample collection point.

- Decontamination (heavy equipment – steam/pressure washers) – 35 feet surrounding the point of operation. This will take place at a centralized location.

Exclusion zones will be delineated, when necessary using barrier tape, cones and/or drive poles, and/or postings to inform and direct facility site personnel and visitors, as necessary. As the majority of these locations are in remote settings, it may not be necessary to delineate the zones utilizing physical

structures and/or signage. This will be at the discretion of the SSO based on the potential for persons to cross into operational zones.

These exclusion zones boundaries have been set at a distance sufficient to remove personnel from hazards associated with these operations.

9.2 SUPPORT ZONE

The support zone for this project will include a staging area where site vehicles will be parked, equipment will be unloaded, and where food and drink containers will be maintained. In all cases, the support zones will be established at areas of the site where exposure to site contaminants would not be expected during normal working conditions or foreseeable emergencies.

9.3 SAFE WORK PERMITS

All exclusion zone work conducted in support of this project will be performed using Safe Work Permits (Figure 9-1) to guide and direct field crews on a task by task basis. An example of the Safe Work Permit to be used is illustrated in Figure 9-1. These work permits will be further supported by the daily meetings conducted during their generation. This effort will ensure all site-specific considerations and changing conditions are incorporated into the planning effort. All permits will require the signature of the FOL and/or the SSO. All personnel engaged in on-site activities will be 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. Safe Work Permits issued will be turned into the FOL and/or the SSO at the termination period listed on the permit.

9.4 SITE MAP

Once the areas of operation, access routes, topography, dispersion routes are determined, a site map will be generated and adjusted as site conditions change. These maps will be posted to illustrate up-to-date information of the zones and access points.

FIGURE 9-1
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. Onsite Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
Tetra Tech NUS

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 ☐
SKA-PAC SAR ☐
Skid Rig ☐
Escape Pack ☐
SCBA ☐
Bottle Trailer ☐
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 suite/coveralls	☐ Yes	☐ No	Gloves (Type)	☐ Yes	☐ No
Steel toe/shank Workboots	☐ Yes	☐ No	Work/rest regimen	☐ 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. Equipment Preparation

	Yes	NA
Equipment drained/depressured	☐	☐
Equipment purged/cleaned	☐	☐
Isolation checklist completed	☐	☐
Electrical lockout required/field switch tested	☐	☐
Blinds/misalignments/blocks & bleeds in place	☐	☐
Hazardous materials on walls/behind liners considered	☐	☐

VIII. Additional Permits required (Hot work, Permit-Required Confined Space entry, excavation etc.)... ☐ Yes ☐ No
If yes, fill out appropriate section(s) on safety work permit addendum

IX. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____

9.5 BUDDY SYSTEM

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

9.6 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

Tetra Tech NUS and subcontractor personnel will provide MSDS's 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 MSDS's will be maintained in a central location (i.e., temporary office, 3-ring binder) and will be available for anyone to review upon request.

9.7 COMMUNICATION

Internal supported communications will be accomplished through the use of two-way radios between field crews. Two-way radio communication devices have been approved for use at NSWC CRANE providing they are intrinsically safe and within the recommended power levels of under 5 watts.

External supported communications will be done so utilizing the telephones at predetermined and approved locations or through cellular phones. Prior to the commencement of site activities, the FOL will determine and arrange for telephone communications, if it is determined a cellular means cannot or will not be used.

The Base Environmental Office will allocate a Public Works/Fire/Security Radio to be used in support of this field effort. This radio will be available 24/7 which will establish a direct link to security and emergency services to be used only in the event of an emergency.

9.8 SITE VISITORS

Site visitors for the purpose of this document are identified as representing the following groups of individuals:

- Personnel invited to observe or participate in operations by Tetra Tech NUS.
- Regulatory personnel (i.e., DOD, EPA,IEPA, 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 our Task Order Manager or designee and following established base access procedures.

Once access to the base is obtained, all personnel who require site (areas of ongoing operations) access will be required to obtain permission from the FOL and the Base Contact. Upon gaining access to the 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 requesting entering into the active areas of operation (within the exclusion zone boundaries) will be required to produce the following information:

  - Information attesting to applicable training (40-hours of HAZWOPER training required for all Southern Division Navy Personnel)
  - 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 under escort. All visitors are required to observe the protective equipment and site restrictions in effect at the site. 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 entry 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.

9.9 SITE SECURITY

Site security 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 final line of security and the primary enforcement contact.

9.10 SANITATION AND BREAK AREAS

This section will address the following items:

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

9.10.1 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 readily accessible at a predetermined approved location.

9.10.2 Potable Water

Potable water as well as electrolyte balance sports drinks such as Gatorade will be provided to the field crews for fluid replacement, as it is necessary under conditions of ambient temperature extremes. 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 when not in use.

Fluid intake recommendations will be made based on the medical evaluations conducted at the end of the decontamination process, as necessary based on ambient conditions.

9.10.3 Showers and Change Rooms

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

9.10.4 Break Areas

Given the size of the project and nature of the tasks to be conducted structured suitable locations for work breaks and warming/cooling regimens will not be necessary. These activities as necessary can take place at the site vehicles in the support zone and at the office provided at NSWC Crane.

10.0 SPILL CONTAINMENT/CONTROL PLAN

10.1 SCOPE AND APPLICATION

This program applies to the single or aggregate accumulation of bulk storage materials (over 55-gallons). As such the application of this Spill Containment/Control Plan will primarily apply to IDW collected as part of the investigative effort and in support of resource deployment.

10.1.1 IDW Management

This task includes the containerization, labeling, staging, monitoring, and final deposition of investigative derived wastes. It is anticipated that this investigation will generate five types of potentially contaminated residues or investigative derived wastes. IDW will be handled as described below:

PPE, tubing, and DPT Sample Liners – All PPE, tubing, and DPT sample liners will be decontaminated and double bagged and placed in the trash receptacles at the facility.

Monitoring Well Development and Purge Waters; Equipment (Heavy and Sampling) Decontamination Fluids – These fluids shall be collected and stored on site in a 300 or 500-gallon plastic holding tank. These fluids shall be discharged to a NSWC Crane permitted Sanitary Sewer system. Discharge shall occur at a manhole designated by NSWC Crane. This spill containment and control plan will apply to this activity during containment and transport to the sanitary system discharge location.

Wastes Cuttings and Rock Cores from Drilling Activities – For each boring, the cuttings obtained will be scanned for VOCs. If all readings obtained during the scan are at background levels, the soil cuttings shall be spread on the ground adjacent to the bore-hole from where they came.
Should readings above background be indicated, then the contaminated cuttings shall be containerized, labeled, and staged until analytical data indicating chemical contaminant concentrations. This information shall be used to determine the most appropriate route of disposal. If the material is determined to be contaminated with VOCs, then it will be containerized and await analysis for disposal. This aspect would fall under the auspice of this spill containment and control plan.

Containerization/Labeling/Staging

For all materials that are containerized, staged, or used as a temporary means for transport will be properly labeled. These activities are to be conducted as follows:

Containerization – Contaminated materials generated (soils) shall be collected and containerized in 55-gallon drums and staged in a centralized location.

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

Drums

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.

300 or 500 Gallon Poly Tank

Contents – Description
Temporary Transfer Tank

10.1.2 Waste Storage

- 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 4-feet between each row of pallets. The decision to construct a bermed and lined area will be the decision of project management .

The 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, soil cuttings, etc.).

An Inventory Log will be maintained by the FOL regarding types of waste materials and estimated 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.

10.1.2.1 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 waste storage that must be manually moved or positioned. This cart will be used to relocate drums within the staging and satellite storage location.

Other means of material handling are acceptable and may be presented to the SSO for evaluation based on their ability to minimize or eliminate material handling hazards.

- Poly Tank – It is estimated that a 300 or a 500-gallon tank will be used in transport of purge/development/decontamination fluids to the drop station. As a reminder these water and fluids weigh on an average of 8.34 pounds/gallon. A full poly tank (500-gallon capacity) will weigh 4,170 pounds (excluding the tank and passengers within the vehicle). Care should taken to match the vehicle weight capacity to the intended load. In addition, the tank should be firmly secured for transport. This additional weight will also impact one's ability to stop. Care should be taken to plan routes and be attentive to road conditions which also may be impacted by the additional loading.

10.1.3 Resource Storage – Limited fuel and Lubricant Storage

This spill containment and control plan will apply to all resource storage. Currently, storage includes

- Diesel Fuel for the Steam Cleaner (Estimated volume = 5-gallons)
- Gasoline for the Power Generators (Estimated Volume = 5-gallons)
- Isopropanol (Decontamination Solvent, Estimated Volume = 4-gallons)
- Miscellaneous oils and lubricants (Consumer commodity levels)

The first step in spill control and containment will be prevention

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.
- All dispensing locations will be supported by a Fire Extinguisher.

10.2 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 the SSO will serve as the Spill Response Coordinators for this operation, should the need arise.

10.3 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.

Drum Storage Area (Soil Cuttings)

- Extra Drum(s) (55-gallon U.N. 1A2) should the need to transfer material from a damaged container arise.
- Container labels
- Signs and postings for the Area
- Shovels, rakes, and or brooms

Poly Transfer Tank

- Tank Repair – Rubber Seals and grommets to repair any small leaks associated with the tank
- Container labels

The following personal protective equipment should be maintained with the Poly Transport Tank in the event or necessity for leak repair.

- Personal Protective Equipment
  - Nitrile outer gloves
  - Splash Shield
  - Impermeable over-boots
  - Rain suit

10.4 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.

1. Notify the SSO or FOL immediately upon detection of a leak or spill.
2. Employ the personal protective equipment stored at with the poly transfer tank. Take immediate actions to stop the leak or spill by plugging or patching the container. Spread the absorbent material in the area of the spill, covering it completely.

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 discussed in Section 2.0 of this HASP.

11.0 CONFINED SPACE ENTRY

Entry into Permit-Required Confined Spaces or Confined Spaces are not part of this scope of work. Therefore, personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces. In order to dispense any confusion over what a confined space is or is not, the following definitions have been provided.

Confined Space: Means a space that

- 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.

Permit-Required Confined Spaces: Means a confined space that has one or more of the following characteristics

- 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 that 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.

12.0 DRUMS/UNIDENTIFIED CONTAINERS

12.1 INTRODUCTION

It is not anticipated that drums or unknown containers will be handled through the execution of this scope of work. However, as drums have been disposed of in this area, this issue should be addressed. Under no circumstances will unknown drums/containers, if discovered at SWMU 2 be handled as part of this scope. Should these items be discovered and there is a request for handling, staging, and disposal of these items this HASP will require modification.

13.0 MATERIALS AND DOCUMENTS

The Tetra Tech NUS FOL shall ensure the following materials/documents are taken to the project site and utilized as required.

- A copy of the planning documents for this Field Effort (HASP, SAP, QAPP, WP)
- A complete copy of the Bid Specifications and Subcontractor signed documents.
- Available Historical Information
- Safe Work Permits for all Exclusion Zone tasks. In addition take some blanks in case there is scope and/or task modification.
- Incident Reports (Blank)
- Supervisor's Accident Report (Blank)
- Medical Data Sheets
- Material Safety Data Sheets for decon solutions, preservatives from the analytical laboratory and any other substances brought to the site to support this scope of work.
- Follow-Up Reports (to be completed by the FOL)
- OSHA Job Safety and Health Poster (posted at the site)
- Training/Medical Surveillance Documentation Form (Blank)
- OSHA 29 CFR 1910.120 (HAZWOPER) training certificates
- First Aid Supply Usage Form
- Emergency Reference Form (Section 2.0, extra copy for posting)
- Health and Safety Guidance Manual

13.1 MATERIALS TO BE POSTED AT THE SITE

The following documentation is to be posted 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 - This list represents all chemicals brought on site, including decontamination solutions, sample preservations, fuel, etc.. This list should be posted in a central area.

Material Safety Data Sheets (MSDS) - 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 - 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 defaces, altered, or covered by other material.

Site Clearance Posting - This list is found within the training section of the HASP (See Figure 8-1). 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) - This list of numbers and directions will be maintained at all phone communications points and in each site vehicle.

Medical Data Sheets/Cards - 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) - this standard will be posted anytime hearing protection or other noise abatement procedures are employed.

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

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

14.0 GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienists
APR	Air Purifying Respirators
ASP	Associate Safety Professional
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CLEAN	Comprehensive Long-Term Environmental Action Navy
CNS	Central Nervous System
CQP	Construction Quality Plan
CSP	Certified Safety Professional
CTO	Contract Task Order
DRI	Direct Reading Instruments
eV	electron Volts
FID	Flame Ionization Detector
FOL	Field Operations Leader
HSGM	Health and Safety Guidance Manual
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HSM	Health and Safety Manager
IDLH	Immediately Dangerous to Life and Health
N/A	Not Available
NIOSH	National Institute Occupational Safety and Health
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Manager
PID	Photo Ionization Detector
PPE	Personal Protective Equipment
PPM	Parts Per Million
PVC	Poly Vinyl Chloride
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analyses Plan
SCBA	Self Contained Breathing Apparatus
SSO	Site Safety Officer
STEL	Short Term Exposure Limit
SWL	Sanitary Waste Landfill

SWMU	Solid Waste Management Unit
TOM	Task Order Manager
TWA	Time Weighted Average
UV	Ultra Violet
WP	Work Plan

ATTACHMENT I

DYE COMPOUNDS POTENTIALLY BURIED AT SWMU 2

DYE COMPOUNDS POTENTIALLY PRESENT AT THE DYE BURIAL GROUND

ANTHRAQUINONE DYES	
1-amino anthraquinone	1,8-di-p-toluidinoanthraquinone
2-aminoanthraquinone	1-hydroxy-4-p-toluidinoanthraquinone
1-amino-2-bromo-4-p-toluidinoanthraquinone	1 -methylaminoantraquinone (Celanthrene Red)
1-amino-8-chloroanthraquinone	1-methylamino-4-p-toluidinoanthraquinone
l-amino-2-methyl-4-p-toluidinoanthraquinone (Alazann Sapphire. Blue R. Base)	HVT-yellow-GK is Indanthrene Yellow GKA Powder
1,4-diaminoanthraquinone	Ind Gold Yel GKAC
1,4-diamino-2,3-dihydroanthraquinone (Disperse Violet 1)	Quinizarin
1,4-diamino-2-methoxyanzhraquinone (Disperse Red 11)	Red Dye. Disperse 9, 1-methylaminoanthraquinone
1,4-dimethylaminoanthraquinone (Disperse Blue 14)	Red Dye, Disperse 9, Reference Standard , 99%, Para 6.5
1,4-di-p-toluidinoanthraquinone (Solvent Green 3) (Quinizarin Green)	Red Dye, Disperse 9, Reference Standard. 99%, Para 6.6
1,5-di-p-toluidinoanthraquinone	
AZO/ANALINE DYES	
Acid Blue 1	Dimethylaminoazobenzene
Acid Orange 10	N,n-dimethyl-p-phenylazoanaline
Acid Yellow 23	O-tolylazo-o-tolylazo-b-naphthol (Sudan Iv)
1-(4-dimethylaminophenylazo)-2-naphthol	Calco Oil Scarlet. 69493
1-methoxybenzenazo-2-naphthol (Solvent Red 1)	Calcozine Rhodamine BXP
1-(2-methoxyphenylazo)-2-naphthol	Disperse Red 5 2-chloro-2-methyl-4-nitro-4'-n,n-bis(2-hydroxyethyl)azobnzene
1-(4-nitrophenylazo)-2-naphthol	DuPont Oil Red. Ref. L4-a (5301). Ser.5211
1-(4-phenylazo)-2-naphthol (Sudan I)	DuPont Oil Yellow C-1904 (CI Solvent Yellow 12)
1-xylene-azo-2-naphthol (Orange 7)	Indigo
2-chloro-2-methyl-4-nitro-4,nn-bis(2-hydroxyethyl)azobe nzene (Disperse Red 5)	Oil Scarlet 1370, Peerless Color
2.4-diaminoazobenzene (Chrysoidine G. Base)	Pyrazoleanthrone
9,10-dianilinoanthracene	Sudan Orange RRA
2-tolylyazoxylylazo-2-naphthol	Sudan Scarlet 6G Special
QUINOLINE DYES	
N-(P-dimethylaminophenyl)-1,4-naphtholquinonimine	2-(2-quinolyl)-1,3-indandione (Chinoline Yellow)
2,2(quinolinyl)-3-indandione (solvent Yellow ~3)	Quinophthalone (Quinoline Yellow Base)
2-quinolyl-2-indandione-1,3 (Rhodamine B)	Vat Yellow 4,Dibenzo (A,h) Pyrene-7.14-dione or 3,4.8,9-dibenzpyrine-10-quinone
INORGANIC DYES	
Aluminum Compounds	Potassium Compounds
Barium Compounds	Sodium Compounds
Copper Compounds	Stearated Yellow Chrome, from MK12 Marine Location Marker

DuPont Oil Blue a (Copper Sulfate)	Strontium Compounds
Iron Compounds	Sulfur
Magnesium Compounds	
OTHER CLASSIFIED ORGANIC DYES OR COMPOUNDS	
Anthracene, 480 Lot #63	Naccosol A
Auramine Hydrochloride	Nitroglycerine
Benzanthrenone RDA 451 Composite R5054	PBAN (Polybutadiene-acrylic Acid-acrylonatrile Terpolymer)
Benzanthrone; 1,9-benz-10-anthrone	Sugars (Sucrose. Lactose. Etc.)
Benzanthrone: Reference Standard Sample Dye, Para 6.4	Uranine (Disodium Fluorescein) (Fluorescent Green Dye)
UNCLASSIFIED COMPOUNDS	
9-diethylamino-phenyl-5-benzo (A) Phenazinone (9-diethlyamino Rosindone)	Oil Scarlet BL, Order # 1789
1-8 Diphenox Quinon Dry GRD	Orange Dye, g G. Spotting
Acid Fast Violet BG (Triphenyl Methane) (Ci 699) (Acid Blue 34)	Para M
Alphazurine B (Trimethylmethane Acid Blue) (Acid Blue 26)	Phthaloperinone
Azosol Brilliant Yellow 6GF Dry (Solvent yellow 44)	Red. 6820 00 624 3503, Spotting
Baghouse Test Dye	Smoke Yellow I is Anthrarufin Dry
Benzan Purf DGRD	Smoke Yellow B-10
Benzan Crude B Dry Ground	Smoke Yellow B-11
Blue Dye, Spotting	Std Red Dye. Spotting
Brombenzang GRD	Transketon Dry
Dye Signal Hi-viz 93%	Violet Dye, DuPont, RDA 435 R1 184
Dye 146	Violet Dye Pa2491, 74.52% Pure
FEAA. Lot 22242583	Yellow Dye, Mix 2, Pep
Green 6820 00625 3503	Yellow Dye RDA 446 744-443-505 R1184
Green Dye, Spotting	Z4CRTO7 Pigment
Helio Fast Yellow 6 GL (Yellow 23)	
1 .5-di-p—toluidinoanthraquinone	

ATTACHMENT II

UTILITY LOCATING AND EXCAVATION CLEARANCE

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE 2

2.0 SCOPE 2

3.0 GLOSSARY 2

4.0 RESPONSIBILITIES 2

5.0 PROCEDURES 3

5.1 BURIED UTILITIES 3
5.2 OVERHEAD POWER LINES 4

6.0 UNDERGROUND LOCATING TECHNIQUES 5

6.1 GEOPHYSICAL METHODS 5
6.2 PASSIVE DETECTION SURVEYS 6
6.3 INTRUSIVE DETECTION SURVEYS 7

7.0 INTRUSIVE ACTIVITIES SUMMARY 7

8.0 REFERENCES 7

ATTACHMENTS

1 Listing of Underground Utility Clearance Resources 8
2 Frost Line Penetration Depths by Geographic Location 10
3 Utility Clearance Form 11

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

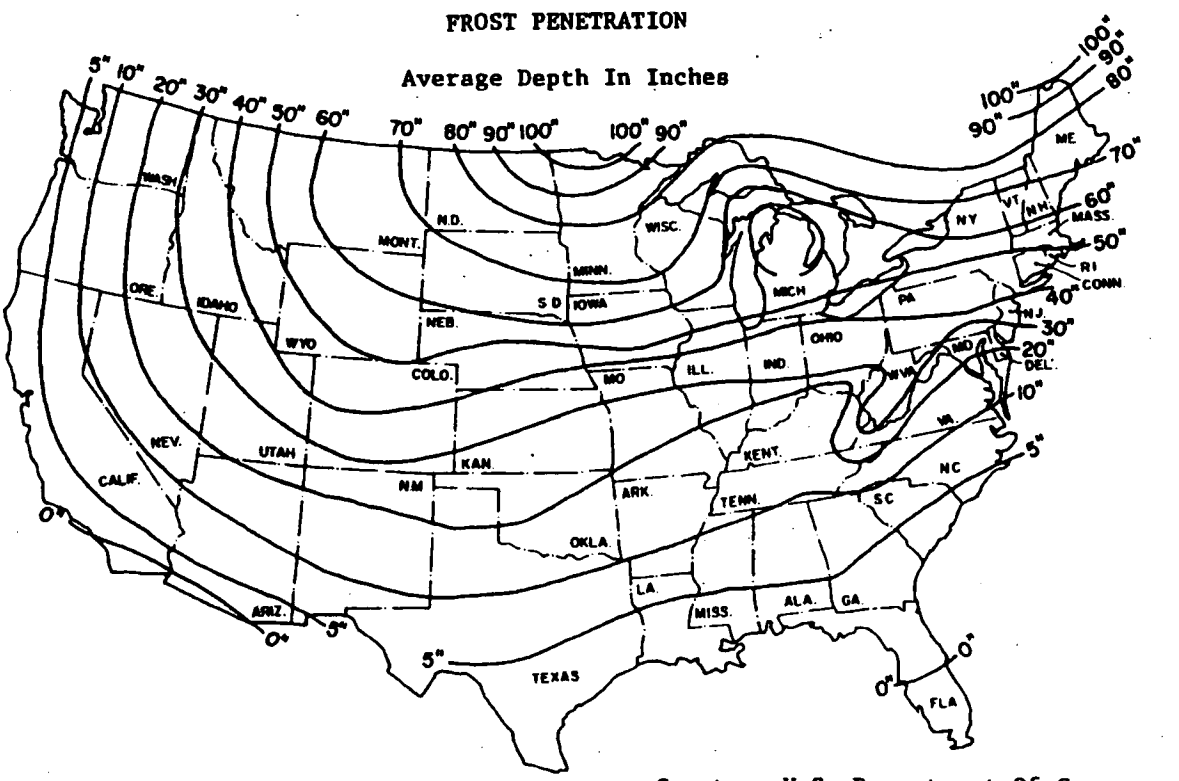
Wyoming One-Call
(800) 348-1030

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

SAFE WORK PERMITS

SAFE WORK PERMIT
DECONTAMINATION ACTIVITIES
SWMU 2

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 (Geoprobe and drill rig). Brushes and spray bottles will be used to decon small sampling equipment. Pressure washers or steam cleaning units will be used to decon the heavy equipment.**

II. Required Monitoring Instrument(s): PID with 10.6 eV lamp source (used to screen equipment)

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)

V. 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: None Anticipated

VI. Chemicals of Concern / Action Level(s) / Response Measures

Chemicals of Concern	Action Level(s)	Response Measures
Decontamination Solvents		Per MSDS

VII. 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

Modifications/Exceptions: PVC rain suits or PE or PVC coated Tyvek for protection against splashes and overspray, if impermeable aprons do not provide adequate protection against overspray or backsplash. Chemical resistant boot covers if excessive liquids are generated or to protected footwear. Hearing protection is required when operating the steam cleaner or pressure washer.

VIII. 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 ( )	☐	☐

IX. 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	☐	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No

Complete Hot Work Permit Per NSWC Crane Requirements (See Attachment V) for all steam cleaner operations. Call (812) 854–1235 Fire Dept. for evaluation and signature. For additional assistance in this matter contact Health Sciences, Pittsburgh Office (412) 921-7090

XI. Special instructions, precautions: Review MSDSs for decontamination solvents prior to use. To minimize the potential for exposure to site contaminants personnel will use PPE and prevent contact with potentially contaminated equipment. 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 constructed of 10-30 mil polyethylene sheeting should be covered in a light coating of sand if the surface becomes to slippery. Site control boundary demarcation for this operation is set at 35 feet surrounding the point of operation. For a Hot Work Operation a Fire Extinguisher 20-A:80-B:C will be required

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR SUBSURFACE OPERATIONS AT SWMU 2

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): **Monitoring well drilling and installation through direct push and hollow stem auger applications; subsurface soil sampling using a hand auger**

Equipment: _____).

II. Required Monitoring Instruments: PID with 10.6 eV lamp source, Visual observation

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: Evacuate when monitoring instrument reading levels exceed action levels specified in Table 5-1, or when visible dust and/or smoke is present and cannot be controlled through area wetting.

V. Chemicals of Concern

*General Contaminants Classifications	Action Level(s)	Response Measures
	>10ppm/>10 minute duration/4 times/day	Notify PHSO
Dusts and Particulates (Dyes and Metals)	>2 mg/m^3 (Visible dust)	Dust Suppression/Area Wetting

VI. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes	☐ No (See Note)	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No (See Note)	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

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 providing it offers the same level of protection.

VIII. 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 ( )	☐	☐

IX. 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	☐	☐	☐

X. Additional Permits required (Utility Locating and Excavation Clearance – Attachment II)..... ☒ Yes ☐ No
For additional assistance contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: Follow the safe work practices for drilling specified in Section 5.2 of this HASP. Use proper lifting techniques defined in Table 5-1 for mobilization/demobilization. Complete an Equipment Inspection Checklist for the Direct Push and HSA 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 steam cleaner or pressure washer until visibly clean. Personnel decontamination will consist of disposing of single use PPE and washing hands and face prior to breaks or meals. Many of the materials in question are solids or liquids with elevated boiling points that bind to particulates. The potential for exposure can occur only through mechanical dispersion (inhalation) or hand to mouth contact (ingestion) through poor work hygiene practices. Minimization of these hazards can control potential exposures. Utility clearance will proceed all subsurface installations. Dye and dye stuff were reportedly disposed of in two ways at SWMU 2. These two ways included in trenches and displaced over the ground within drainage swales. It is anticipated that the majority of the contaminants will present themselves in particulate or bound to particulate form. Some of the dyes used in colored smokes may through hydrolysis or hydration react to create smoke. This is not largely anticipated and given volitization temperatures vapor hazards are not anticipated to be a significant threat. However, suspicious substances (observed or perceived) shall be avoided and reported to the FOL and/or the SSO. Avoid visible dust plumes. If necessary employ area wetting methods. Emergency equipment including fire extinguishers, first aid kits, and eyewashes will be maintained at the ready during these operations.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR MULTI-MEDIA SAMPLING AT SWMU 2

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 surface water and sediment, groundwater, surface & subsurface soils, IDW, and well development.**

Equipment:

II. Required Monitoring Instrument(s): PID with 10.6 eV lamp source

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: Evacuation will be required when visible dust cannot be controlled through area wetting practices or when and if certain dye components hydrolyze or hydrate forming smoke. Safety glasses, hard hats and hearing protection will be worn when working near operating equipment.

V.

Chemicals of Concern	Action Level(s)	Response Measures
*General Contaminants Classifications	>10ppm/>10 minute duration/4 times/day	Notify PHSO
Dusts and Particulates	>2 mg/m^3 (Visible dust)	Dust Suppression/Area Wetting

VI. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☒ No (See note)	Hearing Protection (Plugs/Muffs)	☐ Yes	☒ No
Safety Glasses	☐ Yes	☒ No (See note)	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

Modifications/Exceptions: Reflective vests for high traffic areas. Tyvek coverall if there is a potential for soiling work clothes and PVC or PE coated Tyvek if saturation or work clothes may occur. U.S. Coast Guard approved life vest or lifelines if sampling on or near bodies where drowning hazards exist. Hardhats, safety glasses, and hearing protection when working near operating equipment.

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	☒	☐

IX. 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	☐	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No

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

XI. Special instructions, precautions: The FOL and/or the SSO shall preview all work areas for physical hazards where sampling is to be conducted. Physical hazards will be removed, barricaded, or indicated to exist to the field crew prior to committing personnel or resources. 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. For remote locations pack glass ware in hard sided containers to prevent falls breakage of glassware and possible lacerations.

*- General Contaminant Classifications – Solvents, BTEX compounds

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
MOBILIZATION/DEMOBILIZATION ACTIVITIES
NSWC CRANE, SWMU 2

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)

V. 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: None anticipated

VI. Chemicals of Concern — Action Level(s) — Response Measures
Inventory and Collect MSDSs — Review MSDSs prior to using — _____
For all chemical brought on-site — Chemicals brought on-site

VII. 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
Chemical Resistant Boot Covers	☐ Yes	☐ No	Impermeable apron	☐ Yes	☐ No

Modifications/Exceptions: Hazards associated with this activity are physical in nature such as lifting, site preparation, and construction of barricades around control zones. Each task shall be evaluated by the SSO to determine the need for additional PPE. For example to minimize the potential effects of these hazards (i.e., hammering – flying projectiles – safety glasses will be selected, operation of power tools safety glasses and hearing protection will be employed), hard hats will be employed when for overhead hazards exist. Selection of additional items will be based on site-specific conditions.

VIII. 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 ( )	☒	☐

IX. 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	☐	☐	☐

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

XI. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.). Remove or barricade as appropriate. Establish and construct traffic patterns to segregate pedestrian and vehicular/equipment traffic. Establish pathways over and through areas that are most easily traveled carrying equipment and supplies. Suspend site activities in the event of inclement weather. Employ proper lifting techniques as described on Table 5-1 and Section 6.2.3 for this task. Ensure all shelving installed to stock supplies is adequately secured to the wall.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
REMOVAL OF VEGETATION OPERATIONS
NSWC CRANE, SWMU 2

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): **Clearing and removal of vegetation**

Equipment:).

II. Required Monitoring Instruments: None - Visual observation

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)

V. 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: No conditions are anticipated which will require modification of this level of protection

VI. Chemicals of Concern: None | Action Level(s): None | Response Measures: None

VII. 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 – Leather or Cotton)	☒ 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: Hearing protection, hardhat, safety glasses and chain saw faceshield, chainsaw chaps will be worn when operating chainsaws. Light colored clothing, pants to boots taped. Use repellants for ticks and other associated vectors. Check each other for ticks upon leaving the brush and wooded areas. Report nesting areas and other natural hazards to the FOL and/or the SSO.

VIII. 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 ( )	☐	☐

IX. 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	☐	☐	☐

X. 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: Use proper lifting techniques defined in Table 5-1 for mobilization/demobilization. Complete an Equipment Inspection Checklist for all heavy equipment used in this operation upon arrival to the site, and then every 10 day shift thereafter or after major repairs. Keep the blades of all cutting equipment sharp. Handles and safety guards will be kept in good repair. Snake chaps will be worn in areas where there is a potential for snakes and snake bite. Follow the instructions provided in Table 5-1 for chain saw operation. When cutting trees > 2-inches in girth requires a two-man operation. Always leave an escape path when falling trees. When cutting trees down, cut as close to the ground as possible to minimize trip and fall hazards. Where this is not possible, paint the stumps with fluorescent paint or using flagging to draw peoples attention to their presence. Care should be taken when cutting or removing dead-fall trees as these areas are often preferred nesting locations.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
GEOGRAPHICAL SURVEYING ACTIVITIES
NSWC CRANE, SWMU 2

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): **Surveying (geographical) activities at various sites.**

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)

V. 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 requirements include sleeved shirt and long pants and footwear with an aggressive lug. Safety glasses, hard hats, and hearing protection will be worn when working near operating equipment.

VI. Chemicals of Concern

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

VII. 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

Modifications/Exceptions: Pant legs are to be taped to work boots to prevent entry under the clothing by ticks and other insects when working in heavy brush and wooded areas. 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. Surveyors working along highways and traffic pathways shall wear high visibility vests to increase visual recognition. Steel Toe Boots are not required, however, an aggressive lug boot is recommended to provide adequate traction over uneven terrain.

VIII. 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	☒	☐

IX. 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	☐	☐	☒

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

XI. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Avoid potential nesting areas. 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.. 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.). When cutting tools (Brush hooks and machetes used for cutting lines of sight) are not in use insure they placed in protective sheath. Maintain a ten foot radius around anyone clearing brush using a brush hook or machete.

Permit Issued by: _____ Permit Accepted by: _____

ATTACHMENT IV

EQUIPMENT INSPECTION CHECKLISTS

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)

	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 (As Applicable)			
- 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, As Applicable)			
- 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 (≥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 FOR POWERED/NON-POWERED HAND TOOLS

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., Air compressor, generator, pressure washer, hand tools)

	Good	Need Repair	N/A
Powered Tools – Air Compressor, Pressure washer, Generators			
Fire extinguisher (Type/Rating -_____)	❒	❒	❒
Fluid Levels:			
- Engine oil	❒	❒	❒
- Cooling system fluid	❒	❒	❒
- Hydraulic oil	❒	❒	❒
Oil leak/lube	❒	❒	❒
Exhaust system	❒	❒	❒
Coupling devices and connectors	❒	❒	❒

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? _____	❒	❒
– 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?_____	❒	❒
– Pressure Washers/Steam Cleaners – Angle degree of the tip and pressure rating?_____ Are the angle degree for the tip >25° for units greater than 3,000 psi?_____	❒	❒

Portable Power Tools:	Yes	No
– Tools and Equipment in Safe Condition?_____	❒	❒
– Saw blades, grinding wheels free from recognizable defects (grinding wheels have been sounded)?	❒	❒
– Portable electric tools properly grounded or double insulated?_____	❒	❒
– Are all outside plug and cord electrical connections routed through a GFCI plug?	❒	❒

Portable Power Tools (Continued):

	Yes	No
– Damage to electrical power cords?_____	❒	❒
– Blade guards in place?_____	❒	❒
– Cutting tools - Blades are maintained in a sharp condition?	❒	❒
– Are all circular saws with a cutting blade attachment greater than 2-inches in diameter, chainsaws (gas, hydraulic, and air), pressure washers or pressure actuated tools controlled through a constant pressure switch or throttle that stops upon release?	❒	❒
– Components adjusted as per manufacturer's recommendation?_____	❒	❒
– Safety Equipment available for safe operation per this HASP and the manufacturer's recommendation?_____	❒	❒

Hand Tools (Shovels, brush hooks, machetes, etc.):

	Yes	No
– Handles free from damage (knicks, cracks, splinters, etc.)?_____	❒	❒
– Cutting/digging attachments firmly secured to the handle?_____	❒	❒
– Cutting tools - Blades are maintained in a sharp condition without knicks and gouges in the blade?	❒	❒
– Cutting attachments (machetes, brush hooks) have sheaths or covers to protect persons from the cutting edge, when not in use?_____	❒	❒
– Safety Equipment available for safe operation per this HASP and the manufacturer's recommendation?_____	❒	❒

Operator Qualifications (as applicable for all Powered equipment):

- 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?_____

Identification:

- Is a tagging system available, for positive identification, for tools to be removed from service?_____

Additional Inspection Required Prior to Use On-Site (Powered Equipment)

	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

ATTACHMENT V

HOT WORK PERMIT

HOT 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): Decontamination of sampling and heavy equipment - Steam Cleaner Operation.

Area Work to be Performed: Outdoors Only, Temporary Decontamination Station (Site/SWMU)

II. Names: _____

III. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ TtNUS _____ NSWC Crane

IV. Equipment Preparation Checklist

Equipment Preparation

	Yes	NA
Equipment drained/depressurized	☐	☐
Equipment purged/cleaned	☐	☐
Atmosphere Inerted (Inerting Gas -)	☐	☐
Isolation checklist completed	☐	☐
Electrical lockout required/field switch tested	☐	☐
Blinds/misalignments/blocks & bleeds in place	☐	☐
Hazardous materials on walls/behind liners considered	☐	☐
Paints and/or Coatings	☐	☐

Chemicals of Concern

V. Chemicals of Concern	LEL – UEL (Range)	Correction Factor	Instrument Response Reading
Diesel Fuel (Fuel - Steam Cleaner)	0.6 – 7.5%	0.85	0.85 x instrument reading = actual

Atmospheric Testing (Action Levels)

Hazard Tested	Acceptable Range	Reading	Acceptable?
% Oxygen	19.5 - 23.5%	_____	Yes ☐ No ☐
% LEL/LFL	Less than 10 %	_____	Yes ☐ No ☐
Toxic	PEL/TLV = 200 ppm	_____	Yes ☐ No ☐

Fire Prevention/Protection

Method	Type/Rating	Acceptable?
Fire Extinguisher	20-A:80-B:C	Yes ☐ No ☐
Water Hose	None Required	Yes ☐ No ☐
Flammable Liquid Storage	UL Approved Safety Cans	Yes ☐ No ☐
Shielding/Heat Barriers	Maintain minimum 50-feet from flammable stores	Yes ☐ No ☐
Area Wetting (Dry grasses/timber)	None Required	Yes ☐ No ☐

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

VI. 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: _____

VII. Additional Safety Equipment/Procedures

Hardhat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No	☐ N/A
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No	☐ N/A
Chemical/splash goggles	☐ Yes	☐ No	Radio	☐ Yes	☐ No	☐ N/A
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No	☐ N/A
Splash suit/coveralls	☐ Yes	☐ No	Gloves (Type)	☐ Yes	☐ No	☐ N/A
Steel toe/shank Workboots	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No	☐ N/A
Welding Hood(F.R.=)	☐ Yes	☐ No	Burning Goggles (F.R.=)	☐ Yes	☐ No	☐ N/A
Welding Screens/shields)	☐ Yes	☐ No	Heat Resistant Aprons( )	☐ Yes	☐ No	☐ N/A
Heat Resistant Jacket or Sleeves)	☐ Yes	☐ No	Blow back Protection/Flash Arrestors	☐ Yes	☐ No	☐ N/A

Modifications/Exceptions: _____

VIII. Procedure review with permit acceptors

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

IX. Special instructions, precautions: In case of emergencies Call - NSWC Crane Fire Department (812) 854-1235. A Fire Watch will be posted during all activities that employ and Open Flame. The watch will remain posted for 30-minutes after the cessation of hot work activities.

(F.R. – Filtration Rating)

Permit Issued by: _____ Permit Accepted by: _____

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 <u>not</u> 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

OSHA POSTER

You Have a Right to a Safe and Healthful Workplace.

IT'S THE LAW!

- You have the right to notify your employer or OSHA about workplace hazards. You may ask OSHA to keep your name confidential.
- You have the right to request an OSHA inspection if you believe that there are unsafe and unhealthful conditions in your workplace. You or your representative may participate in the inspection.
- You can file a complaint with OSHA within 30 days of discrimination by your employer for making safety and health complaints or for exercising your rights under the *OSH Act*.
- You have a right to see OSHA citations issued to your employer. Your employer must post the citations at or near the place of the alleged violation.
- Your employer must correct workplace hazards by the date indicated on the citation and must certify that these hazards have been reduced or eliminated.
- You have the right to copies of your medical records or records of your exposure to toxic and harmful substances or conditions.
- Your employer must post this notice in your workplace.

The *Occupational Safety and Health Act of 1970 (OSH Act)*, P.L. 91-596, assures safe and healthful working conditions for working men and women throughout the Nation. The Occupational Safety and Health Administration, in the U.S. Department of Labor, has the primary responsibility for administering the *OSH Act*. The rights listed here may vary depending on the particular circumstances. To file a complaint, report an emergency, or seek OSHA advice, assistance, or products, call 1-800-321-OSHA or your nearest OSHA office: • Atlanta (404) 562-2300 • Boston (617) 565-9860 • Chicago (312) 353-2220 • Dallas (214) 767-4731 • Denver (303) 844-1600 • Kansas City (816) 426-5861 • New York (212) 337-2378 • Philadelphia (215) 861-4900 • San Francisco (415) 975-4310 • Seattle (206) 553-5930. Teletypewriter (TTY) number is 1-877-889-5627. To file a complaint online or obtain more information on OSHA federal and state programs, visit OSHA's website at **www.osha.gov**. If your workplace is in a state operating under an OSHA-approved plan, your employer must post the required state equivalent of this poster.

1-800-321-OSHA

www.osha.gov

U.S. Department of Labor • Occupational Safety and Health Administration • OSHA 3165

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN

Quality Assurance Project Plan
for
RCRA Facility Investigation Study, Risk Assessment, and Corrective Measures Study
at
Solid Waste Management Unit 2 Dye Burial Grounds

Naval Surface Warfare Center Crane Division
Crane, Indiana

Southern Division Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0010

May 2001

TABLE OF CONTENTS

SECTION **PAGE NO.**

ACRONYMS **5**

1.0 PROJECT DESCRIPTION **1-1**
1.1 INTRODUCTION 1-2
1.1.1 Overall Project Objectives 1-2
1.1.2 Project Status/Phase 1-3
1.1.3 QAPP Preparation Guidelines 1-3
1.2 SITE/FACILITY DESCRIPTION 1-4
1.2.1 Location 1-4
1.2.2 Facility Size and Borders 1-4
1.2.3 Natural and Manmade Features 1-5
1.2.4 Topography 1-5
1.2.5 Local Hydrology and Hydrogeology 1-5
1.2.6 Surrounding Land Use 1-6
1.2.7 Ecological Communities and Habitats 1-6
1.3 FACILITY HISTORY 1-7
1.3.1 General History 1-7
1.3.2 Past Data Collection Activities 1-7
1.3.3 Current Status 1-8
1.4 PROJECT OBJECTIVES 1-10
1.4.1 Specific Objectives and Associated Tasks 1-10
1.4.2 Project Target Parameters and Intended Data Uses 1-11
1.4.3 Risk-Related Issues 1-13
1.5 SAMPLE NETWORK DESIGN AND RATIONALE 1-14
1.5.1 Sample Network by Task and Matrix 1-14
1.5.2 Site Maps of Sampling Locations 1-14
1.5.3 Rationale of Selected Sampling Locations 1-14
1.5.4 Sample Network Summary Table 1-14
1.6 PROJECT SCHEDULE 1-14
1.6.1 Anticipated Date of Project Mobilization 1-14
1.6.2 Task Bar Chart and Associated Timeframes 1-14

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY **2-1**

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA **3-1**
3.1 PRECISION 3-1
3.1.1 Definition 3-1
3.1.2 Field Precision Objectives 3-1
3.1.3 Laboratory Precision Objectives 3-1
3.2 ACCURACY 3-2
3.2.1 Definition 3-2
3.2.2 Field Accuracy Objectives 3-2
3.2.3 Laboratory Accuracy Objectives 3-2
3.3 COMPLETENESS 3-3
3.3.1 Definition 3-3
3.3.2 Field Completeness Objectives 3-3
3.3.3 Laboratory Completeness Objectives 3-4

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

3.4 REPRESENTATIVENESS 3-4
3.4.1 Definition 3-4
3.4.2 Measures to Ensure Representativeness of Field Data 3-4
3.4.3 Measures to Ensure Representativeness of Laboratory Data 3-4
3.5 COMPARABILITY 3-4
3.5.1 Definition 3-4
3.5.2 Measures to Ensure Comparability of Field Data 3-5
3.5.3 Measures to Ensure Comparability of Laboratory Data 3-5
3.6 DECISION RULE 3-5
3.6.1 Definition 3-5
3.6.2 Decision Rule Objectives 3-5
3.7 LEVEL OF QC EFFORT 3-5

4.0 SAMPLING PROCEDURES 4-1

5.0 CUSTODY PROCEDURES 5-1
5.1 FIELD CUSTODY PROCEDURES 5-1
5.2 LABORATORY CUSTODY PROCEDURES 5-2
5.3 FINAL EVIDENCE FILES 5-2

6.0 CALIBRATION PROCEDURES AND FREQUENCY 6-1
6.1 FIELD INSTRUMENT CALIBRATION 6-1
6.2 LABORATORY INSTRUMENT CALIBRATION 6-1

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES 7-1
7.1 FIELD MEASUREMENT PROCEDURES 7-1
7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES 7-1
7.2.1 List of Project Target Compounds and Detection Limits 7-1
7.2.2 List of Associated Quality Control Samples 7-2

8.0 INTERNAL QUALITY CONTROL CHECKS 8-1
8.1 FIELD QUALITY CONTROL CHECKS 8-1
8.2 LABORATORY QUALITY CONTROL CHECKS 8-1

9.0 DATA REDUCTION, VALIDATION, AND REPORTING 9-1
9.1 DATA REDUCTION 9-1
9.1.1 Field Data Reduction 9-1
9.1.2 Laboratory Data Reduction 9-2
9.2 DATA VALIDATION 9-2
9.2.1 Procedures Used to Evaluate Field Data 9-3
9.2.2 Procedures Used to Validate Laboratory Data 9-3
9.3 DATA REPORTING 9-4
9.3.1 Field Data Reporting 9-4
9.3.2 Laboratory Data Reporting 9-5

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

10.0 PERFORMANCE AND SYSTEM AUDITS 10-1
10.1 FIELD PERFORMANCE AND SYSTEM AUDITS 10-1
10.1.1 Internal Field Audits 10-1
10.1.2 External Field Audits 10-3
10.2 LABORATORY PERFORMANCE AND SYSTEM AUDITS 10-3
10.2.1 Internal Laboratory Audits 10-3
10.2.2 External Laboratory Audits 10-4

11.0 PREVENTIVE MAINTENANCE PROCEDURES 11-1
11.1. FIELD EQUIPMENT PREVENTIVE MAINTENANCE 11-1
11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE 11-1

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS 12-1
12.1 ACCURACY ASSESSMENT 12-1
12.2 PRECISION ASSESSMENT 12-2
12.3 COMPLETENESS ASSESSMENT 12-2
12.4 DATA ASSESSMENT 12-2

13.0 CORRECTIVE ACTION 13-1
13.1 FIELD CORRECTIVE ACTION 13-1
13.2 LABORATORY CORRECTIVE ACTION 13-1
13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT 13-3

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT 14-1
14.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS 14-1
14.2 FREQUENCY OF QUALITY ASSURANCE REPORTS 14-2
14.3 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS 14-2

REFERENCES R-1

ATTACHMENTS

A LABORATORY STANDARD OPERATING PROCEDURES
B FIELD AUDIT CHECKLIST
C COMPARISON OF LABORATORY LIMITS TO RISK-BASED SCREENING CRITERIA

TABLES

NUMBER		PAGE NO.
1-1	Analytical Methods and Limits of Detection	1-15
1-2	Summary of Analysis Per Media for SWMU 2	1-17
3-1	Quality Control Limits, Matrix Spike and Laboratory Duplicate Samples, Metals Analyses	3-9
3-2	Quality Control Limits, Laboratory Control Samples, Metals Analyses	3-10
3-3	Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples and Surrogate Spikes, Dye Analyses	3-11
3-4	Quality Control Limits, Laboratory Control Samples, Dye Analyses	3-12
3-5	Quality Control Limits, Matrix Spike and Laboratory Duplicate Samples, Miscellaneous Parameters	3-13
3-6	Quality Control Limits, Laboratory Control Samples, Miscellaneous Parameters	3-14
7-1	Summary of Organic and Inorganic Analytical Procedures, Solid and Aqueous Samples	7-3
9-1	Dye Reporting Packages	9-7
11-1	Preventive Maintenance for Analytical Instruments	11-3

FIGURES

NUMBER		PAGE NO.
1-1	Project Schedule	1-19
13-1	Field Task Modification Request Form	13-3

ACRONYMS

ABG	Ammunition Burning Grounds
amsl	above mean sea level
ANR	Analysis not required
AWQC	Ambient Water Quality Criteria
CEC	Cation Exchange Capacity
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
CoC	Chain of Custody
CTO	Contract Task Order
DOD	Department of Defense
DQO	Data Quality Objective
EDQL	Ecological Data Quality Level
FOL	Field Operations Leader
FR	*Federal Register*
FSP	Field Sampling Plan
FTMR	Field Task Modification Request
HPLC	high performance liquid chromatography
IAS	Initial Assessment Study
ICP/MS	Inductively Coupled Plasma/Mass Spectrometry
IDEM	Indiana Department of Environmental Management
IDL	Instrument Detection Limit
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LTL	Laucks Testing Laboratories, Inc.
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NA	Not Applicable
NACIP	Navy Assessment and Control of Installation Pollutants
NEESA	Naval Energy and Environmental Support Agency
NFESC	Naval Facilities Engineering Service Center
NIST	National Institute of Standards and Technology

NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Units
ORP/Eh	Oxidation-Reduction Potential
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PE	Performance evaluation
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SRM	Standard Reference Material
SSL	Soil Screening Level
SWMU	Solid Waste Management Unit
TBD	To be determined
TOC	Total Organic Carbon
TOM	Task Order Manager
TSS	Total Suspended Solids
TtNUS	Tetra Tech NUS, Inc.
U.S. ACE	U.S. Army Corps of Engineers
U.S. EPA	U.S. Environmental Protection Agency
WES	Waterways Experiment Station
%R	Percent Recovery

1.0 PROJECT DESCRIPTION

This project description for the Quality Assurance Project Plan (QAPP) outlines the overall scope of the field investigation to be performed in support of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) study, risk assessment, and corrective measures study that are to be conducted for Solid Waste Management Unit (SWMU) 2 – Dye Burial Grounds.

In 1981 the Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) Program. This program included an investigation of designated sites at the Naval Surface Warfare Center (NSWC) Crane facility. These investigations were known as the Initial Assessment Study (IAS). The Naval Energy and Environmental Support Agency (NEESA) completed the IAS in 1983 with assistance from the Ordnance Environmental Support Agency and the U.S. Army Corps of Engineers (U.S. ACE) Waterways Experiment Station (WES). The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations. Based on the conclusions from the IAS for SWMU 2, it was determined that SWMU 2 did not represent an immediate threat to human health and the environment. It was recommended, however, that further study be conducted at this SWMU to evaluate potential long-term impacts.

In 1989 NSWC Crane was given a final RCRA Part B Permit. The permit contained corrective action requirements to be performed at its SWMUs. In response to the IAS recommendations and the requirements of the permit, RFIs were initiated for SWMU 2. Phases I, II, and III RFI ground water assessments have been performed at SWMU 2. Conclusions regarding the nature and extent of contamination for SWMU 2 were drawn from these studies.

The objective of this field investigation is to obtain sufficient information to perform an RFI study, human health and preliminary ecological risk assessments, and a corrective measures study for SWMU 2. Conclusions from the risk assessment and corrective measures study will be used in a risk management evaluation to determine whether further activities (such as additional remediation, long-term monitoring, etc.) are warranted at the site.

This QAPP presents the organization, objectives, planned activities, and specific Quality Assurance/Quality Control (QA/QC) procedures associated with sample collection and analysis for the field investigation. Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses are described. All QA/QC procedures are structured in accordance with applicable U.S. Environmental Protection Agency (U.S. EPA), U.S. EPA Region 5, and Indiana

Department of Environmental Management (IDEM) requirements, regulations, guidance, and technical standards.

This QAPP was prepared in accordance with U.S. EPA Region 5 QAPP Policy as presented in the U.S. EPA Region 5 QAPP Instructions and Policy (U.S. EPA , 1998). The Naval Facilities Engineering Service Center (NFESC) guidance document titled Navy Installation Restoration Laboratory Quality Assurance Guide (NFESC, 1996) also was used in establishing the QA/QC requirements specified in this QAPP. U.S. EPA Region 5 Risk-Based Screening Levels (RBSLs) for human health and Ecological Data Quality Levels (EDQLs), as well as other human health and ecological based criteria, were used in the development of this QAPP to outline facility-specific project objectives, required levels of analyte detection, and intended data usage.

1.1 INTRODUCTION

This QAPP was developed in support of the field investigation for SWMU 2 – Dye Burial Grounds located at NSWC Crane. The objective of the investigation is to collect data for the conduct of a site-specific RFI study, human health and preliminary ecological risk assessments, and a corrective measures study. This QAPP was prepared by Tetra Tech NUS, Inc. (TtNUS) on behalf of the United States Navy Southern Division Naval Facilities Engineering Command and NSWC Crane. This work was performed under Contract Number N62467-94-D-0888, Contract Task Order (CTO) Number 0010. A Work Plan, Field Sampling Plan (FSP), and Health and Safety Plan (TtNUS, 1999) also have been prepared by TtNUS. These documents have been entirely incorporated into this QAPP through specific reference.

1.1.1 Overall Project Objectives

The purpose of the field investigation is to gather sufficient reliable information to finalize the RFI, conduct a Baseline Human Health Risk Assessment and Screening-Level Ecological Risk Assessment, and perform a CMS at SWMU 2. The RFI, risk assessments, and CMS will be conducted in accordance with the RCRA Corrective Action requirements identified in NSWC Crane's RCRA Part B Permit (issued in 1989). The RFI will also be conducted in accordance with U.S. Environmental Protection Agency (U.S. EPA) guidance in RFI Guidance, EPA 530/SW-89-031 (U.S. EPA, 1989) and Indiana Department of Environmental Management's (IDEM's) Office of Solid and Hazardous Waste Management (OSHWA) guidance in Risk Integrated System of Closure (RISC) User's Guide and Technical Resource Guidance Document (IDEM, 1999). U.S. EPA's Risk Assessment Guidance for Superfund (RAGS) (U.S. EPA, December 1989), Ecological Risk Assessment Guidance for Superfund (U.S. EPA, June 1997), and other available risk assessment guidance will be also used to complete the risk assessments. The CMS will

also be conducted in accordance with IDEM guidance (IDEM, 1999). Details on the conduct of the human health and ecological risk assessments can be found in Sections 8.0 and 9.0, respectively, of the Work Plan. Details of the corrective measures study may be found in Section 10.0 of the Work Plan.

The overall objective of the data collection is to develop representative exposure point concentrations for the defined human and ecological receptors in support of the risk assessments. Exposure point concentrations will be developed for those site-related constituents identified as potential chemicals of concern (i.e., chemicals reported at concentrations that exceed human health and/or ecological risk-based screening criteria) in the site media. Additionally, physical and chemical site information will be collected in support of the corrective measures study. The specific objectives associated with data collection activities for the SWMU are presented in Section 5.0 of the Work Plan and tabulated on Table 5-8 of the Work Plan.

1.1.2 Project Status/Phase

Soil, ground water, surface water, and sediment samples will be collected as part of the field investigation of SWMU 2. Tables 3-1, 3-2, 3-4, and 3-5 of the FSP present the number of samples per medium per analytical parameter to be collected during the field investigation. In general, samples collected at SWMU 2 will be analyzed for Appendix 9 metals, miscellaneous metals, cyanide, miscellaneous wet chemistry parameters, and dyes. A limited number of soil samples will be analyzed for cation exchange capacity (CEC), total organic carbon (TOC), bulk density, grain size, and pH to determine soil physical parameters, their effect on constituent migration, and the potential for risks outside SWMU boundaries and applicable corrective measures. Surface water samples will be analyzed for total suspended solids (TSS), TOC and hardness; and ground water samples will be analyzed for TSS, TOC, sulfate, and chloride to evaluate general water quality. Additionally, groundwater will be tested in the field for natural attenuation parameters including alkalinity, carbon dioxide, ferrous iron, hydrogen sulfide, nitrate, nitrite, sulfide, and dissolved oxygen. Table 1-1 presents the comprehensive list of constituents for analysis. It is anticipated that sufficient information will be obtained to perform the RFI study, human health and ecological risk assessments, and corrective measures study in a single phase of sampling and analysis.

1.1.3 QAPP Preparation Guidelines

As identified previously, this QAPP has been prepared in accordance with the U.S. EPA Region 5 QAPP Instructions and Policy (U.S. EPA, 1998). Additional guidance regarding the generation of the QAPP was obtained during a project scoping meeting. This meeting was a formal teleconference "pre-pre-QAPP" meeting, which was held on May 13, 1999. Representatives from the U.S. EPA Region 5, United States

Navy Southern Division Naval Facilities Engineering Command, NSWC Crane, and TtNUS attended this meeting.

1.2 SITE/FACILITY DESCRIPTION

A brief description of NSWC Crane with respect to SWMU 2, its geological setting, and associated features is presented in this section. Additional details can be found in Section 3.0 of the approved Work Plan (TtNUS, 1999). Specific subsections and figures of the approved Work Plan are referenced, as appropriate.

1.2.1 Location

NSWC Crane is a Naval facility located in southwestern Indiana. It is located 75 miles southwest of Indianapolis, Indiana, and 71 miles northwest of Louisville, Kentucky (Figure 3-1 of the Work Plan). NSWC Crane is in the northern portion of Martin County and a small portion of neighboring Greene, Davies, and Lawrence Counties. Figure 3-2 of the attendant Work Plan depicts the location of the facility as well as the specific location of SWMU 2.

SWMU 2 - Dye Burial Grounds is located in the eastern portion of the facility. The Dye Burial Grounds lies 500 to 1,000 feet southwest of the crest of a north-northwest trending ridge separating Sulphur Creek from Little Sulphur Creek. The site is northeast of the Ammunition Burning Grounds (ABG). Dye Burial Grounds is bounded on the west by Highway 012 and the ABG site, on the north by Highway 58, and on the east by Highway 274. Dye Burial Grounds lies in the southeast one-fourth of Section 5, Township 5N, Range 3W of the Koleen, Indiana, topographic quadrangle.

1.2.2 Facility Size and Borders

NSWC Crane covers approximately 62,463 acres (approximately 100 square miles) in a rural, sparsely populated area. The acreage surrounding the facility is primarily wooded or farmed land. The majority of NSWC Crane is covered by forest.

SWMU 2 – Dye Burial Grounds is a series of at least four main trenches. These trenches were each 10 feet wide, 6 feet deep, and 50 feet long. The trenches were aligned end to end and situated atop a ridge. The trenches reportedly were backfilled to the ground surface with soil in 1972 but were not permanently capped. NSWC Crane placed crushed rock along a roadway immediately north of the trench area in 1987 to facilitate access by well drilling vehicles (USACE, 1998). In 1998, a multi-layered

cap system was placed on the Dye Burial Grounds (Morrison Knudsen Corporation, 1999). Figure 5-1 in the Work Plan presents the site map for Dye Burial Grounds.

1.2.3 Natural and Manmade Features

Natural and manmade features for SWMU 2 are described in Section 5.0 of the Work Plan. The primary natural stresses that created site features are from erosion and siltation. Manmade stresses that generated site features are from land clearing, logging and timber management, fires of manmade origin, and munitions-related stresses.

1.2.4 Topography

The topography at NSWC Crane consists of undulating terrain dissected by many small drainage ways. The elevation of the site ranges from 490 feet above mean sea level (amsl) at a southern drainage way to 860 feet amsl on a ridge in the west-central portion of the site. Several V-shaped drainage ways in the north progress to 2,000-foot-wide floodplains in the south and rise to approximately 150 to 200 feet to the ridgelines.

Section 5.2.1 in the approved Work Plan presents information on the local topography for SWMU 2.

1.2.5 Local Hydrology and Hydrogeology

Six creeks receive drainage in five separate drainage basins at NSWC Crane. The six creeks are Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, and Seed Tick Creek. Surface drainage from NSWC Crane eventually empties into the east fork of the White River, south of the facility. Situated within Crane are Lake Greenwood and several ponds. Lake Greenwood is the main source of water at NSWC Crane and also is used for recreation. None of the surface water from the four SWMUs drains directly into Lake Greenwood. Principle surface drainage from the site is to the south and southwest into Little Sulphur Creek. Surface runoff from the Dye Burial Grounds is rapid, leaving the site in drainage channels that head at the edge of the ridges. The major springs at the site are located in the valleys below the Dye Burial Grounds. Another groundwater seepage was identified on the southwest slope of the site. This "seep" is located at the elevation of the projected Pennsylvanian-Mississippian unconformity, the base of the Mansfield Formation. Flow from the seep is intermittent throughout the year.

Section 5.2.1 in the approved Work Plan presents information on the local hydrology for SWMU 2.

Information on the hydrogeology of the site is located in Section 3.3.5 of the approved Work Plan. In general, aquifers beneath NSWC Crane are considered to be vertically separate from each other by interlayered shale beds that act as aquitards. Ground water recharge occurs where aquifer units outcrop. After entering an aquifer outcrop, ground water flows by gravity down the dip of the aquifer unit. Section 5.2.3 in the approved Work Plan presents information on the local hydrogeology for SWMU 2.

The location of SWMU 2 relative to Lake Greenwood coupled with local and regional ground water flow directions indicate that ground water from the SWMU does not discharge to Lake Greenwood, the principal water supply for NSWC Crane.

1.2.6 Surrounding Land Use

The area surrounding NSWC Crane is comprised of woodlands and small farms. The populace is served by the towns of Odon, Loogootee, and Bedford in Davies, Martin, and Lawrence Counties, respectively. Details of the surrounding land use are provided in Section 3.0 of the Work Plan and in the human health risk assessment methodology section of the Work Plan, Section 8.0.

1.2.7 Ecological Communities and Habitats

Eighty percent of NSWC Crane's 63,000 acres is classified as Central Hardwoods Forest of the United States. Some old agricultural fields are in various stages of biological succession. Openings on dry upland sites contain almost pure strands of grasses with some clumps of woody plants. About 2 percent of the area has been planted with pines to stabilize the soil.

A great variety of habitats is present at NSWC Crane. Many forest animals need several habitats to complete their life cycles. At NSWC Crane, this variety is supplied by the many stages of forest succession, streams, ponds, Lake Greenwood, and grassy open spaces, all of which support a high diversity of animal species.

None of the local plant species present at NSWC Crane are known to be listed as threatened or endangered. No threatened or endangered aquatic, reptilian, amphibian, or mammalian species have been observed at the site. Only two avian species listed as endangered by the Federal government are potential inhabitants at NSWC Crane. These species include the Indiana bat and the peregrine falcon. Details of the ecological setting are provided in the ecological risk assessment methodology section of the Work Plan, Section 9.0.

1.3 FACILITY HISTORY

This section contains a brief summary of the general history of NSWC Crane and SWMU 2.

1.3.1 General History

The facility was opened in 1941 as the Naval Ammunition Depot, Burns City, to serve as an inland munitions production and storage center. The name was changed in 1975 to the Naval Weapons Support Center and in 1992 to NSWC Crane. The Department of Defense (DOD) ammunition procurement responsibilities were transferred to the Army in 1977. The Army has assumed ordnance production, storage, and related responsibilities under the single service management directive. All environmental activities on the installation, including permitting activities, remain the responsibility of the Navy.

1.3.1.1 SWMU 2 – Dye Burial Grounds

The operational history of the Dye Burial Grounds is poorly documented. It is estimated that 50,000 pounds of dyes and dye-contaminated materials were deposited in open trenches at the Dye Burial Grounds between 1952 and 1964. Materials reportedly included magnesium, boxes, and rags contaminated with dyes, and about 60 open drums of dye. Dye Burial Grounds is a series of at least four main trenches. Section 5.0 of the attendant Work Plan contains additional information regarding the history of Dye Burial Grounds.

1.3.2 Past Data Collection Activities

The first investigation conducted for SWMU 2 was the IAS. The IAS began in April 1981 in response to the NACIP Program and was completed in May 1983 by NEESA with assistance from the Ordnance Environmental Support Agency and the USACE WES. The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations. These studies primarily addressed ground water quality. Although none of the sites investigated were determined to represent immediate human health and environmental threats, 14 of the sites included in the IAS were recommended for further study to evaluate potential long-term impacts. SWMU 2 was among the 14 sites recommended for further investigation.

In 1989 NSWC Crane was given a final RCRA Part B Permit. The permit contained corrective action requirements to be conducted at its SWMUs. In response to the recommendation included in the IAS and the corrective action requirements in the Part B Permit, additional characterization of site ground water

was performed at the SWMU. Based on results of the RFI Phase II study, a Phase III ground water study was conducted. Finally, a multi-layered cap system was installed at Dye Burial Grounds.

Details of the investigations previously conducted for SWMU 2 are provided in Section 5.0 of the approved Work Plan. Table 5-1 of the approved Work Plan presents a summary of the historical site investigations for the SWMU.

1.3.3 Current Status

Based on the reports and documents reviewed for SWMU 2, it has been determined that there was a release of hazardous constituents to the environment from past site operations. Historically, no dye analyses were conducted for site media. The assumption of a release of dyes to the environment was based on visual observation of dyes in the soil. Comparisons of historical ground water data with human health and ecological risk-based screening criteria suggest that the magnitude and persistence of potential inorganic releases from site operations may pose an "unacceptable" risk to current and future potential receptors, who may come in contact with potentially contaminated site media. The presence of inorganics as a result of past site operations is questionable. Details are provided in Section 1.3.3.1.

The following sections present a summary of the evaluation of the historical data compared with current human health and ecological risk-based screening criteria. Based on this evaluation, the following detected chemicals of interest (target constituents) and source area release mechanisms have been used to focus the proposed field investigation. Details of the data evaluation and conclusions are presented in Section 5.0 of the approved Work Plan.

1.3.3.1 SWMU 2 – Dye Burial Grounds

Dye Burial Grounds was an open trench dump site from 1952 through 1964. In 1998, a multi-layered cap system was placed over the Dye Burial Grounds.

Based on previous field observations, dyes have most likely been released to the surrounding soil. In ground water, various organics and inorganics were detected; however, it is anticipated that only the inorganics may be a result of a release from past waste disposal activities. There is some uncertainty in linking the presence of metals in ground water to activities at Dye Burial Grounds. Anomalously low pH readings for ground water in some wells that were associated with high metal concentrations may have exacerbated the presence of the metals. Low pH in sandstone is probably a natural phenomenon and

may be responsible for the high concentrations of metals. The distribution of metals within the aquifers is not necessarily coincident with the proximity of the wells to the dye burial trenches (U.S. ACE, 1994).

Various metals, ammonia, nitrate, sulfate, and chloride have been identified as chemicals of interest for ground water at the Dye Burial Grounds because these chemicals were detected in ground water at concentrations that exceed risk-based screening criteria.

Benzene, chloroform, 1,1,2-trichloroethane, 1,4-dichlorobenzene, and Aroclor 1254 were detected in the ground water samples collected from SWMU 2 - Dye Burial Grounds. Similar to other SWMUs at the Base, these chemicals may be present at low levels in the ground water as a result of historical Basewide maintenance practices. Historically, it was common practice to treat areas alongside roadways with a mixture of herbicides and waste fuel oils. This practice was performed for insect control and dust suppression purposes. Since these constituents have been detected at low levels in the ground water at other SWMUs, it is implied that these chemicals may not be site-related constituents. Although these constituents are listed in Section 5.4.3 of the approved Work Plan as detected above the screening criteria, they are not identified as parameters of interest for Dye Burial Grounds.

Acetone, methylene chloride, and some phthalates were detected in the ground water samples collected at the site. Several reported concentrations of these chemicals exceeded risk-based criteria, as illustrated on Figures 5-3 through 5-8 of the Work Plan. These chemicals also were detected in the laboratory and field QC blanks associated with the site samples. They are not considered to be site-related constituents and were eliminated as parameters of interest for Dye Burial Grounds. These chemicals were reported at similar concentrations in environmental samples collected at other SWMUs, thereby supporting the conclusion that the presence of these chemicals is attributable to contamination introduced through sampling (decontamination or ambient conditions) or laboratory analysis.

In the 1988 sampling event, 2,4-dinitrotoluene was detected in well 02-05. The presence of this constituent in site wells was not confirmed in subsequent sampling events. This constituent, as well as 2,4,6-trinitrotoluene, was detected in ground water from the background monitoring well (02C10). The presence of these constituents in the background well and not in the site wells supports historical operations information associated with the site in that explosives/munitions were not placed in the dye burial trenches. Although 2,4-dinitrotoluene is listed in Section 5.4.3 of the approved Work Plan as detected above the screening criteria, it is not identified as a parameter of interest for Dye Burial Grounds.

In the ground water samples collected at the site, several pesticides and a herbicide were reported at concentrations greater than the lowest screening criteria (ground water or surface water criteria). The pesticides/herbicide exceeding criteria in ground water include lindane, aldrin, heptachlor, heptachlor epoxide, endosulfan I, gamma-chlordane, 4,4'-DDE and dinoseb. Because of the widespread use of pesticides/herbicides at many areas at NSWC Crane pesticides/herbicides are assumed to be attributable to Basewide insect control measures. Although these constituents are listed in Section 5.4.3 of the approved Work Plan as detected above the screening criteria, they are not identified as parameters of interest for Dye Burial Grounds.

Endosulfan I, gamma-chlordane, dinoseb, and 4,4'-DDE were identified as chemicals of interest for ground water solely on the basis that reported concentrations exceeded surface water screening criteria for ecological receptors. As mentioned previously, this is a conservative comparison and serves to overestimate potential impacts to surface water as a result of ground water discharge. These chemicals may not be present in the surface water at the site. Although these constituents are listed in Section 5.4.3 of the approved Work Plan as detected above the screening criteria, they are not identified as chemicals of interest for Dye Burial Grounds.

Supporting details for the conclusions regarding detected chemicals of interest for Dye Burial Grounds are presented in Section 5.4 of the attendant Work Plan. A summary of the proposed investigation for SWMU 2 is presented in Table 5-8 of the Work Plan.

1.4 PROJECT OBJECTIVES

The development of the data quality objectives (DQOs) for the entire CTO is presented in Section 4.2 of the attendant Work Plan. The specific investigative objectives for SWMU 2 are presented in Section 5.5 of the Work Plan. A summary of analyses to be conducted per medium is presented on Table 1-2.

This section provides an explanation of the project objectives for the field and laboratory investigations for SWMU 2. A summary of the specific objectives and associated tasks is presented in Section 1.4.1. Project target parameters and intended data uses are listed in Section 1.4.2. A review of the historical data and its impact on the DQOs is presented in Section 1.4.3.

1.4.1 Specific Objectives and Associated Tasks

For this project, it will be necessary to gather sufficient information to achieve the following general objectives:

- Refine the SWMU-specific conceptual risk model for potential human and ecological receptors exposed to site media under current and future land use.

- Refine the list of constituents of interest for the SWMU.

- Calculate representative SWMU-specific exposure point concentrations for the defined current/future human and ecological receptors.

- Assess the overall risk to current/future human and ecological receptors based on the detected levels of constituents present in environmental media at each SWMU.

- Evaluate the information collected to present in an RFI Report.

- Conduct a corrective measures study.

Specific DQOs for SWMU 2 are presented in Table 5-8 of the attendant Work Plan.

To accomplish these goals, a confirmational level of analytical quality is needed. This provides the highest level of data quality necessary to address potential human and ecological risks. These analyses require full documentation of the chosen U.S. EPA standard method or U.S. EPA SW-846 analytical methods, and sample preparation steps, data packages, and data validation sufficient to provide defensible data. QC must be sufficient to define the precision and accuracy of these procedures at every step.

1.4.2 Project Target Parameters and Intended Data Uses

The list of target parameters for the project is included in Table 1-1. Field measurements and laboratory data will be obtained for SWMU 2 to meet the project objectives outlined in the Work Plan (Table 5-8). Laboratory data will be compared with human health and ecological risk-based criteria, with the ultimate objective of determining whether detected constituents are present in the SWMU-specific media at concentrations that may pose an adverse impact to human and ecological receptors. The list of specific risk-based criteria used and compared to the laboratory limits is presented in Attachment C of this QAPP. Historical data were used to identify detected parameters of interest for SWMU 2 and to develop the target parameters for the project.

1.4.2.1 Field Parameters

The field parameters to be collected at SWMU 2 are listed in Table 5-8 of the approved Work Plan. The following are field parameters for ground water: dissolved oxygen, pH, specific conductance, temperature, alkalinity, ferrous iron, carbon dioxide, sulfide, hydrogen sulfide, turbidity, oxidation-reduction potential (ORP/Eh), nitrate, nitrite and water level measurements. This information will be used to ensure that well water is equivalent to formation water (i.e., ensure the representativeness of the sample) and to monitor the potential for natural attenuation. Also, these data will provide general water quality information for evaluating the potential use of natural attenuation as a remedy. No soil field measurements will be taken.

1.4.2.2 Laboratory Parameters

Table 1-1 provides a list of the laboratory parameters. This list of parameters includes the RCRA Appendix IX metals, miscellaneous metals, dyes, and some miscellaneous wet chemistry parameters. In general, the list of chosen analytical methods is composed of U.S. EPA SW-846 methods. The NSWC Crane Lab developed a high performance liquid chromatography (HPLC) quantitative analytical method for the dye analysis. The method has been reviewed and approved by U.S. EPA Region 5. Specific chemicals to be included in each analytical fraction, as well as identification of the analytical methods to be used, are presented in Table 1-1. Further information regarding analytical methods, including references, is provided in Section 7.0 of this QAPP.

Also included in Table 1-1 are the project-specific, risk-based target levels and laboratory-specific, method detection limits (MDLs) for organics, instrument detection limits (IDLs) for inorganics, and reporting limits (RLs) for the target parameters and chosen analytical methods. The risk-based target levels presented in Table 1-1 are based upon the lowest applicable current human health and ecological risk-based criteria. A tabular presentation of the human health and ecological risk-based criteria used as a basis for determining the target levels is provided in Attachment C of this QAPP. The following lists provide a summary of the types of risk-based target criteria used for this project:

<u>Aqueous Matrix:</u>

- Federal Maximum Contaminant Levels (MCLs)
- U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water
- Federal Ambient Water Quality Criteria (AWQC) for Freshwater
- IDEM Tier I Default Cleanup Level

- U.S. EPA Region 5 EDQLs for Surface Water
- Preliminary Remediation Standards for dyes developed by U.S. EPA Region 5 for this project

Solid Matrix:

- U.S. EPA Soil Screening Level (SSL) for Ingestion
- U.S. EPA SSL for Inhalation
- U.S. EPA SSL for Migration to Ground Water
- U.S. EPA Region 9 PRGs for Residential Land Use
- IDEM Tier I Surface Soil Default Cleanup Level for Residential Land Use
- IDEM Tier I Subsurface Soil Default Clean Levels for Residential Land Use
- U.S. EPA Region 5 EDQLs for Soil
- U.S. EPA Region 5 EDQLs for Sediment
- Preliminary Remediation Standards for dyes developed by U.S. EPA Region 5 for this project

Based on the limitations of the best available analytical technology, RLs or IDLs/MDLs for some analytes could not reach the risk-based levels. Section 1.4.3 (Risk-Related Issues) presents the chemical-specific rationales as to the validity of using the technology-based RL and IDL/MDL, as well as the impact of the historical data on the selection of analytical methods and reporting limits.

Information on specific decision rules regarding the use of this data is included in Section 4.2.5 of the Work Plan.

1.4.3 Risk-Related Issues

TtNUS worked closely with the subcontracted analytical laboratories to select and optimize analytical methods in an effort to attain, to the greatest extent possible, laboratory RLs and IDLs/MDLs at concentrations less than or equal to the risk-based target levels. For example, as noted on Table 1-1, metals are to be analyzed via U.S. EPA SW-846 Method 6020 [Inductively Coupled Plasma/Mass Spectrometry (ICP/MS)] in place of U.S. EPA SW-846 Method 6010B (ICP/Atomic Emission Spectroscopy) for the Appendix 9 metals to achieve lower RLs and IDLs. As shown on Table 1-1, the RLs or IDLs for some metals/cyanide are greater than the screening criteria. The IDLs for most of these metals, however, are less than the screening criteria.

1.5 SAMPLE NETWORK DESIGN AND RATIONALE

Information regarding the sample network and design, as well as the rationale for the proposed sampling, is provided in this section. Since the details for the proposed field investigation are defined in the Work Plan, specific references to associated Work Plan sections are provided.

1.5.1 Sample Network by Task and Matrix

The proposed sample network for SWMU 2 is described in Section 5.5.2 of the Work Plan. Table 5-8 of the Work Plan presents summaries of the proposed samples for the SWMU per environmental matrix.

1.5.2 Site Maps of Sampling Locations

Section 5.5.2 and Figure 5-8 of the approved Work Plan present information on the sampling locations for Dye Burial Grounds (SWMU 2).

1.5.3 Rationale of Selected Sampling Locations

Section 5.5.2 and Table 5-8 of the approved Work Plan present information on the rationale for the selection of sampling locations for Dye Burial Grounds (SWMU 2).

1.5.4 Sample Network Summary Table

Tables 3-1 and 3-4 in the attendant FSP presents a summary of the sample network.

1.6 PROJECT SCHEDULE

This section outlines the schedule for field investigation activities at NSWC Crane.

1.6.1 Anticipated Date of Project Mobilization

The earliest date for start of field work for sample collection is February 5, 2001. Figure 1-1 presents the overall project schedule.

1.6.2 Task Bar Chart and Associated Timeframes

The dates of projected milestones are shown in Figure 1-1.

TABLE 1-1

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2

Chemical	Aqueous Matrix			Solid Matrix			
	Laboratory MDL (ug/L)[1]	Laboratory RL (ug/L)[1]	Lowest Risk-Based Target Level (ug/L)[2]	Laboratory MDL (mg/kg)[1]	Laboratory RL (mg/kg)[1]	Lowest Risk-Based Soil Target Level (mg/kg)[2]	Lowest Risk-Based Sediment Target Level (mg/kg)[2]
APPENDIX IX METALS (SW-846 METHOD 6020 ICP/MS, UNLESS OTHERWISE NOTED)							
Antimony	0.1	1	6	0.05	1	0.1423	0.3
Arsenic	0.1	1	0.045	0.05	1	0.39	0.0059
Barium	0.1	1	2000	0.05	1	1.04	82
Beryllium	0.1	1	4	0.05	1	0.1	-- [3]
Cadmium	0.1	1	0.66	0.05	1	0.00222	0.4
Chromium (total)	0.1	5	11	0.05	1	2	--
Cobalt	0.1	3	5	0.05	1	0.14033	50
Copper	0.1	2	5	0.05	1	2.96	16
Lead	0.1	1	1.3	0.05	1	0.05373	31
Mercury (SW-846 Method 7470A/7471A)	0.14	0.2 [5]	0.0013	0.07	0.2 [5]	0.073	0.1
Nickel	0.1	10	29	0.05	1	7	16
Selenium	0.3	1	5	0.15	1	0.02765	0.3
Silver	0.1	3	1	0.05	1	2	0.5
Thallium	0.1	1	0.56	0.05	1	0.04	--
Tin	0.1	10	73	0.05	5	7.62	45000
Vanadium	0.1	2	19	0.05	1	1.59	300
Zinc	0.4	10	58.9	0.2	1	6.62	120
MISCELLANEOUS METALS (SW-846 METHOD 6010B)[5]							
Aluminum	81	200	--	8.1	20	--	--
Calcium	150	5000	--	15	500	--	--
Iron	13	100	--	1.3	10	--	--
Magnesium	7.6	5000	--	0.76	500	--	--
Manganese	0.2	15	--	0.02	1.5	--	--
Potassium	16	5000	--	1.6	500	--	--
Sodium	76	5000	--	7.6	500	--	--
MISCELLANEOUS PARAMETERS							
Cyanide (SW-846 Method 9012A) (mg/L or mg/kg))	0.74	10	5.2	0.1	1	1.33	0.0001
Dissolved Methane (Microseeps, Inc., Method AM18)	0.005	0.015	5[9]				NA
Bulk Density	NA	NA	--	NA	NA	--	--
Grain Size	NA	NA	--	NA	NA	--	--
Nitrite/Nitrate (EPA 353.2) (ug/L)	2	10	10000 (nitrate)	ANR	ANR	--	--
Nitrite (SW-846 Method 9056) (mg/L)	20	100	1000	ANR	ANR	--	--
Biochemical Oxygen Demand (EPA 405.1) (mg/L)	31.2	100	--	ANR	ANR	--	--
Chemical Oxygen Demand (EPA 410) (mg/L)	74.2	1000	--	ANR	ANR	--	--
Hardness (Standard Methods 2340B) (mg/L)	--	--	1	ANR	ANR	--	--
Total Suspended Solids (EPA 160.1) (mg/L)	--	2000[4]	--	ANR	ANR	--	--
Total Organic Carbon (TOC) (EPA 415.1) (mg/L)	350	1000	--	--	1000	--	--
pH (SW-846 9045C) (S.U.)	ANR	ANR	--	--	1	--	--
CEC (SW-846 9081) (meq/100g)	ANR	ANR	--	--	6	--	--

TABLE 1-1

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 2

Chemical	Aqueous Matrix			Solid Matrix			
	Laboratory MDL (ug/L)(1)	Laboratory RL (ug/L)(1)	Lowest Risk-Based Target Level (ug/L)(2)	Laboratory MDL (mg/kg)(1)	Laboratory RL (mg/kg)(1)	Lowest Risk-Based Soil Target Level (mg/kg)(2)	Lowest Risk-Based Sediment Target Level (mg/kg)(2)
DYES (NSWC CRANE HPLC METHOD) [6]							
Acid Blue 45	26.7	23.3	--	0.8	14.0	--	--
Acid Blue 1	43.8	26.6	450 [7]	0.6	16.0	10 [7]	--
Acid Yellow 3	24.6	22.9	--	0.1	13.7	--	--
Basic Yellow 2	170.0	23.1	60 [7]	1.4	13.9	1.3 [7]	--
Acid Yellow 23	12.8	25.1	--	0.4	15.1	--	--
Acid Yellow 73	13.5	22.6	--	0.2	13.6	--	--
Acid Orange 10	13.0	25.1	100 [7]	0.5	15.1	6.46 [7]	--
Disperse Violet 1	11.1	16.3	--	0.5	9.8	--	--
Solvent Yellow 33	13.7	17.5	--	0.1	10.5	--	--
Disperse Blue 14	16.7	18.7	--	0.9	11.2	--	--
Acid Red 64	12.1	62.5	--	0.2	37.5	--	--
Acid Blue 9	25.1	22.6	230000 [7]	0.1	13.6	1630 [7]	--
Basic Violet 10	15.0	19.9	570 [7]	0.2	11.9	12 [7]	--
2-Aminoanthraquinone	12.6	23.4	2.01 [7]	0.1	14.0	14.7 [7]	--
Solvent Orange 3	11.7	16.0	600 [7]	0.1	9.6	124 [7]	--
1-Aminoanthraquinone	12.2	16.7	2.01 [8]	0.4	9.6	14.7 [8]	--
Solvent Yellow 14	13.5	17.7	460 [7]	0.1	10.6	3.23 [7]	--
Solvent Orange 7	6.1	18.0	730 [7]	0.8	10.8	52 [7]	--
Solvent Yellow 3	16.2	19.9	0.02 [7]	0.4	11.3	0.13 [7]	--
Solvent Red 1	7.9	29.0	INS	2.3	17.4	INS	--
Disperse Red 9	14.8	16.5	--	0.2	9.9	--	--
Solvent Yellow 2	11.8	20.0	0.01 [7]	0.2	12.0	0.110 [7]	--
Solvent Green 3	18.5	18.4	--	1.2	11.0	--	--
Solvent Red 24	2.9	7.1	--	0.0	4.3	--	--

MDL = method detection limit
RL = reporting limit

µg/L = micrograms per liter.
mg/kg = milligrams per kilogram.

mg/L = milligrams per liter.
ANR = Analysis Not Required

NA = Not Applicable
INS = Insufficient Information

Shaded cells indicate laboratory MDLs that exceed a risk-based target level for the project.
Shaded cells indicate laboratory RLs that exceed a risk-based target level for the project.

1 Method detection limits (MDLs) and reporting limits (RLs) as provided by Laucks Testing Laboratories, Inc. and NSWC Crane Lab (dyes, bulk density and grain size).
These values may change prior to the SWMU investigations as laboratory MDLs and RLs are updated.
2 Value is based on the lowest human health or ecological risk-based criteria as presented in Appendix D of the Work Plan.
3 Risk-based target level is not provided, since human and ecological risk-based criteria are not available for this chemical.
4 Laucks Testing Laboratories is confident that it can reliably report to this PQL, even though this value is less than two times the MDL.
5 These are not Appendix 9 metals. They are being analyzed for general groundwater quality information. They are not to be included in the screening process; therefore, no criteria are listed.
6 Aqueous values are based on the long gradient low level method low spike. Soil values are based on short gradient low spike.
7 These values were developed by USEPA Region 5 specifically for this project.
8. These values were developed for 2-aminoanthraquinone.

TABLE 1-2

SUMMARY OF ANALYSIS PER MEDIA FOR SWMU 2
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

	Chemical Category			
	Matrix	Dyes	Metals[1]	Miscellaneous Parameters[2]
SWMU 2 - Dye Burial Grounds				
	Soil	X	X	X
	Sediment	X	X	
	Surface Water	X	X[3]	X
	Ground Water	X	X	X

1 Metals include Appendix 9 metals and the following miscellaneous metals: aluminum, calcium, iron, magnesium, manganese, potassium, and sodium.
2 Miscellaneous parameters include the following:
Surface Water - TOC, TSS, CN, and hardness
Ground Water - TOC, TSS, CN, nitrate/nitrite, sulfate and chloride
Solid matrix - pH, TOC, CEC, bulk density and grian size
3 Analysis will be conducted for both total and dissolved fractions of metals.

TOC - Total organic carbon
TSS - Total suspended solids
CEC - Cation exchange capacity
CN - Cyanide

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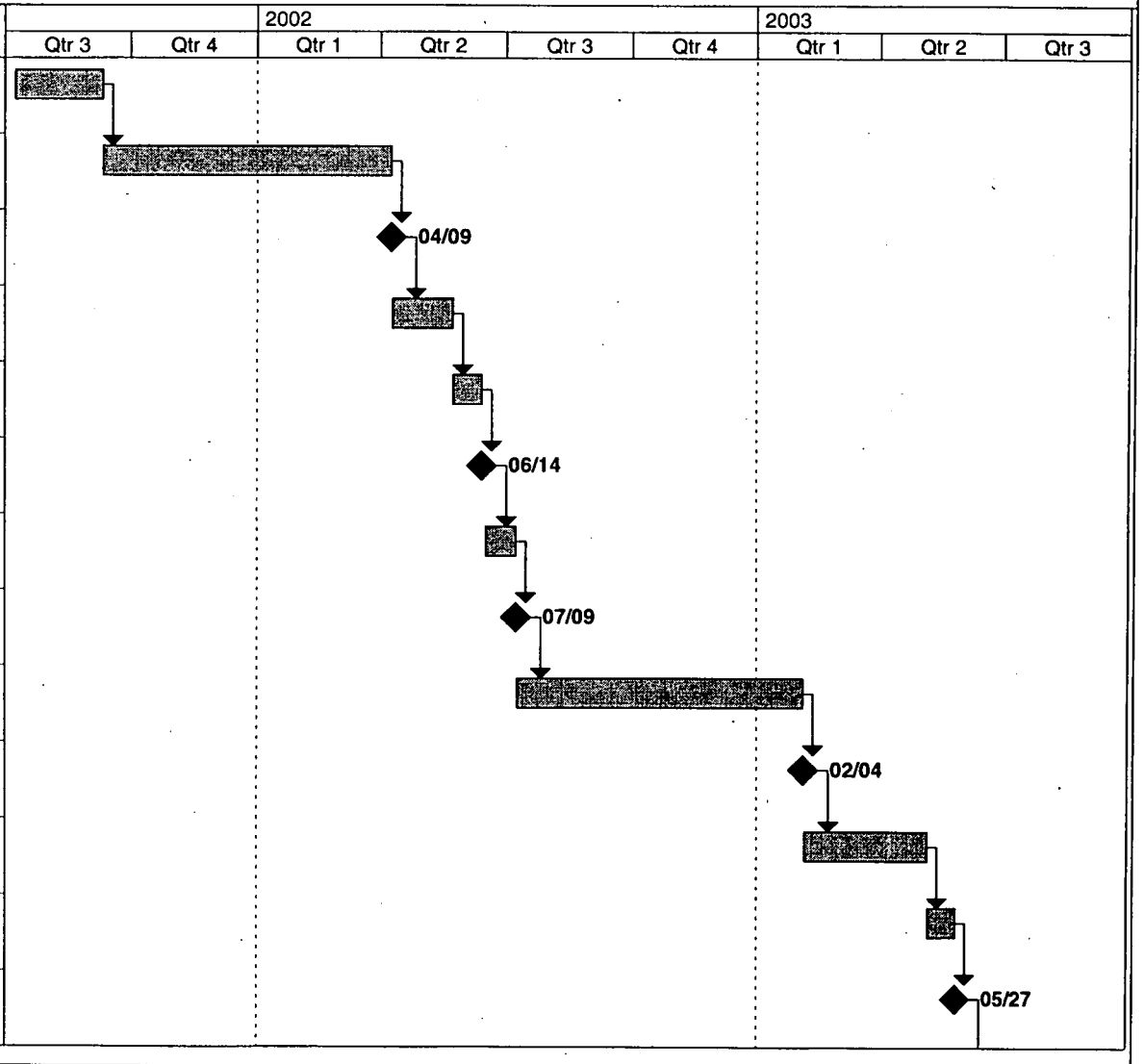
FIGURE 1-1
CURRENT PROJECT SCHEDULE
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA

ID	Task Name	Duration	Start
1	Conduct Field Operations	46 days	Mon 07/09/01
2	Prepare Draft RFI and Risk Assessment Report	150 days	Tue 09/11/01
3	Submit Draft RFI And Risk Assessment Report To EPA/IDEM	0 days	Tue 04/09/02
4	EPA/IDEM Review Period	32 days	Wed 04/10/02
5	Prepare Comment Response	15 days	Fri 05/24/02
6	Submit Comment Response	0 days	Fri 06/14/02
7	Prepare Final RFI and Risk Assessment Report	16 days	Mon 06/17/02
8	Submit Final RFI and Risk Assessment Report	0 days	Tue 07/09/02
9	Prepare Draft CMS Report	149 days	Wed 07/10/02
10	Submit Draft CMS Report to EPA/IDEM	0 days	Tue 02/04/03
11	EPA/IDEM Review Period	64 days	Wed 02/05/03
12	Prepare Comment Response	15 days	Tue 05/06/03
13	Submit Comment Response	0 days	Tue 05/27/03

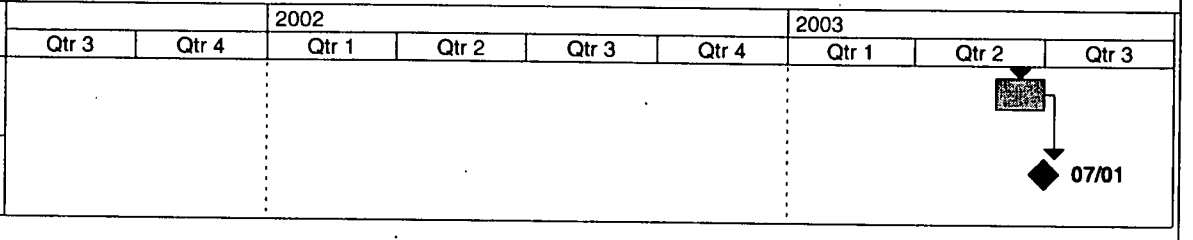


Project: Figure 1-1
Date: Thu 05/10/01

Task		Summary		Rolled Up Progress	
Split		Rolled Up Task		External Tasks	
Progress		Rolled Up Split		Project Summary	
Milestone		Rolled Up Milestone			

FIGURE 1-1
CURRENT PROJECT SCHEDULE
SWMU 2 - DYE BURIAL GROUNDS
NSWC CRANE, INDIANA

ID	Task Name	Duration	Start
14	Prepare Final CMS Report	24 days	Wed 05/28/03
15	Submit Final CMS Report	0 days	Tue 07/01/03



Project: Figure 1-1
Date: Thu 05/10/01

Task		Summary		Rolled Up Progress	
Split		Rolled Up Task		External Tasks	
Progress		Rolled Up Split		Project Summary	
Milestone	◆	Rolled Up Milestone	◇		

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization for the NSWC Crane field investigation for SWMU 2 is provided in Section 2 of the approved Work Plan. A project organization chart is provided, and management, QA, laboratory, and field responsibilities are presented.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody (CoC), laboratory analysis, and reporting that will provide results that are technically sound and legally defensible in a court of law. Intended data uses are described in Section 1.4 of this QAPP and Section 4.0 of the Work Plan. Specific procedures for sampling, CoC, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance of field and laboratory equipment, and corrective action are described in other sections of this QAPP.

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

3.1 PRECISION

3.1.1 Definition

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

3.1.2 Field Precision Objectives

Field duplicate precision monitors the consistency with which environmental samples were obtained and analyzed. In general, field duplicate results for aqueous matrix samples are considered to be precise if the relative percent difference (RPD) is less than or equal to 30 percent and field duplicate results for solid matrix samples are considered to be precise if the RPD is less than or equal to 50 percent. Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 analytical samples per matrix.

3.1.3 Laboratory Precision Objectives

Precision for organic analyses will be measured via the RPDs for matrix spike/matrix spike duplicate (MS/MSD) samples. Laboratory precision QC samples will be analyzed with a minimum frequency of 5 percent (i.e., 1 QC sample per 20 environmental samples per matrix). Laboratory precision is measured

via comparison of RPD values and precision control limits specified in the analytical method or by the laboratory's QA/QC program. Precision for inorganic analyses will be measured via RPDs for laboratory duplicates. Tables 3-1, 3-3, and 3-5 present precision control limits for MS/MSD and laboratory duplicate RPDs, as applicable, for each analytical fraction. (Tables 3-2, 3-4, and 3-6 present accuracy control limits, which are explained in Section 3.2.)

3.2 ACCURACY

3.2.1 Definition

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

3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of rinsate and trip blanks and is ensured through adherence to all sample handling, preservation, and holding time requirements. Accuracy and precision requirements for field measurements (e.g., pH) are ensured through routine instrument calibration, as presented in Section 2.8.1 of the approved FSP.

3.2.3 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample result with a known or calculated value and is expressed as a percent recovery (%R). Percent recoveries are derived from the analysis of known amounts of compounds spiked into deionized water [i.e., laboratory control sample (LCS) analysis] or into actual samples (i.e., surrogate or MS analysis). LCS analysis, which may also be referred to as blank spike analysis, measures the accuracy of laboratory operations. Surrogate and MS analyses measure the accuracy of laboratory operations as affected by sample matrix. LCS and MS analyses are performed at a frequency of 1 per 20 associated samples of like matrix. Surrogate spike analysis is performed for all organic chromatographic analyses. Laboratory accuracy is assessed via comparison of calculated %R values with accuracy control limits specified in the analytical method or by the laboratory's QA/QC program.

Accuracy for organic analyses will be measured via the percent recoveries for surrogate spikes, MS/MSDs, and LCSs. Accuracy for inorganic analyses will be measured via percent recoveries for MSs and LCSs. Tables 3-1 through 3-6 present accuracy control limits for MS, surrogate spike, and LCS recoveries, as applicable, for each analytical fraction.

3.3 COMPLETENESS

3.3.1 Definition

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

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed); errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory contamination), or strong matrix effects can become apparent (e.g., extremely low MS recovery). These instances result in data that do not meet QC criteria. Completeness will be calculated for each chemical category (e.g., metals, dyes) per media. If critical data points are lost, resampling and/or reanalysis may be required.

Validation will be performed for 100 percent of the laboratory data for this investigation based on the requirements of the analytical methods and this QAPP. To the extent practicable for SW-846 analyses, validation will be performed in accordance with the U.S. EPA Region 5 Standard Operating Procedures for Validation of Contract Laboratory Program Organic Data (U.S. EPA Region 5, 1993a) and Region 5 Standard Operating Procedures for Validation of Contract Laboratory Program Inorganic Data (U.S. EPA, 1993b); and the U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (U.S. EPA, 1994a) and U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (U.S. EPA, 1994b). Data rejected as a result of the validation process will be treated as unreliable, unusable data.

3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. Field completeness for this project is expected to be greater than 90 percent.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid laboratory measurements per matrix obtained from all the laboratory measurements per matrix taken in the project. Laboratory completeness for this project is expected to be greater than 95 percent.

3.4 REPRESENTATIVENESS

3.4.1 Definition

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

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness depends on the proper design of the sampling program and will be satisfied by ensuring that the FSP is followed and that proper sampling techniques are used.

3.4.3 Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing field duplicate samples. The sampling network for the soil, sediment, surface water, and ground water monitoring program was designed to provide data representative of facility conditions. During development of this sampling network, consideration was given to past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to the RCRA program. The rationale of the sampling network is presented in detail in Section 5.0 of the attendant Work Plan.

3.5 COMPARABILITY

3.5.1 Definition

Comparability is defined as the confidence with which one data set can be compared with another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measure).

Additionally, consideration is given to seasonal conditions and other environmental variations that could exist to influence analytical results.

3.5.2 Measures to Ensure Comparability of Field Data

Comparability depends on the proper design of the sampling program and will be satisfied by ensuring that the FSP is followed and that proper sampling techniques are used. It also depends on recording field measurements using consistent units. Units to be used for field measurements are provided in Section 9.1.1.

3.5.3 Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented. Results will be reported in units that ensure comparability with previous data. The units used for the laboratory measurements are provided in Section 9.1.2 of this QAPP.

3.6 DECISION RULE

3.6.1 Definition

A decision rule is a statement that indicates the attributes a decision maker wishes to evaluate for a population and how the knowledge would guide the selection of a course of action to solve a problem.

3.6.2 Decision Rule Objectives

Decision levels, expressed as human health or ecological target decision levels, for each critical measurement parameter are specified in Table 1-1 of this QAPP. The decision rules and a flowchart of these rules are presented in Section 4.0 of the attendant Work Plan.

3.7 LEVEL OF QC EFFORT

Rinsate blank, ambient blank, source water blank, field duplicate, method blank, laboratory duplicate, laboratory control, and MS samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. Internal QC samples (i.e., laboratory QC samples) are explained in Section 8.0 of this QAPP. External QC measures (i.e., field QC samples) consist of field duplicates, ambient blanks, source water blanks, and equipment rinsate blanks. Information gained from these analyses further characterizes the level of data quality obtained to support project goals. Each of these

types of field QC samples undergo the same preservation, analysis, and reporting procedures as the related environmental samples. Each type of field QC sample is detailed below.

Field duplicates are two samples collected either (1) independently at the same sampling location in the case of ground water and surface water or (2) as a single sample split into two portions in the case of soil or sediment. Field duplicates are collected and analyzed for chemical constituents to measure the precision of the sampling and analysis methods used. The general level of the QC effort will be one field duplicate for every 10 or fewer investigative samples per medium. Also, one field duplicate sample for every 10 or fewer groundwater samples will be analyzed for natural attenuation parameters.

Ambient blanks will be submitted for analysis to provide the means to assess the quality of the data resulting from the FSP. Ambient blank samples are analyzed to check for interfering contaminants that could potentially be present in ambient air at the sampling site (e.g., particulates on a windy day in a dry, dusty area). The parameter list for the ambient blank depends on the conditions at the site at the time of sampling. Ambient blanks will be collected at the sampling location by placing analyte-free water directly into the same types of containers, preserved and stored in the same manner as field samples. The need for collection of an ambient blank and the parameter list for the blank will be based on conditions at the time of sampling at the discretion of the Field Operations Leader (FOL). Section 2-7 of the attendant FSP details the basis for collection of an ambient blank.

Equipment rinstate blanks are used to assess the effectiveness of decontamination procedures. Equipment rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after sampling and decontamination and then placing the rinse water in the appropriate sample container for analysis. One rinsate blank will be collected per each type of sampling equipment used (e.g., pump) per day that sampling is conducted. If pre-cleaned, dedicated, or disposable sampling equipment is used, one rinsate blank per lot per type of equipment used must be collected as a "batch blank." Rinsate blanks are analyzed for the same chemical constituents as the associated environmental samples.

Source water blanks are obtained by sampling the analyte-free water and/or potable water source(s) used for decontamination of sampling equipment. Source water blanks are used to determine whether the analyte-free water or the potable water (used for steam cleaning) may be contributing to sample contamination. One source water blank will be collected for each source of water used for decontamination.

MSs are investigative samples analyzed to provide information about the effect of the sample matrix on the digestion and measurement methodology. All MSs for organic analyses are performed in duplicate and, as previously defined, are referred to as MS/MSD samples. One MS or MS/MSD sample will be collected/designated for every 20 or fewer investigative samples per medium. Extra sample volume must be collected for samples designated for MS/MSD analysis for dye analysis. Specifically, two extra 1000-mL bottles for dye analyses are required. Specific details regarding extra sample volume required for MS/MSD samples are provided for each analytical fraction in Tables 2-1 and 2-2 of the FSP. MS/MSD samples are further explained in Section 8.0 of this QAPP.

Tables 3-2 and 3-5 in the attendant FSP indicate the total number of QC samples to be collected on the basis of parameter and matrix. Specific locations for the collection of MS/MSD and duplicate samples are approximated on these tables. The order of sample collection cannot always be planned in advance because the Base is a working facility and access to certain areas may be restricted on some days. To maintain the proper frequency of QC sampling, the location of sampling must be somewhat flexible.

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TABLE 3-1

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE AND LABORATORY DUPLICATE SAMPLES
METALS ANALYSES
NSWC CRANE, INDIANA

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy[2] (%R)	Precision[3] (RPD)	Accuracy[2] (%R)	Precision[3] (RPD)
APPENDIX IX METALS BY SW-846 METHOD 6020 (UNLESS OTHERWISE NOTED)				
Antimony	75-125	35	75-125	20
Arsenic	75-125	35	75-125	20
Barium	75-125	35	75-125	20
Beryllium	75-125	35	75-125	20
Cadmium	75-125	35	75-125	20
Chromium (total)	75-125	35	75-125	20
Cobalt	75-125	35	75-125	20
Copper	75-125	35	75-125	20
Lead	75-125	35	75-125	20
Mercury (SW-846 Method 7070A)	75-125	35	75-125	20
Nickel	75-125	35	75-125	20
Selenium	75-125	35	75-125	20
Silver	75-125	35	75-125	20
Thallium	75-125	35	75-125	20
Tin	75-125	35	75-125	30
Vanadium	75-125	35	75-125	20
Zinc	75-125	35	75-125	20
MISCELLANEOUS METALS BY SW-846 METHOD 6010B				
Aluminum	75-125	35	75-125	20
Calcium	75-125	35	75-125	20
Iron	75-125	35	75-125	20
Magnesium	75-125	35	75-125	20
Manganese	75-125	35	75-125	20
Potassium	75-125	35	75-125	20
Sodium	75-125	35	75-125	20

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 These acceptance limits apply to spikes that augment the native sample analyte concentration by at least 25 percent.
3 These acceptance limits apply to original and duplicate sample concentrations >5X RL. If one or both of the results is <5X RL, the acceptance criterion is ± RL. If one of the results is a non-detect, the reported %RPD will be 200%.

TABLE 3-2

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
METALS ANALYSES
NSWC CRANE, INDIANA

Chemical	Solid Matrix Accuracy (%R)[2]	Aqueous Matrix Accuracy (%R)[2]
APPENDIX IX METALS BY SW-846 METHOD 6020 (UNLESS OTHERWISE NOTED)		
Antimony	75-125	75-125
Arsenic	80-120	80-120
Barium	80-120	80-120
Beryllium	80-120	80-120
Cadmium	80-120	80-120
Chromium (total)	80-120	80-120
Cobalt	80-120	80-120
Copper	80-120	80-120
Lead	80-120	80-120
Mercury (SW-846 Method 7470A)	80-120	80-120
Nickel	80-120	80-120
Selenium	80-120	80-120
Silver	75-125	75-125
Thallium	80-120	80-120
Tin	80-120	80-120
Vanadium	80-120	80-120
Zinc	80-120	80-120
MISCELLANEOUS METALS BY SW-846 METHOD 6010B		
Aluminum	80-120	80-120
Calcium	80-120	80-120
Iron	80-120	80-120
Magnesium	80-120	80-120
Manganese	80-120	80-120
Potassium	80-120	80-120
Sodium	80-120	80-120

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

2 The laboratory may use a purchased standard reference material (SRM) in place of an LCS. If a SRM is used, the acceptance limits provided by the supplier of the SRM may be used unless the SRM limits are wider than the acceptance limits provided in this table. If the SRM limits are wider, the laboratory must use the acceptance limits provided in this table.

TABLE 3-3

QUALITY CONTROL LIMITS [1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
DYE ANALYSES
NSWC CRANE, INDIANA

Chemical	Solid Matrix [2]		Aqueous Matrix [3]	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD) [5]
Acid Blue 9	3 - 9	35	16 - 113	37
Acid Blue 45	46 - 75	35	0 - 117	53
Acid Orange 10	191 - 213	35	50 - 114	20
Acid Red 64	61 - 69	35	43 - 109	22
Acid Yellow 23	55 - 74	35	48 - 111	20
Acid Yellow 73	61 - 68	35	47 - 110	20
1-Aminoanthraquinone	73 - 94	35	41 - 96	20
2-Aminoanthraquinone	42 - 46	35	36 - 87	21
Basic Violet 10	93 - 105	35	46 - 111	21
Disperse Blue 14	34 - 73	35	35 - 109	26
Disperse Red 9	40 - 48	35	46 - 115	22
Disperse Violet 1	45 - 68	35	46 - 100	20
Solvent Green 3	25 - 72	35	2 - 84	47
Solvent Orange 3	51 - 54	35	41 - 92	20
Solvent Orange 7	58 - 94	35	37 - 65	20
Solvent Red 1	25 - 88	35	38 - 74	20
Solvent Red 24	50-150 [6]	35 [6]	34 - 102	25
Solvent Yellow 2	41 - 47	35	47 - 104	20
Solvent Yellow 3	210 - 225	35	49 - 116	20
Solvent Yellow 14	41 - 44	35	42 - 88	20
Solvent Yellow 33	35 - 41	35	46 - 106	20
Anthracene [4]	42 - 57	NA	0 - 106	NA
Benzanthrone [4]	99 - 113	NA	32 - 120	NA

NA - Not Applicable

1 Soil QC limits are based on the seven low spike samples analyzed during method performance/validation (Round 1). Aqueous QC limits are based on the eleven low spike deionized water samples analyzed during method optimization/validation (Rounds 2 and 3). These limits are advisory limits and will be updated as more data points become available.

2 Soil QC limits are based on the short gradient because quantitation of soil sample results will be made from the short gradient.

3 Aqueous QC limits are based on the long gradient because quantitation for aqueous samples will be made from the long gradient.

4 Surrogate QC limits are based on (avg)X $\pm$ 3s.

5 RPD values were calculated for all compounds. RPD limits of 20% for aqueous and 35% for solids were substituted for the calculated value in instances where the calculated RPD was less than the 20% or 35% limit.

6 Acceptance limits will be revised as data becomes availlable.

TABLE 3-4

QUALITY CONTROL LIMITS [1]
LABORATORY CONTROL SAMPLES
DYE ANALYSES
NSWC CRANE, INDIANA

Chemical	Solid Matrix [2]	Aqueous Matrix [3]
	Accuracy (%R)	Accuracy (%R)
Acid Blue 9	3 - 9	16 - 113
Acid Blue 45	46 - 75	0 - 117
Acid Orange 10	191 - 213	50 - 114
Acid Red 64	61 - 69	43 - 109
Acid Yellow 23	55 - 74	48 - 111
Acid Yellow 73	61 - 68	47 - 110
1-Aminoanthraquinone	73 - 94	41 - 96
2-Aminoanthraquinone	42 - 46	36 - 87
Basic Violet 10	93 - 105	46 - 111
Disperse Blue 14	34 - 73	35 - 109
Disperse Red 9	40 - 48	46 - 115
Disperse Violet 1	45 - 68	46 - 100
Solvent Green 3	25 - 72	2 - 84
Solvent Orange 3	51 - 54	41 - 92
Solvent Orange 7	58 - 94	37 - 65
Solvent Red 1	25 - 88	38 - 74
Solvent Red 24	50 - 150 [5]	34 - 102
Solvent Yellow 2	41 - 47	47 - 104
Solvent Yellow 3	210 - 225	49 - 116
Solvent Yellow 14	41 - 44	42 - 88
Solvent Yellow 33	35 - 41	46 - 106
Anthracene [4]	42 - 57	0 - 106
Benzanthrone [4]	99 - 113	32 - 120

1 Soil QC limits are based on the seven low spike samples analyzed during method performance/validation. Aqueous QC limits are based on the eleven low spike deionized water samples analyzed during method optimization/validation. These limits are advisory limits and will be updated as more data points become available.
2 Soil QC limits are based on the short gradient because quantitation of soil sample results will be made from the short gradient.
3 Aqueous QC limits are based on the long gradient because quantitation for aqueous samples will be made from the long gradient.
4 Surrogate QC limits are based on (avg)X $\pm$ 3s.
5 Acceptance limits will be revised as data becomes available.

TABLE 3-5

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE AND LABORATORY DUPLICATE SAMPLES
MISCELLANEOUS PARAMETERS
NSWC CRANE, INDIANA

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision [2] (RPD)	Accuracy (%R)	Precision [2] (RPD)
MISCELLANEOUS PARAMETERS				
Hardness (Standard Method 2340B)	ANR[3]	ANR	NA[4]	30
Sulfate (SW 846 Method 9056)	ANR	ANR	81 - 115	20
Chloride (SW 846 Method 9056)	ANR	ANR	73 - 121	11
Total Organic Carbon (U.S. EPA 415.1)	50-150	30	70-119	11
Total Suspended Solids (U.S. EPA 160.1)	ANR	ANR	NA	20
pH (SW-846 Method 9045C)	NA	10	ANR	ANR
CEC (SW-846 Method 9081)	TBD[5]	30	ANR	ANR
Bulk Density (ASTM D2937)	NA	NA	ANR	ANR
Grain Size (ASTM D422)	NA	NA	ANR	ANR

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 These acceptance limits apply to original and duplicate sample concentrations >5X RL. If one or both of the results is <5X RL, the acceptance criterion is ± 5X RL. If one of the results is a non-detect, the reported %RPD will be 200%.
3 Analysis not required.
4 Not applicable.
5 To be determined.

TABLE 3-6

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
MISCELLANEOUS PARAMETERS
NSWC CRANE, INDIANA

Chemical	Solid Matrix Accuracy (%R) [2]	Aqueous Matrix Accuracy (%R) [2]
MISCELLANEOUS PARAMETERS		
Hardness (Standard Method 2340B)	ANR[3]	NA[4]
Sulfate (SW 846 Method 9056)	ANR	90 - 110
Chloride (SW 846 Method 9056)	ANR	90 - 110
Total Organic Carbon (U.S. EPA 415.1)	50-150	80-120
Total Suspended Solids (U.S. EPA 160.1)	ANR	NA
pH (SW-846 9045C)	NA	ANR
CEC (SW-846 9081)	TBD[5]	ANR
Bulk Density (ASTM D2937)	NA	ANR
Grain Size (ASTM D422)	NA	ANR

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 As noted in the laboratory SOPs, the laboratory may use a purchased standard reference material (SRM) in place of an LCS. If an SRM is used, the acceptance limits provided by the supplier of the SRM may be used unless the SRM limits are wider than the acceptance limits provided in this table. If the SRM limits are wider, the laboratory must use the acceptance limits provided in this table.
3 Analysis not required
4 Not applicable.
5 To be determined.

4.0 SAMPLING PROCEDURES

Field sampling procedures for the field investigation for SWMU 2 are detailed in Section 2.0 of the Field Sampling Plan (FSP) and in the Standard Operating Procedures (SOPs) included in the FSP. Appendix A contains the FSP.

5.0 CUSTODY PROCEDURES

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

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

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

5.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the laboratory or entrusted to a commercial overnight courier. CoC reports are completed for each sample shipment. The reports are filled out in a legible manner, using waterproof ink, and are signed (and dated) by the sampler. Pertinent notes, such as whether the sample was field filtered or whether the sample is suspected to be high in contaminant concentration, also are indicated on the CoC report. Information similar to that contained in the CoC report is provided on the sample label, which is securely attached to the sample bottle. In addition, sample tags will be affixed to the sample bottles and will be returned by the analytical laboratory for inclusion in the final evidence file. A temperature blank will be included in each cooler.

Full details regarding sample CoC (including use of custody seals and sample shipment protocols) are contained in CTO 10 SOPs 11 and 12, which are provided in Attachment B of the FSP. CTO 10 SOP 11

presents maintenance of site logbooks, site notebooks, and other field records. Additionally, each of the various sampling SOPs incorporated into the FSP contains a section that addresses relevant sample documentation (i.e., completion of sample logsheets, etc.). All sample records are eventually docketed into the Administrative Record at NSWC Crane.

5.2 LABORATORY CUSTODY PROCEDURES

When samples are received by the subcontracted laboratory, the laboratory's sample custodian will examine each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The custodian will then open the cooler and measure its internal temperature by measuring the temperature of the temperature blank; as previously noted, a temperature blank will be included in each cooler. The temperature reading will be documented by each of the subcontracted laboratories in the comments column of the CoC report. The sample custodian will then sign the CoC report and examine the contents of the cooler. Sample container breakages or discrepancies between the CoC report and sample label documentation will be recorded. The pH of chemically preserved samples will be checked using Hydrion paper and recorded. A Laucks Testing Laboratories, Inc., CLP Sample Receipt Log and Supplemental Sample Receipt Log as shown in Appendix 3 of SOP LTL-4002 (Attachment A of this QAPP), will be completed by Laucks Testing Laboratories, Inc. As presented in the NSWC Crane Lab SOPs CR4052-PD-2500 and CR4052-PD-003 located in Attachment A, the samples will be inspected prior to acceptance into their laboratory. All problems or discrepancies noted during this process are to be promptly reported to the TtNUS Task Order Manager (TOM). Samples are then logged into the laboratory's laboratory information management system (LIMS). Other pertinent issues relating to sample custody, such as specific procedures for sample handling, storage, dispersement for analysis, and remnant disposal, are presented in the laboratory SOPs included in Attachment A of this QAPP.

5.3 FINAL EVIDENCE FILES

The Administrative Record at NSWC Crane will be the repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. NSWC Crane will be the custodian of the evidence file and will maintain the contents of these files, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, and data reviews in a secure, limited access location and under custody of the NSWC Crane Site Manager. The control file will include at a minimum:

- Field logbooks
- Field data and data deliverables
- Photographs and negatives

- Drawings
- Laboratory data deliverables
- Data validation reports
- Data assessment reports
- Progress reports, QA reports, interim project reports, etc.
- All custody documentation (tags, forms, airbills, etc.).

Upon completion of the contract, all files associated with these field investigations will be maintained in the Administrative Record at NSWC Crane and will be available for inspection by the regulatory agencies for a period of 50 years. The final evidence file will be offered to U.S. EPA at the end of the 50 year period.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated to obtain valid and usable results. The requirement to properly calibrate instruments before use applies equally to field instruments as it does to fixed laboratory instruments. Field instrument calibration is presented in Section 6.1. Laboratory instrument calibration is outlined in Section 6.2.

6.1 FIELD INSTRUMENT CALIBRATION

Field instrument calibration is presented in Section 2.8.1 of the FSP.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibration, initial calibration verification, and continuing calibration verification. Generally three to five points are acceptable for the initial calibration; however, SW-846 methods require five points. In all cases, an independently prepared standard (i.e., from a second source or a different lot number from the primary source) will be used as a calibration verification solution. Due to the specialized nature of the dye compounds independently prepared standards are not available.

All standards used to calibrate analytical instruments must be obtained from the National Institute of Standards and Technology (NIST) or through a reliable commercial supplier with a proven record for quality standards. All commercially supplied standards will be traceable to NIST reference standards, where possible, and appropriate documentation will be obtained from the supplier. When documentation is not available, the laboratory will analyze the standard and compare the results with U.S. EPA-known or previous NIST-traceable standard. Due to the rarity of many of the dyes, certified standards are not available; therefore, bulk lot samples will be used as standards.

Calibration procedures, frequency requirements, acceptance criteria, and conditions that require recalibration are described for each analytical procedure in the applicable laboratory SOPs included in Attachment A of this QAPP. It should be noted for the dye method that quantitation will be derived from the linear curve. Therefore, evaluation of the RSD will not be used as a basis for validation of the data. A correlation coefficient (r) greater than or equal to 0.99 will be used to determine the acceptability of the initial calibration curve.

In addition to the initial calibration standards, the Crane Laboratory also developed a library of known and unknown dye compounds. The library is composed of compounds for which the laboratory was not able to

obtain certified standards, compounds that were present on-site in unmarked containers, or compounds that performed poorly during extraction and analysis. If any of these compounds are determined to be present in the samples, a single point calibration will be used for quantitation. The dye method was developed using guidelines for the development and validation of SW-846 methods. Procedures and requirements outlined in SW-846 Method 8000 were used to establish quality control items and associated acceptance limits for surrogate, matrix, and blank spike recovery as well as initial and continuing calibration acceptance limits. Unless specified otherwise in the SOP, SW-846 Method 8000 may be used to establish QA/QC for the dye method.

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

With the exception of samples collected for dye analysis, bulk density, and grain size, all samples collected as part of the NSWC Crane SWMU 2 investigation will be analyzed by Laucks Testing Laboratories, Inc., 940 South Harney Street, Seattle, Washington 98108; (206) 767-5060; FAX (206) 767-5063. Analysis for dyes, bulk density and grain size will be performed by the NSWC Crane Laboratory, Warfare Center, 300 Highway 361, Code 4052 Building 2707, Crane, Indiana, 47522; (812) 854-5506; FAX (812) 854-5054. Laucks Testing Laboratories, Inc., has successfully completed the laboratory evaluation process required as part of the NFESC QA Program and described in the Navy Installation Restoration Laboratory Quality Assurance Guide (NFESC, 1996).

Field measurements and analytical procedures are addressed in the remainder of this section.

7.1 FIELD MEASUREMENT PROCEDURES

Chemical/physical parameters to be measured using field instrumentation or field test kits include temperature, specific conductance, pH, dissolved oxygen, alkalinity, ferrous iron, carbon dioxide, sulfide, hydrogen sulfide, nitrate, nitrite, ORP/Eh, turbidity, and water level. Measurement of field parameters is presented in Section 2.8 of the FSP. Calibration of field instruments is addressed in Section 2.8.1 of the FSP.

7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

Table 7-1 provides a summary of the laboratory analytical methods and associated laboratory SOPs to be used during the field investigation for SWMU 2. Laboratory SOPs for these analyses are included in Appendix A of this QAPP.

7.2.1 List of Project Target Compounds and Detection Limits

A complete list of the target compounds/analytes; project-specific risk-based target levels; and laboratory-specific IDLs/MDLs and RLs are provided in Table 1-1. The IDLs provided for metals have been experimentally determined as described in Section 6.2.6 of Laucks Testing Laboratories, Inc., SOP LTL-1011. This procedure is based on the procedure for IDL determination as specified in the U.S. EPA CLP (ILM04.0; U.S. EPA, 1995). All inorganic and miscellaneous environmental data will be reported to the analyte's laboratory-specific RL, with the exception of arsenic which will be reported to the IDL. An analyte's RL is based on the associated IDL with adjustments made to ensure that the precision and accuracy requirements of the method are attainable. RLs and IDLs will be adjusted on a sample-by-

sample basis, as necessary, based on dilutions, sample volume and, for soil and sediment samples, percent moisture.

Dye compounds will be reported to the laboratory-specific RL. The RL is determined using the low point of the calibration standard with adjustments, as necessary, based on dilutions, sample volume and, or soil and sediment samples, percent moisture. The RL is also the lowest point at which confirmational spectra can be obtained for each compound.

7.2.2 List of Associated Quality Control Samples

In addition to the field QC samples (field duplicates, trip blanks, rinsate blanks, etc.) presented in Section 3.0 of this QAPP, laboratory QC samples, including method blanks, preparation blanks, LCSs, etc., will be analyzed. Laboratory QC samples are detailed in Section 8.0 of this QAPP. The analytical SOPs included in Attachment A of this QAPP address minimum QC requirements for each associated analytical method.

TABLE 7-1

SUMMARY OF ORGANIC AND INORGANIC ANALYTICAL PROCEDURES SOLID AND AQUEOUS SAMPLES NSWC CRANE, INDIANA

Analytical Parameter	Preparation Method	Analytical Method	Preparation/Analytical SOP(s) [1]
Appendix IX Metals (except mercury) - total	Aqueous SW-846 3010A or SW-846 3015 Solid SW-846 3050B or SW-846 3051	SW-846 6020	Aqueous LTL-7009 or LTL-7010 Solid LTL-7012 or LTL-7015 Analytical LTL-7202
Appendix IX Metals (except mercury) - dissolved	---[3]	SW-846 6020	LTL-7202
Miscellaneous Metals - total	Aqueous SW-846 3010A or SW-846 3015 Solid SW-846 3050B or SW-846 3051	SW-846 6010B	Aqueous LTL-7009 or LTL-7010 Solid LTL-7012 or LTL-7015 Analytical LTL-7105
Miscellaneous Metals - dissolved	---[3]	SW-846 6010B	LTL-7105
Mercury - total & dissolved	SW-846 7470A/ 7471A	SW-846 7470A/ 7471A	LTL-7501
Dyes	Aqueous/Solid NSWC Crane Lab Method CR4052-PD-2500	NSWC Crane Lab Method CR4052-PD-2500	NSWC Crane Lab Method CR4052-PD-2500
Hardness (Surface Water only)	---[3]	Standard Method[5] 2340B	SM-2340B
Sulfate (Ground Water only)	---[3]	SW-846 9056	LTL-9110
Chloride (Ground Water only)	---[3]	SW-846 9056	LTL-9110
Total Organic Carbon (Aqueous and Solid)	---[3]	U.S. EPA[4] 9060	LTL-9115
Total Suspended Solids (Aqueous Only)	---[3]	U.S. EPA[4] 160.1	LTL-9202
pH (Solid Only)	---[3]	SW-846 9045C	LTL-9113
CEC (Solid Only)	---[3]	SW-846 9081	LTL-6006
Bulk Density (Solid Only)	---[3]	ASTM D2937	CR4052-PD-012
Grain Size (Solid Only)	---[3]	ASTM D422	CR4052-PD-013

1 Laboratory SOPs are included in Attachment A of this QAPP.
2 U.S. EPA, 1986. Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd Ed. and subsequent updates.
3 No preparation method is required for this parameter.
4 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes.
5 American Public Health Association, 1995. Standard Methods for the Examination of Water and Wastewater 19th Edition. Washington, DC.

8.0 INTERNAL QUALITY CONTROL CHECKS

Field-related QC checks are addressed in Section 3.0 of this QAPP and in Section 2.7 of the FSP. This section provides additional information regarding internal QC checks for the field and the laboratory.

8.1 FIELD QUALITY CONTROL CHECKS

Internal QC procedures for pH, specific conductance, temperature, dissolved oxygen, alkalinity, ferrous iron, carbon dioxide, sulfide, ORP/Eh, and turbidity will include calibrating the instruments as described in Section 2.8.1 of the FSP and in the SOPs provided in Attachment B of the FSP. Assessment of field sampling precision and bias will be made by collection of field duplicates and rinsate blanks for laboratory analysis. Collection of field QC samples will be performed in accordance with the procedures provided in Section 2.7 of the FSP at the frequencies indicated in Tables 3-3 and 3-6 of the FSP.

8.2 LABORATORY QUALITY CONTROL CHECKS

The identified subcontract laboratories have QC programs that ensure the reliability and validity of the analyses performed at the laboratories. Each laboratory maintains a QA Plan that describes the policies, organization, objectives, QC activities, and specific QA functions used by the laboratory. All analytical procedures are documented in writing as SOPs. Each analytical SOP specifies minimum QC requirements for the procedure. As previously noted, SOPs for all analyses to be performed during the field investigation for SWMU 2 are included in Attachment A of this QAPP. Table 7-1 provides a list of the SOPs associated with each analytical procedure. In addition, the laboratories maintain SOPs regarding general laboratory QA procedures. Several of these SOPs, as applicable, are also included in Attachment A of this QAPP. The Table of Contents included in Attachment A provides a list of SOP titles and associated SOP numbers for all SOPs contained in the attachment.

Several internal laboratory QC checks are briefly highlighted in the remainder of this section. Additional QC requirements that are specific to the NFESC QA Program, and therefore requirements for this project, are specified, as applicable, for each QC check.

Laboratory method blanks are prepared and analyzed in accordance with the analytical method used to determine whether contaminants originating from laboratory sources have been introduced and have affected environmental sample analyses. Method blanks for analytical methods that include preparative extraction or digestion procedures also are called preparation blanks. A method blank for inorganic aqueous or solid sample analysis generally consists of an aliquot of analyte-free water that is subjected to

the same preparation and analysis procedures as the environmental samples undergoing analysis. The aqueous matrix results for method blanks associated with soil samples are normalized to a fictitious soil sample and presented on a dry weight basis assuming 100 percent solids. For the organic aqueous method blank sample, analysis generally consists of an aliquot of analyte-free water that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. The organic solid matrix method blank is an aliquot of sand (or in some cases sodium sulfate) that is subjected to the same preparation and analysis procedures as the environmental samples. The solid method blank results are presented on a dry weight basis assuming 100 percent solids. Criteria for method blanks and corrective actions for noncompliant results are described in each of the SOPs for determinative analysis in Attachment A of this QAPP. Under no circumstances are laboratory method blank contaminant values subtracted from environmental sample analysis results.

Matrix spike analysis for organic fraction analyses will be performed in duplicate (i.e., MS/MSD analysis) with a frequency of 1 per 20 environmental samples per matrix as a measure of laboratory accuracy and precision. For inorganic analyses, MS and laboratory duplicate analysis will be performed for every 20 environmental samples per matrix. Laboratory duplicates are prepared by obtaining two sample aliquots from the same sample container and analyzing each portion following the same analytical procedures. For extractable organic MSD analyses, a sample aliquot from a separate sample container is used for analysis. As detailed in Section 3.7 of this QAPP, the field crew will provide extra volumes of sample matrices designated for laboratory QC analyses, as required.

Based on NFESC requirements, MS samples should contain all targeted analytes of interest. This will occur for metal analysis. However, because of the extensive list of dye compounds and the overlapping retention times of some of these compounds, it is not feasible to spike and analyze for the full list of dyes in the MS/MSD samples. Therefore, MS/MSD samples for this fraction will be spiked with a representative list of these chemicals. Tables specifying matrix spiking compounds per analytical method and associated statistical laboratory control limits to be used for these field investigations are provided in Section 3.0.

If the MS recovery is not within applicable control limits, the laboratory will assess the batch to determine whether the spike results are attributable to a matrix effect or are the result of other problems in the analytical process. Based on NFESC requirements, if all the batch QC elements that are not affected by the sample matrix are in control (e.g., method blank, LCS, calibration checks) and if no evidence indicates that spiking was not properly performed, the poor spike recovery may be attributed to matrix effects. In this case, the failed MS will be addressed in the case narrative, but re-preparation and re-analysis are not required. If any of the batch QC elements that are not affected by the sample matrix are out of control, or

if any evidence indicates that spiking may have been improperly performed, the MS and/or MSD sample will be re-processed through the entire analytical sequence unless insufficient sample is available. Details of noncompliant MS/MSD and laboratory duplicate results will be included in the Sample Delivery Group (SDG) narrative.

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled) which are similar in nature to the compounds of concern and are not likely to be present in environmental media. Surrogates are spiked into each sample, standard, and method blank before analysis and are used in organic chromatographic analysis procedures as a check of method effectiveness. Surrogate recoveries will be evaluated against the laboratory-derived statistical control limits presented in Section 3.0. Corrective actions for noncompliant surrogate recoveries are presented in the relevant determinative SOPs included in Attachment A of this QAPP. Details of noncompliant surrogate recoveries will be included in the SDG narrative.

Laboratory control samples or blank spike samples serve to monitor the overall performance of each step during the analysis, including the sample preparation. LCSs must be included in each preparation or analytical batch of 20 samples or less and must be analyzed using the same sample preparations, analytical methods, and QA/QC procedures as those used for the samples. Based on the requirements of the NFESC QA Program, LCSs for wet chemistry and metals analyses must contain all analytes of interest. The spiking lists for dye analyses will contain analytes that represent each of the nine groups of analytes on the target analyte list. LCS results will be evaluated against the control limits statistically established by the laboratory. Tables specifying LCS spiking compounds per analytical method and associated statistical laboratory control limits to be used for the field investigation for SWMU 2 are provided in Section 3.0.

Based on NFESC QA Program requirements, if recovery of an LCS falls outside the control limits, the laboratory will reject the data for the analytical batch and take corrective action. The associated samples, extracts, or digestates may be reanalyzed a single time, and if the LCS recoveries meet acceptance criteria, the data will be reported. If LCS analyte recovery is still outside the acceptance limits, the associated samples in the preparation batch will be reprocessed if sufficient sample is available and holding times have not elapsed. If repreparation or reanalysis is not possible, the SDG narrative will include details of the failed LCS.

Internal standard performance criteria ensure that chromatographic analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50 percent to + 100 percent) from the associated 12-hour calibration

standard. The retention time of the internal standards in samples and blanks must not vary by more than ±30 seconds from the retention time of the associated 12-hour calibration standard.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the procedures to be used for data reduction, validation, and reporting for the field investigation for SWMU 2 for NSWC Crane. Data generated during the course of the field investigation will be maintained in hard copy form in the Administrative Record at NSWC Crane.

9.1 DATA REDUCTION

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

9.1.1 Field Data Reduction

Field data will be generated through on-site water quality testing for general indicator parameters, including pH, specific conductance, turbidity, dissolved oxygen, alkalinity, ORP/Eh, water level, and temperature. Direct-read instrumentation will be used in the field for these water quality parameters. HACH field test kits will be used for natural attenuation parameters (i.e., alkalinity, carbon dioxide, ferrous iron, hydrogen sulfide, nitrate, nitrite, sulfide and dissolved oxygen). Field measurements will be recorded on sample logsheets immediately after measurements are taken. If an error is made in the field records, the error will be legibly crossed out (single-line strikeout), initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. Further information regarding field documentation is provided in CTO 10 SOP 11, which is included in Attachment B of the FSP. The field measurements will later be encoded into the NSWC Crane database. Field data will be entered in the electronic database manually, and the entries will be verified by an independent reviewer to ensure that no transcription errors occurred. Field measurements will be recorded and reported in the following units:

- pH - standard units (S.U.)
- Temperature - degrees Celsius
- Specific conductance - microSiemens per centimeter (mS/cm)
- Turbidity - Nephelometric Turbidity Units (NTU)
- Dissolved oxygen - milligrams per liter (mg/L)
- ORP/Eh - millivolts (mV)
- Water level - feet (ft)

- Alkalinity - (mg/L)
- Nitrite - (mg/L)
- Nitrate - (mg/L)
- Ferrous Iron - (mg/L)
- Carbon dioxide - (mg/L)
- Sulfide - (mg/L)
- Hydrogen Sulfide - (mg/L)

9.1.2 Laboratory Data Reduction

Data reduction will be completed by the subcontracted laboratories in accordance with the method-specific laboratory SOPs included in Attachment A of this QAPP. In addition, SOP LTL-1018 (provided in Attachment A of this QAPP) presents the procedures used by Laucks Testing Laboratories, Inc., for review and approval of data. NSWC Crane Lab SOP CR4052-PD-2500 presents the procedures used by this lab for review and approval of the dye data.

Laboratory analytical data will be reported using standard concentration units to ensure comparability with previous analytical results. Solid matrix samples will be reported on a dry weight basis. All environmental data will be reported to the laboratory's analyte-specified RL, with the exception of arsenic which will be reported to the IDL. Reporting units for the various classes of chemicals under consideration are as follows:

- Metals - µg/L; mg/kg
- Dyes - µg/L; µg/kg
- Sulfate - mg/L
- Chloride – mg/L
- Hardness – mg/L
- TOC - mg/L; mg/kg
- TSS – mg/L
- pH – standard units (S.U.)
- CEC – milliequivalent per 100 grams (meq/100g)
- Bulk density - gram per cubic centimeter (g/cm^3)
- Grain size - micrometer (µm)

9.2 DATA VALIDATION

Validation of field measurements and laboratory analytical data is presented in this section. Validation of field data will be limited to real time "reality" checks, whereas laboratory analytical data will be validated in accordance with current U.S. EPA guidance and the analytical method. Validation of field measurements is addressed in Section 9.2.1. Validation of laboratory analytical data is explained in Section 9.2.2.

9.2.1 Procedures Used to Evaluate Field Data

Field measurements will not be subjected to a formal data validation process. However, field technicians will ensure that the equipment used for field measurement is performing accurately via compliance with the applicable SOPs provided in the FSP for test kits containing QC check requirements (e.g., check standard and blank analysis). The required QC checks will be analyzed and compared to acceptance criteria to verify acceptable performance prior to use. As described in Section 9.1.1, all field data entered into the electronic database will be independently reviewed for transcription errors.

9.2.2 Procedures Used to Validate Laboratory Data

One hundred percent of the laboratory analytical data will be subjected to data validation to ensure that the data are of evidentiary quality. Validation of analytical data will be completed by the TtNUS Environmental Chemistry/Toxicology Department located in TtNUS's Pittsburgh office. Final review and approval of validation deliverables will be completed by the Department's Data Validation Coordinator.

Data validators will review the chemical analytical data packages submitted by the laboratory. Analytical results will be validated versus the applicable analytical methods, the SOPs included in Attachment A of this QAPP, and the requirements of this QAPP. Validation of these data including the use of qualifying flags will conform to the U.S. EPA Region 5 Standard Operating Procedures for Validation of Contract Laboratory Program Organic Data (U.S. EPA Region 5, 1993a) and Region 5 Standard Operating Procedures for Validation of Contract Laboratory Program Inorganic Data (U.S. EPA, 1993b); and the U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (U.S. EPA, 1994a) and U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (U.S. EPA, 1994b) to the greatest extent practicable for non-CLP data. The data validator will generate a report describing data limitations that will be reviewed internally by the Data Validation Coordinator before submittal to the TOM.

For the SWMU 2 dyes some deviations from these validation protocols are anticipated because of the specialized nature of the dye analyses. Holding times, initial and continuing calibrations, method blanks,

surrogate compounds, and check standards will be validated against the EPA protocols identified above. LCSs, and MSs and MSDs will be validated against the criteria listed in Tables 3-3 and 3-4 with the understanding that any continued method development by the NSWC Crane laboratory may yield acceptance criteria that are more consistent with the EPA validation protocols identified above than are the Table 3-3 and 3-4 limits. For example, spike recoveries may prove to fall closer to the theoretically expected 100% recovery as presented in the EPA protocols. In those cases, the revised validation criteria will be considered to represent improved method performance and will be used in lieu of the acceptance criteria presented in Table 3-3 and 3-4. Deviations from Table 3-3 and 3-4 acceptance limit usage will be documented in the RFI report.

The identification of any particular dye will rely on a combination of the observed chromatographic retention time and a visual interpretation of sample spectra relative to calibration spectra. The visual comparisons are subject to professional judgment because the degree of match or mismatch between sample and calibration spectra cannot be quantified at this time. Therefore, the spectra of identified dyes will be reviewed by TtNUS chemists as a quality control check of the NSWC Crane laboratory identifications. Differences in data interpretation between the NSWC Crane laboratory and TtNUS are not expected. However, if the TtNUS project chemist disagrees with the NSWC Crane laboratory's identification of a dye, the TtNUS project chemist will open a dialog with the NSWC Crane laboratory to resolve the disagreement. The considerations undertaken to reach agreement between the NSWC Crane laboratory and TtNUS will be documented in the project file and summarized in the RFI report. Any changes in the identification of a dye will result in a recalculation of the concentration of the dye using the appropriate corresponding calibration factors.

9.3 DATA REPORTING

This section presents data reporting requirements for field and laboratory analytical data. Section 9.3.1 explains field measurement data handling and reporting. Section 9.3.2 details laboratory data handling and reporting.

9.3.1 Field Data Reporting

Field data will be reported in the units presented in Section 9.1.1. Documentation of field activities is described in CTO 10 SOP 11, which is included in Attachment B of the FSP. Field measurements will be transferred from the sample log sheets to the electronic database manually and will be reviewed for accuracy by an independent reviewer.

All records regarding field measurements (i.e., field logbooks, sampling logbooks, and sample logsheets) will be placed in the TtNUS central files upon completion of the field effort. Entry of these results in the database will require removal of these records from the files. Outcards will be used to document the removal of any such documentation from the files (date, person, subject matter). After database entry is complete, all records will be copied for placement in TtNUS central files; all original records will be sent to NSWC Crane for inclusion in the final evidence files, as described in Section 5.3.

9.3.2 Laboratory Data Reporting

Data reported by each laboratory for all analytical fractions will be in a CLP-type reporting format. All pertinent QC data including raw data and summary forms for blanks, standards analysis, calibration information, etc., will be provided for all analyses. Case narratives will be provided for each SDG. SOP LTL-4201 (Attachment A of this QAPP) provides further details regarding the information that will be included in CLP-type packages produced by Laucks Testing Laboratories, Inc. and NSWC Crane Lab SOP CR4052-PD-2500 (Appendix A of this QAPP) provides information on the reporting package deliverable from their laboratory. Dye compounds which are tentatively identified using spectra from the "unknowns" library shall be flagged as JN by the laboratory on the Forms 1s. Dye compounds which have been affected by co-elution shall be flagged as C by the laboratory on the Form Is. Due to the magnitude of the reporting packages for the dye analysis, both a full and abbreviated data package are proposed for dyes. Table 9-1 presents the contents of each package. Full packages are to be provided when there is a positive result. The abbreviated package will be provided for non-detects.

Data will be handled electronically pursuant to the electronic deliverable requirements specified in TtNUS's Basic Ordering Agreement with analytical laboratories. This agreement requires the analytical laboratories to provide data in both hard copy and electronic form. The database will include pertinent sampling information such as sample number, sampling date, and general location. Units will be clearly summarized in the database and will conform to those identified in Section 9.1.2. The original electronic diskettes and data validation reports for the NSWC Crane field investigation for SWMU 2 will be maintained in the Administrative Record at NSWC Crane; copies will be maintained in TtNUS central files. SOP CT-05 lists database management and QA and is included in Attachment A of this QAPP.

Validation will be completed using the hard copy data. Upon completion of validation of an SDG and review by the Data Validation Coordinator, the validation qualifiers will be entered in the electronic database and will be subjected to independent review for accuracy. During this review process, the electronic database printout will be compared with the hard copy data to ensure that the hard copy data

and electronic data are consistent. Data validation and incorporation of data qualifiers into the electronic database must be completed before statistical evaluation of the data.

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TABLE 9-1

DYE REPORTING PACKAGES
NSWC CRANE, INDIANA

FULL DATA PACKAGE:	
Case Narrative:	Sample Identification and Laboratory Number Cross-reference table, a discussion of any problems encountered during extraction or analysis, signature of laboratory quality assurance officer.
Form 1s:	Analytical results for each sample, method blank, blank spike, and matrix spike. Forms should also contain the following: Sample ID, Lab ID, Date Collected, Date Extracted, Date Analyzed, Initial Weight/Volume, Final Volume, Dilution Factor, Percent Moisture, File Number, Reporting Limits, and Qualifiers. The raw data consisting of spectra of peak maxima, chromatogram, and quantitation report must accompany each Form 1.
Surrogate Recoveries:	Tabulate recoveries for each sample, method blank, blank spike, and matrix spike. Include acceptance range for surrogate recoveries for specific matrix.
Blank Spikes:	Tabulate amount spiked, percent recoveries, and acceptance ranges for specific matrix.
Matrix Spike/Matrix Spike Duplicate:	Tabulate amount spiked, amount present in native sample, percent recoveries, relative percent differences, and acceptance ranges for specific matrix.
Initial Calibration:	Summarize all data points from each of the five concentration levels and calculate percent relative standard deviation and/or correlation coefficient. Include linear equations if used. The raw data for each standard consisting of spectra of peak maxima, chromatogram, and quantitation report must accompany the summary.
Continuing Calibration:	Calculate and present in tabular form the percent difference (percent drift) for each analyte. Calculate and present in tabular form the retention time and retention time windows for each analyte. The raw data for each standard consisting of spectra of peak maxima, chromatogram, and quantitation report must accompany the summary.
Support Documentation:	Copies of the chain-of-custody, sample check-in sheet, extraction log, HPLC log, and standard prep log must accompany each sample delivery group (SDG).
SCREENING LEVEL DATA PACKAGE:	
Full data package minus raw data. Raw data must be stored electronically by the laboratory.	

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be performed periodically to ensure that work is being implemented in accordance with the approved project plans and in an overall satisfactory manner. Some examples of pertinent audits are as follows:

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

- The TOM will maintain contact with the FOL and Data Validation Coordinator to ensure that management of the acquired data proceeds in an organized and expeditious manner. Validation and incorporation of validation results into the electronic database must be completed before statistical evaluation of the data.

- Details regarding additional audit responsibilities, frequency, and procedures are detailed in the remainder of this section. Field performance and system audits are presented in Section 10.1. Laboratory performance and system audits are explained in Section 10.2.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

This section presents the responsibilities, frequencies, and procedures associated with internal and external field performance and system audits.

10.1.1 Internal Field Audits

10.1.1.1 Internal Field Audit Responsibilities

In addition to the daily checks performed by the FOL, an independent performance and system audit of field activities may be conducted by the TtNUS Quality Assurance Manager (QAM) or designee. Such audits are scheduled as part of the NSWC Crane RCRA environmental investigation program, which includes this and other environmental projects, with individual projects being selected for audit by the QAM without the involvement of the TOM. If a formal field audit is conducted for this study, the QAM (or designee) will be responsible for ensuring that sample collection, handling, and shipping protocols, as well as equipment decontamination and field documentation procedures, are being performed in accordance with the approved project plans and SOPs.

10.1.1.2 Internal Field Audit Frequency

Internal field audits will be conducted at the beginning of the field program. These audits allow for identification and correction of problems early in the program.

10.1.1.3 Internal Field Audit Procedures

The field audit will be conducted in accordance with the following procedures:

- Before the audit, the auditor will prepare a detailed checklist to be used as an auditing guide. An example audit checklist is provided in Attachment B of this QAPP.
- Upon arrival at the audit location, the auditor will conduct a pre-audit meeting with the responsible management of the organization or project to be reviewed.
- Field audits will include a review of required project documentation (logbooks, sample log sheets, etc.) and field operations (ground water and soil sampling, sample handling, etc.) to evaluate completeness and compliance with applicable SOPs.
- The audit checklist will be used to record observations including any noted nonconformances.
- A formal post-audit debriefing will be conducted, and potential immediate corrective actions will be discussed.
- The auditor will generate a formal audit report that will address corrective actions. This report will be provided by the auditor to the TOM.
- The TOM will ensure that all corrective actions are addressed and will provide written verification of corrective action implementation to the auditor.
- The auditor will manage corrective action verification and audit closure.
- The following audit records will be maintained by the QAM:

- Audit checklists
- Audit reports
- Response evaluations
- Verification of corrective actions
- Follow-up checklists and audit reports

10.1.2 External Field Audits

10.1.2.1 External Field Audit Responsibilities

External field audits may be conducted by the IDEM, U.S. EPA Region 5, or both.

10.1.2.2 External Field Audit Frequency

External field audits may be conducted at any time during field activities at the discretion of the IDEM and U.S. EPA Region 5. If an audit is to be conducted, scheduling should be coordinated through the QAM to ensure that personnel and equipment are available as necessary. Personnel being audited may or may not be informed of the impending audit at the discretion and request of the auditing body.

10.1.2.3 Overview of the External Field Audit Process

External audit procedures are at the discretion of U.S. EPA Region 5 and the IDEM.

10.2 LABORATORY PERFORMANCE AND SYSTEM AUDITS

This section presents the responsibilities, frequencies, and procedures associated with internal and external laboratory performance and system audits.

10.2.1 Internal Laboratory Audits

10.2.1.1 Internal Laboratory Audit Responsibilities

The QA/QC Officer or appropriate designee of each of the subcontracted laboratories performs routine internal audits of the laboratory. Internal laboratory audits also are conducted by the U.S. Navy for Laucks Testing Laboratories, Inc. TtNUS holds no responsibility for such audits. Performance and system audits of laboratories are coordinated through the NFESC by an independent QA contractor. It is the responsibility of the NFESC and its contractor to ensure that the subcontracted laboratories comply with

good laboratory practices and the general requirements of all analytical services provided by the laboratory.

10.2.1.2 Internal Laboratory Audit Frequency

At a minimum, Laucks Testing Laboratories, Inc., conducts internal system audits of each laboratory analytical department on an annual basis. Internal audits are performed biannually at Laucks Testing Laboratories, Inc., if no external audits are conducted. In addition, each laboratory department at Laucks Testing Laboratories, Inc., analyzes blind performance evaluation samples as described in SOP LTL-1009 (Attachment A of this QAPP). Data audits also are performed by the Laucks Testing Laboratory QA/QC Officer at least once per year for each analytical area.

The NSWC Crane laboratory also monitors the quality of work as described in the Crane Division Quality Manual, a copy of which is provided in Attachment A.

Internal laboratory performance and system audits are completed by the U.S. Navy for Laucks Testing Laboratories, Inc. on an 18-month schedule.

10.2.1.3 Internal Laboratory Audit Procedures

Internal system audits are conducted to detect any problems in sample flow, analytical procedures, or documentation and to ensure adherence to laboratory SOPs. Laucks Testing Laboratories, Inc.'s, internal audit procedures are described in SOP LTL-1017 (Attachment A of this QAPP). NSWC Crane Laboratory's internal audit procedures are described in SOP CR4052-PD-009.

Internal U.S. Navy laboratory audit procedures, as performed by a Navy contractor, include a pre-screening process that requires review of the laboratory's QA manual, analysis of performance evaluation (PE) samples, generation of data deliverables for the PE samples, an on-site technical systems audit of the laboratory, and satisfactory resolution of all deficiencies and findings.

10.2.2 External Laboratory Audits

10.2.2.1 External Laboratory Audit Responsibilities

External audits may be performed by the IDEM and U.S. EPA Region 5 at their discretion. U.S. EPA Region 5 has recently audited Laucks Testing Laboratories, Inc., for another related NSWC Crane project, and the outcome was favorable. Each laboratory also is involved in external audits and performance

evaluation studies throughout the year, as required, to maintain certifications and/or approvals by other regulatory agencies or programs.

10.2.2.2 External Laboratory Audit Frequency

An external laboratory audit may be conducted by U.S. EPA Region 5 or IDEM prior to or during sampling and analysis activities.

10.2.2.3 Overview of the External Laboratory Audit Process

External audit procedures are at the discretion of U.S. EPA Region 5 and the IDEM. External laboratory audits may include (but are not limited to) review of laboratory analytical procedures, laboratory on-site audits, and/or submission of PE samples to the laboratory for analysis.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

Measuring equipment used in environmental monitoring or analysis for the NSWC Crane field investigation for SWMU 2 will be maintained in accordance with the manufacturer's operation and maintenance manuals. Equipment and instruments will be calibrated in accordance with the procedures and at the frequency presented in Section 6.0 (Calibration Procedures and Frequency). Preventive maintenance for field and laboratory equipment are detailed in the remainder of this section.

11.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

Preventive maintenance of field equipment is presented in Section 2.8.2 of the attendant FSP. The TtNUS FOL will be responsible for ensuring that equipment is operating properly before use and that routine maintenance is performed and documented. Any problems encountered while operating the instrument will be recorded in the field logbook, including a description of the symptoms and corrective actions taken. If problems with the equipment are detected and service is required, the equipment will be logged, tagged, and segregated from equipment in proper working order. Use of the instrument will not be resumed until the problem is resolved.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential to ensuring their readiness when needed. Dependent on manufacturer's recommendations, maintenance intervals are established for each instrument. All instruments will be labeled with a model number and serial number, and a maintenance logbook will be maintained for each instrument. Personnel will be alerted to the maintenance status of the equipment they are using at all times. Table 11-1 provides a summary of preventive maintenance procedures performed by Laucks Testing Laboratories, Inc., and NSWC Crane Laboratory for key analytical instruments and equipment.

The use of manufacturer-recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the various gas chromatographs and metals instruments are of sufficient grade to minimize fouling of the instrument. The routine use of septa, chromatographic columns, and other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime. An inventory of critical spare parts will also be maintained by the laboratory to minimize instrument downtime.

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TABLE 11-1

**PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS
NSWC CRANE, INDIANA
PAGE 1 OF 2**

Instrument	Laboratory[1]	Preventive Maintenance	Maintenance Frequency
HPLC	NSWC	Change filter frit in mixer.	As needed (when pressure builds).
		Change column pre-filter.	As needed (2-3 months).
		Rinse water pump with methanol, filter water, sonicate water intake filter frit.	Approximately weekly.
		Change pump seals.	As needed
ICP/MS	LTL	Clean or change air filters, change pump oil.	Semiannually.
		Clean torch, replace nebulizer tips, replace pump tubing, replace injector, change cones.	As needed.
		Check mass calibration.	Every 2 weeks.
		Check sensitivity.	Daily.
ICP/AES	LTL	Service Intercooler.	Annually.
		Rinse and clean nebulizer cap and spray chamber.	Monthly or as needed.
		Clean torch, vacuum filters.	Bimonthly.
		Profile instrument, examine autosampler tubing and replace as needed.	Daily.
		Empty rinse container, fill rinse water reservoir.	As needed
Mercury Analyzer	LTL	Check and replace pump tubing, check and replace membrane, check and clean windows.	As needed.
Spectro-photometer	LTL	Clean sample compartment and entrance windows.	Semiannually.
		Check wavelength calibration.	Annually.
Ion Chromato-Graph	LTL	Replace pump seals.	Annually.
		Lubricate analytical pump motor.	Semiannually.
		Check chromatography module and all gas lines for leaks.	Every run.
		Clean conductivity detector cell electrodes, check cell calibration.	Monthly.
		Replace bed supports, clean columns, clean AMMS (membrane suppresser), replace autosampler pipette tip.	As needed.

TABLE 11-1

PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS
NSWC CRANE, INDIANA
PAGE 2 OF 2

Instrument	Laboratory[1]	Preventive Maintenance	Maintenance Frequency
Lachat Ion Analyzer	LTL	Lubricate pump. Replace pump tubing. Change cadmium column.	Semiannually. As needed (~ 1 to 2 months) As needed.
TOC Analyzer	LTL	Change pump tubing. Change other tubing, change furnace tubes, change LiOH tube, change tin trap, adjust optical balance, change septum, change permeation dryer tubing. Change IR filter screen, change gas tubing.	Each run. As needed. Check monthly; replace as needed.
Refrigerators	LTL NSWC	Monitor temperature.	Daily.
Solid Phase Extraction Manifold	NSWC	Grease manifold and glassware joints with vacuum grease. Clean step-saver extraction glassware. Empty fluid trap between manifold and vacuum system.	Daily. Each run. Each run.
Density of Soil Density Tubes	NSWC	Visually inspect for dulled and damaged edges. Determine the mass of the density tube.	Every fifth sampling with tube. Every fifth sampling with tube.
Particle-Size Analysis Sieves	NSWC	Clean with soap and water. Optically/visually inspect.	After each use. After every third sample.

1 LTL – Laucks Testing Laboratories, Inc.
NSWC – NSWC Crane Laboratory

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

The purpose of this section is to indicate the methods by which it will be ensured that the data collected for this investigation coincides with the project DQOs and input requirements as specified in Section 4.0 of the attendant Work Plan. The data assessment will be conducted to evaluate analytical data quality via compliance with the QC objectives listed in Tables 3-1 through 3-6 of Section 3.0 and data validation described in Section 9.2. Additionally, the data will be reviewed for indications of interferences to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies. Compliance with the completeness objectives for field and laboratory data/measurements will be calculated by hand (field measurements) and electronically via a database subroutine (laboratory data). Equations to be used for the accuracy, precision, and completeness assessment are outlined in Sections 12.1, 12.2 and 12.3, respectively. Section 12.4 presents additional data quality considerations that will be evaluated after completion of data validation.

12.1 ACCURACY ASSESSMENT

As presented in Section 8.2, to ensure the accuracy of the analytical procedures, a minimum of 1 of every 20 samples per matrix will be spiked with a known amount of the analyte(s) to be evaluated. The spiked sample is then analyzed. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared with the reported value of the analyte in the unspiked sample determines the %R. Control charts are plotted by the laboratory for each commonly analyzed compound and kept on matrix- and analyte-specific bases. The %R for a spiked sample is calculated by using the following formula:

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

Percent recoveries for LCS and surrogate compound results are determined according to the following equation:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Known Amount Added}} \times 100$$

12.2 PRECISION ASSESSMENT

As presented in Section 8.2, laboratory duplicate samples (for inorganic analyses) and MSD samples (for organic analyses) will be prepared and analyzed at a minimum frequency of 1 per every 20 environmental samples per matrix. As described in Section 3.7, field duplicate samples also will be collected at a minimum frequency of 1 per 10 environmental samples per matrix. The RPD between the sample (or spike) and duplicate (or duplicate spike) is calculated by using the following formula:

$$\text{RPD} = \frac{\text{Amount in Sample 1} - \text{Amount in Sample 2}}{0.5(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \times 100$$

12.3 COMPLETENESS ASSESSMENT

As defined in Section 3.3, completeness is the ratio of the number of valid sample results to the total number of samples per medium. Following the completion of the analytical testing and data validation, the percent completeness will be calculated using the following equation:

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

12.4 DATA ASSESSMENT

The field and laboratory data collected during the investigation for SWMU 2 will be used to determine whether the level of the constituents present at the site poses an adverse human health or ecological impact. The QC results associated with each analytical parameter for each matrix will be compared with the objectives presented in Sections 3.1 though 3.5 of this QAPP. Only data generated in association with QC results meeting these objectives and deemed usable by data validation will be considered usable for quantitative purposes.

In addition, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific and parameter-specific basis. The results of this assessment will be presented in the data usability assessment performed for SWMU 2. Examples of issues to be considered in this assessment are as follows:

- Deviations, if any, from the field sampling SOPs (Refer to Section 9.2.2)
- Deviations, if any, from the laboratory analytical SOPs
- Deviations, if any, from the FSP

- Deviations, if any, from the data validation procedures
- Identification and explanation of elevated reporting limits
- Identification of unusable data (i.e., data qualified as "R")

13.0 CORRECTIVE ACTION

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

13.1 FIELD CORRECTIVE ACTION

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

Corrective action may include resampling and may involve amending previously approved field procedures. Minor modifications to field activities, such as the collection of additional samples, will be initiated at the discretion of the FOL, subject to on-site approval by the NSWC Crane Environmental Protection Department. Major modifications, such as the elimination of a sampling point, must be approved and documented via a Field Task Modification Request (FTMR). Approval of the corrective action will be obtained by the U.S. Navy (in conjunction with U.S. EPA Region 5 and IDEM). The FOL is responsible for initiating FTMRs; an FTMR will be prepared for all deviations from the project plan documents, as applicable. An example of an FTMR is provided as Figure 13-1. Copies of all FTMRs will be maintained with the on-site project planning documents and will be placed in the final evidence file.

13.2 LABORATORY CORRECTIVE ACTION

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

- QC data are outside established warning or control limits.
- Method blank analyses yield concentrations of target analytes exceeding acceptable levels.
- Undesirable trends are detected in spike %Rs or in duplicate RPDs.

- There is an unexplained change in compound detection capability.
- Inquiries concerning data quality are received.
- Deficiencies are detected by laboratory QA staff audits or from PE sample test results.

Any corrective action taken above the analyst level that cannot be performed immediately at the instrument will be documented. Corrective actions are typically documented for out-of-control situations on a Corrective Action Form or an Out-of-Control Event Form. Copies of the forms used by Laucks Testing Laboratories, Inc. are included as Appendices 1 and 3 of SOP LTL-1008, which is in Attachment A of this QAPP. Further details describing the system used by Laucks Testing Laboratories, Inc. to identify, document, and resolve out-of-control events is provided in SOP LTL-1008. Further detail describing the system used by NSWC Crane Laboratory to identify, document, and resolve out-of-control events is provided in SOP CR4052-PD-009.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

The need for corrective action may become apparent during data validation, interpretation, or presentation activities. The performance of rework (i.e., resampling or reanalysis), the institution of a change in work procedures, or the provision of additional/refresher training are possible corrective actions relevant to data evaluation activities. The TOM will be responsible for approving the implementation of corrective action.

FIGURE 13-1

EXAMPLE OF FIELD TASK MODIFICATION REQUEST FORM

FIELD TASK MODIFICATION REQUEST FORM

Client Identification _____ Project Number _____ FTMR Number _____

To _____ Location _____ Date _____

Description:

_____

_____

_____

_____

Reason for Change:

_____

_____

_____

_____

Recommended Disposition:

_____

_____

_____

_____

_____

Field Operations Leader (Signature, if applicable) Date

Disposition:

_____

_____

_____

_____

_____

Task Order Manager (Signature, if required) Date

_____

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

Others as required _____

_____

_____

_____

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reports to management will be provided in various formats during the course of the NSWC field investigation for SWMU 2. Data validation letters will be prepared on an SDG-specific basis and will summarize QA issues for the subcontracted laboratory data. In addition, daily reports via telephone summarizing accomplishments and QA/QC issues during the field investigation will be made by the FOL to the TOM. Monthly progress reports will be prepared by the TOM. QA reports will also be prepared by the subcontracted analytical laboratories if QC limits are updated during the field investigation or if significant plan deviations result from unanticipated circumstances.

14.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS

The data validation reports will address all major and minor laboratory noncompliances as well as noted sample matrix effects. If major problems occur with an analytical laboratory (e.g., repeated or extreme holding time exceedances or calibration noncompliances, etc.), the Data Validation Coordinator will notify the TOM, QAM, Technical Program Manager, Deputy Program Manager, and Laboratory Services Coordinator. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. These reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensational adjustments. Corrective actions for major noncompliances are initiated at the program level.

The FOL will provide the TOM with daily reports via telephone during the course of the sampling event. These reports will explain accomplishments, deviations from the FSP, upcoming activities, and a QA summary. The TOM provides a monthly progress report to the Navy that addresses the project budget, schedule, accomplishments, planned activities, and QA/QC issues and intended corrective actions.

The subcontracted analytical laboratories will provide a QA report to TtNUS if QC limits for parameters associated with the NSWC Crane field investigation for SWMU 2 are updated or if significant plan deviations result from unanticipated circumstances. Since MDLs/RLs, as applicable, will be included in the analytical data packages for NSWC Crane samples, it is not necessary for the laboratories to include updated MDLs/RLs in their QA reports unless the updates result in RLs that exceed risk-based target levels.

14.2 FREQUENCY OF QUALITY ASSURANCE REPORTS

The following frequencies will apply to QA reports for the NSWC Crane field investigation for SWMU 2: (1) data validation QA reports - contingent on SDG delivery data; (2) field progress reports - daily during the course of the sampling event; (3) monthly progress reports - monthly; and (4) laboratory QA reports - as required based on QC limit updates or the occurrence of plan deviations resulting from unanticipated circumstances.

14.3 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS

Data validation QA reports are provided to the TOM for inclusion in the project files. If major problems are observed for a given laboratory, the Technical Program Manager, Deputy Program Manager, QAM, TOM, and Laboratory Services Coordinator are provided with copies of the QA report. Daily field progress reports via telephone are provided to the TOM. Monthly progress reports are provided to the U.S. Navy. Laboratory QA reports are provided to the TOM; these reports will be forwarded to U.S. EPA Region 5 only if QC updates result in RLs that exceed risk-based target levels or if QC limits for key parameters (e.g., dyes or other analytes that are associated with the site based on site history) degrade significantly or if any significant plan deviations result from unanticipated circumstances. Copies of any cited QA reports will be provided to the U.S. EPA Region 5 immediately on request.

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U.S. EPA Region 5, 1998. Region 5 QAPP Instructions and Policy. Waste, Pesticides, and Toxics Division, Chicago, IL. April.

ATTACHMENT A

LAUCKS TESTING LABORATORIES INC., SOPs AND NSWC CRANE SOPs PROVIDED IN SEPARATE VOLUME FOR REGULATORY AGENCIES ONLY

ATTACHMENT B

FIELD AUDIT CHECKLIST

Tetra Tech NUS, Inc.

FIELD AUDIT CHECKLIST – April 2001

QA/QC Procedures

1. Were any field observations, deficiencies, nonconformances, or complaints recorded by the site QA/QC Officer or other personnel?
   If so, summarize below.

   _____
   _____
   _____
   _____
   _____

2. Based on personnel interview, did any variances from the project planning documents occur? If so, what were they?

   _____
   _____
   _____
   _____

3. Were field modification records pertinent to the above initiated in an appropriate manner?

   _____

4. If applicable, were corrective action plans implemented (according to proper procedure)?

   _____
   _____
   _____

5. Were field QC samples obtained with the frequency as specified in the FSP text and tables 3-2 and 3-5?

   _____

6. For the site, were field duplicates submitted "blind" to the laboratory?

   _____
   _____

7. For the site, are sufficient replicate aliquots of samples designated to the laboratory for the matrix spike/duplicate analyses as specified in the FSP text and tables 3-2 and 3-5?

Boring Samples

8. Is the drilling method specified in the FSP and CTO 10 SOP 2-8 being used?

9. Are the sampling devices designated in the FSP, and applicable CTO 10 SOPs being used?

10. In accordance with the FSP and CTO 10 SOP 2-8, the FOL has the authority to change drilling methods if site conditions so dictate. Did any change in drilling methods from that cited in the project planning documents occur? If so, discuss.

11. If a change in drilling methods was required, did the FOL properly document the change and the rationale for the change?

12. Were any field changes initiated by the drilling subcontractor? If so, was the FOL notified and were the changes documented?

13. During soil sampling, using a hollow stem auger and a split-barrel sampler, the drive weight assembly, for forcing the steel split-barrel sampler (2"OD x 20 or 26" length) into the ground, must weigh 140 lbs. with a free fall of 30". Was this method, per CTO 10 SOP 2-7 followed?

_____
_____
_____
_____

14. If water was used to prevent blowback or plugging of the hollow stem auger, has the following been recorded:

corollary field blank sample identification _____
amount of water introduced _____
amount of water recovered _____
amount of water extracted during well development _____

15. Have all abandoned borings been backfilled as specified in the FSP, section 2?

_____
_____

16. When applicable, was the casing cleaned before sampling? (In most cases, an inch or two of cuttings may be left in the borehole with little or no problem. However, if more than a few inches for cuttings are encountered, the borehole must be recleaned prior to attempting sampling.)

water wash (disturbed samples above and below water table) _____
clean-out auger (undisturbed samples below water table) _____
dry method (undisturbed samples above water table) _____

17. Were any drilling lubricants used?

_____
_____
_____

18. Were detailed boring logs maintained by the site geologist for each borehole as specified in the FSP and CTO 10 SOP 2-14?

_____
_____
_____
_____

19. Was the following information complete on the borehole logs:
    description of materials _____
    description of samples _____
    sampling method _____
    blow counts _____
    final location for drilling _____

20. Was the following information recorded in the boring logs and/or the field notebook?

    For soil classification from core samples:

    Was the USCS classification indicated per CTO 10 SOP 2-14 Table 1?

    _____

    Were the following characteristics indicated per CTO 10 SOP 2-7 and 2-14?

    color _____
    soil type _____
    relative density and consistency _____
    weight percentage _____
    moisture _____
    stratification _____
    texture/fabric/bedding _____

21. If classification was performed based on soil and rock drill cuttings, were the following requirements satisfied:

    were cuttings obtained from 5-foot intervals? _____
    were cuttings preserved in a glass sample jar or ziploc prior to classification? _____
    were any changes in color or lithology recorded? _____
    were any potential fracture zones noted? _____

22. Were sample aliquots from split-spoon samplers obtained representatively?

    _____

    _____

Monitoring Well Installation

23. Were monitoring wells constructed and installed in accordance with the FSP, section 2 and figure 2-1 and CTO 10 SOP 2-8?

    _____

    _____

Soil Sampling

24. For surface soil samples obtained by hand auger or scoop or trowel, were the following practices followed?

    area cleared of loose debris prior to sampling _____
    location marked with numbered stake or pinflag _____
    sketch approximate locations of sample points in site notebook and/or sample log sheet
    _____

Groundwater Sampling

25. Were all monitoring wells properly developed, purged and aloud to recovered prior to sampling in accordance with the FSP and CTO 10 SOP 2-3 and 2-8?

    _____
    _____

26. Was the requirement of CTO 10 SOP 2-3 and 2-4 met for well preparation prior to sampling?

    _____

27. When applicable, were well volumes calculated as described in CTO 10 SOP 2-3?

    _____

28. If samples were acquired by a pump, was the pump lowered to midscreen (middle of open section of uncased wells) for sample acquisition?

    _____

Surface Water and Sediment Sampling

29. In accordance with CTO 10 SOP 2-5, surface water samples shall be taken at approximately half the sample pool depth. Were surface water samples obtained as directed in the SOP?

    _____
    _____

30. Was specific conductance, temperature, DO, pH, turbidity and ORP recorded for each sample as specified in the FSP and CTO 10 SOP 2-4 and 2-5?

    _____
    _____
    _____

31. CTO 10 SOP 2-5 indicates that the farthest downstream sample be obtained first and that subsequent samples be taken as one works upstream. Was this practice observed?

_____

_____

32. In accordance with CTO 10 SOP 2-5, sampling at the surface should never be performed unless specifically sampling for a known constituent which is immiscible and on top of the water. Sample containers should be inverted, lowered to the approximate sample depth, then positioned at an approximate 45-degree angle with the mouth of the bottle facing upstream in order to acquire the sample. If applicable, was this technique observed?

_____

_____

Calibration and Use of Field Monitoring Equipment

33. Were the following calibration criteria observed:

calibration according to manufacturer's instructions _____
calibration only by qualified individuals _____
calibrated and operationally checked prior to project assignment _____
use of certified/traceable standards _____
calibration documented _____
if applicable, maintenance documented _____

34. For Photoionization Detectors (PIDs), is the proper (10.6 ev) lamp installed?

_____

_____

_____

_____

35. Because PIDs will not respond to methane or hydrogen cyanide, confirm that the instrument is not being used for this purpose, or for the detection of combustible gases or oxygen deficiency.

_____

_____

36. Confirm that proper PID Start-up and Shut-down procedures are performed as required, as specified in CTO 10 SOP 2-13.

_____

_____

_____

_____

37. Has PID UV light source window cleaning been conducted as required in CTO 10 SOP 2-13?

_____

38. Has the PID ionization chamber been cleaned as required in CTO 10 SOP 2-13?

_____

39. Has the PID unit been recharged after every use as specified in CTO 10 SOP 2-13?

_____
_____

Equipment Decontamination Procedures

40. Has an adequate pre-determined area for steam-cleaning of equipment been established?

_____
_____

41. Is the decontamination (decon) area lined and/or bermed?

_____
_____

42. Is equipment decontaminated by steam-cleaning as required (e.g., transport vehicles, drill rigs, backhoes, downhole tools, augers, well casings, and screens)?

_____
_____

43. Was steam-cleaning conducted:

prior to commencement of field activities? _____
between boring locations? _____
at the end of field activities?_____

44. The sequence of solvents used is contingent upon the target analytes of concern (and Health & Safety considerations). Is the decon sequence outlined in the project planning documents and CTO 10 SOP 2-9 being strictly observed?

_____
_____

45. Verify that all sampling equipment not subject to steamcleaning (e.g., trowels, mixing bowls, bailers, etc.) are subjected to decontamination per the sequence outlined in the project planning documents and CTO 10 SOP 2-9.

46. Have all water level indicators been decontaminated via (1) potable water rinse, (2) deionized water rinse per CTO 10 SOP 2-9?

Waste Handling Procedures

47. Were cuttings or fluids disposed of in accordance with project planning documents (i.e., drummed, tanked, or discharged to the NSWC Crane permitted sanitary sewer system) as specified in the FSP?

48. The project planning documents provide for the disposal of Personal Protective Equipment (PPE) by double-bagging and discard into trash receptacles at the facility, has this been done?

49. If applicable, were used spill-containment materials containerized or otherwise acceptably disposed of?

Sample Handling

50. Are the appropriate containers provided by the laboratory being used for each fractional type of sample?

51. Has the Ambient Temperature blank been handled properly and one submitted with each cooler of samples?

52. Have equipment rinsate blanks of the proper type and frequency been obtained?

53. Have Field Blanks been obtained from water sources applicable to the field effort?

54. Have the rinsate and field blanks been designated for the same analyses as the associated samples?

55. Have all samples been properly preserved in accordance with the FSP section 2, tables 2-1and 2-2, and CTO 10 SOP 2-12?

56. Is field filtration conducted in accordance with the requirements of CTO 10 SOP 2-4 and 2-5?

57. If applicable, have the hazardous sample packaging and shipping procedures outlined in CTO 10 SOP 2-12 been followed?

58. Has sample custody been maintained with regard to the following criteria:

A sample is under an individual's custody if:

- it is in the individual's actual possession
- it is in the individual's view after possession
- it was locked up to prevent tampering
- it was placed in a designated and identified secure area

(The sample remains in the individual's custody until it is entrusted to a laboratory courier or commercial express carrier.)

Documentation

59. Are all sample logs complete (i.e., containing all information stipulated in CTO 10 SOP 2-11 and 2-14)?

60. Have chain-of-custody (COC) forms been filled out for all samples, including field quality control samples, as stipulated in the FSP and CTO 10 SOP 2-11?

61. Have the COC forms been signed by the appropriate individual, at each step, that the samples are relinquished, as stipulated in the FSP and CTO 10 SOP 2-11?

62. Have the COC forms been filled-out using black waterproof ink, as stipulated in the FSP and CTO 10 SOP 2-11?

63. If the COC form was corrected, was a line drawn through the information and was the change dated and initialed, as stipulated in the FSP and CTO 10 SOP 2-11? (Use of white-out or erasure is not permitted.)

64. Have the appropriate analyses (per the project planning documents) been properly designated for each sample on the chain-of-custody form, as stipulated in the FSP and CTO 10 SOP 2-11?

65. Have all sample labels been filled out appropriately and completely in accordance with CTO 10 SOP 2-10?

66. Have all sample labels been filled out using indelible ink in accordance with CTO 10 SOP 2-10?

67. Have the samples been identified according to the scheme depicted in the FSP and CTO 10 SOP 2-10?

68. Do the sample identifications agree between the sample log, field notebook, sample label, sample tag and chain-of-custody form?

69. When applicable, have the name of the photographer, date, time, site location, and site description been entered sequentially into the site logbook as documentative photographs of the sampling been taken?

70. Where samples have been split with a private party or government agency, have Receipt of Samples forms been filled-out and signed?

71. Has the following information (at minimum) been recorded in the site logbook: (as specified in CTO 10 SOP 2-11)

- arrival/departure of site visitors
- arrival/departure of equipment
- sample pickup, COC form nos., carrier company, time
- sampling activities/sample logsheet nos.
- start/completion of boreholes, monitoring wells
- health and safety issues

72. Is the site logbook a bound notebook with consecutively numbered pages that cannot be easily removed (as specified in CTO 10 SOP 2-11)?

73. As required by CTO 10 SOP 2-11, does the cover of the site logbook contain the following information?

project name _____
project number _____
Contractors (or teaming firm) name _____
sequential book number _____
start date _____
end date _____

74. As required by CTO 10 SOP 2-11, has the following information been recorded at the beginning of each day?

date _____
start time _____
weather conditions _____
all field personnel present _____
any visitors present _____

75. Do the site logbook entries summarize the daily activities and refer to other site notebooks or logsheets where applicable, as required by CTO 10 SOP 2-11?

_____

76. Have all site logbook entries been made in black indelible ink, as required by CTO 10 SOP 2-11?

_____
_____

77. If a logbook entry was corrected, was a line drawn through the information and was the change dated and initialed, as required by CTO 10 SOP 2-11? (Use of white-out or erasure is not permitted.)

_____
_____

78. Did the individual making the logbook entry sign it, as required by CTO 10 SOP 2-11?

_____

ATTACHMENT C

COMPARISON OF LABORATORY LIMITS TO RISK-BASED SCREENING CRITERIA

TABLE C-1
TABULAR PRESENTATION OF RBSLs FOR RBTL SELECTION
NSWC CRANE, CRANE, INDIANA

PARAMETER	Aqueous Matrix Laboratory MDL (ug/L)	Aqueous Matrix Laboratory RL (ug/L)	REGION 5 ECO DQLs SURFACE WATER (ug/L)	Footnote	FEDERAL MCLs (ug/L)	Footnote	FEDERAL AWQCs FRESHWATER ACUTE (ug/L)	Footnote	FEDERAL AWQCs FRESHWATER CHRONIC (ug/L)	Footnote	IDEM TIER 1 DEFAULT RESIDENTIAL GW CLOSURE LEVELS (ug/L)	IDEM TIER 1 DEFAULT INDUSTRIAL GW CLOSURE LEVELS (ug/L)	Footnote	Footnote	REGION 9 TAP WATER PRGs (ug/L)	Footnote	USEPA REGION 5 RISK-BASED SCREENING LEVELS (ug/L) (9)
APPENDIX IX METALS (SW-846 Method 6020 ICP/MS)																	
Antimony	0.1	1	31		6						6	41	N	N	15	N	
Arsenic	0.1	1	53		50		340		150		50 C	50 C	C	C	0.045	C	
Barium	0.1	1	5000		2000						2000 C	7200	N	max	2600	N	
Beryllium	0.1	1	7.6		4						4 C	4 C	N	C	73	N	
Cadmium	0.1	1	0.66		5		4.3	1	2.2	1	5	51	N	N	18	N	
Chromium (total)	0.1	5	42		100		16	6	11	6	100	510	C	C	110 (6)	N	
Cobalt	0.1	3	5										N	max	2200	N	
Copper	0.1	2	5		1300	2,3	13	1	9	1	1300	3800	N	N	1400	N	
Lead	0.1	1	1.3		15	2	65	1	2.5	1	15	42	N	N			
Mercury (SW-846 Method 7470A/7471A)	0.14	0.2 (10)	0.0013		2		1.4		0.77		2	31			11	N	
Nickel	0.1	10	29		100	4	470	1	52	1	100	2000	N	N	730	N	
Selenium	0.3	1	5		50				5		50	510	N	N	180	N	
Silver	0.1	3	1		100	5	3.4	1			180	510	N	N	180	N	
Thallium	0.1	1	0.56		2						2	9			2.9 (7)		
Tin	0.1	10	73										N	max	22000	N	
Vanadium	0.1	2	19										N	N	260	N	
Zinc	0.4	10	58.9		5000	5	120	1	120	1	11000	31000	N	max	11000	N	
MISCELLANEOUS METALS (SW-846 METHOD 6010B Trace)																	
Aluminum	81	200			50-200	1	750		87				N	max	36000	N	
Calcium	150	5000															
Iron	13	100			300	1			1000				N	max	11000	N	
Magnesium	7.6	5000															
Manganese	0.2	15			50	1							N	N	880	N	
Potassium	16	5000															
Sodium	76	5000															
DYES (NSWC CRANE HPLC METHOD)																	
Acid Blue 45	26.7	23.3															
Acid Yellow 23	12.8	25.1															
Acid Yellow 73	13.5	22.6															
Acid Orange 10	13.0	25.1															100
Acid Blue 1	43.8	26.6															450
Basic Yellow 2	170.0	23.1															60
Disperse Violet 1	11.1	18.3															
Solvent Yellow 33	13.7	17.5															
Disperse Blue 14	16.7	18.7															
Acid Red 64	12.1	62.5															
Acid Blue 9	25.1	22.6															230000
Basic Violet 10	15.0	19.9															570
2-Aminoanthraquinone	12.6	23.4															2.01
Solvent Orange 3	11.7	16.0															600
1-Aminoanthraquinone	12.2	16.1															2.01 (11)
Solvent Yellow 14	13.5	17.7															460
Solvent Orange 7	6.1	18.0															730
Acid Yellow 3	24.6	22.9															
Solvent Yellow 3	16.2	18.9															0.02
Solvent Red 1	7.9	29.0															
Disperse Red 9	14.8	16.5															
Solvent Yellow 2	11.8	20.0															0.01
Solvent Green 3	18.5	18.4															
Solvent Red 24	2.9	7.1															
MISCELLANEOUS PARAMETERS																	
Cyanide (SW-846 Method 9012A)	0.74 (mg/L)	10 (mg/L)	5.2	8	200				5.2	8					730	8	
CEC (SW-846 Method 9081)	ANR	ANR															
Hardness (standard Methods 2340B)	---	1000(ug/L)															
Nitrate	2(ug/L)	10(ug/L)			10000										10000	N	
Nitrite	2(ug/L)	10(ug/L)			1000										1000	N	
pH (SW-846 9045C)	ANR	ANR			6.5-8.5	5			6.5-9								
Total Organic Carbon (TOC) (EPA 415.1)	350	1000															
Total Suspended Solids (EPA 160.1)	---	2000(ug/L)															
Bulk Density	ANR	ANR															
Grain Size	ANR	ANR															

MDL = method detection limit
RL = reporting limit

µg/L = micrograms per liter.
mg/L = milligrams per liter.

ANR = Analysis Not Required

Shaded cells indicate laboratory MDLs that exceed a risk-based target level for the project.

1 Criteria are hardness dependent.
2 Action level.
3 Secondary MCL for copper is 1,000 ug/L.
4 Value is being remanded.
5 Secondary MCL, based on aesthetic drinking water qualities (i.e., color, odor, taste, etc.).
6 Hexavalent chromium.
7 Thallium carbonate
8 Free Cyanide
9 These values were developed by USEPA Region 5 specifically for this project.
10 Laucks Testing Laboratories is confident that it can reliably report to this PQL, even though this value is less than two times the MDL.
11 2-amino anthraquinone is used as a surrogate for 1-amino anthraquinone.

TABLE C-2

TABULAR PRESENTATION OF SOIL AND SEDIMENT RBSLs FOR RBTL SELECTION
NSWC CRANE, CRANE,
INDIANA

PARAMETER	Solid Matrix Laboratory MDL (mg/kg)	Solid Matrix Laboratory RL (mg/kg)	EPA GENERIC SSLs INGESTION (mg/kg)	Footnote	EPA GENERIC SSLs INHALATION (mg/kg)	Footnote	EPA GENERIC SSLs MIGRATION TO GW (mg/kg) DAF = 1	Footnote	REGION 5 ECO DQLs SOIL (mg/kg)	Footnote	REGION 5 ECO DQLs SEDIMENT (mg/kg)	Footnote	IDEM TIER 1 DEFAULT RESIDENTIAL SOIL CLOSURE LEVELS (mg/kg)	Footnote	IDEM TIER 1 DEFAULT RESIDENTIAL SOIL DIRECT CONTACT (mg/kg)	Footnote	REGION 9 SOIL PRGs FOR RESIDENTIAL LAND USE (mg/kg)	REGION 9 SOIL PRGs FOR INDUSTRIAL LAND USE (mg/kg)	USEPA REGION 5 RISK-BASED SCREENING LEVELS (mg/kg) (5)
APPENDIX IX METALS (SW-846 Method 6020 ICP/MS)																			
Antimony	0.05	1	31				0.3		0.1423				5.4		138		31	820	
Arsenic	0.05	1	0.4		750		1		5.7		0.0059		3.9	C	3.9	C	0.39	2.7	
Barium	0.05	1	5500		690000		82		1.04				1600		24000		5400	100000	
Beryllium	0.05	1	0.1		1300		3		1.06				1.9	C	1.9	C	150	2200	
Cadmium	0.05	1	78		1800		0.4		0.00222		0.596		7.5		12		3	810	
Chromium (total)	0.05	1	390	1	270	1	2	1					38		470		210	450	
Cobalt	0.05	1							0.14033		50						4700	100000	
Copper	0.05	1							2.96		16		580		13000		2900	76000	
Lead	0.05	1	400	2					0.05373		31		81		350		400	1000	
Mercury (SW-846 Method 7470A/7471A)	0.07	0.2 (6)	23		10		0.1		0.073		0.174		2.1		55				
Nickel	0.05	1	1600		13000		7		13.6		16		130		6900		1600	41000	
Selenium	0.15	1	390				0.3		0.02765				5.2		1700		390	10000	
Silver	0.05	1	390				2		4.04		0.5		31		1700		390	10000	
Thallium	0.05	1					0.04		0.05692				2.9		31		6.3 (3)	160 (3)	
Tin	0.05	5							7.62								47000	100000	
Vanadium	0.05	1	550				300		1.59								550	14000	
Zinc	0.2	1	23000				620		6.62		120		10000		104000		23000	100000	
MISCELLANEOUS METALS (SW-846 METHOD 6010B Trace)																			
Aluminum	8.1	20															76000	100000	
Calcium	15	500																	
Iron	1.3	10															23000	100000	
Magnesium	0.76	500																	
Manganese	0.02	1.5															1800	32000	
Potassium	1.6	500																	
Sodium	7.6	500																	
DYES (NSWC CRANE HPLC METHOD)																			
Acid Blue 45	0.8	14.0																	
Acid Yellow 23	0.4	15.1																	
Acid Yellow 73	0.2	13.6																	
Acid Orange 10	0.5	15.1																	6.46
Acid Blue 1	0.6	16.0																	10
Basic Yellow 2	1.4	13.9																	1.3
Disperse Violet 1	0.5	9.8																	
Solvent Yellow 33	0.1	10.5																	
Disperse Blue 14	0.9	11.2																	
Acid Red 64	0.2	37.5																	
Acid Blue 9	0.1	13.6																	1630
Basic Violet 10	0.2	11.9																	12
2-Aminoanthraquinone	0.1	14.0																	14.7
Solvent Orange 3	0.1	9.6																	129
1-Aminoanthraquinone	0.4	9.6																	14.7[7]
Solvent Yellow 14	0.1	10.6																	3.23
Solvent Orange 7	0.8	10.8																	52
Acid Yellow 3	0.1	13.7																	
Solvent Yellow 3	0.4	11.3																	0.13
Solvent Red 1	2.3	17.4																	
Disperse Red 9	0.2	9.9																	
Solvent Yellow 2	0.2	12.0																	0.11
Solvent Green 3	1.2	11.0																	
Solvent Red 24	0.0	4.3																	
MISCELLANEOUS PARAMETERS (ANALYTICAL METHODS TO BE DETERMINED BASED ON LABORATORY CAPABILITIES																			
Cyanide (SW-846 Method 9012A)	0.1	1	1600				2		1.33	4	0.0001	4					1100		
CEC (SW-846 Method 9081)	--	6 (meq/100g)																	
Hardness (standard Methods 2340B)	ANR	ANR																	
Nitrate	ANR	ANR																	
Nitrite	ANR	ANR																	
pH (SW-846 9045C)	--	1(S.U.)																	
Total Organic Carbon (TOC) (EPA 415.1)	--	1000																	
Total Suspended Solids (EPA 160.1)	ANR	ANR																	
Bulk Density	NA	NA																	
Grain Size	NA	NA																	

MDL = method detection limit
RL = reporting limit

NA = Not Applicable
mg/kg = milligrams per kilogram.

ANR = Analysis Not Required

Shaded cells indicate laboratory MDLs that exceed a risk-based target level for the project.

Footnotes:

1 Assume hexavalent chromium.
2 OSWER soil screening [illegible] residential land use (USEPA, July 1994).
3 Thallium carbonate.
4 Free Cyanide
5 These values were developed by USEPA Region 5 specifically for this project.
6 Laucks Testing Laboratories [illegible] dent that it can reliably report to this POL, even though this value is less than two times the MDL.
7 2-amino anthraquinone is [illegible] urrogate for 1-amino anthraquinone.

APPENDIX D

RISK-BASED SCREENING LEVELS

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
1,1,1,2-TETRACHLOROETHANE	1	0.43	6.9		90.25
1,1,1-TRICHLOROETHANE	200	790	200		88
1,1,2,2-TETRACHLOROETHANE		0.055	0.896		13
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE		59000			
1,1,2-TRICHLOROETHANE	5	0.2	5		650
1,1-DICHLOROETHANE		810	2090		47
1,1-DICHLOROETHENE	7	0.046	7		78
1,2,3,4,6,7,8-HPCDD		0.000045 [1]			0.000000279 [2]
1,2,3,4,6,7,8-HPCDF		0.000045 [1]			0.00129 [3]
1,2,3,4,7,8,9-HPCDF		0.000045 [1]			0.00129 [3]
1,2,3,4,7,8-HXCDD		0.00045 [1]			0.000000279 [2]
1,2,3,4,7,8-HXCDF		0.00045 [1]			0.00129 [3]
1,2,3,6,7,8-HXCDD		0.00045 [1]			0.000000279 [2]
1,2,3,6,7,8-HXCDF		0.00045 [1]			0.00129 [3]
1,2,3,7,8,9-HXCDD		0.00045 [1]			0.000000279 [2]
1,2,3,7,8,9-HXCDF		0.00045 [1]			0.00129 [3]
1,2,3,7,8-PECDD		0.0000009 [1]			0.000000279 [2]
1,2,3,7,8-PECDF		0.000009 [1]			0.00129 [3]
1,2,3-TRICHLOROPROPANE		0.0016			12.11
1,2,4,5-TETRACHLOROBENZENE		11			26.24
1,2,4-TRICHLOROBENZENE	70	190	70		69.2
1,2-DIBROMO-3-CHLOROPROPANE	0.2	0.048			11.2
1,2-DIBROMOETHANE		0.00076			22.5
1,2-DICHLOROBENZENE	600	370	600		11
1,2-DICHLOROETHANE	5	0.12	5		190
1,2-DICHLOROPROPANE	5	0.16	5		380
1,2-DIPHENYLHYDRAZINE		0.084			
1,3,5-TRINITROBENZENE		1100			
1,3-DICHLOROBENZENE	600	17	231		87
1,3-DINITROBENZENE		3.7			2.36

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
1,4-DICHLOROBENZENE	75	0.47	75		43
1,4-DIOXANE		6.1			
1,4-NAPHTHAQUINONE					0.044
1,4-PHENYLENEDIAMINE		6900			
1-NAPHTHYLAMINE					0.67
2,3,4,6,7,8-HXCDF		0.00045 [1]			0.00129 [3]
2,3,4,6-TETRACHLOROPHENOL		1100		1 [17]	14.06
2,3,4,7,8-PECDF		0.0000009 [1]			0.00129 [3]
2,3,7,8-TCDD	0.00003	0.00000045			0.0000003
2,3,7,8-TCDF		0.0000045 [1]			0.00129 [3]
2,4,5-T		370			686.33
2,4,5-TP (SILVEX)	50	290			326.64
2,4,5-TRICHLOROPHENOL		3700	3650	1 [17]	
2,4,6-TRICHLOROPHENOL		6.1	77.4	2 [17]	2
2,4,6-TRINITROTOLUENE		2.2			
2,4-D	70	370			
2,4-DICHLOROPHENOL		110	110	0.3 [17]	18
2,4-DIMETHYLPHENOL		730	730	400 [17]	100.17
2,4-DINITROPHENOL		73	73		4.07
2,4-DINITROTOLUENE		73	1.25		230
2,6-DICHLOROPHENOL				0.2 [17]	
2,6-DINITROTOLUENE		37	1.25		42
2-ACETYLAMINOFLUORENE					534.97
2-AMINO-4,6-DINITROTOLUENE					
2-BUTANONE		1900	2500		7100
2-CHLORO-1,3-BUTADIENE		14			
2-CHLORONAPHTHALENE		490			0.396
2-CHLOROPHENOL		38	38.4	0.1 [17]	8.8
2-HEXANONE					1710
2-METHYL-4,6-DINITROPHENOL					

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
2-METHYLNAPHTHALENE					329.55
2-METHYLPHENOL		1800	1830		
2-NAPHTHYLAMINE					
2-NITROANILINE		2.2	10		
2-NITRO-O-TOLUIDINE		2			
2-NITROPHENOL					13.5
2-NITROTOLUENE		370			
2-PICOLINE					3790
3,3'-DICHLOROBENZIDINE		0.15	1.89		99.75
3,3'-DIMETHYLBENZIDINE		0.0073			
3-METHYLCHOLANTHRENE					0.0891
3-METHYLPHENOL		1800			
3-NITROANILINE					
3-NITROTOLUENE		370			
4,4'-DDD		0.28	3.55		0.0011
4,4'-DDE		0.2	2.5		0.00000000496
4,4'-DDT		0.2	2.5	0.001	0.001
4,6-DINITRO-2-METHYLPHENOL					2.3
4-AMINO-2,6-DINITROTOLUENE					
4-AMINOBIPHENYL					
4-BROMOPHENYL PHENYL ETHER					1.5
4-CHLORO-3-METHYLPHENOL				3000 [17]	20
4-CHLOROANILINE		150	146		231.97
4-CHLOROPHENYL PHENYL ETHER					
4-METHYL-2-PENTANONE		160			3680
4-METHYLPHENOL		180	183		
4-NITROANILINE					
4-NITROPHENOL		2300			35
4-NITROQUINOLINE-1-OXIDE					
4-NITROTOLUENE		370			

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
7,12-DIMETHYL BENZ(A)ANTHRACENE					0.548
A,A-DIMETHYLPHENETHYLAMINE					
ACENAPHTHENE		370	461	20 [17]	9.9
ACENAPHTHYLENE					4840
ACETONE		610	768		78000
ACETONITRILE		71			30000
ACETOPHENONE		0.042			687.89
ACROLEIN		0.042			0.205
ACRYLONITRILE		3.7			0.89
ALDRIN		0.004	0.0501		0.0185
ALLYL ALCOHOL		180			
ALPHA-BHC		0.011	0.135		12.38
ALPHA-CHLORDANE	2 [6]	0.19 [6]	2 [6]	0.0043 [6]	0.00029 [6]
ALUMINUM	50 to 200 [7]	37000		87	
ANILINE		12			0.44
ANTHRACENE		1800	43.4		0.029
ANTIMONY	6	15			31
ARAMITE		2.7			3.08
AROCLOR-1016	0.5 [8]	0.034 [8]	0.5 [8]	0.014 [8]	0.000029 [8]
AROCLOR-1221	0.5 [8]	0.034 [8]	0.5 [8]	0.014 [8]	0.000029 [8]
AROCLOR-1232	0.5 [8]	0.034 [8]	0.5 [8]	0.014 [8]	0.000029 [8]
AROCLOR-1242	0.5 [8]	0.034 [8]	0.5 [8]	0.014 [8]	0.000029 [8]
AROCLOR-1248	0.5 [8]	0.034 [8]	0.5 [8]	0.014 [8]	0.000029 [8]
AROCLOR-1254	0.5 [8]	0.034 [8]	0.5 [8]	0.014 [8]	0.000029 [8]
AROCLOR-1260	0.5 [8]	0.034 [8]	0.5 [8]	0.014 [8]	0.000029 [8]
ARSENIC	50	0.045	50	150	53
BARIUM	2000	2600	2000		5000
BENZENE	5	0.39	5		114
BENZIDINE		0.00029			
BENZO(A)ANTHRACENE		0.092	1.17		0.839

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
BENZO(A)PYRENE	0.2	0.0092	0.2		0.014
BENZO(B)FLUORANTHENE		0.092	1.17		9.07
BENZO(G,H,I)PERYLENE					7.64
BENZO(K)FLUORANTHENE		0.92	0.8		0.0056
BENZOIC ACID		150000	146000		
BENZYL ALCOHOL		11000	11000		281.24
BERYLLIUM	4	0.016	4		7.6
BETA-BHC		0.037	0.473		0.495
BIS(2-CHLOROETHOXY)METHANE					6400
BIS(2-CHLOROETHYL)ETHER		0.0098	0.3		1140
BIS(2-CHLOROISOPROPYL) ETHER		0.27	4.23		
BIS(2-ETHYLHEXYL)PHTHALATE	6	4.8	6		2.1
BROMODICHLOROMETHANE	80 [9]	0.18	100		
BROMOFORM	80 [9]	8.5	100		466
BROMOMETHANE		8.7	24.9		
BUTYLBENZYL PHTHALATE		7300	2690		49
CADMIUM	5	18	5	2.2	0.66
CALCIUM					
CARBON DISULFIDE		1000	2380		84.1
CARBON TETRACHLORIDE	5	0.17	5		5.9
CHLOROBENZENE	100	39	100	20 [17]	10
CHLOROBENZILATE		0.25			7.16
CHLOROETHANE		8600			230000
CHLOROFORM	80 [9]	0.16	100		79
CHLOROMETHANE		1.5			
CHROMIUM (TOTAL)	100 [11]	180 [10]	100 [11]	11 [11]	42 [11]
CHRYSENE		9.2	1.6		0.033
CIS-1,2-DICHLOROETHENE	70	61	70		
CIS-1,3-DICHLOROPROPENE		0.081 [12]			7.9
COBALT		2200			5

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
COPPER	1300 [13]	1400		9	5
CYANIDE	200	730 [14]		5.2 [14]	5.2 [14]
DELTA-BHC					666.67
DIALLATE		1.1			29
DIAZINON		33			
DIBENZO(A,H)ANTHRACENE		0.0092	0.117		0.0016
DIBENZOFURAN		24			20
DIBROMOCHLOROMETHANE	80 [9]	1			6400
DIBROMOMETHANE		370			
DICHLORODIFLUOROMETHANE		390			
DIELDRIN		0.0042	0.0532	0.056	0.000026
DIETHYL PHTHALATE		29000	29200		3
DIMETHOATE		7.3			41.2
DIMETHYL PHTHALATE		370000	365000		73
DI-N-BUTYL PHTHALATE		3700	3650		3
DI-N-OCTYL PHTHALATE		730	20		30
DINOSEB	7	37			0.39
DIPHENYLAMINE		910			412.51
DISULFOTON		1.5			0.0402
ENDOSULFAN I		220 [16]	219 [16]	0.056	0.003
ENDOSULFAN II		220 [16]	219 [16]	0.056	0.003
ENDOSULFAN SULFATE					2.22
ENDRIN	2	11	0.2	0.036	0.002
ENDRIN ALDEHYDE					0.15
ETHION		18			
ETHYL METHACRYLATE		550			
ETHYLBENZENE	700	1300	700		17.2
FAMPHUR				0.01	
FLUORANTHENE		1500	206		8.1
FLUORENE		240	307		3.9

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
GAMMA-BHC	0.2	0.052	0.2		0.01
GAMMA-CHLORDANE	2 [6]	0.19 [6]	2 [6]	0.0043 [6]	0.00029 [6]
HEPTACHLOR	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0.2	0.0074	0.2	0.0038	0.00048
HEXACHLOROBENZENE	1	0.042	1		0.00024
HEXACHLOROBUTADIENE		0.86	7.3		0.134
HEXACHLOROCYCLOPENTADIENE	50	260	50	1 [17]	77.04
HEXACHLOROETHANE		4.8	7.68		30.5
HEXACHLOROPHENE		11			0.137
HEXACHLOROPROPENE					20
HMX		1800			
INDENO(1,2,3-CD)PYRENE		0.092	0.022		4.31
IRON	300 [7]	11000		1000	
ISOBUTYL ALCOHOL		1800			34800
ISODRIN					0.0185
ISOPHORONE		71	896		900
ISOSAFROLE					
KEPONE		0.0037			0.159
LEAD	15 [13]	4		2.5	1.3
MAGNESIUM					
MALATHION		730		0.1	
MANGANESE	50 [7]	1700			
MERCURY	2	11	2	0.77	0.0013
METHACRYLONITRILE		1			
METHAPYRILENE					
METHOXYCHLOR	40	180	40	0.03	0.005
METHYL IODIDE					
METHYL METHACRYLATE		1400			2800
METHYL METHANE SULFONATE					
METHYL PARATHION		9.1			

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
METHYLENE CHLORIDE	5	4.3	5		430
NAPHTHALENE		6.2	307		44
NICKEL	100	730	100	52	29
NITRATE	10000	10000			
NITRATE/NITRITE	10000	1000 [16]			
NITRITE	1000	1000			
NITROBENZENE		3.4	9.42	30 [17]	740
NITROGLYCERIN					
N-NITROSODIETHYLAMINE		0.00045			767.94
N-NITROSODIMETHYLAMINE		0.0013			
N-NITROSODI-N-BUTYLAMINE		0.002			1000
N-NITROSO-DI-N-PROPYLAMINE		0.0096	0.46		
N-NITROSODIPHENYLAMINE		14	174		13
N-NITROSOMORPHOLINE					
N-NITROSO-N-METHYLETHYLAMINE		0.0031			
N-NITROSOPIPERIDINE					
N-NITROSOPYRROLIDINE		0.032			
O,O,O-TRIETHYL PHOSPHOROTHIOATE					58.25
OCDD		0.00045 [1]			0.000000278 [2]
OCDF		0.00045 [1]			0.00129 [3]
O-TOLUIDINE		0.28			
P-(DIMETHYLAMINO)AZOBENZENE					
PENTACHLOROBENZENE		29			0.47
PENTACHLOROETHANE					56.42
PENTACHLOROPHENOL	1	0.56	1	15	5.23
PETN					
pH				6.5-9	
PHENACETIN					6.3
PHENANTHRENE					2.1
PHENOL		22000	21900	300 [17]	100

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
PHORATE		7.3			3.62
POTASSIUM					
PRONAMIDE		2700			160
PROPIONITRILE					6080
PROPYLENE GLYCOL		730000			
PROPYLENE GLYCOL , MONOETHYL ETHER		26000			
PROPYLENE GLYCOL, MONOMETHYL ETHER		26000			
PROPYLENE OXIDE		0.22			
P-TOLUIDINE		0.35			
PURSUIT		9100			
P-XYLENE	10000 [17]	1400 [19]	10000		117 [17]
PYDRIN		910			
PYRENE		180	135		0.3
PYRIDINE		37			2380
RDX		0.61			
SAFROLE					40
SELENIUM	50	180	50	5	5
SILVER	100 [7]	180	183		1
SODIUM					
STYRENE	100	1600	100		56
TETRACHLOROETHENE	5	1.1	5		8.9
TETRAETHYLDITHIOPYROPHOSPHATE		18			13.9
TETRYL		370			
THALLIUM	2	2.9 [4]	2		0.56
THIONAZIN					
TIN		22000			73
TOLUENE	1000	720	1000		253
TOXAPHENE	3	0.061	3	0.0002	0.0002
TRANS-1,2-DICHLOROETHENE	100	120	100		310
TRANS-1,3-DICHLOROPROPENE		0.081 [12]			7.9

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

CHEMICAL	FEDERAL MCL[a]	USEPA REGION IX TAPWATER PRG[b]	IDEM TEIR 1 DEFAULT CLEANUP LEVEL RESIDENTIAL GROUND WATER[d]	FEDERAL AWQC FRESHWATER CHRONIC[c]	USEPA REGION 5 SURFACE WATER EDQL[e]
TRICHLOROETHENE	5	1.6	5		75
TRICHLOROFLUOROMETHANE		1300			
VANADIUM		260			19
VINYL ACETATE		410	1850		248.03
VINYL CHLORIDE	2	0.02	2		9.2
XYLENES, TOTAL	10000	1400 [5]	10000		117
ZINC	5000 [7]	11000	11000	120	58.9

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
MCL Maximum Contaminant Level
NSWC Naval Surface Warfare Center
PRG Preliminary Remediation Goal
USEPA United States Environmental Protection Agency

a USEPA, October 1996.
b USEPA, Region IX, May 1998.
c USEPA, December 1998a.
d IDEM, October 1997.
e USEPA, Region 5, April 1998 (Appendix C).

1 Calculated using toxicity criteria for 2,3,7,8-TCDD and toxicity equivalent factors (TEFs) (USEPA, March 1989).
2 Polychlorinated dibenzo-p-dioxins.
3 Polychlorinated dibenzofurans.
4 Thallium carbonate.
5 o-, m-Xylene.
6 Chlordane.
7 Secondary MCL, based on aesthetic drinking water qualities (i.e., color, odor, taste, etc.).
8 Total for all Aroclor congeners.

TABLE D-1

RISK-BASED SCREENING LEVELS - AQUEOUS MEDIA (UG/L)
NSWC CRANE, INDIANA

9 Total for all trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
10 Hexavalent chromium.
11 Total chromium.
12 1,3-Dichloropropene.
13 Action level.
14 Free cyanide.
15 Nitrite.
16 Endosulfan.
17 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable but not toxic to humans.

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

14 OSWER soil screening level for residential land use (USEPA, July 1994).
15 Total xylenes.

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

CHEMICAL	USEPA GENERIC SSLs[a]			USEPA REGION IX RESIDENTIAL SOIL PRG[c]	IDEM TIER 1 DEFAULT CLEANUP LEVEL[d]		USEPA REGION 5 EDQL[e]	
	INGESTION	INHALATION	MIGRATION TO GROUND WATER[b]		SURFACE SOIL	SUBSURFACE SOIL	SOIL	SEDIMENT
1,1,1,2-TETRACHLOROETHANE				2.8	33.4	0.0719	225	0.01089
1,1,1-TRICHLOROETHANE		1200	0.1	680	1000	1.93	29.8	0.24685
1,1,2,2-TETRACHLOROETHANE	3	0.6	0.0002	0.36	5.37	0.00696	0.12722	0.02908
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE				5600				
1,1,2-TRICHLOROETHANE	11	1	0.0009	0.82	10.2	0.0304	28.8	0.67351
1,1-DICHLOROETHENE	1	0.07	0.003	0.052	0.726	0.0579	8.28	0.02327
1,2,3,4,6,7,8-HPCDD				0.00038 [1]			0.000000199 [2]	0.0000033 [2]
1,2,3,4,6,7,8-HPCDF				0.00038 [1]			0.0000386 [3]	1.29E-08 [3]
1,2,3,4,7,8,9-HPCDF				0.00038 [1]			0.0000386 [3]	1.29E-08 [3]
1,2,3,4,7,8-HXCDD				0.000038 [1]			0.000000199 [2]	0.0000033 [2]
1,2,3,4,7,8-HXCDF				0.000038 [1]			0.0000386 [3]	1.29E-08 [3]
1,2,3,6,7,8-HXCDD				0.000038 [1]			0.000000199 [2]	0.0000033 [2]
1,2,3,6,7,8-HXCDF				0.000038 [1]			0.0000386 [3]	1.29E-08 [3]
1,2,3,7,8,9-HXCDD				0.000038 [1]			0.000000199 [2]	0.0000033 [2]
1,2,3,7,8,9-HXCDF				0.000038 [1]			0.0000386 [3]	1.29E-08 [3]
1,2,3,7,8-PECDD				0.0000076 [1]			0.000000199 [2]	0.0000033 [2]
1,2,3,7,8-PECDF				0.000076 [1]			0.0000386 [3]	1.29E-08 [3]
1,2,3-TRICHLOROPROPANE				0.0014			3.36	0.00835
1,2,4,5-TETRACHLOROBENZENE				16			2.02	20.9
1,2,4-TRICHLOROBENZENE	780	3200	0.3	480	1000	5.29	11.1	8.44
1,2-DIBROMO-3-CHLOROPROPANE				0.32			0.03518	0.01998
1,2-DIBROMOETHANE				0.0049			1.23	0.01237
1,2-DICHLOROBENZENE	7000	560	0.9	370	595	17.2	2.96	0.23132
1,2-DICHLOROETHANE	7	0.4	0.001	0.34	3.99	0.0238	21.2	0.05418
1,2-DICHLOROPROPANE	9	15	0.001	0.34	4.94	0.0298	32.7	0.35161
1,2-DIPHENYLHYDRAZINE				0.56				
1,3,5-TRIMETHYLBENZENE				21				
1,3-DICHLOROBENZENE				41	878	12	37.7	3.01
1,3-DINITROBENZENE				5.5			0.6547	0.000924
1,4-DICHLOROBENZENE	27		0.1	3	41.9	2.16	0.54559	1.45
1,4-DIOXANE				40			2.05	0.00000543
1,4-NAPHTHOQUINONE							1.67	0.0000211
1-NAPHTHALAMINE							3.03	0.00109
2,3,4,6,7,8-HXCDF				0.000038 [1]			0.0000386 [3]	1.29E-08 [3]
2,3,4,6-TETRACHLOROPHENOL				1600			0.19878	1.51
2,3,4,7,8-PECDF				0.000076 [1]			0.0000386 [3]	1.29E-08 [3]
2,3,7,8-TCDD				0.0000038			0.000000199	0.0000033
2,3,7,8-TCDF				0.000038 [1]			0.0000386 [3]	1.29E-08 [3]
2,4,5-T				550			0.59634	5.39
2,4,5-TP (SILVEX)				440			0.1088	7.35
2,4,5-TRICHLOROPHENOL	7800		14	5500	1000	248	14.1	5.39

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

CHEMICAL	USEPA GENERIC SSLs[a]			USEPA REGION IX RESIDENTIAL SOIL PRG[c]	IDEM TIER 1 DEFAULT CLEANUP LEVEL[d]		USEPA REGION 5 EDQL[e]	
	INGESTION	INHALATION	MIGRATION TO GROUND WATER[b]		SURFACE SOIL	SUBSURFACE SOIL	SOIL	SEDIMENT
2,4,6-TRICHLOROPHENOL	58	200	0.008	40	387	1.49	9.94	0.08484
2,4,6-TRINITROTOLUENE				15				
2,4-D				640			0.02725	0.00579
2,4-DICHLOROPHENOL	230		0.05	160	547	1.08	87.5	0.13363
2,4-DIMETHYLPHENOL	1600		0.4	1100	1000	9	0.01	0.30453
2,4-DINITROPHENOL	160		0.01	110	365	0.292	0.06086	0.00133
2,4-DINITROTOLUENE	0.9		0.00004	110	6.26	0.00979	1.28	0.07513
2,6-DICHLOROPHENOL							1.17	0.00394
2,6-DINITROTOLUENE	0.9		0.00003	55	6.26	0.00847	0.03283	0.02062
2-ACETYLAMINOFLUORENE							0.59634	0.01532
2-AMINO-4,6-DINITROTOLUENE								
2-BUTANONE				6900	1000	11.4	89.6	0.50156
2-CHLORO-1,3-BUTADIENE				3.6			0.0029	0.00106
2-CHLORONAPHTHALENE				3700			0.01218	0.000157
2-HEXANONE							12.6	1.01
2-METHYL-4,6-DINITROPHENOL								
2-METHYLNAPHTHALENE							3.24	0.0202
2-METHYLPHENOL	3900		0.8	2700	1000	13.9	40.4	0.000826
2-NAPHTHYLAMINE							3.03	0.00174
2-NITROANILINE				3.3	10.9	0.0568	74.1	0.000222
2-NITRO-O-TOLUIDINE								
2-NITROPHENOL							1.6	0.00777
2-NITROTOLUENE								
2-PICOLINE							9.9	0.75305
3,3'-DICHLOROBENZIDINE	1		0.0003	0.99	9.46	0.33	0.64638	0.02822
3,3'-DIMETHYLBENZIDINE				0.048			0.1042	0.002
3-METHYLCHOLANTHRENE							0.07794	8190
3-METHYLPHENOL				2700			3.49	0.000845
3-NITROANILINE							3.16	0.000222
3-NITROTOLUENE								
4,4'-DDD	3		0.8	2.4	17.7	142	0.75815	5.03
4,4'-DDE	2		3	1.7	12.5	448	0.59587	0.00142
4,4'-DDT	2		2	1.7	12.5	264	0.0175	0.00119
4,6-DINITRO-2-METHYLPHENOL							0.14408	0.01038
4-AMINO-2,6-DINITROTOLUENE								
4-AMINOBIPHENYL							0.00305	0.00566
4-BROMOPHENYL PHENYL ETHER								1.68
4-CHLORO-3-METHYLPHENOL							7.95	0.38818
4-CHLOROANILINE	310		0.03	220	730	0.969	1.1	0.14608
4-CHLOROPHENYL PHENYL ETHER								0.656112
4-METHYL-2-PENTANONE				750			443	0.54437

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

CHEMICAL	USEPA GENERIC SSLs[a]			USEPA REGION IX RESIDENTIAL SOIL PRG[c]	IDEM TIER 1 DEFAULT CLEANUP LEVEL[d]		USEPA REGION 5 EDQL[e]	
	INGESTION	INHALATION	MIGRATION TO GROUND WATER[b]		SURFACE SOIL	SUBSURFACE SOIL	SOIL	SEDIMENT
4-METHYLPHENOL				270	912	1.09	163	0.000808
4-NITROANILINE							21.9	0.000222
4-NITROPHENOL				3400			5.12	0.00778
4-NITROQUINOLINE-1-OXIDE							0.12222	0.00124
4-NITROTOLUENE								
7,12-DIMETHYL BENZ(A)ANTHRACENE							16.3	66.4
A,A-DIMETHYL PHENETHYLAMINE				55			0.30016	0.0089
ACENAPHTHENE	4700		29	2600	1000	133	682	0.00671
ACENAPHTHYLENE							682	0.00587
ACETONE	7800	100000	0.8	1400	1000	3.09	2.5	0.70912
ACETONITRILE				200			1.37	0.17437
ACETOPHENONE				0.49			300	0.246
ACROLEIN				0.1			5.27	0.0000144
ACRYLONITRILE				0.19			0.02393	0.00129
ALDRIN	0.04	3	0.02	0.026	0.249	4.91	0.00332	0.002
ALLYL ALCOHOL				270				
ALPHA-BHC	0.1	0.8	0.00003	0.086	0.676	0.00719	0.09939	0.006
ALPHA-CHLORDANE	0.5[7]	20[7]	0.5[7]	1.6[7]	3.23[7]	9.61[7]	0.224[7]	0.0045[7]
ALUMINUM				75000				
ARAMITE				18			166	0.00000111
AROCLOR-1016	1[6]			0.2[6]	0.7[6]	6.18[6]	0.000332[6]	0.0341[6]
AROCLOR-1221	1[6]			0.2[6]	0.7[6]	6.18[6]	0.000332[6]	0.0341[6]
AROCLOR-1232	1[6]			0.2[6]	0.7[6]	6.18[6]	0.000332[6]	0.0341[6]
AROCLOR-1242	1[6]			0.2[6]	0.7[6]	6.18[6]	0.000332[6]	0.0341[6]
AROCLOR-1248	1[6]			0.2[6]	0.7[6]	6.18[6]	0.000332[6]	0.0341[6]
AROCLOR-1254	1[6]			0.2[6]	0.7[6]	6.18[6]	0.000332[6]	0.0341[6]
AROCLOR-1260	1[6]			0.2[6]	0.7[6]	6.18[6]	0.000332[6]	0.0341[6]
BARIUM	5500	690000	82	5200	1000	1000	1.04	
BENZENE	22	0.8	0.002	0.62	8.98	0.0338	0.25462	0.14157
BENZIDINE				0.0019				
BENZO(A)ANTHRACENE	0.9		0.08	0.56	4.62	18.6	5.21	0.0317
BENZO(A)PYRENE	0.09		0.4	0.056	0.462	8.16	1.52	0.0319
BENZO(B)FLUORANTHENE	0.9		0.2	0.56	4.62	57.4	59.8	10.4
BENZO(G,H,I)PERYLENE							119	0.17
BENZO(K)FLUORANTHENE	9		2	5.6	46.2	39.4	1480	0.24
BENZOIC ACID	310000		20	100000	1000	588		
BENZYL ALCOHOL				16000	1000	85.6	65.8	0.03394
BERYLLIUM	0.1	1300	3	0.14	1.87	63.2	1.06	
BETA-BHC	0.4		0.0001	0.3	2.29	0.0257	0.00398	0.005
BIS(2-CHLOROETHOXY)METHANE							0.30209	0.34971
BIS(2-CHLOROETHYL)ETHER	0.6	0.2	0.00002	0.18	1.64	0.33	23.7	0.21196

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

CHEMICAL	USEPA GENERIC SSLs[a]			USEPA REGION IX RESIDENTIAL SOIL PRG[c]	IDEM TIER 1 DEFAULT CLEANUP LEVEL[d]		USEPA REGION 5 EDQL[e]	
	INGESTION	INHALATION	MIGRATION TO GROUND WATER[b]		SURFACE SOIL	SUBSURFACE SOIL	SOIL	SEDIMENT
BIS(2-CHLOROISOPROPYL) ETHER				2.5	31.3	0.33		
BIS(2-ETHYLHEXYL)PHTHALATE	46	31000	180	32	304	1000	0.92594	0.182
BROMODICHLOROMETHANE	10	3000	0.03	0.98	11.3	0.632	0.53978	7.26
BROMOMETHANE	110	10	0.01	3.8	34.8	0.122	0.23516	0.94674
BUTYLBENZYL PHTHALATE	16000	930	810	930	928	928	0.23889	0.25669
CADMIUM	78	1800	0.4	37	24	7.52	0.00222	0.596
CALCIUM								
CARBON DISULFIDE	7800	720	2	350	725	19.1	0.09412	0.13397
CARBON TETRACHLORIDE	5	0.3	0.003	0.23	3.53	0.0659	2.98	0.03573
CHLOROBENZENE	1600	130	0.07	54	474	1.3	13.1	0.06194
CHLOROETHANE				1600				58.6
CHLOROFORM	100	0.3	0.03	0.24	3.33	0.586	1.19	0.027
CHLOROMETHANE				1.2			10.4	0.10832
CHROMIUM (TOTAL)	390 [9]	270 [9]	2 [9]	30 [10]	1000 [9]	38.4 [9]	0.4 [9]	26 [9]
CHRYSENE	88		8	56	462	25.5	4.73	0.0571
CIS-1,2-DICHLOROETHENE	780	1200	0.02	42	118	0.4	0.78373 [5]	0.20894 [5]
CIS-1,3-DICHLOROPROPENE	4	0.1	0.0002	0.081 [11]	1.36 [11]	0.00909 [11]	0.39786	0.00296
COBALT				3300			0.14033	50
COPPER				2800			0.3132	16
CYANIDE	1600		2	1100 [12]			1.33 [12]	0.0001 [12]
DEMETON				2.2				
DI(2-ETHYLHEXYL)ADIPATE				370				
DIALLATE				7.3			0.45214	0.00151
DIAZINON				49				
DIBENZO(A,H)ANTHRACENE	0.09		0.08	0.056	0.462	17.7	18.4	0.00622
DIBENZOFURAN				210				1.52
DIBROMOCHLOROMETHANE	8	1300	0.02	5.3			2.05	0.26761
DIBROMOMETHANE				550			65	0.0000859
DICHLORODIFLUOROMETHANE				94			39.5	0.00133
DIELDRIN	0.04	1	0.0002	0.028	0.266	0.0456	0.00238	0.002
DIETHYL PHTHALATE	63000	2000	23	44000	1000	454	24.8	0.00804
DIMETHOATE				11			0.21802	0.19015
DIMETHYL PHTHALATE				100000	1000	1000	734	0.02495
DI-N-BUTYL PHTHALATE	7800	2300	270	5500	1000	1000	0.14979	0.1105
DI-N-OCTYL PHTHALATE	1600	10000	10000	1100	1000	1000	709	40.6
DINOSEB				55			0.0218	0.01178
DIPHENYLAMINE				1400			1.01	0.0346
DISULFOTON				2.2			0.01988	0.32408
ENDOSULFAN I	470 [13]		0.9 [13]	330 [13]	1000 [13]	19.6 [13]	0.11927	0.000175
ENDOSULFAN II	470 [13]		0.9 [13]	330 [13]	1000 [13]	19.6 [13]	0.11927	0.000104
ENDOSULFAN SULFATE							0.03578	0.0346

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

CHEMICAL	USEPA GENERIC SSLs[a]			USEPA REGION IX RESIDENTIAL SOIL PRG[c]	IDEM TIER 1 DEFAULT CLEANUP LEVEL[d]		USEPA REGION 5 EDQL[e]	
	INGESTION	INHALATION	MIGRATION TO GROUND WATER[b]		SURFACE SOIL	SUBSURFACE SOIL	SOIL	SEDIMENT
ENDRIN	23		0.05	16	54.7	0.0992	0.0101	0.00267
ENDRIN ALDEHYDE							0.0105	3.2
ETHION				27				
ETHYL METHACRYLATE				140			30	0.000602
ETHYLBENZENE	7800	400	0.7	230	395	13.4	5.16	0.0001
FAMPHUR							0.0497	0.00178
FLUORANTHENE	3100		210	2000	1000	883	122	0.1113
FLUORENE	3100		28	1800	1000	171	122	0.0212
GAMMA-BHC (LINDANE)	0.5		0.0005	0.42	3.01	0.00936	0.005	0.00094
GAMMA-CHLORDANE	0.5 [7]	20 [7]	0.5 [7]	1.6 [7]	3.23 [7]	9.61 [7]	0.224 [7]	0.0045 [7]
HEPTACHLOR	0.1	0.1	1	0.099	0.557	22.6	0.00598	0.0006
HEPTACHLOR EPOXIDE	0.07	5	0.03	0.049	0.464	0.666	0.15188	0.0006
HEXACHLOROBENZENE	0.4	1	0.1	0.28	2.66	2.2	0.19678	0.02
HEXACHLOROBUTADIENE	8	8	0.1	5.7	36.5	16.1	0.03978	1.38
HEXACHLOROCYCLOPENTADIENE	550	10	20	380	1000	400	0.75537	4.68
HEXACHLOROETHANE	46	55	0.02	32	125	0.582	0.59634	0.22273
HEXACHLOROPHENE				16			0.19878	231
HEXACHLOROPROPENE								0.0002
HMX				2700				
INDENO(1,2,3-CD)PYRENE	0.9		0.7	0.56	4.62	3.05	109	0.2
IRON				22000				
ISOBUTYL ALCOHOL				10000			20.8	3.35
ISODRIN							0.00332	0.05516
ISOPHORONE	670	4600	0.03	470	1000	5.27	139	0.4223
ISOSAFROLE							9.94	0.00412
KEPONE				0.025			0.03272	0.00331
LEAD	400 [14]			400 [14]			0.05373	31
MAGNESIUM								
MALATHION				1100				
MANGANESE				3100				
MERCURY	23	10	0.1	22	54.7	2.09	0.1	0.174
METHACRYLONITRILE				1.8			0.05705	0.0000297
METHAPYRILENE							2.78	0.0000144
METHOXYCHLOR	390		8	270	903	156	0.01988	0.00359
METHYL IODIDE								
METHYL METHACRYLATE				2200			984	0.16756
METHYL METHANE SULFONATE				0.31549			0.31549	0.00000474
METHYL PARATHION				14			0.000292	0.000755
METHYLENE CHLORIDE	85	13	0.001	8.5	124	0.0231	4.05	1.26
NAPHTHALENE	3100		4	55	1000	25.8	0.09939	0.0346
NICKEL	1600	13000	7	1500	1000	130	13.6	16

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

CHEMICAL	USEPA GENERIC SSLs[a]			USEPA REGION IX RESIDENTIAL SOIL PRG[c]	IDEM TIER 1 DEFAULT CLEANUP LEVEL[d]		USEPA REGION 5 EDQL[e]	
	INGESTION	INHALATION	MIGRATION TO GROUND WATER[b]		SURFACE SOIL	SUBSURFACE SOIL	SOIL	SEDIMENT
NITRATE								
NITRATE/NITRITE								
NITRITE								
NITROBENZENE	39	92	0.007	16	91.2	0.062	1.31	0.4876
NITROGLYCERIN								
N-NITROSODIETHYLAMINE				0.003			0.06933	0.02277
N-NITROSODIMETHYLAMINE				0.0087			0.0000321	0.00000275
N-NITROSODI-N-BUTYLAMINE				0.022			0.26707	0.77204
N-NITROSO-DI-N-PROPYLAMINE	0.09		0.000002	0.063	0.608	0.0025	0.54368	0.000217
N-NITROSODIPHENYLAMINE	130		0.06	91	810	9.66	0.54514	0.15524
N-NITROSOMORPHOLINE							0.07057	0.0000037
N-NITROSO-N-METHYLETHYLAMINE				0.02			0.00166	0.00000485
N-NITROSOPIPERIDINE							0.00665	0.0000226
N-NITROSOPYRROLIDINE				0.21			0.01258	0.000000908
O,O,O,-TRIETHYL PHOSPOROTHIOATE							0.81757	0.18894
O-TOLUIDINE				1.9			2.97	0.000199
OCDD				0.0038 [1]			0.000000199 [2]	0.0000033 [2]
OCDF				0.0038 [1]			0.0000386 [3]	1.29E-08 [3]
P-D(IMETHYLAMINO) AZOBENZENE							0.03976	0.31799
PENTACHLOROBENZENE				44			0.49695	63.2
PENTACHLOROETHANE							10.7	0.68918
PENTACHLOROPHENOL	3		0.001	2.5	19.9	0.0276	0.11927	30.1
PETN								
PHENACETIN							11.7	0.00225
PHENANTHRENE							45.7	0.0419
PHENOL	47000		5	33000	1000	113	120	0.02726
PHORATE				11			0.000496	0.000881
POTASSIUM								
PRONAMIDE				4100			0.0136	0.0016
PROPIONITRILE							0.04983	0.11466
PYRENE	2300		210	1500	1000	568	78.5	0.053
PYRIDINE				55			1.03	0.10617
RDX				4				
SAFROLE							0.40398	0.16486
SELENIUM	390		0.3	370	1000	5.2	0.02765	
SILVER	390		2	370	1000	31	4.04	0.5
SODIUM								
STYRENE	16000	1500	0.2	1700	1000	3.53	4.69	0.44496
TETRACHLOROETHENE	12	11	0.003	4.7	50.2	0.0577	9.92	0.19583
TETRAETHYL DITHIOPYROPHOSPHATE				27			0.59634	0.55998
TETRYL				550				

TABLE D-2

RISK-BASED SCREENING LEVELS - SOLID MEDIA (MG/KG)
NSWC CRANE, INDIANA

CHEMICAL	USEPA GENERIC SSLs[a]			USEPA REGION IX RESIDENTIAL SOIL PRG[c]	IDEM TIER 1 DEFAULT CLEANUP LEVEL[d]		USEPA REGION 5 EDQL[e]	
	INGESTION	INHALATION	MIGRATION TO GROUND WATER[b]		SURFACE SOIL	SUBSURFACE SOIL	SOIL	SEDIMENT
THALLIUM			0.04	6 [4]	1000	2.85	0.05692	
THIONAZIN								
TIN				45000			7.62	
TOLUENE	16000	650	0.6	520	654	11.7	5.45	52.5
TOXAPHENE	0.6	89	2	0.4	3.86	30.8	0.11927	0.000109
TRANS-1,2-DICHLOROETHENE	1600	3100	0.03	62	192	0.679	0.78373	0.20894
TRANS-1,3-DICHLOROPROPENE	4	0.1	0.0002	0.081 [11]	1.36 [11]	0.00909 [11]	0.39788	0.00296
TRICHLOROETHENE	58	5	0.003	2.7	48.3	0.057	12.4	0.17956
TRICHLOROFLUOROMETHANE				380			16.4	19.7
VANADIUM	550		300	520			1.59	
VINYL ACETATE	78000	1000	8	420	1000	7.85	12.7	0.01295
VINYL CHLORIDE	0.3	0.03	0.0007	0.021	0.304	0.0135	0.64614	0.002
XYLENES, TOTAL	160000 [15]	410 [5]	9 [6]	210 [6]	413 [5]	189 [5]	10 [15]	1.88 [15]
ZINC	23000		620	22000	1000	1000	6.62	120

EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
PRG Preliminary Remediation Goal
SSL Soil Screening Level
USEPA United States Environmental Protection Agency

a USEPA, May 1996.
b Because of karst geologic conditions at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
c USEPA, Region IX, May 1998.
d IDEM, October 1997.
e USEPA, Region 5, April 1998 (Appendix C).

1 Calculated using toxicity criteria for 2,3,7,8-TCDD and toxicity equivalent factors (TEFs) (USEPA, March 1989).
2 Polychlorinated dibenzo-p-dioxins.
3 Polychlorinated dibenzofurans.
4 Thallium carbonate.
5 o-Xylene.
6 m-Xylene.
7 Chlordane.
8 Total for all Aroclor congeners.
9 Total chromium.
10 Hexavalent chromium.
11 1,3-Dichloropropene.
12 Free cyanide.
13 Endosulfan.

APPENDIX E

DATA MANAGEMENT CHECKLIST

DATABASE PLANNING CHECKLIST

PROJECT NAME _____ PROJECT NUMBER _____

PROJECT MANAGER _____ PLANNING DATE _____

1 Provide a general description of the project (regulatory authority, media to be samples, approximate number of samples by media, analyses by media, data evaluation tasks required):

_____
_____
_____
_____
_____

2. Provide a general description of the sample nomenclature that will be used for samples collected by Brown & Root Environmental:

_____
_____
_____
_____

3. Will historical data be entered in the database? Yes No

4. Will historical data be used to define the nature and extent of contamination? Yes No

5. Will historical data be used for risk assessment purposes? Yes No

6. How much historical data exists (i.e., number of samples by matrix, analysis by matrix)?

_____
_____
_____
_____

7. In what format will the historical data be provided? Hardcopy Electronic

8. If historical data are in electronic form, what software was used and what is the format?

_____
_____
_____
_____

9. If historical data are in hardcopy form, will Form I's, summary tables, or reports be provided? Copies of historical data will be necessary to generate a budget estimate.

_____
_____
_____
_____

10. Will Quality Assurance review of historical data be necessary? Yes No

11. If Quality Assurance review of historical data is necessary, describe the scope of the Quality Assurance review:

_____
_____
_____
_____

12. Will a GIS database be necessary for the project? Yes No

13. What nomenclature has been (will be) used to identify field duplicate samples?

14 Will field duplicate results be averaged and presented as one result in the data base? Will they be presented as distinct results, or will both the average and the distinct results be presented?

15. How will the average value for duplicate samples be determined on a matrix-specific base?

16. Are any unvalidated data to be included in the database? Yes No

17. Will unvalidated data be used for defining the nature and extent of contamination? Yes No

18. Will unvalidated data be used for risk assessment purposes? Yes No

19. Are any field screening data to be included in the database? Yes No

20. Will field screening data be used for defining the nature and extent of contamination? Yes No

21. Will field screening data be used for risk assessment purposes? Yes No

22. Will statistical correlation of laboratory and field screening data be necessary? Yes No

23. If a correlation exists between field screening and laboratory data, will the results of regression analysis be used to define nature and extent? Yes No

24. If a correlation exists between field screening and laboratory data, will the results of regression analysis be used to support the risk assessment? Yes No

25. Will field parameters be included in the database (e.g., pH, conductance, temperature)? Yes No

26. Will statistical correlations be necessary for TCLP versus RAS/SAS data? Yes No

27. Will statistical correlations be necessary for filtered versus unfiltered samples? Yes No

28. Will any other statistical correlations be necessary? Yes No

29. Are there wells that have been screened in different aquifers? Yes No

30. Will data for various aquifers be segregated by depth? Yes No

31. Can the sample nomenclature system be used to identify wells in different aquifers? Yes No

32. Will samples from other matrices (soil, sediment, or surface water) be segregated by depth? Yes No

33. Can the sample nomenclature system be used to identify depth-specificity? Yes No

34. Have any removal actions be performed at the site? Yes No

If removal actions have been performed, plan and cross-sectional views reflecting the extent of the removal action must be provided.

35. Will any composite sample results be included in the database? Yes No

36. If composite samples are included how will they be used for the nature and extent of contamination?

37. If composite samples are included how will they be used for the risk assessment?

38. Will the site be segregated into Areas of Concern, Solid Waste Management Units, etc? Yes No

39. Is the sample nomenclature adequate for such segregation? Yes No

If the sample nomenclature is inadequate for assigning samples to an AOC or SWMU, the Project Manager or designee must provide a base map of tabular summary clearly delineating the relationship between each sample and each AOC/SWMU.

40. Were any temporal samples collected (e.g., quarterly sampling of wells)? Yes No

41. If temporal samples were collected, how will they be used to define the nature and extent of contamination?

42. If temporal samples were collected, how will they be used to support the risk assessment?

43. Are State, Federal, or Regional criteria to be included in data summary tables? Yes No

44. Identify the criteria that must be presented in the summary tables.

45. Will State, Federal, or Regional criteria be used to select COPCs? Yes No

46. Identify the criteria to be used as COPC selection tools.

47. Are filtered and unfiltered surface water samples differentiated? Yes No

48. If such samples are differentiated, how?

49. Which of these samples will be used for the human health risk assessment?

Surface Water Filtered Unfiltered
Groundwater Filtered Unfiltered

50. Which of these samples will be used for the ecological assessment?

Surface Water	Filtered Unfiltered
Groundwater	Filtered Unfiltered

51. Will background data be included in the database? Yes No

52. How are background samples identified?

53. Will background results be used to support selection of COPCs? Yes No

53. What statistical analyses will be required for the background data?

54. Will background data be segregated by depth? Yes No

55. What background matrices must be segregated by depth?

56. What format will be used for data presentation (e.g., appendices and summary tables, comprehensive text tables, tag maps, isoconcentration contours, etc.)?

APPENDIX F

EDD FORMAT

ELECTRONIC DATA FORMAT REQUIREMENTS

1.0 INTRODUCTION

The laboratory is to provide 3.5" high density diskette(s) containing separate database (DBF) files in the format specified in this Attachment. The electronic deliverable includes all environmental samples, sample dilutions, sample reanalyses, and laboratory quality control samples. **All entries in the electronic deliverable must agree exactly with the final entries reported on the hardcopy data package sample result summaries**. Any corrections made to the hardcopy data must also be made to the electronic file. Appropriate qualifiers as identified by the analytical protocol must also be designated; laboratory QC non-compliance codes are not to be depicted.

Each diskette is to be properly labeled with the laboratory name, project name, file name(s), and laboratory point of contact. Electronic files should be delivered in the same fashion as are the hard copy data packages. A separate .dbf file shall be made for each analytical fraction (by method) and each sample delivery group (SDG). The files shall be named with the first character being the analytical fraction designator, followed by an underscore, followed by the SDG name. For example, the file for the volatile fraction for SDG BR001 should be named V_BR001.DBF. Additionally, the laboratory must provide a hardcopy listing all electronic files saved to the diskette, indicating what analytical fraction and matrix the file data contained therein pertain to. All electronic data deliverables are due within the same time established for the associated hardcopy data packages.

In addition, the laboratory QC officer must read and sign a copy of the Quality Assurance Review Form displayed on the next page of this Attachment. Electronic deliverables are not considered to be complete without the accompanying Quality Assurance Review Form.

I _____, as the designated Quality Assurance Officer, hereby attest that all electronic deliverables have been thoroughly reviewed and are in agreement with the associated hardcopy data. The enclosed electronic files have been reviewed for accuracy (including significant figures), completeness and format. The laboratory will be responsible for any labor time necessary to correct enclosed electronic deliverables that have been found to be in error. I can be reached at (_____)_____ if there are any questions or problems with the enclosed electronic deliverables.

Signature:_____ Title: _____ Date: _____

The analytical data shall be delivered electronically in a Dbase III file format (filename.dbf). The exact structure of the database is described in the table below. It shall be the responsibility of the laboratory to ensure that all electronic entries are in strict accordance with the information provided on the Form I.

An example database shall be sent for review prior to the first electronic deliverable in Dbase III format. The example file will be examined for completeness and comments will be sent to the laboratory. Any questions regarding the electronic deliverable shall be directed to Patrick Hooper at Tetra Tech NUS (412)921-8250.

DATA FIELD	DATA TYPE	FIELD WIDTH	DATA FIELD DESCRIPTION
SAMPLE_NO	C	25	Field sample ID as listed on the chain-of-custody. The sample number indicated in this field should never be truncated. The only exception for this field not matching the chain-of-custody is for reanalyses and matrix spike results in which a RE or MS suffix will be added to the sample number respectively.
TRUNCATE	C	15	If the field sample ID listed on the Chain of Custody is truncated by the laboratory for use with the laboratory software, the truncated sample ID should appear in this field.
LAB_ID	C	15	Laboratory number for the given sample.
LABORATORY	C	25	Laboratory name.
BATCH_NO	C	10	Laboratory code for batch of samples included in a given run.
ASSOC_BLNK	C	15	Laboratory name of the method blank associated with that particular batch of samples.
QC_TYPE	C	15	Normal Environmental Sample = "NORMAL", Laboratory Duplicate = "DUPLICATE", Matrix Spike = "MS", Matrix Spike Duplicate = "MSD", Laboratory Control Sample = "LCS", Laboratory Control Sample Duplicate = "LCSD", Method Blank = "M BLANK", Preparation Blank = "P BLANK".
SAMP_DATE	D	8	Date of sample collection as indicated on the Chain of Custody. Example: 11/07/93.
REC_DATE	D	8	Date sample was received by the laboratory.
EXTR_DATE	D	8	Date sample was extracted or prepared by the laboratory.
ANAL_DATE	D	8	Date sample was analyzed by the laboratory.
RUN_NUMBER	N	2 (0)	The number of the analytical run for a given sample in sequence. For example, if a sample is diluted and reanalyzed, the original run number would be 1 and the reanalysis would be 2.
SDG	C	15	Sample delivery group identifier assigned by the laboratory. This number should exactly match the SDG designated on the hardcopy data package.
DATA FIELD	DATA TYPE	FIELD WIDTH	DATA FIELD DESCRIPTION

PROJECT_NO	C	10	Identification of Project Number or CLEAN Task Order (CTO) number.
PROJ_MNGR	C	25	The Brown & Root Project Manager's last name, followed by a comma, followed by the first initial of the Project Manager (e.g. Hutson, D).
PARAMETER	C	45	Chemical or analyte name exactly as reported on Form I.
CAS_NO	C	10	Chemical Abstract Service number for the parameter listed. The CAS number should be reported exactly as it is listed in publications such as the Merck Index. This field should be left blank for those parameters not having CAS numbers (e.g. Total Organic Carbon).
FRACTION	C	5	Metals = 'M', Volatiles = 'OV', Semivolatiles/BNAs = 'OS', Pesticides = 'PEST', Herbicides = 'HERB', Polychlorinated Biphenyls = 'PCB', Explosives = 'EXP', Any petroleum hydrocarbon or fuel = 'TPH', Wet Chemistry = 'WET', Radionuclide = 'RAD', Miscellaneous = 'MISC'
METHOD	C	20	Analytical method used to quantitate parameter concentrations as listed in the laboratory technical specification (e.g. '8270A' for SW-846 Method 8270A.
LAB_RESULT	N	20 (6)	Reported value in units specified in the UNITS field containing the proper number of significant digits. The % Recovery shall be placed in this field for matrix spike and laboratory control sample results.
UNITS	C	5	The units of measure as reported on the Form I.
LAB_QUAL	C	2	The laboratory qualifier as reported on the Form I. For example, a 'U' qualifier should be used for all nondetected results.
IDL	N	15 (6)	Instrument detection limit in units specified in the UNITS field.
MDL	N	15 (6)	Method detection limit in units specified in the UNITS field and method specified in the METHOD field.
CRDL_CRQL	N	15 (6)	Contract Required Detection/Quantitation Limit in the units specified in the UNITS field. RDL for non-CLP parameters.
DIL_FACTOR	N	6 (1)	Dilution factor.
PCT_MOIST	N	5 (1)	Percent moisture for soil samples; blank for water samples.
COMMENTS	C	20	Analytical result qualifier or comment other than that listed in the LAB_QUAL field. Example: 'Reanalysis'.

C = Character string (everything shall be reported in capital letters)
N = Numeric string (decimal places are in parentheses in field width column)
D = Date (Ex: 05/25/97)

APPENDIX G

DATABASE STRUCTURE

Database Structure

The NSWC Crane CTO10 master database shall contain 18 standard tables to store all chemical, geological, and hydrogeological data. The structure, indexes, primary keys, and relations for each table are defined below.

TABLE: well
PRIMARY KEY: location

Table Structure

FIELD	TYPE	DESCRIPTION
Location	C (25)	Unique location name.
post_id	C (20)	Location name as derived from original source document.
instal_date	D (8)	Date the monitoring well was installed. Null for other location types.
loc_type	C (4)	Type of location.
Northing	N (15,4)	Northing coordinate in horizontal datum referenced in the HORIZ_DATUM field.
Easting	N (15,4)	Easting coordinate in horizontal datum referenced in the HORIZ_DATUM field.
horiz_datum	C (8)	Datum in which the horizontal coordinates were derived.
grnd_surf	N (15,4)	Ground surface elevation with reference to mean sea level in vertical datum referenced in the VERT_DATUM field
vert_datum	C (25)	Datum in which the vertical coordinates were derived.
datum_state	C (2)	State for which datum was developed
Surveyed	L (1)	Logical field denoting whether positional data were surveyed or digitized.
Surveyor	C (50)	Company who performed the survey.
survey_date	D (8)	Date in which survey was performed.
surv_method	C (25)	Surveying method used.
Longitude	N (15,4)	Longitude
Latitude	N (15,4)	Latitude

Table Indexes

INDEX	TYPE
Location	Primary
Hd	Regular
Vd	Regular
loc_type	Regular

Table Relations:

Relation 1
*RelatedChild loc_type
*RelatedTable loc_type_vvl
*RelatedTag loc_type

Relation 2
*RelatedChild hd
*RelatedTable horiz_datum_vvl
*RelatedTag hd

Relation 3
*RelatedChild vd
*RelatedTable vert_datum_vvl
*RelatedTag vd

TABLE: loc_type_vvl - Valid value list for LOC_TYPE field in the well table.

PRIMARY KEY: loc_type

Table Structure

FIELD	TYPE	DESCRIPTION
loc_type	C (4)	Location type
Description	C (40)	Description of location type

Table Indexes

INDEX	TYPE
loc_type	Primary

TABLE: horiz_datum_vvl - Valid value list for HORIZ_DATUM field in the well table.
PRIMARY KEY: hd (horiz_datum)

Table Structure

FIELD	TYPE	DESCRIPTION
Horiz_datum	C (15)	Datum in which x,y coordinates reflect

Table Indexes

INDEX	TYPE
hd (horiz_datum)	Primary

Table Indexes

INDEX	TYPE
loc_type	Primary

TABLE: vert_datum_vvl - Valid value list for VERT_DATUM field in the well table.
PRIMARY KEY: vd (vert_datum)

Table Structure

FIELD	TYPE	DESCRIPTION
Vert_datum	C (15)	Datum in which z coordinate reflects

Table Indexes

INDEX	TYPE
vd (vert_datum)	Primary

TABLE: sample_data - Sample data table
PRIMARY KEY: nsample

Table Structure

FIELD	TYPE	DESCRIPTION
Location	C (25)	Unique location name.
Matrix	C (4)	Sample matrix
Nsample	C (35)	Unique sample identification
Sample	C (25)	Sample identification as designated on Chain-of-Custody
Sacode	C (8)	Sample code for reference to field duplicates
top_depth	N (5,1)	Depth in feet to the top of the sample interval. Applicable for soil and sediment samples.
Bottom_depth	N (5,1)	Depth in feet to the bottom of the sample interval. Applicable fo soil and sediment samples. *Rule Expression*: if(bottom_depth>0,top_depth<=bottom_depth)

qc_type	C (2)	Quality control type
Status	C (10)	Status of sample location – Normal or excavated
sample_date	D (8)	Date in which sample was collected
Validated	L (1)	Logical field denoting whether or not data validation was performed on sample
coll_method	C (10)	Sample collection method
cto_proj	C (5)	Clean task order (Navy) or project number in which the sample was collected (e.g. "129")
proj_manager	C (25)	Internal projcect manager for which the data was originally generated (e.g. "Hutson, D.").

Table Indexes

INDEX	TYPE
Location	Regular
Nsample	Primary
Sacode	Regular
Matrix	Regular
Status	Regular
qc_type	Regular
coll_meth	Regular

Table Relations:

Relation 1
*RelatedChild sacode
*RelatedTable sacode_vvl
*RelatedTag sacode

Relation 2
*RelatedChild qc_type
*RelatedTable qc_type_vvl
*RelatedTag qc_type

Relation 3
*RelatedChild matrix
*RelatedTable matrix_vvl
*RelatedTag matrix

Relation 4
*RelatedChild location
*RelatedTable well
*RelatedTag location

Relation 5
*RelatedChild coll_meth
*RelatedTable coll_method_vvl
*RelatedTag coll_meth

TABLE: sacode_vvl - Sample code valid value list for SACODE field in sample_data.dbf
PRIMARY KEY: sacode

Table Structure

FIELD	TYPE	DESCRIPTION
Sacode	C (8)	Sample code designating whether sample is a normal environmental sample, a field duplicate or the average of field duplicate pairs
Description	C (30)	Description of sacode entry

Table Indexes

INDEX	TYPE
Sacode	Primary

TABLE: qc_type_vvl - Quality control valid value list for QC_TYPE field in sample_data.dbf
PRIMARY KEY: qc_type

Table Structure

FIELD	TYPE	DESCRIPTION
qc_type	C (10)	Quality control type
Description	C (30)	Description of quality control type

Table Indexes

INDEX	TYPE
qc_type	Primary

TABLE: matrix_vvl - Matrix valid value list for MATRIX field in sample_data.dbf
PRIMARY KEY: matrix

Table Structure

FIELD	TYPE	DESCRIPTION
Matrix	C (4)	Sample matrix
Description	C (25)	Description of sample matrix code

Table Indexes

INDEX	TYPE
Matrix	Primary

TABLE: well_completion
PRIMARY KEY: None

Table Structure

FIELD	TYPE	DESCRIPTION
Location	C (25)	Unique location name
top_casing	N (8,2)	Elevation of top of well casing in vertical datum found in VERT_DATUM in the well table
hole_diameter	N (5,1)	Diameter of the drilled hole in inches *Rule Expression*: hole_diameter>casing_id.AND.hole_diameter>casing_od
scr_aquifer	C (30)	Aquifer name in which the screen resides
screen_material	C (15)	Type of material in which the screen is constructed from
scrn_slot_size	N (5,1)	Screen slot size in thousandths of an inch
scrn_top_depth	N (5,2)	Depth below ground surface to the top of the screen (in feet)
scrn_bot_depth	N(5,2)	Depth below ground surface to the bottom of the screen *Rule Expression*: if(scrn_bot_depth>0,scrn_top_depth<scrn_bot_depth)
scrn_top_elev	N (6,2)	Elevation the top of the screen in vertical datum found in VERT_DATUM in the well table.
scrn_bot_elev	N (6,2)	Elevation the top of the screen in vertical datum found in VERT_DATUM in the well table. *Rule Expression*: if(scrn_bot_elev>0,scrn_top_depth>scrn_bot_depth)
drill_method	C (15)	Drilling method for well installation
Contractor	C (20)	Drilling contractor
casing_material	C (15)	Type of material in which the casing is constructed from
depth_to_seal	N (8,2)	Depth below ground surface to seal (in feet)

seal_material	C (15)	Type of material in which the seal is constructed from
fill_top_depth	N (6,2)	Depth below ground surface to the top of fill material (in feet)
fill_bot_depth	N (6,2)	Depth below ground surface to the bottom of fill material (in feet). *Rule Expression*: if(fill_bot_depth>0.fill_top_depth<scrn_bot_depth)
fill_material	C (20)	Type of material used for fill.
comments	M (4)	Geologist's comments

Table Indexes

INDEX	TYPE
location	Regular

Table Relations:
Relation 1
*RelatedChild location
*RelatedTable well
*RelatedTag location

TABLE: lithology
PRIMARY KEY: None

FIELD	TYPE	DESCRIPTION
location	C (25)	Unique location name
top_lithology	N (6,2)	Depth in feet below ground surface to the top of lithologic unit
bottom_lithology	N (6,2)	Depth in feet below ground surface to the bottom of lithologic unit
uscs_code	C (5)	Unified Soil Classification Service Code for lithology type
blow_counts	C (8)	Number of blow counts recorded on boring log
description	C (80)	Geologist's description of lithology
comments	M (4)	Geologist's comments.

Table Indexes

INDEX	TYPE
location	Regular
uscs_code	Regular

Table Relations:
Relation 1
*RelatedChild location
*RelatedTable well
*RelatedTag location
Relation 2
*RelatedChild uscs_code
*RelatedTable lithology_vvl
*RelatedTag uscs_code

TABLE: lithology_vvl - Lithology valid value list for USCS_CODE field in lithology.dbf
PRIMARY KEY: uscs_code

Table Structure

FIELD	TYPE	DESCRIPTION
uscs_code	C (4)	Unified Soil Classification Service Code for lithology type
descript	C (70)	Description of lithology for given USCS code

Table Indexes

INDEX	TYPE
uscs_code	Primary

TABLE: coll_method_vvl - Collection method valid value list for COLL_METHOD field in sample_data.dbf
PRIMARY KEY: coll_meth

Table Structure

FIELD	TYPE	DESCRIPTION
coll_method	C (10)	Sample collection method

Table Indexes

INDEX	TYPE
coll_method	Primary

TABLE: cas_vvl - CAS number valid value list for CAS field in analytical results.dbf
PRIMARY KEY: cas

Table Structure

FIELD	TYPE	DESCRIPTION
parameter	C (40)	Parameter or chemical name
cas	C (11)	Chemical Abstracts Service Number

Table Indexes

INDEX	TYPE
parameter	Regular
cas	Primary

TABLE: analytic_results
PRIMARY KEY: nfp (nsample+fraction+parameter)

Table Structure

FIELD	TYPE	DESCRIPTION
nsample	C (35)	Unique sample identification
lab_id	C (15)	Laboratory sample identification
laboratory	C (25)	Laboratory name
batch_no	C (10)	Analytical batch number
assoc_blnk	C (15)	Associated blank
extr_date	D (8)	Extraction date
anal_date	D (8)	Analysis date
run_number	I (4)	Sequential analytical run number
sdg	C (15)	Sample delivery group
parameter	C (45)	Parameter or chemical name (using IUPAC nomenclature where appropriate)
cas	C (11)	Chemical Abstracts Service Number
fraction	C (5)	Analtytical fraction
method	C (20)	Analytical method
lab_result	N (20,6)	Analytical result as reported by the laboratory
lab_qual	C (5)	Qualifier as reported by the laboratory
val_res	N (20,6)	Final result (via validation or otherwise)

result	C (20)	Final analytical result with the correct number of significant figures
val_qual	C (3)	Validation qualifer (null if data were not validated)
qual	C (3)	Final qualifer (validation or otherwise)
units	C (5)	Units of measure for the RESULT field
idl	N (15,6)	Instrument detection limit (same units as UNITS field)
mdl	N (15,6)	Method detection limit (same units as UNITS field)
crdl_crql	N (15,6)	Contract required detection/quantitation limit (same units as UNITS field)
dil_factor	N (6,1)	Dilution factor
pct_moist	N (5,1)	Percent moisture
comments	C (20)	Comments from laboratory analyst

Table Indexes

INDEX	TYPE
nfp	Primary
units	Regular
qual	Regular
fraction	Regular
parameter	Regular
nsample	Regular
cas	Regular

Table Relations:

Relation 1
*RelatedChild cas
*RelatedTable cas_vvl
*RelatedTag cas
Relation 2
*RelatedChild units
*RelatedTable units_vvl
*RelatedTag units
Relation 3
*RelatedChild qual
*RelatedTable qual_vvl
*RelatedTag qual
Relation 4
*RelatedChild fraction
*RelatedTable fraction_vvl
*RelatedTag fraction
Relation 5
*RelatedChild parameter
*RelatedTable para_vvl
*RelatedTag para
Relation 6
*RelatedChild nsample
*RelatedTable sample_data
*RelatedTag nsample

TABLE: units_vvl - Units valid value list for UNITS field in analytical_results.dbf
PRIMARY KEY: Units

Table Structure

FIELD	TYPE	DESCRIPTION
Units	C (8)	Units of measure for chemical analysis
Description	C (20)	Description of units

Table Indexes

INDEX	TYPE
Units	Primary

TABLE: qual_vvl
PRIMARY KEY: qual - Qualifier valid value list for QUAL field in analtyic_results.dbf

Table Structure

FIELD	TYPE	DESCRIPTION
Qual	C (5)	Final QA qualifier
Description	C (60)	Definition of qualifier

Table Indexes

INDEX	TYPE
Qual	Primary

TABLE: fraction_vvl - Analytical fraction valid value list for FRACTION field in analytic_results.dbf
PRIMARY KEY: fraction

Table Structure

FIELD	TYPE	DESCRIPTION
Fraction	C (10)	Analytical fraction
Description	C (35)	Description of fraction

Table Indexes

INDEX	TYPE
Fraction	Primary

TABLE: para_vvl
PRIMARY KEY: parameter

Table Structure

FIELD	TYPE	DESCRIPTION
Para	C (60)	Parameter or chemical name
frac_name	C (35)	Analytical fraction for given parameter

Table Indexes

INDEX	TYPE
Para	Primary

TABLE: fluid
PRIMARY KEY: None

Table Structure

FIELD	TYPE	DESCRIPTION
Location	C (25)	Unique location name
Fluid_date	D (8)	Date measurement was taken
meas_elev	N (8,2)	Measuring point elevation
dep_to_water	N (6,2)	Depth below ground surface to water table (in feet)
dep_to_fp	N (6,2)	Depth below ground surface to free product (in feet)
elev_water	N (8,2)	Elevation of water level
elev_fp	N (8,2)	Elevation of free product
prod_thick	N (6,2)	Product thickness in feet

Table Indexes

INDEX	TYPE
location	Regular

Table Relations:
Relation 1
*RelatedChild location
*RelatedTable well
*RelatedTag location

APPENDIX H

ARCVIEW GIS STRUCTURE

ArcView GIS Structure

The NSWC Crane CTO10 ArcView GIS shall have the following directory structure and database table structure.

Part One: Directory Structure

The following table defines the directory structure and major file names/types located within each directory.

Main subdirectory	First tier subdirectories	Second tier subdirectories	Files/Types
p:\gis\project name\	database\		coordinate.dbf cross_reference.dbf res_ gw.dbf res_so.dbf res_sd.dbf res_sw.dbf well_completion.dbf
		criteria\	crit_ gw.dbf crit_so.dbf crit_ sd.dbf crit_sw.dbf crit_des.dbf
	mapping\	aerial\	registered aerial photos
		drg\	USGS Digital Raster Graphic
		image\	GeoStatistic Layers, pictures of sites, equipment, EVS, and all other raster files.
		dwg\	AutoCAD files
		dgn\	Microstation files
		shp\	samp_gw.shp .dbf .shx samp_so.shp .dbf .shx samp_sd.shp .dbf .shx samp_sw.shp .dbf .shx and all other AV shape files
	working\	database\	files used to generate specific drawings will be put under the working subdirectory in subdirectories similar to database & mapping. These will not be included in CD deliverable.
		mapping\	same as above

Part Two: Database Table Structure

The ArcView GIS will contain separate database tables to store analytical, criteria, and coordinate information. The structure of these tables is presented below.

Analyticl Data Table

The following table lists all the fields contained in the analytic database table.

FIELD	VISIBLE	ALIAS	DESCRIPTION
site	Yes	Site or SWMU	Site or SWMU
location	Yes	Location	Unique location name
nsample	Yes	Sample	Unique sample identification
sample	No		Sample identification as designated on Chain-of-Custody
sample_date	Yes	Sample Date	Date in which sample was collected
matrix	Yes	Matrix	Sample matrix
sacode	Yes	Sample Code	Sample code for reference to field duplicates
depth	Yes	Depth	Depth in feet to the middle of the sample interval. Applicable for soil and sediment samples.
top_depth	Yes	Top Depth	Depth in feet to the top of the sample interval. Applicable for soil and sediment samples.
bottom_depth	Yes	Bottom Depth	Depth in feet to the bottom of the sample interval. Applicable for soil and sediment samples. Rule Expression: if(bottom_depth>0,top_depth<=bottom_depth)
parameter	Yes	Parameter	Parameter or chemical name (using IUPAC nomenclature where appropriate)
cas	Yes	CAS	Chemical Abstracts Service Number
fraction	Yes	Fraction	Analytical fraction
val_res	Yes	Numeric Result	Final result (via validation or otherwise)
qual	Yes	Qualifier	Final qualifier (validation or otherwise)
units	Yes	Units	Units of measure for the RESULT field
method	Yes	Method	Analytical method
status	Yes	Status	Status of sample location – Normal or excavated
validated	Yes	Validated	Logical field denoting whether or not data validation was performed on sample
coll_method	Yes	Collection Method	Sample collection method
cto_proj	Yes	CTO	Clean task order (Navy) or project number in which the sample was collected (e.g. "129")
proj_manager	Yes	Project Manager	Internal project manager for which the data was originally generated (e.g. "Hooper, P.").
lab_id	No	Laboratory ID	Laboratory sample identification
laboratory	No	Laboratory	Laboratory name
batch_no	No	Batch Number	Analytical batch number

assoc_blnk	No	Associated Blank	Associated blank
extr_date	No	Extraction Date	Extraction date
anal_date	No	Analysis date	Analysis date
run_number	No	Run Number	Sequential analytical run number
sdg	No	SDG	Sample delivery group
lab_result	No	Result	Analytical result as reported by the laboratory
lab_qual	No	Lab Qualifier	Qualifier as reported by the laboratory
result	No	String Result	Final analytical result with the correct number of significant figures
val_qual	No	Validation Qualifier	Validation qualifier (null if data were not validated)
idl	No	Detection Limit	Instrument detection limit (same units as UNITS field)
mdl	No	Detection Units	Method detection limit (same units as UNITS field)
crdl_crql	No		Contract required detection/quantitation limit (same units as UNITS field)
dil_factor	No	Dilution factor	Dilution factor
pct_moist	No	Percent moisture	Percent moisture
ourresult	No		
qc_type	No		Quality control type
comments	No	Comments	Comments from laboratory analyst

Criteria Table

Each medium will have a criteria table to specify the applicable criteria for all parameters.

FIELD	ALIAS	DESCRIPTION
parameter	Parameter	Parameter or chemical name (using IUPAC nomenclature where appropriate)
epa_mcl	None	Federal MCL – groundwater

Note: usually there will be many criteria fields. This example table only shows the "epa_mcl" criteria field.

Criteria Description Table

This table stores the definition or description of all standards and criteria used in the project. For example, epa_mcl's media would be GW, description would be "Federal Maximum Contaminant Level".

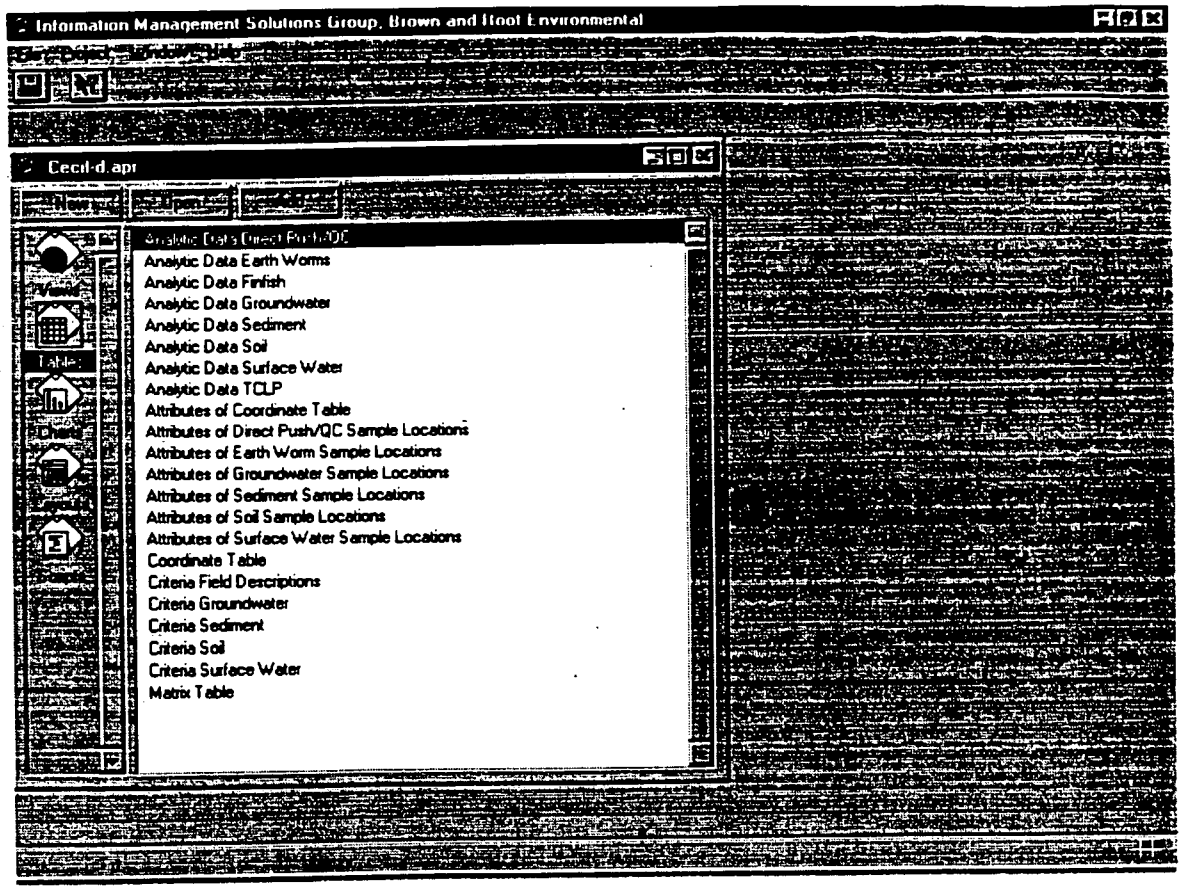
FIELD	Visible	DESCRIPTION
Field	Yes	
Media	Yes	
Descript	Yes	

Coordinate Table

The coordinate table holds all the geographic position information of sampling locations

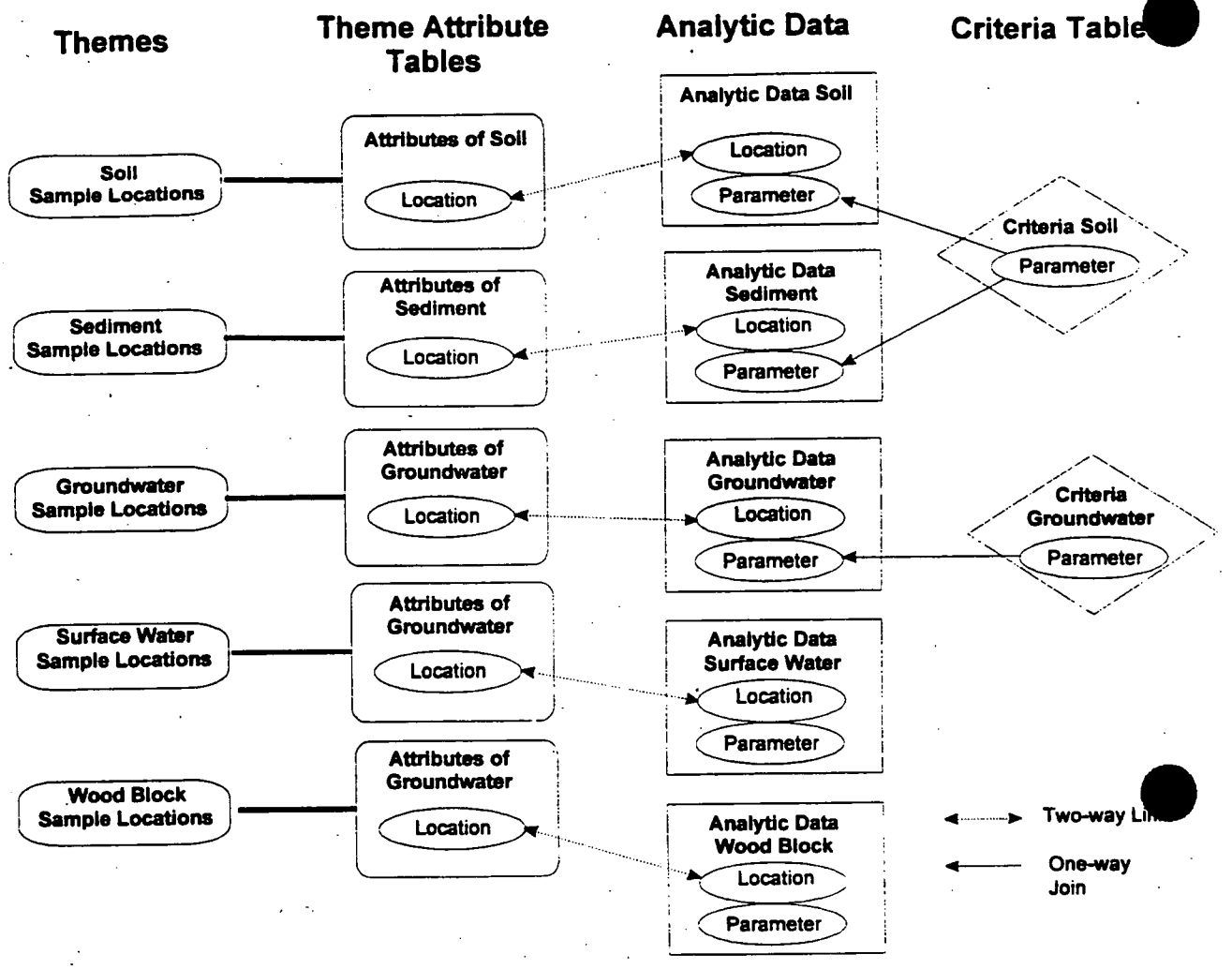
FIELD	Visible	ALIAS	DESCRIPTION
Location	Yes	None	Unique location name.
post_id	Yes	Location Designation	Location name as derived from original source document.
instal_date	No	Installation Date	Date the monitoring well was installed. Null for other location types.
loc_type	Yes	Location Type	Type of location. Example MW, HP, etc.
northing	Yes		Northing coordinate in horizontal datum referenced in the HORIZ_DATUM field.
Easting	Yes		Easting coordinate in horizontal datum referenced in the HORIZ_DATUM field.
Grnd_surf	Yes	Ground Surface Elevation	Ground surface elevation with reference to mean sea level in vertical datum referenced in the VERT_DATUM field
horiz_datum	Yes	Horizontal Datum	Datum in which the horizontal coordinates were derived.
Vert_datum	Yes	Vertical Datum	Datum in which the vertical coordinates were derived.
Datum_state	Yes	Coordinate System	State for which datum was developed
Surveyed	Yes		Logical field denoting whether positional data were surveyed or digitized.
Surveyor	Yes		Company who performed the survey.
Survey_date	No	Survey Date	Date in which survey was performed.
Surv_method	No	Survey Method	Surveying method used.
Longitude	No		Longitude
Latitude	No		Latitude
gw_code	Yes		This will be populated by database personnel. It will be used for event driven theme.
Sd_code	Yes		This will be populated by database personnel. It will be used for event driven theme.
So_code	Yes		This will be populated by database personnel. It will be used for event driven theme.
Sw_code	Yes		This will be populated by database personnel. It will be used for event driven theme.
_nullflags	No		Various fields are put in by database starting here and followed by several fields. Make all of these invisible

Table Links



All sample location theme attribute tables are two-way linked to the corresponding analytical data table. In addition, the analytical data tables are joined to the criteria table. The following diagram illustrates the relationship.

Database Model



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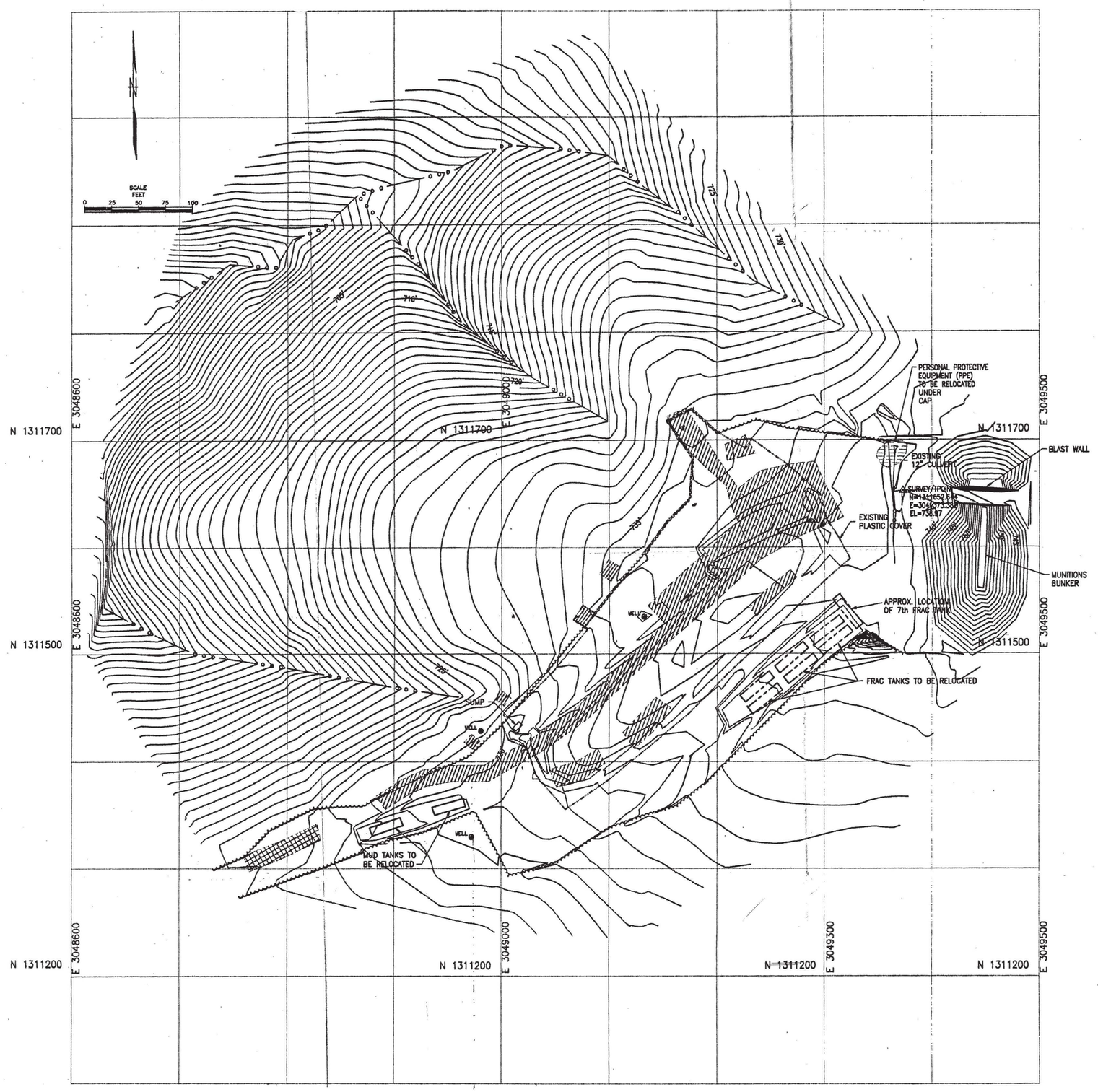

REVISIONS

REV.	DATE	DESCRIPTION	BY	LEAD ENGR.	DEPT. MGR.	PROJ. MGR.
A	6/19/97	ISSUED FOR BID AND REVIEW				
0	6/25/97	ISSUED FOR CONSTRUCTION				

NOTES

LEGEND

- EXISTING TREE LINE
- LIMIT OF PLASTIC COVER
- EXISTING MONITORING WELL
- AREAS OF WASTE PREVIOUSLY EXCAVATED AND REPLACED WITH CLEAN SOIL.
- AREAS PREVIOUSLY IDENTIFIED WITH DYE CONTAMINATION
- EXISTING FRAC TANKS
- SURVEY CONTROL POINT
- EXISTING MUD TANKS

SWMU#02/II
DYE BURIAL GROUND
INTERIM MEASURES CAP

NSWC, CRANE DIVISION
EASTERN SECTION
EXISTING SITE PLAN

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL SERVICES

DEPT	ARCH	STR/CIV	MECH	ELECT	PIPING	INST	Q/A	ENG. MGR.	PROJ. MGR.
INT									
DATE									

SCALE: 1"=50'-0		
DRAWN: R. EVANS	6/16/97	
DESIGNED: C. WAITE	6/17/97	
CHECKED:		
VERIFIED:		
APPROVED:		
AUTOCAD FILE NAME: 4324-02.DWG		

WORK ORDER NUMBER: 4324

DRAWING NUMBER: C-02 REV: 0

00003802X

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