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# Final
# Field Sampling Plan
for
# RCRA Ground Water Monitoring
at the
# Ammunition Burning Grounds, Old Rifle Range, Demolition Range, and Old Jeep Trail

## Naval Surface Warfare Center
## Crane Division
Crane, Indiana

**VOLUME I - TEXT, APPENDIX B, AND APPENDIX D**

## Southern Division
## Naval Facilities Engineering Command
**Contract Number N62467-94-D-0888**
**Contract Task Order 0038**

September 1999

# FIELD SAMPLING PLAN
# FOR
# RCRA GROUND WATER MONITORING
# AT THE
# AMMUNITION BURNING GROUNDS, OLD RIFLE RANGE, DEMOLITION RANGE, AND OLD JEEP TRAIL

**NAVAL SURFACE WARFARE CENTER, CRANE DIVISION**
**CRANE, INDIANA**

**REVISION 3**
**SEPTEMBER 1999**

**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 0038**

Ralph R. Basinski Date 10/27/99
RALPH R. BASINSKI, Q.E.P.
TASK ORDER MANAGER
TETRA TECH NUS, INC.

Debbie Wroblewski Date 4/14/00
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

Paul V. Frank Date 4-14-00
PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

Allen A. DeBus Date 9/27/99
ALLEN DEBUS
QUALITY ASSURANCE REVIEWER
U.S. EPA REGION 5

Peter Ramanauskas Date 9/27/99
PETER RAMANAUSKAS
PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

_____ Date_____
JIM HUNSIKER
ENVIRONMENTAL DEPARTMENT MANAGER
NSWC CRANE

_____ Date_____
E.P. JOHNS
ENGINEER IN CHARGE U.S. NAVY
NAVAL FACILITIES ENGINEERING COMMAND

_____ Date_____
KARYL SCHMIDT
HAZARDOUS WASTE GEOLOGIST
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

_____ Date_____
TOM BRENT
PERMIT PROJECT MANAGER
NSWC CRANE

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# 1.0 INTRODUCTION

This Field Sampling Plan (FSP) for the Naval Surface Warfare Center Crane (NSWC Crane), Indiana, was prepared for the U.S. Department of the Navy (Navy) by Tetra Tech NUS, Inc. (TtNUS) under the Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) contract, Contract Number N62467-94-D-0888, Contract Task Order (CTO) 038. A copy of this FSP is maintained at the NSWC Crane Environmental Division offices.

This FSP describes the standard sampling procedures to be used for the long-term ground water monitoring program for the Ammunition Burning Grounds (ABG), Old Rifle Range (ORR), and Demolition Range (DR) at the NSWC Crane, Indiana. The sampling procedures also apply to corrective action monitoring at the Old Jeep Trail (OJT). Specific monitoring points and analyses have not yet been identified for the OJT. The FSP supports a scope of work for the completion of the RCRA Quality Assurance Project Plan (QAPP). This FSP specifies requirements for all field sampling work that may be undertaken under this QAPP at the NSWC Crane facility and serves as a stand-alone guide for use in the field by all members of the field team. All monitoring will comply with applicable Indiana and United States Environmental Protection Agency (U.S. EPA) regulations. This document has been prepared in accordance with the U.S. EPA Region 5 QAPP Policy (U.S. EPA Region 5, April 1998).

All field sampling activities will be conducted in accordance with the site security and Health and Safety Plan developed for the field sampling activities described in this FSP.

The ground water monitoring program at the ABG, ORR, DR, and OJT of the NSWC Crane facility will consist of the following tasks:

- Ground water sampling
- Maintain permanent monitoring wells
- Ground water spring sampling
- Surface water sampling
- Equipment decontamination

- Ground water-level measurements

- Investigation-derived waste handling and disposal

This FSP consists of five sections. Section 1.0 presents this introduction. Section 2.0 provides a brief description of the background information at the site. Section 3.0 details the present ground water monitoring system. Section 4.0 provides detailed information on site-specific aspects of the environmental sampling procedures and field operations. Section 5.0 provides a project schedule for implementation of the FSP.

Boring logs/monitoring well construction sheets, Field Forms, and Standard Operating Procedures (SOPs) for these activities are included in Appendices A, B, and C, respectively. Appendix D contains a table that summarizes subsets of the explosives constituents list to be used for the ground water monitoring program.

## 1.1 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the project management for the RCRA Ground Water and Surface Water Monitoring program to be conducted at the NSWC Crane ABG, ORR, and DR and the Corrective Action Monitoring program for the OJT. Included in the following sections are the staffing and coordination requirements.

### 1.1.1 Project Organization Chart

At the direction of the Navy, TtNUS is responsible for the overall management and implementation of contract field activities. Personnel from the Navy 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 1-1. Corresponding addresses and telephone numbers of key personnel are listed by organization in Table 1-1. Responsibilities for program management, project management, field operations, and laboratory operations 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.

## FIGURE 1-1

## PROJECT ORGANIZATION CHART NAVAL SURFACE WARFARE CENTER CRANE, INDIANA

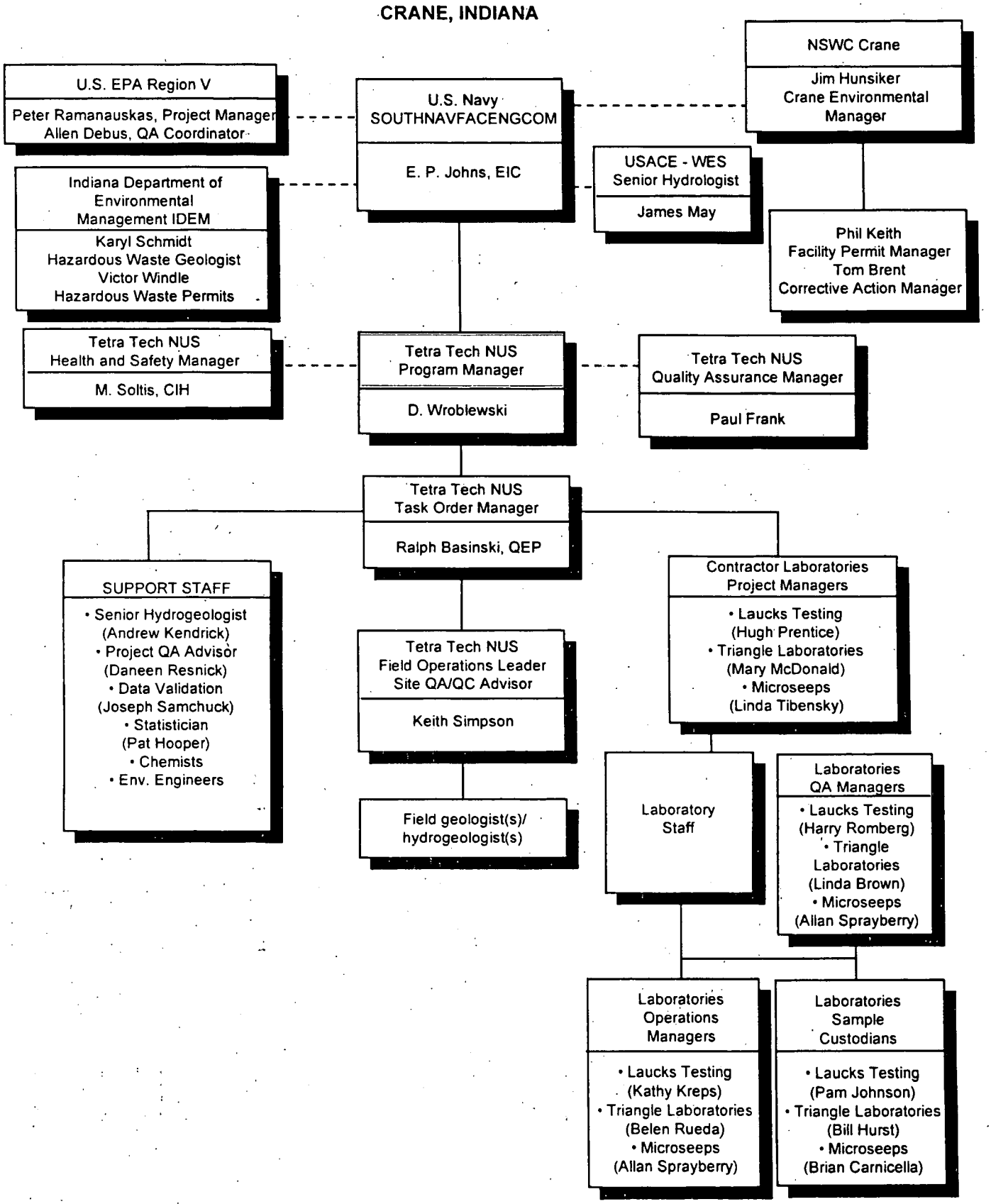

**TABLE 1-1**

**CONTACT LIST**
**NAVAL SURFACE WARFARE CENTER**
**CRANE, INDIANA**
**PAGE 1 OF 3**

| PERSON/ TITLE/ ORGANIZATION | ADDRESS | TELEPHONE |
|---|---|---|
| Peter Ramanauskas<br>Project Manager<br>U.S. EPA Region V | EPA Region V<br>77 West Jackson Street<br>Chicago, Illinois 60604 | (312) 886-6146<br>FAX: (312) 353-4788 |
| Allen Debus<br>QA Coordinator<br>U.S. EPA Region V | EPA Region V<br>77 West Jackson Street<br>Chicago, IL 60604 | (312) 886-6186<br>FAX: (312) 353-4788 |
| Karyl Schmidt<br>IDEM Hazardous Waste Geology Chief<br>Indiana Department of Environmental Management | IDEM<br>Office of Solid and Hazardous Waste Management<br>100 N. Senate Avenue<br>Indianapolis, Indiana 46206-6015 | (317) 232-8713<br>FAX: (317) 232-3403 |
| Victor Windle<br>IDEM Hazardous Waste Permits Chief<br>Indiana Department of Environmental Management | IDEM<br>Office of Solid and Hazardous Waste Management<br>100 N. Senate Avenue<br>Indianapolis, Indiana 46206-6015 | (317) 232-3242<br>FAX: (317) 232-3403 |
| E. P. Johns<br>Engineer In Charge<br>U.S. Navy<br>SOUTHNAVFACENGCOM | Department of Navy<br>SOUTHNAVFACENGCOM<br>Code 1829<br>2155 Eagle Drive<br>Charleston, SC 29406 | (843) 820-5523<br>FAX: (843) 820-7465 |
| Jim Hunsiker<br>Crane Environmental Manager<br>NSWC Crane | NSWC Crane<br>Code 095<br>B-3260<br>300 Highway 361<br>Crane, Indiana 47522-5009 | (812) 854-3233<br>FAX: (812) 854-4177 |
| Tom Brent<br>Corrective Action Manager<br>NSWC Crane | NSWC Crane<br>Code 095<br>B-3260<br>300 Highway 361<br>Crane, Indiana 47522-5009 | (812) 854-6160<br>FAX: (812) 854-4177 |
| Phil Keith<br>Facility Permit Manager<br>NSWC Crane | NSWC Crane<br>Code 095<br>B-3260<br>300 Highway 361<br>Crane, Indiana 47522-5009 | (812) 854-6163<br>FAX: (812) 854-4177 |
| Debbie Wroblewski<br>Program Manager<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8968<br>FAX: (412) 921-4040 |

**TABLE 1-1**

**CONTACT LIST**
**NAVAL SURFACE WARFARE CENTER**
**CRANE, INDIANA**
**PAGE 2 OF 3**

| PERSON/ TITLE/ ORGANIZATION | ADDRESS | TELEPHONE |
|---|---|---|
| Paul Frank<br>Quality Assurance Manager<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8950<br>FAX: (412) 921-4040 |
| Matt Soltis<br>Health and Safety Manager<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8912<br>FAX: (412) 921-4040 |
| Ralph Basinski<br>Task Order Manager<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8308<br>FAX: (412) 921-4040 |
| Keith Simpson<br>Field Operations Leader &<br>Site QA/QC Advisor<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8131<br>FAX: (412) 921-4040 |
| Andrew Kendrick<br>Senior Hydrogeologist<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8623<br>FAX: (412) 921-4040 |
| Daneen Resnick<br>Project QA Advisor<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8744<br>FAX: (412) 921-4040 |
| Joseph Samchuck<br>Data Validation<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8510<br>FAX: (412) 921-4040 |
| Pat Hooper<br>Statistician<br>Tetra Tech NUS | Tetra Tech NUS<br>661 Andersen Drive<br>Pittsburgh, PA 15220-2745 | (412) 921-8250<br>FAX: (412) 921-4040 |
| James May<br>Geologist<br>United States Corp of Engineers<br>Waterways Experiment Station | Waterways Experiment Station<br>3909 Halls Ferry Road<br>Vicksburg, Mississippi 39180 | (601) 634-3395<br>FAX: (601) 634-3543 |
| Hugh Prentice<br>Project Manager<br>Laucks Testing | Laucks Testing<br>940 South Harney Street<br>Seattle, WA 98053 | (206) 767-5060<br>FAX: (206) 767-5491 |
| Harry Romberg<br>Lab QA Manager<br>Laucks Testing | Laucks Testing<br>940 South Harney Street<br>Seattle, WA 98053 | (206) 767-5060<br>FAX: (206) 767-5491 |
| Kathy Krepps<br>Lab Operations Manager<br>Laucks Testing | Laucks Testing<br>940 South Harney Street<br>Seattle, WA 98053 | (206) 767-5060<br>FAX: (206) 767-5491 |

**TABLE 1-1**

**CONTACT LIST**
**NAVAL SURFACE WARFARE CENTER**
**CRANE, INDIANA**
**PAGE 3 OF 3**

| PERSON/ TITLE/ ORGANIZATION | ADDRESS | TELEPHONE |
|---|---|---|
| Pam Johnson<br>Lab Sample Custodian<br>Laucks Testing | Laucks Testing<br>940 South Harney Street<br>Seattle, WA 98053 | (206) 767-5060<br>FAX: (206) 767-5491 |
| Mary McDonald<br>Project Manager<br>Triangle Laboratories | Triangle Laboratories, Inc.<br>801 Capitola Drive<br>Durham, NC 27713 | (919) 544-5729<br>FAX: (919) 544-5491 |
| Linda Brown<br>Lab QA Manager<br>Triangle Laboratories | Triangle Laboratories, Inc.<br>801 Capitola Drive<br>Durham, NC 27713 | (919) 544-5729<br>FAX: (919) 544-2113 |
| Belen Reuda<br>Lab Operations Manager<br>Triangle Laboratories | Triangle Laboratories, Inc.<br>801 Capitola Drive<br>Durham, NC 27713 | (919) 544-5729<br>FAX: (919) 544-5491 |
| Bill Hurst<br>Sample Custodian<br>Triangle Laboratories | Triangle Laboratories, Inc.<br>801 Capitola Drive<br>Durham, NC 27713 | (919) 544-5729<br>FAX: (919) 544-5491 |
| Linda Tibensky<br>Project Manager<br>Microseeps, Inc. | Microseeps, Inc.<br>UPARC<br>220 William Pitt Way<br>Pittsburgh, PA 15238 | (412) 826-5245<br>FAX: (412) 826-3433 |
| Allan Sprayberry<br>Lab QA/Operations Manager<br>Microseeps, Inc. | Microseeps, Inc.<br>UPARC<br>220 William Pitt Way<br>Pittsburgh, PA 15238 | (412) 826-5245<br>FAX: (412) 826-3433 |
| Brian Carnicella<br>Sample Custodian<br>Microseeps, Inc. | Microseeps, Inc.<br>UPARC<br>220 William Pitt Way<br>Pittsburgh, PA 15238 | (412) 826-5245<br>FAX: (412) 826-3433 |

### 1.1.2 Management Responsibilities

**U.S. EPA Project Manager**

The U.S. EPA Project Manager (PM) oversees the implementation of the RCRA Corrective Action and 40 CFR 264 Subpart X Ground Water and Surface Water Monitoring program for NSWC Crane. The U.S. EPA PM represents Agency considerations and will provide input from this perspective, as well as lend general historical and technical assistance to NSWC Crane field activities.

**Indiana Department of Environmental Management**

The Indiana Department of Environmental Management (IDEM) project manager oversees the implementation of the RCRA closure program under 40 CFR 265 Subpart G for the NSWC Crane.

**Navy Project Managers**

The Navy Engineer In Charge (EIC) 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 and their subcontractors. In matters such as facilitation of access, oversight, etc., the Navy EIC is assisted by the Facility Permit Manager (FPM) and the Corrective Action Project Manager (CAPM).

**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 clerical resources for Program operations and maintains consistency in procedures and projects among Contract Task Order (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 and TtNUS and Navy quality standards. The TOM is responsible for the preparation and distribution of the QAPP, at the direction of the Navy EIC, to all parties connected with the project,

including the laboratories. The TOM will report to the Navy EIC and is responsible for technical quality control and project oversight. Additional responsibilities of the TOM are

- Ensuring timely resolution of project-related technical, quality, safety, or waste management issues.
- Functioning as primary interface with the Navy EIC and point of contact, field personnel, and laboratory points-of-contact.
- Monitoring and evaluating subcontractor laboratory 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.
- Approving the implementation of corrective action.

**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 Health and Safety Plan.
- Implementation of the Site Security and Health and Safety Plan.
- Assigning the Site Safety Officer and supervising his/her performance.
- Conducting Health and Safety audits.
- Preparing Health and Safety reports for management.

### 1.1.3 Quality Assurance Responsibilities

This section identifies the quality assurance responsibilities for the NSWC Crane Ground Water Monitoring program. Responsibilities of the U.S. EPA Region V, IDEM, TtNUS personnel, and the analytical laboratory are discussed.

**U.S. EPA Region V Quality Assurance Coordinator**

The U.S. EPA Region V Quality Assurance Coordinator has the responsibility to review and approve the QAPP and provide overall Quality Assurance support and review throughout the Remedial Facilities Investigation (RFI) and permitting process. The IDEM hazardous waste geologist has the responsibility to review and approve the QAPP and provide overall quality assurance throughout the closure process. Additional U.S. EPA and IDEM responsibilities may include

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

**TtNUS Quality Assurance Manager**

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

- Developing, maintaining, and monitoring quality assurance policies and procedures.
- Providing training to TtNUS staff in Quality Assurance/Quality Control (QA/QC) policies and procedures.
- Conducting systems and performance audits to monitor compliance with environmental regulations, contractual requirements, Project Plan requirements, and corporate policies and procedures.
- Conducting audits of project records.
- Monitoring subcontractor quality controls and records.

- Assisting in the development of corrective action plans and 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 quality assurance reports for management.

**TtNUS Project QA Advisor**

The TtNUS Project QA Advisor provides support to the TOM in preparation and review of the QAPP, coordination of work performed by office technical staff, and performance of data assessment.

**TtNUS Data Validation Coordinator**

Validation of analytical data will be completed by staff chemists in the TtNUS Chemistry/Toxicology Department. The TtNUS Data Validation Coordinator, Joseph Samchuck, is responsible for final review and approval of validation deliverables.

**TtNUS Statisticians**

Statisticians in the TtNUS Information Management Solutions Department will perform statistical analysis of analytical data. Patrick Hooper is the manager of this department.

### 1.1.4 Laboratory Responsibilities

As discussed in Section 7.0 of the attendant QAPP, with the exception of dioxin/furan and dissolved methane analyses, Laucks Testing Laboratories, Inc., of Seattle, Washington, will perform all ground water analyses. Dioxin/furan analysis will be performed by Triangle Laboratories, Inc., of Durham, North Carolina. Dissolved methane analysis will be performed by Microseeps, Inc., of Pittsburgh, Pennsylvania.

The sub-contracted laboratories shall have the responsibility for analyzing all ground water and surface water samples in accordance with the analytical methods and additional requirements specified in the attendant QAPP. It shall also be the responsibility of the analytical laboratories to properly dispose of

unused sample aliquots. Responsibilities of key laboratory personnel are outlined in the following paragraphs.

**Laboratory Project Manager**

- Ensure that method- and project-specific requirements are properly communicated and understood by laboratory personnel.
- 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**

- Support the QA program within the laboratory.
- Provide management overview of both production and quality-related laboratory activities.
- Maintain adequate staffing to meet analytical and quality objectives.
- Approve all laboratory SOPs and QA documents.

**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:

- Supervise the receipt, inspection, and log-in of all samples received by the laboratory.

- Manage sample storage facilities.

- Notify laboratory project manager of sample receipt as well as any sample receipt problems.

**Laboratory Technical Staff**

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

### 1.1.5 Field Responsibilities

TtNUS will be responsible for field activities. The TtNUS field team will be organized according to the activities that are 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

- Field Technical Staff

The FOL is responsible for coordinating all onsite 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 and field and chain-of-custody documentation, will assume custody of all samples, and will ensure the proper handling and shipping of samples. The FOL will be a highly experienced environmental professional and will report directly to the TtNUS TOM. Specific FOL responsibilities include the following:

- Functions as communications link among field staff members, the Site QA/QC Advisor, Site Safety Officer, the FPM, the Facility Corrective Action Manager, and the TOM.
- Oversees the mobilization and demobilization of all field equipment and subcontractors.
- Coordinates and manages the Field Staff.
- Adheres to the work schedules provided by the TOM.
- Bears responsibility for maintenance of the site logbook, field forms logbook, and field recordkeeping.
- Initiates field task modification requests when necessary.
- Identifies and resolves problems in the field, resolves difficulties in consultation with the FPM and Corrective Action Manager, implements and documents corrective action procedures, and provides communication between the field team and upper management.

The FOL (or his 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:

- Ensures that field duplicates and field quality control blanks are collected with the proper frequency.
- Ensures that additional volumes of sample are supplied to the analytical laboratory with the proper frequency to accommodate laboratory QA/QC analyses.

- Ensures that measuring and test equipment (MTE) are calibrated, used, and maintained in accordance with applicable procedures.

- Acts as liaison among site personnel, laboratory personnel, and the QAM.

- Manages bottleware shipments and oversees field preservation and in-field filtration activities.

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

**Field Staff**

The field staff for this project will be drawn from TtNUS's pool of corporate resources. All of the designated field team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

# 2.0 BACKGROUND INFORMATION

## 2.1 SITE LOCATION AND DESCRIPTION

NSWC Crane is located in the southwestern portion of Indiana. It is approximately 75 miles southwest of Indianapolis, 71 miles northwest of Louisville, Kentucky, and immediately east of Burns City and Crane Village, Indiana. NSWC Crane encompasses approximately 62,463 acres (approximately 100 square miles) of the northern portion of Martin County and smaller portions of Greene, Davies, and Lawrence Counties (Murphy, 1994, p. 5). A location map of the NSWC Crane facility is shown on Figure 2-1.

Three areas have been identified at the NSWC Crane facility for long-term ground water monitoring: the Ammunition Burning Grounds (ABG), Old Rifle Range (ORR), and Demolition Range (DR). One area, the Old Jeep Trail (OJT), will undergo corrective action ground water monitoring. Figure 2-2 shows the locations of the ABG, ORR, and the DR. The surface water and ground water monitoring at the ABG, ORR, and DR is being conducted to monitor the impact of past and future treatment of munitions/explosives by Open Burning/Open Detonation (OB/OD). Ground water monitoring is required by the Resource Conservation and Recovery Act (RCRA) operating permit and Corrective Action and Closure for these units.

The ABG site encompasses approximately 50 acres and is located in the eastern central portion of NSWC Crane. It is used for the treatment of propellants/explosives, rocket motors, candles, flares, solvents, detonators, fuses, and other items. The DR is located in the central portion of the NSWC Crane, and it occupies approximately 90 acres. This site is used for the detonation of explosives and related devices. The ORR encompasses approximately 20 acres and is located immediately northeast of the DR. It is used for the treatment of maximum picrate materials. Formerly, the ORR was used for training and firing of small weapons. The OJT is located along Little Sulphur Creek, approximately ¼ mile south of the ABG. The OJT site was used during past base operations to burn out unused bombs and to flash explosive powder.

## 2.2 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

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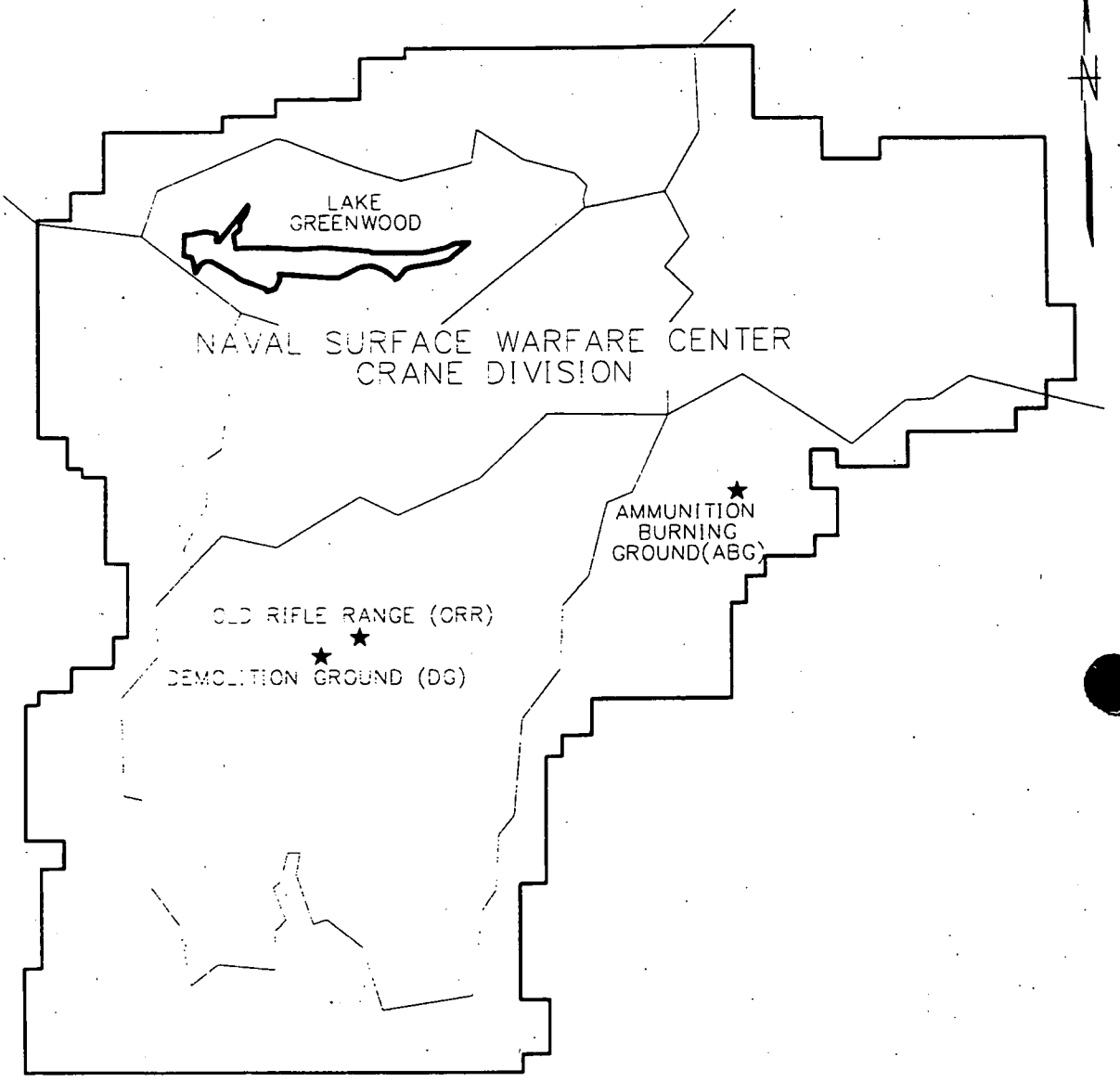


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★ TREATMENT LOCATIONS

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| CHECKED BY DATE | Ammunition Burning Grounds, Old Rifle Range, Demolition Range, and Old Jeep Trail Locations<br>Naval Surface Warfare Center<br>Crane, Indiana | APPROVED BY | DATE |
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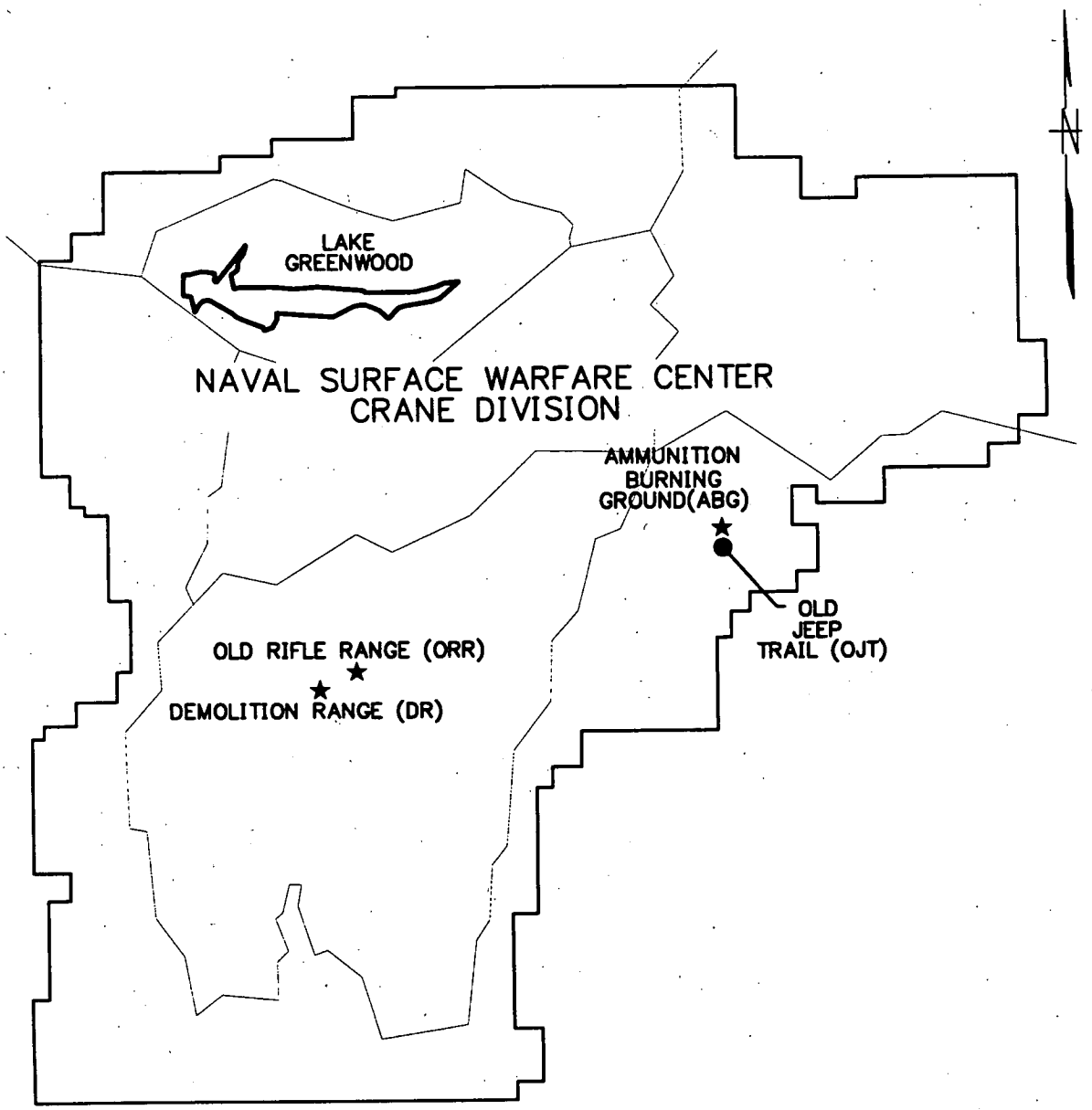


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★ TREATMENT LOCATIONS

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| DRAWN BY MF DATE 5/4/99 | DEPARTMENT OF THE NAVY SOUTHERN DIV FACILITIES ENGINEERING COMD | AMMUNITION BURNING GROUNDS, OLD RIFLE RANGE, DEMOLITION RANGE AND OLD JEEP TRAIL LOCATIONS<br>NAVAL SURFACE WARFARE CENTER<br>CRANE, INDIANA | CONTRACT NO. 7651 |
| CHECKED BY DATE | | | APPROVED BY DATE |
| COST/SCHED-AREA | | | APPROVED BY DATE |
| SCALE AS NOTED | | | DRAWING NO. FIGURE 2-2 REV. 0 |

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(Murphy and Wade, 1995, p. 23). 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. Numerous springs, caverns, caves, and other solution-weathering features can be found along this escarpment and on the eastern edge of the NSWC Crane facility. The boundary between the Crawford Upland and the Mitchell Plain near the western boundary of NSWC Crane is gradual (Murphy and Wade, 1995, p. 23). Elevations on the Crawford Upland on the NSWC Crane property range from 500 feet national geodetic vertical datum (NGVD) to greater than 850 feet NGVD. Topographic relief in the Crawford Upland ranges from 100 feet to 350 feet. Greater relief exists in the eastern part of NSWC Crane near the Chester Escarpment (Murphy and Wade, 1995, p. 23).

### 2.2.1 Ammunition Burning Grounds

The ABG is approximately 2,000 feet long and 1,000 feet wide and is located on the headwaters of Little Sulphur Creek. The ABG is located on the inside of a topographic bowl that opens to the southeast and is bounded to the northwest, northeast, and south by highlands. The lowlands in the center of this feature were carved by Little Sulphur Creek. The surface elevation at the ABG ranges from 480 feet NGVD in the southeast to 845 feet along the highland drainage divide (Murphy, 1994, p. 15). Figure 2-3 shows the ABG and the various treatment units.

### 2.2.2 Old Rifle Range

The ORR is located to the east and along the toe of the slope of the DR. The ORR extends from the toe of this slope on its western boundary to approximately 1,200 to 1,500 feet east to NSWC Crane Highway 8. The highest elevation at the ORR site is approximately 530 feet NGVD, near the toe of the slope to the west, and the lowest elevation is approximately 500 feet; the local relief is about 30 feet. East of the ORR, the ground surface slopes farther to the east where Turkey Creek is located, approximately 250 feet away. Adjacent to the ORR, Turkey Creek is approximately at 485 feet NGVD (Murphy and Wade, 1995, p. 26). Figure 2-4 shows the ORR and the various treatment units. Figure 2-5 shows the location of the ORR on the NSWC facility and in relation to the nearby DR.

### 2.2.3 Demolition Range

The DR is located on the top of a north-south-trending topographic ridge that is bounded on the east by the south-flowing Turkey Creek in the valley, on the west by the south-flowing Boggs Creek, and on the

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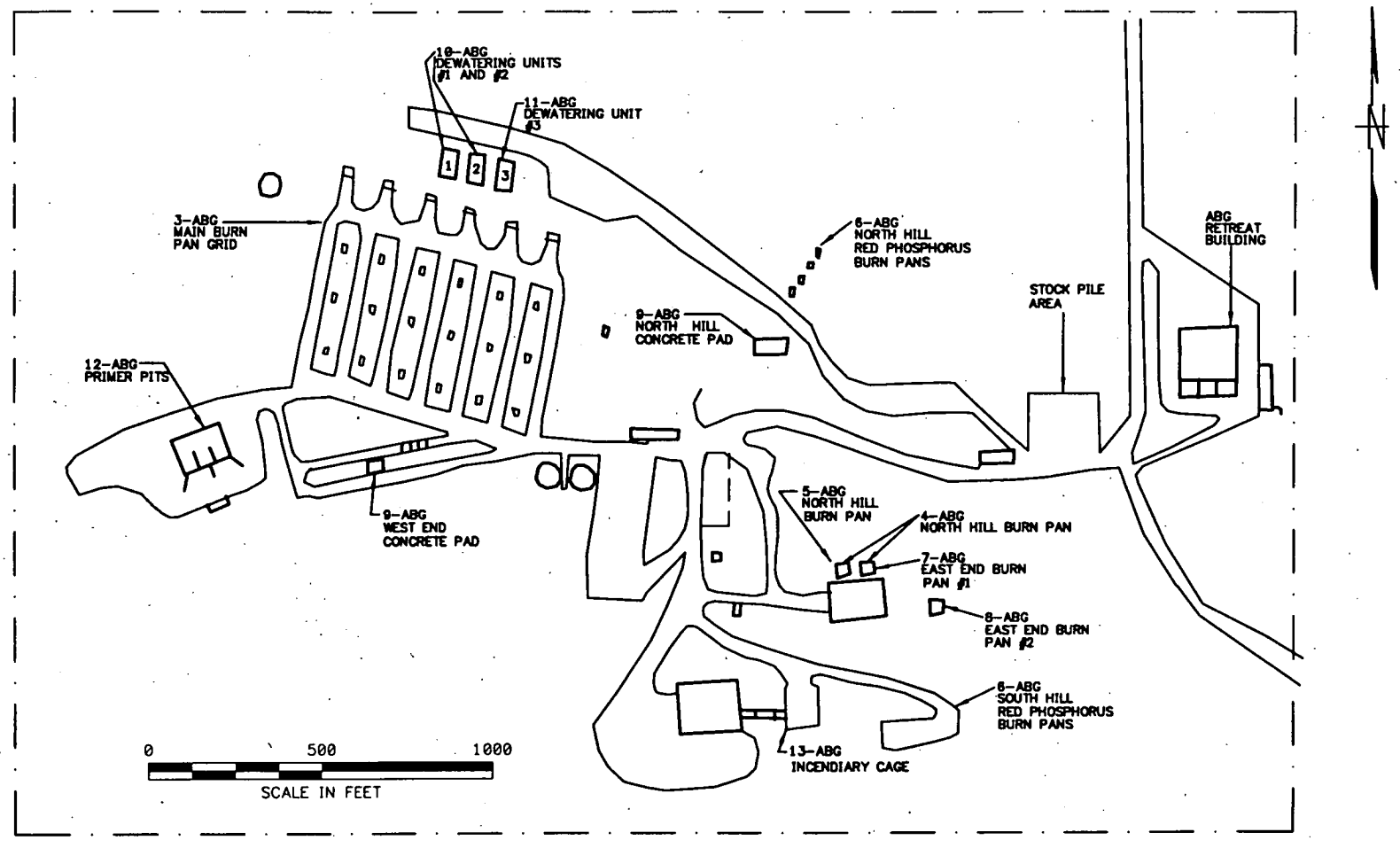


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| COST/SCHED-AREA | | | APPROVED BY DATE |
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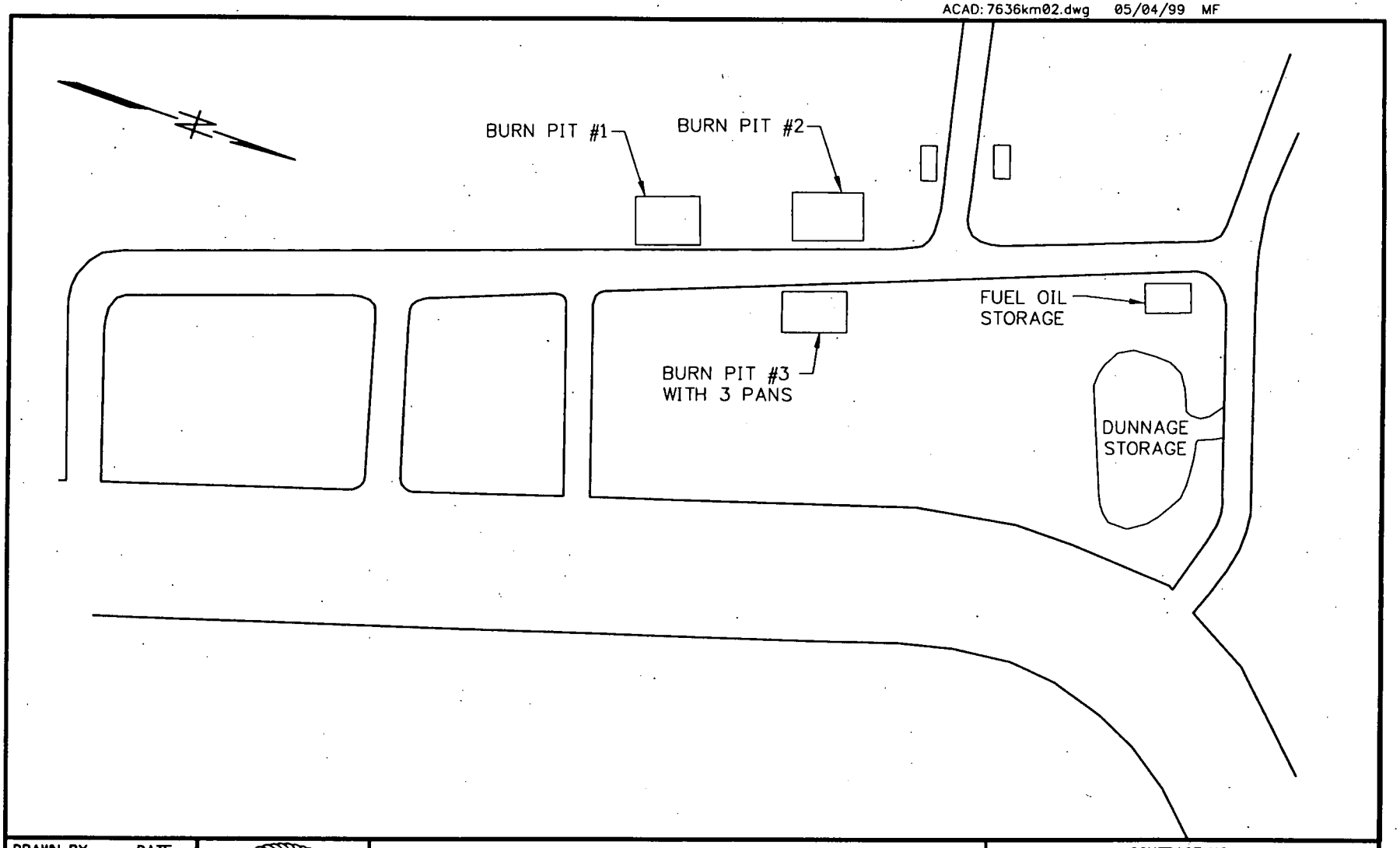


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| DRAWN BY MF DATE 5/4/99 | SITE PLAN OF THE OLD RIFLE RANGE (ORR) SHOWING TREATMENT UNITS AND AUXILIARY FUEL STORAGE LOCATIONS NSWC CRANE, CRANE, INDIANA | CONTRACT NO. 7651 | |
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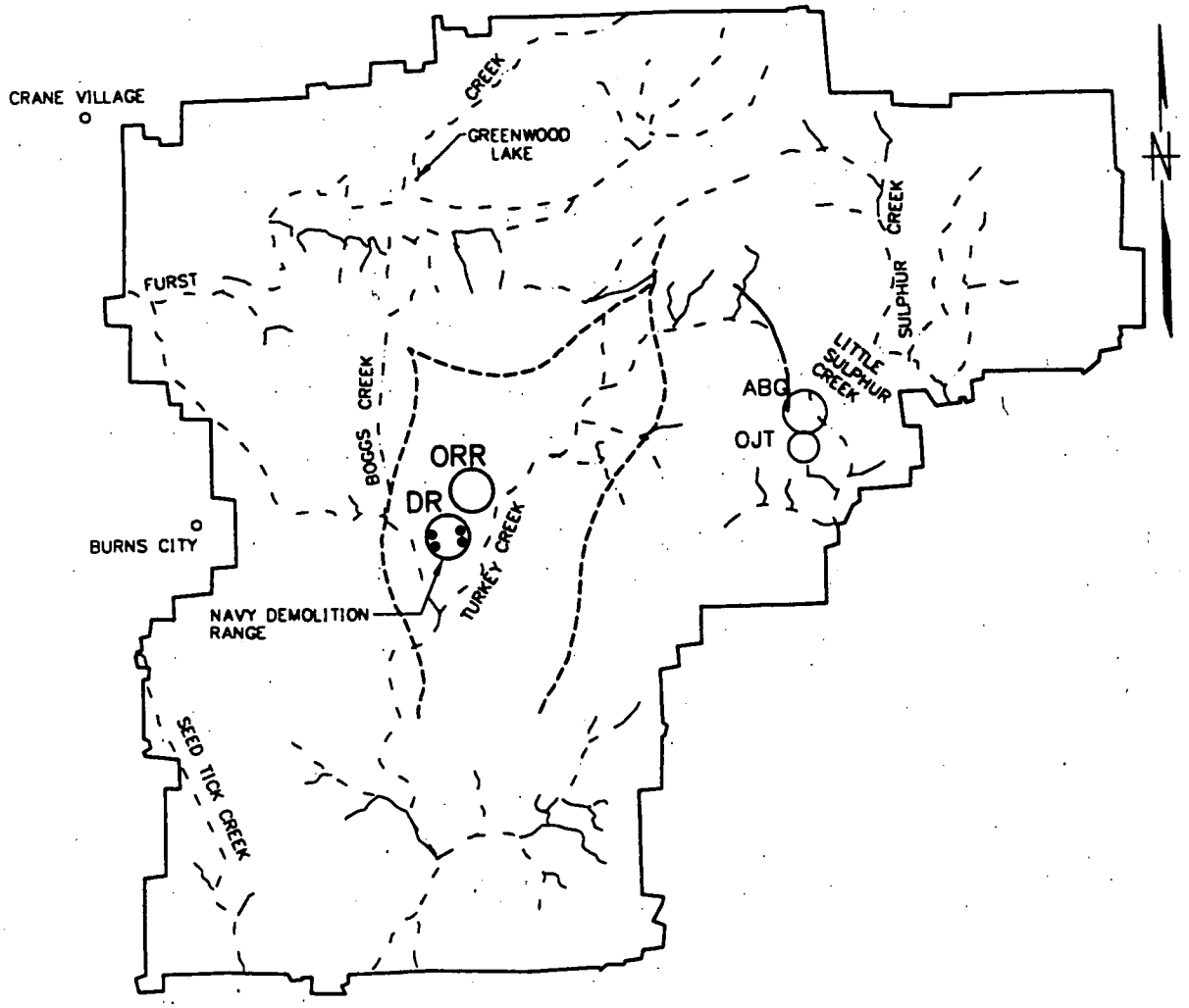


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SUBTITLE: TECHNICAL REPORT GL-88-27
GEOLOGY AND HYDROGEOLOGY OF THE AMMUNITION BURNING GROUND
CRANE NAVAL WEAPONS SUPPORT CENTER
VOLUME I: MAIN TEXT
RICHARD HUNT
DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS
OCTOBER 1988

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DEPARTMENT OF THE NAVY SOUTHERN DIV FACILITIES ENGINEERING COMD

LOCATION OF DEMOLITION RANGE (DR)
AND SURROUNDING FEATURES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

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

south by the confluence of the two creeks. The ridge is approximately 100 to 500 feet wide, and its topographic ridge slopes steeply to the east, south, and west. The maximum elevation at the DR is approximately 685 feet NGVD. The minimum elevation of Turkey and Boggs Creek in the area is approximately 475 feet NGVD. The maximum topographic relief at the site is approximately 210 feet (Murphy and Wade, 1995, p. 25). Figure 2-5 shows the DR, ORR and surrounding features.

### 2.2.4 Old Jeep Trail

The OJT is located along Little Sulphur Creek, approximately ¼ mile south of the ABG. The OJT site is situated in the northwest-southeast-trending valley incised by Little Sulphur Creek. Little Sulphur Creek turns south at the southeastern corner of the OJT site. The topographic relief at the central portion of the site ranges from 550 feet mean sea level (msl) in the valley to approximately 610 feet on the valley walls (Murphy, 1994). The stream valley is approximately 350 feet wide. Figure 2-6 shows the OJT in relationship to the ABG and Little Sulfur Creek.

## 2.3 CLIMATOLOGY

NSWC Crane is located in a warm, temperate climatic zone. In general, the summers are warm and humid, and winters are mild with occasionally short cold periods. The temperature ranges from an average maximum July temperature of 89°F to an average minimum January temperature of 26°F. Precipitation is fairly evenly distributed throughout the calendar year, with the maximum precipitation occurring during the spring and early summer. The average annual precipitation received at the facility is 44 inches, consisting of 42 inches of rain and 15 inches of snow. The average humidity ranges from 40 to 90 percent in summer and 60 to 90 percent in winter. The RCRA Air Quality Assessment (B&R Environmental, 1997c) has additional details on climatology.

## 2.4 HYDROLOGY

The summary information on surface waters contained in this section was obtained from the following documents:

- RCRA RFI SWMU 06/09 Demolition Area (Murphy and Wade, 1995).

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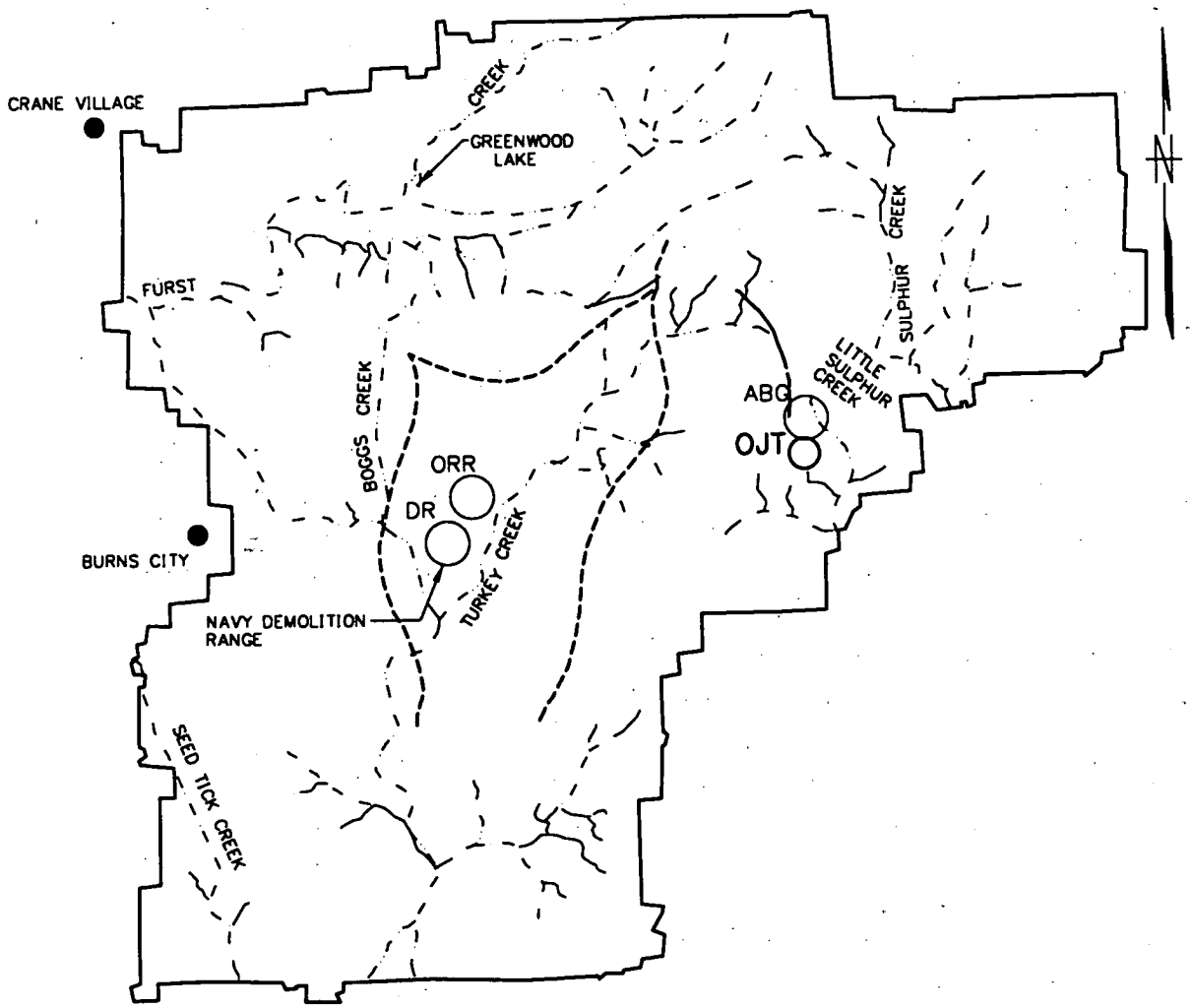


SUBTITLE: TECHNICAL REPORT GL-88-27
GEOLOGY AND HYDROGEOLOGY OF THE AMMUNITION BURNING GROUND
CRANE NAVAL WEAPONS SUPPORT CENTER
VOLUME I: MAIN TEXT
RICHARD HUNT
DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS
OCTOBER 1988

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| DRAWN BY MF DATE 5/4/99 | | LOCATION OF OLD JEEP TRAIL (OJT) AND SURROUNDING FEATURES NAVAL SURFACE WARFARE CENTER CRANE, INDIANA | CONTRACT NO. 7651 |
| CHECKED BY DATE | | | APPROVED BY DATE |
| COST/SCHED-AREA | | | APPROVED BY DATE |
| SCALE AS NOTED | | | DRAWING NO. FIGURE 2-6 REV. 0 |

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

- RCRA RFI Ground Water Release Characterization, SWMU 03/10, Ammunition Burning Grounds (Murphy, 1994).

- Hydogeologic and Geochemical Assessment of the Porous Media and Karstic Flow Regimes of the Beech Creek Aquifer, Ammunition Burning Grounds, Naval Surface Warfare Center, Crane, Indiana (Baedke, 1998).

These documents may be referenced for additional details.

The surface water drainage pattern at NSWC Crane is characterized by a dense, dendritic pattern that flows generally to the south and southwest of the base. Seven creeks drain the surface water at the base into the East Fork of the White River.

The ABG is located on the eastern side of a major drainage divide. This divide trends from the southwest to the northeast along NSWC Crane Road 161. A majority of the surface runoff drains to the south and southeast into Little Sulphur Creek. Little Sulphur Creek discharges into Sulphur Creek in the southeast portion of the site. Sulphur Creek in turn discharges into Indian Creek and then the White River (Murphy, 1994, p. 14-15).

Surface water from the DR is collected in a series of surface drainage gullies that discharge into sediment retention ponds in the active areas. Figure 2-5 shows the locations of the sedimentation ponds. North of the active areas, surface runoff discharges into Boggs and Turkey Creek. Both Boggs and Turkey Creeks flow to the south, where they meet immediately south of the DR. From this confluence, Boggs Creek continues to flow to the south and, approximately 5 miles downstream, it discharges into the White River (Murphy and Wade, 1995, p. 25).

Surface water from a large portion of the ORR drains primarily to the east into Turkey Creek. Surface water from the northernmost section of the ORR drains into an intermittent stream that in turn flows southeast and east and discharges into Turkey Creek (Murphy and Wade, 1995, p. 26).

Surface water from the OJT drains into Little Sulphur Creek. Little Sulphur Creek enters the OJT from the northwest and trends to the southeast, where it is met by an unnamed north-south-trending tributary at the southeastern corner of the site. At this confluence, Little Sulphur Creek turns to the south. In the middle

of the OJT, Little Sulphur Creek splits into two channels until it rejoins at approximately 400 feet downstream. Figure 2-6 shows these details.

## 2.5 GEOLOGY AND STRATIGRAPHY

The summary information on geology and stratigraphy contained in this section was obtained from the following documents:

- RCRA RFI SWMU 06/09 Demolition Area (Murphy and Wade, 1995).
- RCRA RFI Ground Water Release Characterization, SWMU 03/10 Ammunition Burning Grounds (Murphy, 1994).

These documents may be referenced for additional details.

The subsurface 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 5 to 20 feet below ground surface and generally consist of two types: Pleistocene-age unconsolidated deposits and unconsolidated residual soils derived from the underlying bedrock (Dunbar, 1982, p. 10). The Pleistocene-age deposits consist of alluvial, colluvial, and marsh deposits containing silt, sand, and gravel and lacustrine deposits consisting of clay, silt, and sand. The unconsolidated residual soils were derived from the in-place weathering and decomposition of the underlying sedimentary bedrock. The residual soil deposits consist of clay, silt, and sand. These unconsolidated deposits are prevalent in the OJT area, where as much as 25 feet of alluvium and highly weathered bedrock was found below the Little Sulphur Creek valley. This portion of Indiana was not glaciated; thus, there are no glacial deposits in evidence at the Crane facility.

Bedrock underlying the Crane facility consists of sedimentary rocks from the Lower Pennsylvanian-age Raccoon Creek Group and the Upper Mississippian-age Stephensport and West Baden Groups (Dunbar, 1982, p. 10). The Lower Pennsylvanian rock at the facility consists of shale, sandstone, and coal beds. The Upper Mississippian rock consists of limestone, shale, and sandstone. The geologic units encountered at the facility, in descending order (youngest to oldest), include the Mansfield Formation (Pennsylvanian Raccoon Creek Group), Hardinsburg shale Formation (Mississippian Stephensport Group), Golconda/Haney limestone Formation (Stephensport Group), Indian Springs shale member, Big Clifty Group (Stephensport Group), Big Clifty sandstone member, Big Clifty Group (Stephensport Group), Beech Creek limestone Formation

(Stephensport Group), Elwren shale Formation (West Baden Group), Reelsville shale and limestone Formations (West Baden Group), Sample shale and sandstone Formations (West Baden Group), Beaver Bend limestone Formation (West Baden Group), and finally the Bethel shale and sandstone Formations (West Baden Group; Murphy and Wade, 1995, pp. 27-29, and Palmer, 1989). A stratigraphic column for the NSWC Crane facility is shown on Figure 2-7.

Generally, shale from the Hardinsburg Formation (Mississippian Stephensport Group) is found as the surficial bedrock at the ABG site. Sandstone and shale from the Mansfield Formation (Pennsylvanian Raccoon Creek Group) or the Hardinsburg Formation (Mississippian Stephensport Group) are found as the surficial bedrock at the DR and ORR sites. Surfical bedrock at the OJT is either highly weathered sandstone or limestone from the Big Clifty Formation or Beech Creek Formations (Mississippian Stephensport Group), respectively, or shale from the underlying Elwren Formation (Mississippian West Baden Group; Murphy, 1994, p. 11-13).

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 at approximately 30 to 35 feet per mile (Dunbar, 1982, p. 10). The bedrock structure immediately south of the ABG is locally distorted as a result of a domed bedrock feature (Murphy, 1994, p. 10).

## 2.6 HYDROGEOLOGY

The summary information on hydrogeology contained in this section was obtained from the following documents:

- RCRA RFI SWMU 06/09 Demolition Area, Murphy and Wade, 1995.
- RCRA RFI Ground Water Release Characterization, SWMU 03/10, Ammunition Burning Grounds (Murphy, 1994).
- Hydogeologic and Geochemical Assessment of the Porous Media and Karstic Flow Regimes of the Beech Creek Aquifer, Ammunition Burning Grounds, Naval Surface Warfare Center, Crane, Indiana (Baedke, 1998).

These documents may be referenced for additional details.

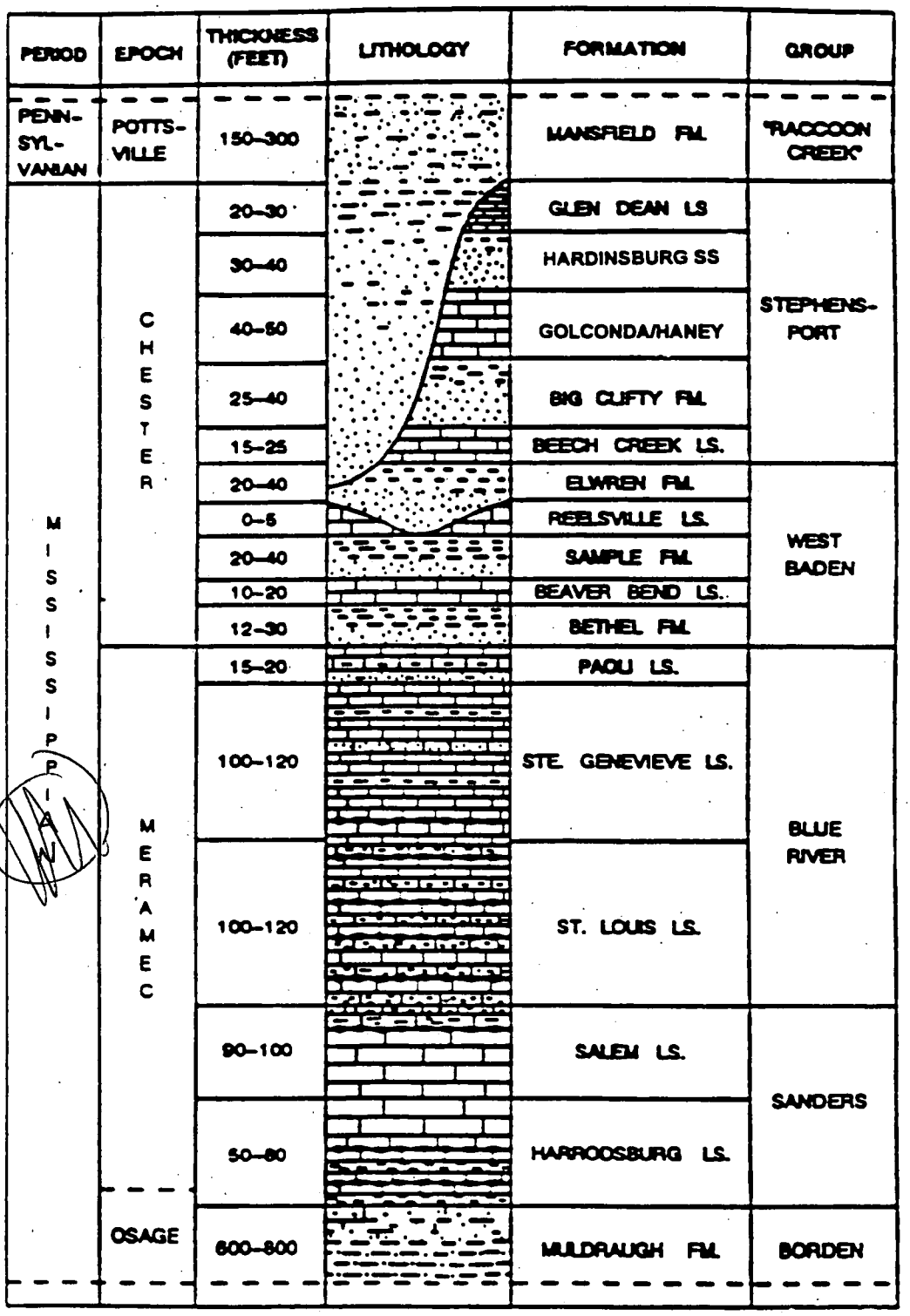



Figure 2-7 Stratigraphic column for rock units encountered at NSWC Crane
Naval Surface Warfare Center
Crane, Indiana

Final Report RCRA Facility Investigation,
Phase III Groundwater Release Characterization,SWMU 03/10,
Ammunition Burning Ground, Volume I William L. Murhpy, May 1994-Figure 7
After Palmer A.N. 1969, A Hydrologic Study of Indiana Karst, Ph.D. Thesis, Indiana Univ

The hydrogeology underlying NSWC Crane can generally be characterized as a series of fractured carbonate bedrock aquifers separated by several relatively low-permeability aquitards. Ground water flow through this carbonate aquifer system is influenced, at least in part, by solution channels and/or caverns. The following sections describe the hydrogeology of the ABG, ORR, DR, and the OJT.

### 2.6.1 Ammunition Burning Grounds

Ground water in the ABG generally exists in three primary bedrock aquifers: the Golconda/Haney limestone aquifer, which is interconnected with the Big Clifty sandstone/Beech Creek limestone aquifer (the uppermost aquifer system), and the Beaver Bend limestone, the lower aquifer. The two aquifers are separated by a lower permeability shale aquitard (Elwren Formation.). The Beaver Bend aquifer is considered hydraulically isolated from the uppermost aquifer system. Ground water migration from the ABG occurs principally through solution-weathered joints and bedding planes and, secondarily, through pore spaces in the rock itself. The Beech Creek limestone has evidence of poorly developed karstic features; however, none of these features are visible on the surface of the ABG. The Golconda/Haney and the Big Clifty/Beech Creek aquifer are recharged by surface infiltration in some sections of the ABG (Murphy, 1994). Ground water from the Golconda/Haney Formation has been shown to recharge the Big Clifty/Beech Creek Formation (Hunt, 1988), thus creating the uppermost aquifer. The Elwren shale underlying the Beech Creek limestone acts as an underlying aquitard and causes ground water to flow laterally downgradient to the south and southeast along this boundary. Thus, the underlying Beaver Bend aquifer is considered to be isolated hydraulically from the overlying aquifer(s) at the ABG (Murphy, 1994).

Dye tracer tests conducted at ABG indicate that surface springs A, B, and C, located north and south of the ABG, are hydraulically connected with the Beech Creek aquifer (Murphy, 1994). Spring A, located on the east valley wall approximately 1.5 miles south of the ABG, discharges ground water from the Beech Creek aquifer. According to Murphy (1994), the travel time for ground water in the Beech Creek aquifer from the mouth of the spring is estimated at approximately 2 miles per day (10,560 feet per day). Spring C, located on the east valley wall of Little Sulphur Creek about 1 mile south of the ABG, Spring B, discharges ground water from the Beech Creek aquifer only during high flow conditions (Murphy, 1994).

### 2.6.2 Old Rifle Range and Demolition Range

Ground water is located in three principal aquifers in the ORR and DR: the Mansfield sandstone aquifer; the Golconda/Haney limestone aquifer; and the Big Clifty sandstone/Beech Creek limestone aquifer. In

the ORR site, a fourth aquifer is discerned in the shallow alluvium and Big Clifty sandstone. Similar to the ABG, ground water flow in the bedrock aquifers occurs principally through solution-weathered joints and bedding planes and secondarily through pore spaces in the rock. The continuous Big Clifty sandstone/Beech Creek limestone is the deepest aquifer monitored throughout the DR and ORR areas. The Big Clifty/Beech Creek aquifer is underlain by the Elwren shale, which is 10 feet thick in the DR and ORR areas. Ground water flow in the Big Clifty/Beech Creek aquifer is toward the south and southwest but locally is toward the east in the direction of Turkey Creek near the ORR. Ground water flow in the Golconda/Haney aquifer is toward the south and southwest but is southeastward locally near the ORR. The Mansfield aquifer is found locally near the DR in shallow perched zones confined by low-permeability shale found in this unit.

### 2.6.3 Old Jeep Trail

Ground water in the OJT area is generally found in an unconfined surficial unconsolidated/bedrock aquifer. This aquifer consists of a mixture of unconsolidated alluvial deposits and highly weathered bedrock material in the Little Sulphur Creek valley floor. This aquifer was determined to be hydraulically connected to the Big Clifty sandstone/Beech Creek limestone aquifer located along the valley walls. The Elwren shale Formation, which underlies the unconsolidated deposits and the Big Clifty/Beech Creek aquifer, appears to form a vertical, impermeable barrier to ground water flow. Ground water appears to be recharged in the OJT from surface water losses from Little Sulphur Creek (Murphy, 1994, p. 11-16).

# 3.0 GROUND WATER MONITORING SYSTEM

## 3.1 MONITORING WELL LOCATIONS

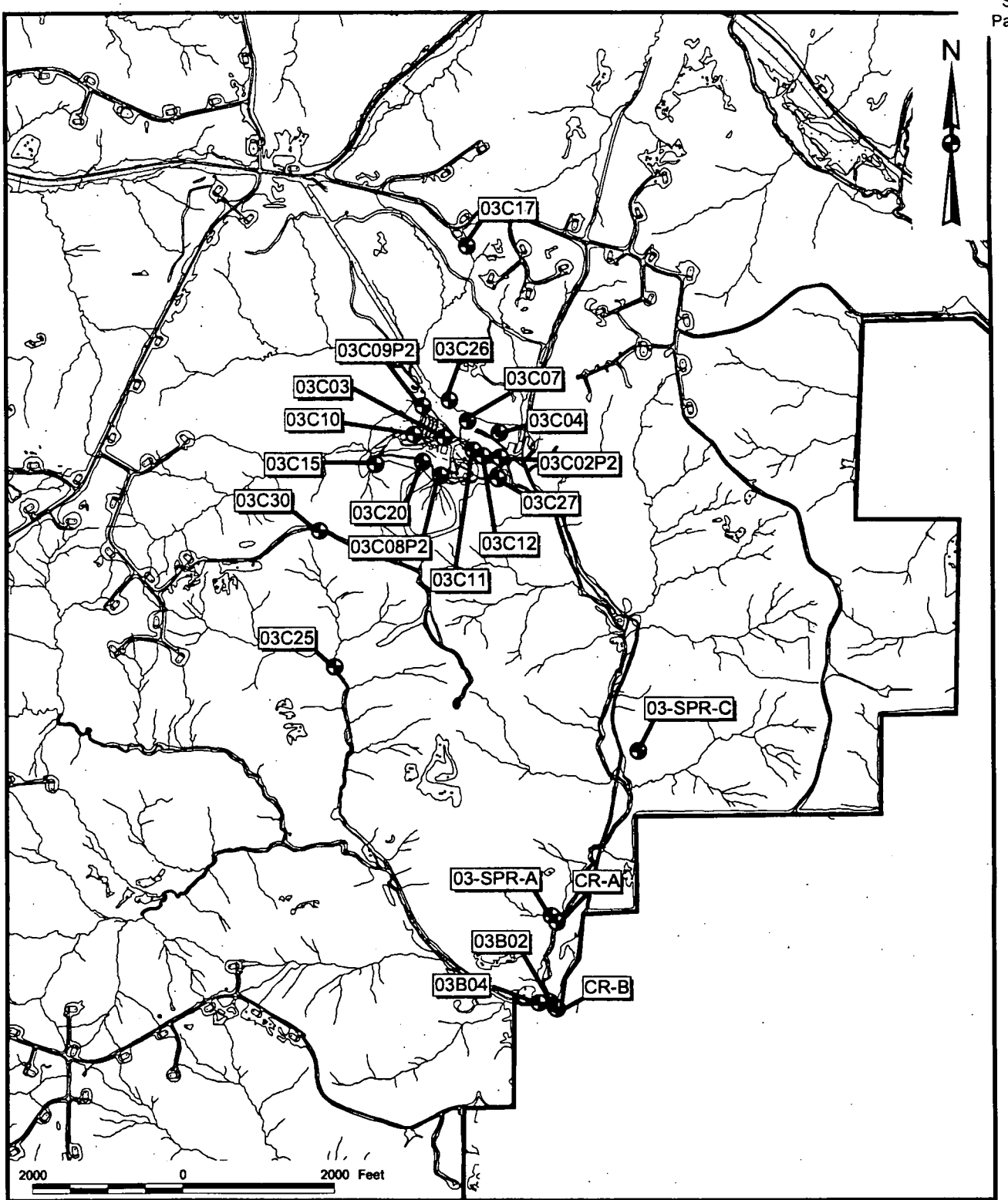
Monitoring wells that will be sampled under the direction of the approved Ground Water Monitoring Plan and this approved FSP were installed as a part of a RCRA Facility Investigation (RFI) performed at the ABG (Murphy and Wade, 1995), interim status and closure requirements for the waste pile and surface impoundments at the ABG, and an RFI performed at the ORR and DR (Murphy, 1994). The locations of all existing wells proposed for monitoring at the ABG, ORR, and the DR can be found on Figures 3-1, 3-2, and 3-3, respectively. Appendix A contains boring logs and monitoring well construction sheets for wells to be sampled in accordance with this FSP. Further investigations are necessary to determine which wells will be selected or installed for ground water monitoring at the OJT.

## 3.2 MONITORING WELL CONSTRUCTION DETAILS

Monitoring wells have been installed at the ABG, ORR, DR, and OJT as part of the previous RFIs conducted at the aforementioned sites. A certain number of these wells have been selected to be sampled, in accordance with the long-term monitoring program proposed in the approved Ground Water Monitoring Plan. The wells selected for the plan are discussed in the following subsections.

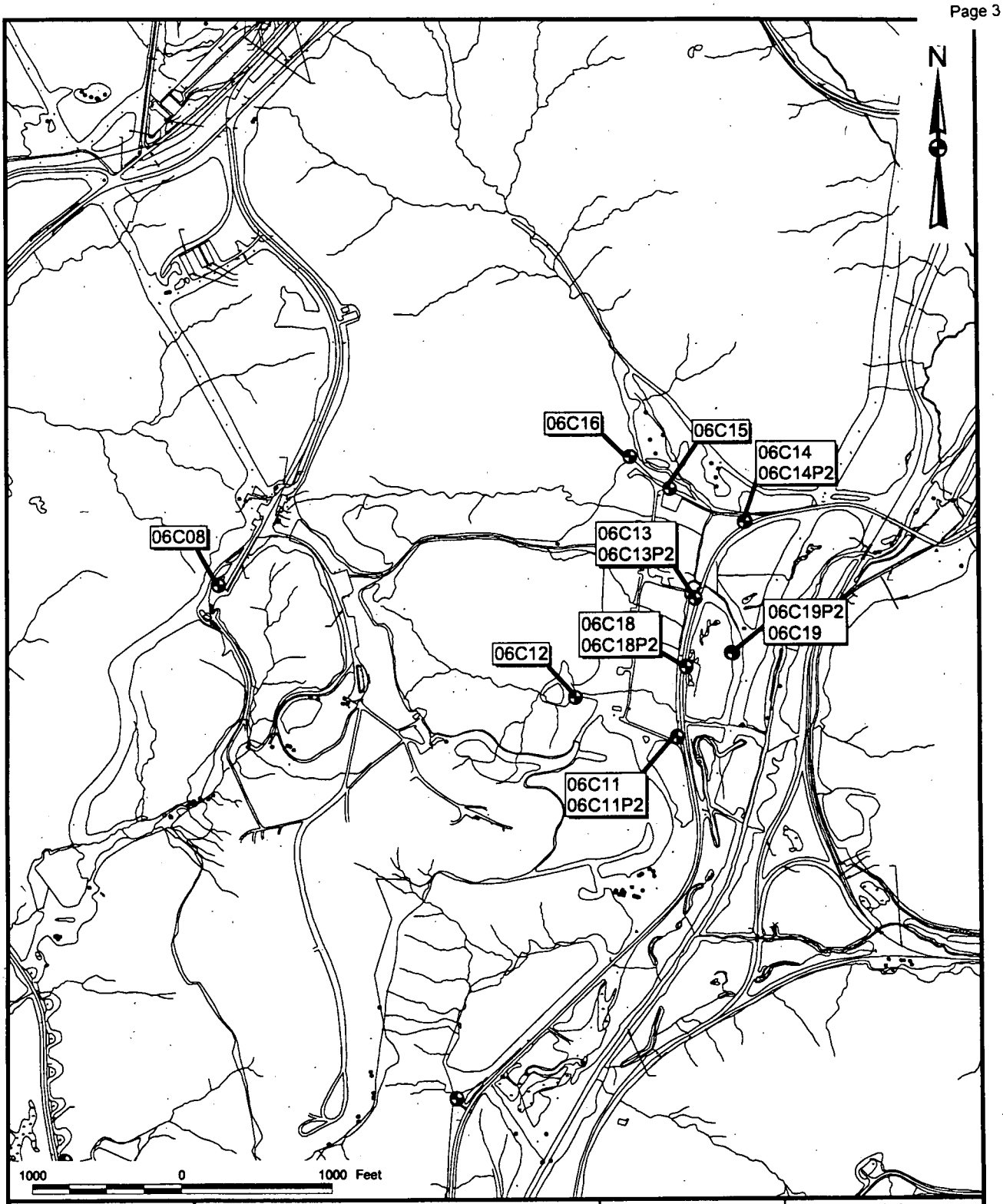
### 3.2.1 Ammunition Burning Grounds Monitoring Wells

A total of 98 monitoring wells have been installed in the ABG as a part of the field investigation for the RFI (Murphy, 1994). Eighteen of the monitoring wells have been selected to be sampled as a part of the approved long-term Ground Water Monitoring Plan at the ABG. Each of these wells was constructed of 2-inch-diameter polyvinyl chloride (PVC) riser above the water table and polytetrafluoroethylene (i.e., Teflon®) riser and screen below the water table (see Figure 3-5). Each of the wells was installed with 10-foot-long well screens. Table 3-1 summarizes the construction details for the 18 wells included in the RCRA monitoring program. Additional information can be found in the RFI Report written by Murphy (1994). Figure 3-1 shows the locations of the ABG monitoring wells, including surface water monitoring points. Figure 3-4 shows the locations of the ground water monitoring wells nearest the treatment units. Figure 3-5 shows a typical well installation at the ABG. U.S. EPA has approved this design, which does not incorporate concrete well pads. IDEM requires that wells have pads. Therefore, the wells at the ABG used for closure monitoring have pads.




| | | | |
|---|---|---|---|
| DRAWN BY S. TABLER / DATE 11/13/97 | Tetra Tech NUS, Inc. | CONTRACT NUMBER CTO-038 | OWNER NO. — |
| CHECKED BY — / DATE — | MONITORING LOCATIONS<br>AMMUNITION BURNING GROUNDS<br>NAVAL SURFACE WARFARE CENTER<br>CRANE, INDIANA | APPROVED BY — / DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — / DATE — | |
| SCALE AS NOTED | | DRAWING NO. Figure 3-1 | REV 0 |

P:\GIS\CRANE\CRANE.APR 5/5/99 JAL Figure 3-1

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|---|---|---|---|
| DRAWN BY S. TABLER | DATE 11/13/97 | Tetra Tech NUS, Inc. | CONTRACT NUMBER CTO-038 | OWNER NO. — |
| CHECKED BY — | DATE — | MONITORING LOCATIONS<br>OLD RIFLE RANGE<br>NAVAL SURFACE WARFARE CENTER<br>CRANE, INDIANA | APPROVED BY — | DATE — |
| COST/SCHEDULE-AREA | | | APPROVED BY — | DATE — |
| SCALE AS NOTED | | | DRAWING NO. Figure 3-2 | REV 0 |

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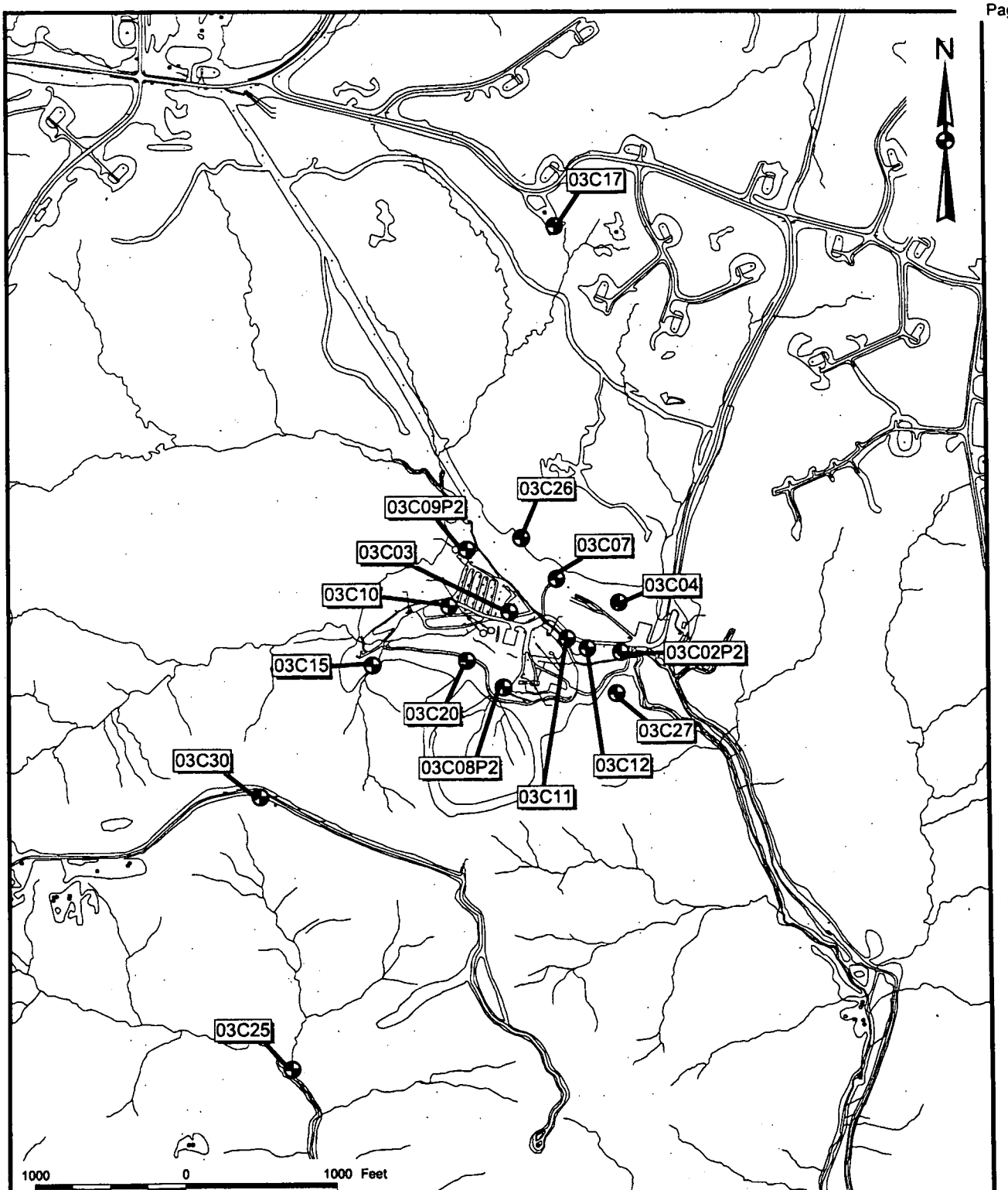
| | | | |
|---|---|---|---|
| DRAWN BY S. TABLER | DATE 11/13/97 | Tetra Tech NUS, Inc. | CONTRACT NUMBER CTO-038 / OWNER NO. — |
| CHECKED BY — | DATE — | MONITORING LOCATIONS<br>DEMOLITION RANGE<br>NAVAL SURFACE WARFARE CENTER<br>CRANE, INDIANA | APPROVED BY — / DATE — |
| COST/SCHEDULE-AREA | | | APPROVED BY — / DATE — |
| SCALE AS NOTED | | | DRAWING NO. Figure 3-3 / REV 0 |

P:\GIS\APR\CRANE.APR 5/5/99 JAL Figure 3-3




| | | | |
|---|---|---|---|
| DRAWN BY S. TABLER | DATE 11/13/97 | Tetra Tech NUS, Inc. | CONTRACT NUMBER CTO-038 / OWNER NO. — |
| CHECKED BY — | DATE — | MONITORING WELL LOCATIONS<br>AMMUNITION BURNING GROUNDS<br>NAVAL SURFACE WARFARE CENTER<br>CRANE, INDIANA | APPROVED BY — / DATE — |
| COST/SCHEDULE-AREA | | | APPROVED BY — / DATE — |
| SCALE AS NOTED | | | DRAWING NO. Figure 3-4 / REV 0 |

P:\GIS\APR\CRANE.APR 5/5/99 JAL Figure 3-4

Final Report, RCRA Facility Investigation,
Phase III, Groundwater Release Characterization, SWMU 03/10,
Ammunition Burning Ground, Volume I, William L. Murhpy, May 1994-Figure 6

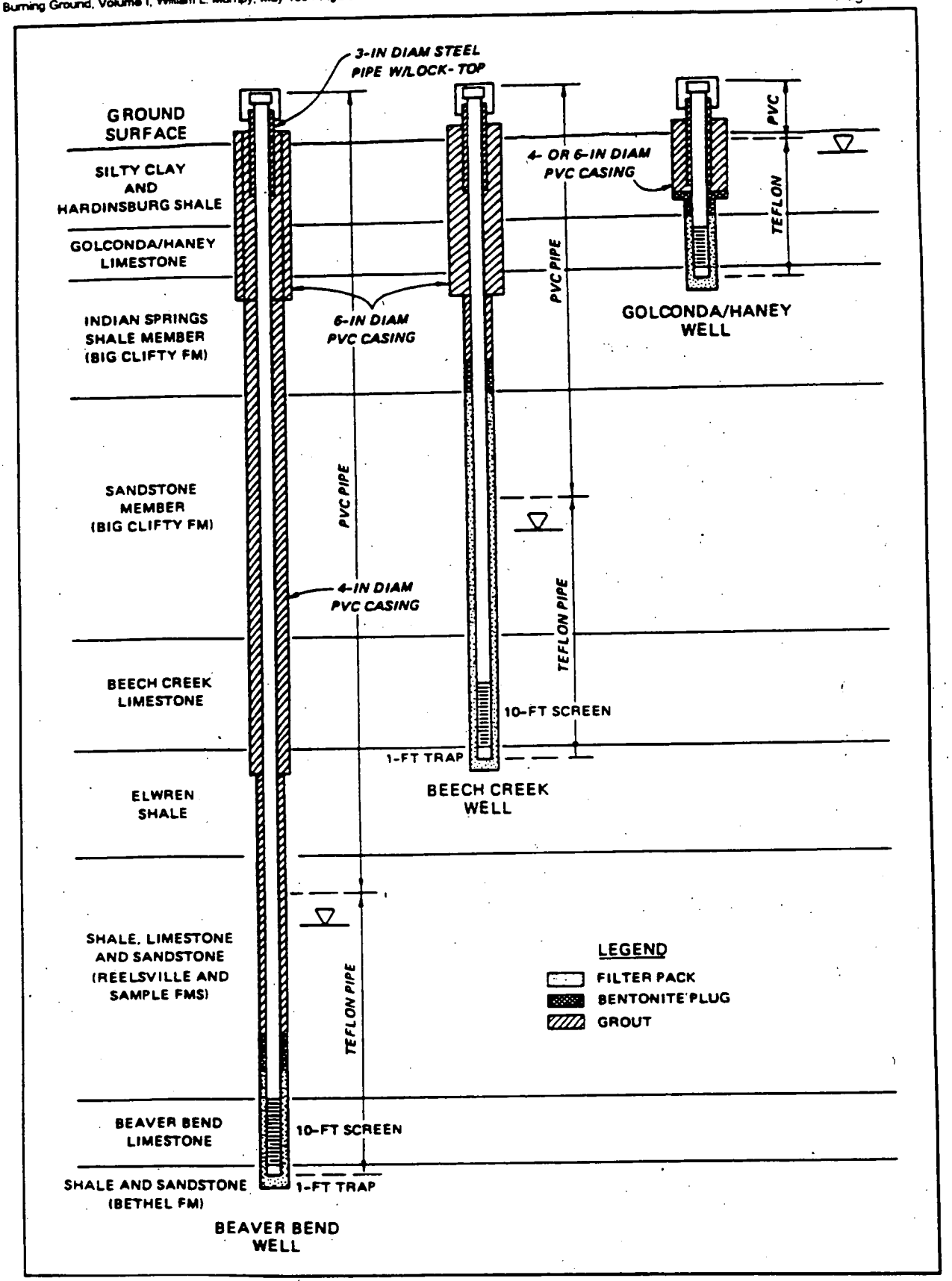



Figure 3-5
Well Installation Diagrams
for the Ammunition Burning Grounds
Naval Surface Warfare Center
Crane, Indiana

TABLE 3-1

MONITORING WELL CONSTRUCTION DETAILS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 5

| Well I.D. | North Coordinate | East Coordinate | Ground Elevation[b] (ft) | Top of Casing Elevation[b,c] (ft) | Top/Bottom of Screen (ft BGS) | Screened Formation[a] | Total Depth (ft BGS) | Depth to Bedrock (ft BGS) |
|---|---|---|---|---|---|---|---|---|
| AMMUNITION BURNING GROUNDS | | | | | | | | |
| 03B02 | 1302809.5 | 3048253.0 | 502.08 | 503.79 | 9.6-14.6 | Alluvium | 15.8 | NA |
| 03B04 | 1302867.5 | 3048040.1 | 504.54 | 506.37 | 9.5-14.5 | Alluvium | 16.5 | NA |
| 03C02P2 | 1310168.4 | 3047545.5 | 580.79 | 582.90 | 38.0-48.0 | Beech Creek | 49.0 | NA |
| 03C03 | 1310439.5 | 3046802.9 | 597.63 | 599.70 | 139.0-149.0 | Beaver Bend | 150.7 | NA |
| 03C04 | 1310497.1 | 3047530.7 | 622.34 | 624.26 | 73.5-83.5 | Beech Creek | 85.3 | NA |
| 03C07 | 1310659.1 | 3047118.4 | 634.48 | 636.32 | 88.7-98.7 | Beech Creek | 101.6 | NA |
| 03C08P2 | 1309937.9 | 3046761.2 | 624.19 | 629.15 | 90.0-100.0 | Beech Creek | 101.6 | NA |
| 03C09P2 | 1310856.1 | 3046523.3 | 601.12 | 603.38 | 62.0-72.0 | Beech Creek | 73.0 | NA |
| 03C10 | 1310479.3 | 3046404.4 | 605.95 | 607.92 | 66.0-76.0 | Beech Creek | 78.8 | NA |
| 03C11 | 1310261.2 | 3047188.0 | 589.94 | 592.26 | 47.5-57.5 | Beech Creek | 59.5 | NA |
| 03C12 | 1310193.9 | 3047321.7 | 586.37 | 587.13 | 39.0-49.0 | Beech Creek | 51.2 | NA |
| 03C15 | 1310086.1 | 3045893.7 | 618.87 | 621.10 | 88.5-98.5 | Beech Creek | 101.1 | NA |
| 03C17 | 1313000.2 | 3047118.5 | 693.92 | 696.01 | 138.5-148.5 | Beech Creek | 149.5 | NA |
| 03C20 | 1310116.8 | 3046520.8 | 644.82 | 646.55 | 108.0-118.0 | Beech Creek | 120.0 | NA |
| 03C25 | 1307385.0 | 3045357.6 | 594.94 | 596.68 | 59.7-69.7 | Beech Creek | 70.7 | NA |

TABLE 3-1

MONITORING WELL CONSTRUCTION DETAILS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 5

| Well I.D. | North Coordinate | East Coordinate | Ground Elevation[b] (ft) | Top of Casing Elevation[b,c] (ft) | Top/Bottom of Screen (ft BGS) | Screened Formation[a] | Total Depth (ft BGS) | Depth to Bedrock (ft BGS) |
|---|---|---|---|---|---|---|---|---|
| 03C26 | 1310931.7 | 3046881.6 | 638.78 | 640.62 | 94.0-104.0 | Beech Creek | 105.7 | NA |
| 03C27 | 1309894.9 | 3047514.8 | 601.70 | 603.75 | 60.5-70.5 | Beech Creek | 73.3 | NA |
| 03C30 | 1309204.0 | 3045150.2 | 776.90 | 778.72 | 250.5-260.5 | Beech Creek | 263.6 | NA |
| Little Sulphur Creek at Boundary | 1302793.2 | 3048273.3 | 497.20 | NA | NA | NA | NA | NA |
| Little Sulphur Creek below Spring A | 1303954.8 | 3048269.2 | 506.73 | NA | NA | NA | NA | NA |
| Spring A | 1304029.7 | 3048278.4 | 507.18 | NA | NA | NA | NA | NA |
| Spring C | 1306151.7 | 3049225.1 | 528.98 | NA | NA | NA | NA | NA |
| OLD RIFLE RANGE | | | | | | | | |
| 06C08[d] | 1305263.4 | 3023131.9 | 706.56 | 708.50 | 239.8-279.8 | Big Clifty/ Beech Creek | 283.2 | 5.8 |
| 06C11 | 1304239.4 | 3026195.1 | 499.60 | 501.65 | 36.2-56.2 | Big Clifty/ Beech Creek | 61.1 | 24.1 |
| 06C11P2 | 1304244.1 | 3026195.0 | 499.48 | 501.69 | 20.0-30.0 | Upper Big Clifty | 30 | 24.1 |
| 06C12 | 1304511.9 | 3025518.0 | 520.00 | 522.02 | 56.5-76.5 | Big Clifty/ Beech Creek | 82.8 | 8.5 |

TABLE 3-1

MONITORING WELL CONSTRUCTION DETAILS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 3 OF 5

| Well I.D. | North Coordinate | East Coordinate | Ground Elevation[b] (ft) | Top of Casing Elevation[b,c] (ft) | Top/Bottom of Screen (ft BGS) | Screened Formation[a] | Total Depth (ft BGS) | Depth to Bedrock (ft BGS) |
|---|---|---|---|---|---|---|---|---|
| 06C13 | 1305168.9 | 3026320.4 | 504.83 | 506.97 | 35.0-55.0 | Big Clifty/ Beech Creek | 62.9 | 22.5 |
| 06C13P2 | 1305163.8 | 3026319.2 | 504.71 | 506.75 | 20.0-30.0 | Upper Big Clifty | 30 | 22.5 |
| 06C14 | 1305681.1 | 3026655.1 | 507.73 | 509.77 | 28.0-48.0 | Big Clifty/ Beech Creek | 52.7 | 14.5 |
| 06C14P2 | 1305678.0 | 3026651.2 | 507.67 | 509.73 | 15.0-25.0 | Upper Big Clifty | 25.0 | 13.0 |
| 06C15 | 1305903.7 | 3026153.0 | 511.16 | 513.19 | 36.0-56.0 | Big Clifty/ Beech Creek | 62.2 | 1.5 |
| 06C16 | 1306119.8 | 3025886.8 | 529.95 | 532.26 | 63.8-83.8 | Big Clifty/ Beech Creek | 88.5 | 8.3 |
| 06C18 | 1304709.3 | 3026255.1 | 504.70 | 507.08 | 466.04-446.04 (elevation) | Big Clifty/ Beech Creek | 62.4 | 23.3 |
| 06C18P2 | 1304714.7 | 3026256.0 | 504.75 | 507.09 | 23.0-33.0 | Upper Big Clifty | 33 | 23.3 |
| 06C19 | 1304802.8 | 3026569.9 | 500.87 | 504.12 | 34.4-54.4 | Beech Creek | 54.4 | 18.4 |
| 06C19P2 | 1304802.9 | 3026559.3 | 500.60 | 503.87 | 11.5-21.5 | Alluvium/Upper Big Clifty | 21.5 | 18.2 |
| DEMOLITION RANGE | | | | | | | | |
| 06C02 | 1303737.6 | 3026274.8 | 511.02 | 512.89 | 47.1-67.1 | Lower | 75.4 | 4.7 |

TABLE 3-1

MONITORING WELL CONSTRUCTION DETAILS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 4 OF 5

| Well I.D. | North Coordinate | East Coordinate | Ground Elevation[b] (ft) | Top of Casing Elevation[b,c] (ft) | Top/Bottom of Screen (ft BGS) | Screened Formation[a] | Total Depth (ft BGS) | Depth to Bedrock (ft BGS) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Penn/Beech Crk | | |
| 06C03 | 1301803.5 | 3024713.1 | 505.40 | 506.71 | 66.8-86.8 | Big Clifty/ Beech Creek | 91.8 | 15 |
| 06C03P2 | 1301809.1 | 3024712.3 | 505.82 | 506.84 | 10.0-20.0 | Golconda/Haney | 20 | 8.7 |
| 06C04 | 1299507.1 | 3024249.4 | 517.12 | 519.51 | 78.0-98.0 | Big Clifty/ Beech Creek | 103.3 | 8.8 |
| 06C04P2 | 1299503.8 | 3024245.5 | 517.21 | 519.54 | 17.0-27.0 | Golconda/Haney | 27 | 8.8 |
| 06C05 | 1299601.5 | 3022184.2 | 504.12 | 506.26 | 60.4-80.4 | Big Clifty/ Beech Creek | 86.4 | 6.4 |
| 06C-0 | 1301396.2 | 3022101.6 | 509.41 | 511.45 | 460.29-440.29 (elevation) | Lower Penn/ Beech Creek | 86.4 | 23.5 |
| 06C06P2 | 1301392.4 | 3022105.3 | 509.29 | 511.38 | 22.5-32.5 | Pennsylvanian | 132.5 | 23.5 |
| 06C07 | 1303362.9 | 3021263.2 | 510.23 | 512.53 | 61.6-81.6 | Beech Creek | 87.5 | 3.2 |
| 06C08P2 | 1305259.6 | 3023136.7 | 706.40 | 708.43 | 81.5-91.5 | Pennsylvanian | 91.5 | 4.7 |
| OLD JEEP TRAIL | | | | | | | | |
| Monitoring well network to be determined later[e] | | | | | | | | |

## TABLE 3-1

## MONITORING WELL CONSTRUCTION DETAILS
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA
## PAGE 5 OF 5

Notes:

a Alluvium unconsolidated deposits, shallow aquifer
Pennsylvanian sandstone aquifer
Golconda/Haney limestone aquifer
Big Clifty sandstone aquifer
Beech Creek limestone aquifer
Beaver Bend limestone aquifer

b All elevations adjusted from NGVD 29 to NGVD 88 per National Geodetic Survey Data Sheets North Central Disc, October 1995.

c All monitoring points were surveyed in March 1999.

d 06C08 is listed as an upgradient well for both the ORR and the DR.

e Monitoring well network to be determined following additional investigative activities.

All monitoring wells installed in the ABG were constructed of 2-inch PVC riser above the water table and Teflon riser and screen below the water table. DR, and ORR are constructed of 2-inch PVC casing, riser, and well screens.

All monitoring wells at the ABG are constructed with gravel pads, with the exception of wells 03B02 and 03B04, which have concrete pads. All monitoring well pads at the DR and ORR are gravel.

BGS = below ground surface
NA = not applicable

### 3.2.2 Old Rifle Range and Demolition Range Monitoring Wells

A total of 60 monitoring wells have been installed in the ORR and DR as a part of the field investigation for the RFI (Murphy and Wade, 1995). Twelve monitoring wells from the ORR and 10 monitoring wells from the DR have been selected to be sampled as a part of the long-term approved Ground Water Monitoring Plan at these areas. Each of these wells was constructed of 2-inch-diameter PVC riser and well screen (see Figure 3-6). The well screens range in length from 10 to 40 feet. Table 3-1 summarizes the well construction details for the wells included in the RCRA monitoring program for ORR and DR. Additional information can be found in the RFI Report written by Murphy and Wade (1995). Figure 3-2 shows the locations of the ORR ground water monitoring wells. Figure 3-3 shows the locations of the DR monitoring wells.

### 3.2.3 Old Jeep Trail Monitoring Wells

At the present time, insufficient information is available on which monitoring wells will be sampled at the OJT area. Further investigative activities need to be performed to determine a proper monitoring network to meet the objectives of this investigation. Once a monitoring well network is determined, a long-term ground water monitoring plan for this site will be included as an addendum to this report.

## 3.3 SURVEYING

All existing ground water monitoring wells were surveyed prior to this investigation. Because the wells were retrofitted for installation of low-flow sampling pumps, the wells included in this sampling program were resurveyed. The horizontal locations were surveyed to the nearest 0.10 foot and the vertical locations or elevations were surveyed to the nearest 0.01 foot. The elevations at the ground surface, where the uncapped well riser is notched, and at the top of the protective casing were surveyed. All horizontal survey measurements were tied into the Indiana State Plane Coordinates and the 1983 North American Datum (NAD83). All vertical survey measurements were referenced to the 1988 National Geodetic Vertical Datum (NGVD88) and mean sea level (msl). All elevations were adjusted, as necessary, from the 1929 NGVD (NGVD29) to NGVD88 per National Geodetic Survey Data Sheets north central disc, October 1995.

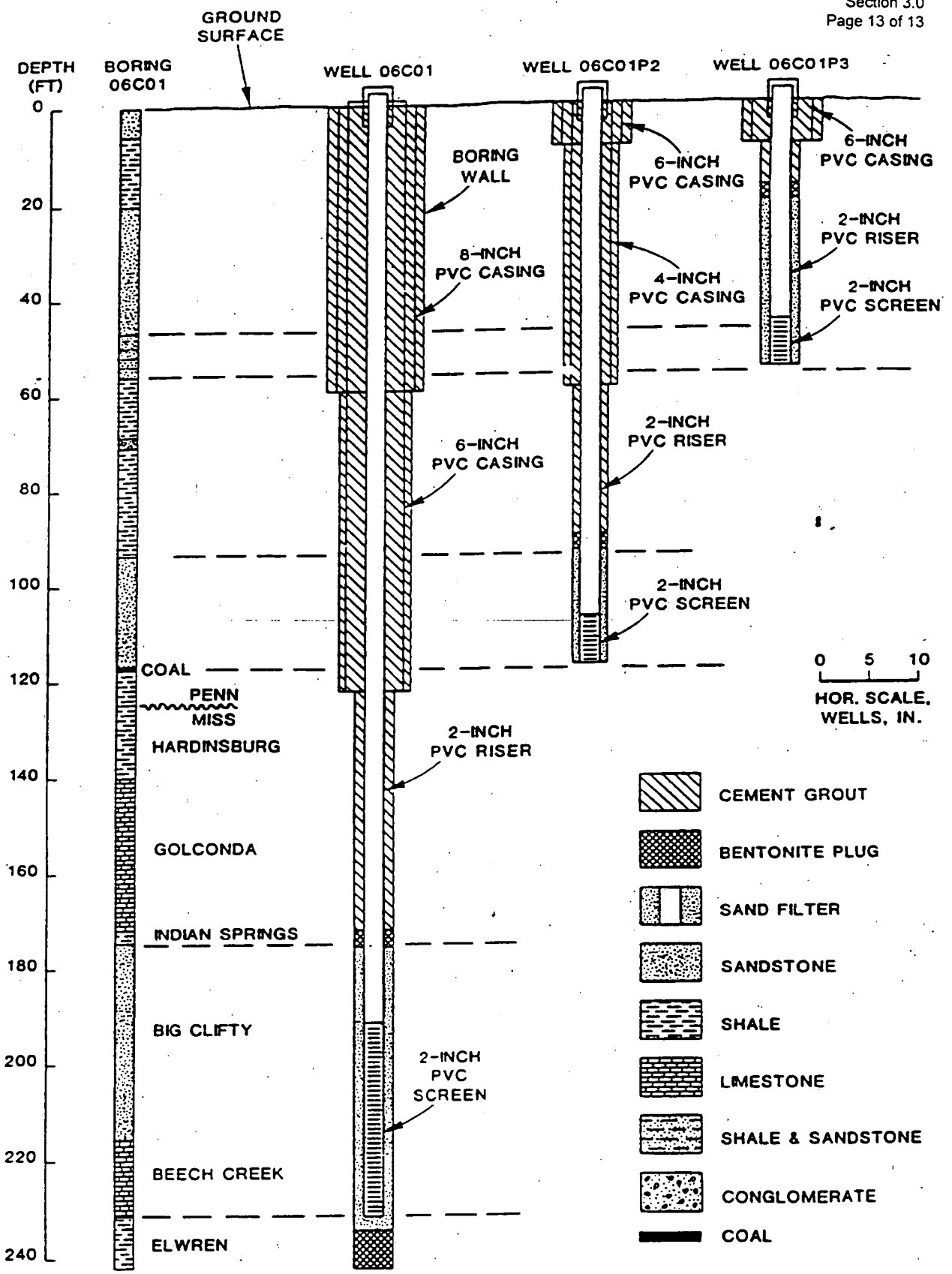



Figure 3-6
Well Installation Diagrams
for the Old Rifle Range and Demolition Range
Naval Surface Warfare Center
Crane, Indiana

# 4.0 GROUND WATER SAMPLING AND ANALYSIS AND FIELD OPERATIONS

The following sections describe the details concerning the monitoring wells, surface water, and spring waters to be sampled, frequency of sampling, sampling procedures, and target constituents for the NSWC Crane facility, as outlined by the RCRA Ground Water Monitoring Requirements as described in 40 CFR 264 Subpart F and the approved Ground Water Monitoring Plan.

## 4.1 SELECTION OF MONITORING WELLS AND SPRINGS FOR SAMPLING AND ANALYSIS

A total of 18 monitoring wells, two surface water locations, and two ground water springs from the ABG, 14 monitoring wells from the ORR, and 11 monitoring wells from the DR (monitoring well 06C08 is slated for sampling under both the ORR and the DR) will be sampled under the direction of the approved Ground Water Monitoring Plan and this approved FSP. OJT wells have not yet been selected. Following is a description of the field-sampling program for each unit. Table 1-1 of the approved QAPP summarizes the overall objectives of the ground water monitoring program. The approved QAPP also contains the detailed field and laboratory QA/QC requirements.

### 4.1.1 Ammunition Burning Grounds

Table 4-1 lists each of the ABG ground water, spring water, and surface water monitoring points and, for each monitoring well, the associated screened formation. Quarterly analysis shall take place for a minimum of 3 years or 1 year after contaminated soil is removed and cleaned up, whichever is later. Seminannual monitoring shall continue after that point for the same parameters. Monitoring for natural attenuation will occur during the first eight quarters. Table 4-2 describes the monitoring points and sample analyses that will be conducted on each monitoring point every quarter for the first eight quarters. Table 4-3 describes the monitoring points and the sample analyses that will be conducted after monitoring for natural attenuation is complete. Table 4-4 describes the monitoring points and sample analyses of Appendix IX parameters that will be conducted at each compliance monitoring point annually throughout the compliance period. The Appendix IX analyses are in addition to the quarterly and seminannual monitoring. Field measurements, including specific conductance, pH, temperature, turbidity, oxidation-reduction potential (ORP), and dissolved oxygen, will be obtained by a meter at each sampling location. Water-level measurements will be made for all wells during all sampling events using a water-level meter at each sampling location. Alkalinity (carbonate, bicarbonate, and hydroxide) will be analyzed in the field for each monitoring point using a field test kit. Additional field analyses will be conducted for ground water, spring water, and surface water included in the natural attenuation-monitoring program, as

## TABLE 4-1

## AMMUNITION BURNING GROUNDS
## GROUND WATER/SURFACE WATER/SPRING WATER MONITORING POINTS
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Monitoring Points | Screened Formation |
|---|---|
| 03B02 | Al |
| 03B04 | Al |
| 03C02P2 | BC |
| 03C03 | BB |
| 03C04 | BC |
| 03C07 | BC |
| 03C08P2 | BC |
| 03C09P2 | BC |
| 03C10 | BC |
| 03C11 | BC |
| 03C12 | BC |
| 03C15 | BC |
| 03C17 | BC |
| 03C20 | BC |
| 03C25 | BC |
| 03C26 | BC |
| 03C27 | BC |
| 03C30 | BC |
| Little Sulphur Creek Below Spring A | NA |
| Little Sulphur Creek at Boundary | NA |
| Spring A | NA |
| Spring C | NA |

Legend:

Al - Alluvium
BB - Beaver Bend
BC - Beech Creek
NA – Not applicable

# TABLE 4-2

## AMMUNITION BURNING GROUNDS
## QUARTERLY MONITORING - QUARTERS 1 THROUGH 8
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Monitoring Point | Field[1] | Volatiles[1] | Dissolved Gases[1] | Explosives[1] | Metals[1] (Total) | Metals[1] (Dissolved) | Cyanide | TOX | TOC | Sulfide | Sulfate | Phosphorus (Total and Dissolved) | Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 03B02 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03B04 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03C02P2 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C03 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03C04 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03C07 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C08P2 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C09P2 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C10 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03C11 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03C12 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03C15 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C17 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C20 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C25 | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| 03C26 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C27 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | • |
| 03C30 | A, B | B | | A | A, D | A, C, D | • | • | • | | • | • | |
| Little Sulphur Creek Below Spring A | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| Little Sulphur Creek at Boundary | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| Spring A | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |
| Spring C | A, B, C | B, C | A | A, B | A, B, D | A, C, D | • | • | • | • | • | • | • |

1 The letters A, B, C, etc., indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of this approved FSP.

# TABLE 4-3

## AMMUNITION BURNING GROUNDS
## QUARTERLY AND SEMINANNUAL MONITORING AFTER QUARTER 8
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Monitoring Point | Field[1] | Volatiles[1] | Explosives[1,2] | Metals [1] (Total) | Metals [1] (Dissolved) | Cyanide | TOX | TOC | Sulfate | Phosphorus (Total and Dissolved) | Chloride |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 03C02P2 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C03 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C04 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C07 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C08P2 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C09P2 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C15 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C17 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C20 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C25 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C26 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C27 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| 03C30 | A, B | B | A | A | A, C | • | • | • | • | • | • |
| Spring A | A, B | B | A | A | A, C | • | • | • | • | • | • |
| Spring C | A, B | B | A | A | A, C | • | • | • | • | • | • |

1 The letters A, B, C, etc., indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of this approved FSP.

2 Explosives Subset A will be analyzed unless natural attenuation demonstration shows that explosives from Subset B are present and need to be monitored further.

Note: Monitoring for natural attenuation is scheduled only for the first eight quarters. Therefore the analytical scheme has been modified to discontinue analysis of natural attenuation parameters.

**TABLE 4-4**
**AMMUNITION BURNING GROUNDS**
**ANNUAL APPENDIX IX MONITORING**
**NAVAL SURFACE WARFARE CENTER**
**CRANE, INDIANA**

| Monitoring Points | Appendix IX Volatile Organic Compounds (1) | Appendix IX Semivolatile Organic Compounds (1) | Appendix IX Pesticides/ PCBs (1) | Appendix IX Herbicides (1) | Appendix IX Dioxins/ Furans (1) | Sulfide |
|---|---|---|---|---|---|---|
| 03C02P2 | A | A | A | A | A | • |
| 03C03 | A | A | A | A | A | • |
| 03C04 | A | A | A | A | A | • |
| 03C07 | A | A | A | A | A | • |
| 03C08P2 | A | A | A | A | A | • |
| 03C09P2 | A | A | A | A | A | • |
| 03C15 | A | A | A | A | A | • |
| 03C17 | A | A | A | A | A | • |
| 03C20 | A | A | A | A | A | • |
| 03C25 | A | A | A | A | A | • |
| 03C26 | A | A | A | A | A | • |
| 03C27 | A | A | A | A | A | • |
| 03C30 | A | A | A | A | A | • |
| Spring A | A | A | A | A | A | • |
| Spring C | A | A | A | A | A | • |

1 The letters A, B, C, etc., indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of this approved FSP.

Note Annual Appendix IX monitoring will be performed in conjunction with quarterly and semiannual monitoring. Because the analytes included in volatile subsets B and C are completely contained within volatile subset A, separate analyses for volatile subsets B and C will not be performed when analyzing a sample for volatile subset A.

identified in Table 4-2, using field test kits. These additional field analyses include carbon dioxide, dissolved oxygen, ferrous iron, hydrogen sulfide, nitrate, and nitrite.

Section 7 of the approved Ground Water Monitoring Plan contains details on the purposes for which ground water, surface water, and spring water monitoring is being conducted at the ABG and the use of monitoring data.

### 4.1.2 Old Rifle Range

Table 4-5 lists each of the ORR ground water monitoring points and the associated screened formation. Table 4-6 describes the sample analysis that will be conducted on each monitoring point quarterly. Field parameters including specific conductivity, pH, temperature, turbidity, ORP, dissolved oxygen, and water level will be measured for all wells during each quarterly sampling event. Sample laboratory analysis will include explosives, RCRA Appendix IX total and dissolved metals, ammonia, cyanide, Total Organic Carbon (TOC), and Total Organic Halides (TOX). Table 4-7 describes the sample analysis for Appendix IX parameters that will be conducted annually. Appendix IX monitoring will be in addition to the quarterly monitoring described in Table 4-6. Ground water will be sampled for laboratory analysis of RCRA Appendix IX Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), pesticides/PCBs, herbicides, dioxins/furans, and sulfide.

Monitoring well 06C08 is slated for sampling under both the ORR and the DR monitoring programs. This well is upgradient for the DR and ORR. Thus, taking only one ground water sample from this well is sufficient for the requirements at both the ORR and the DR.

Section 8 of the approved Ground Water Monitoring Plan contains details on the purposes for which ground water monitoring is being conducted at the ORR and the use of the data.

### 4.1.3 Demolition Range

Table 4-8 lists each of the DR ground water monitoring points and associated screened formations. Table 4-9 describes the analyses that will be conducted on samples from each monitoring point semiannually. Field parameters, including specific conductivity, pH, temperature, turbidity, ORP, dissolved oxygen, and water level, will be measured and recorded from all wells in the field during each sampling event. Semiannual samples for laboratory analysis will include explosives, RCRA Appendix IX total and dissolved metals, cyanide, TOC, and TOX.

## TABLE 4-5

## OLD RIFLE RANGE
## MONITORING WELL SUMMARY
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Wells | Screened Formation |
|---|---|
| 06C08 | BC/BC |
| 06C11 | BC/BC |
| 06C11P2 | BCU |
| 06C12 | BC/BC |
| 06C13 | BC/BC |
| 06C13P2 | BCU |
| 06C14 | BC/BC |
| 06C14P2 | BCU |
| 06C15 | BC/BC |
| 06C16 | BC/BC |
| 06C18 | BC/BC |
| 06C18P2 | BCU |
| 06C19 | BC/BC |
| 06C19P2 | BCU |

BCU - Big Clifty Upper
BC/BC - Big Clifty/Beech Creek

## TABLE 4-6

## OLD RIFLE RANGE
## QUARTERLY MONITORING
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Wells | Field[1] | Explosives[1] | Ammonia | Appendix IX Metals[1] (Total) | Appendix IX Metals[1] (Dissolved) | Cyanide | TOX | TOC |
|---|---|---|---|---|---|---|---|---|
| 06C08[2] | A | A, C | • | A, D | A, D | • | • | • |
| 06C11 | A | A, C | • | A, D | A, D | • | • | • |
| 06C11P2 | A | A, C | • | A, D | A, D | • | • | • |
| 06C12 | A | A, C | • | A, D | A, D | • | • | • |
| 06C13 | A | A, C | • | A, D | A, D | • | • | • |
| 06C13P2 | A | A, C | • | A, D | A, D | • | • | • |
| 06C14 | A | A, C | • | A, D | A, D | • | • | • |
| 06C14P2 | A | A, C | • | A, D | A, D | • | • | • |
| 06C15 | A | A, C | • | A, D | A, D | • | • | • |
| 06C16 | A | A, C | • | A, D | A, D | • | • | • |
| 06C18 | A | A, C | • | A, D | A, D | • | • | • |
| 06C18P2 | A | A, C | • | A, D | A, D | • | • | • |
| 06C19 | A | A, C | • | A, D | A, D | • | • | • |
| 06C19P2 | A | A, C | • | A, D | A, D | • | • | • |

1 The letters A, B, C, etc. indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of this approved FSP.

2 Monitoring well 06C08 is also an upgradient well for the DR. Analyses are also listed in Table 4-9.

## TABLE 4-7

## OLD RIFLE RANGE
## ANNUAL APPENDIX IX GROUND WATER MONITORING
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Wells | Appendix IX Volatile Organic Compounds (1) | Appendix IX Semivolatile Organic Compounds (1) | Appendix IX Pesticides/ PCBs (1) | Appendix IX Herbicides (1) | Dioxins/ Furans (1) | Sulfide |
|---|---|---|---|---|---|---|
| 06C08 | A | A | A | A | A | • |
| 06C11 | A | A | A | A | A | • |
| 06C11P2 | A | A | A | A | A | • |
| 06C12 | A | A | A | A | A | • |
| 06C13 | A | A | A | A | A | • |
| 06C13P2 | A | A | A | A | A | • |
| 06C14 | A | A | A | A | A | • |
| 06C14P2 | A | A | A | A | A | • |
| 06C15 | A | A | A | A | A | • |
| 06C16 | A | A | A | A | A | • |
| 06C18 | A | A | A | A | A | • |
| 06C18P2 | A | A | A | A | A | • |
| 06C19 | A | A | A | A | A | • |
| 06C19P2 | A | A | A | A | A | • |

1 The letters A, B, C, etc. indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of this approved FSP.

Note: Annual Appendix IX monitoring will be performed in conjunction with quarterly monitoring.

## TABLE 4-8

## DEMOLITION RANGE MONITORING WELL SUMMARY NAVAL SURFACE WARFARE CENTER CRANE, INDIANA

| Wells | Screened Formation |
|---|---|
| 06C02 | BC/BC |
| 06C03 | BC/BC |
| 06C03P2 | G/H |
| 06C04 | BC/BC |
| 06C04P2 | G/H |
| 06C05 | BC/BC |
| 06C06 | LP/BC |
| 06C06P2 | P |
| 06C07 | BC |
| 06C08 | BC/BC |
| 06C08P2 | P |

BC = Beech Creek
BC/BC = Big Clifty/Beech Creek
G/H = Golconda/Haney LS
LP/BC = Lower Pennsylvanian/Beech Creek
P = Pennsylvanian

## TABLE 4-9

## DEMOLITION RANGE
## SEMIANNUAL MONITORING
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Wells | Field[1] | Explosives[1] | Appendix IX Metals[1] Total | Appendix IX Metals[1] Dissolved | Cyanide | TOC | TOX |
|---|---|---|---|---|---|---|---|
| 06C02 | A | A | A, D | A, D | • | • | • |
| 06C03 | A | A | A, D | A, D | • | • | • |
| 06C03P2 | A | A | A, D | A, D | • | • | • |
| 06C04 | A | A | A, D | A, D | • | • | • |
| 06C04P2 | A | A | A, D | A, D | • | • | • |
| 06C05 | A | A | A, D | A, D | • | • | • |
| 06C06 | A | A | A, D | A, D | • | • | • |
| 06C06P2 | A | A | A, D | A, D | • | • | • |
| 06C07 | A | A | A, D | A, D | • | • | • |
| 06C08[2] | A | A | A, D | A, D | • | • | • |
| 06C08P2 | A | A | A, D | A, D | • | • | • |

1 The letters A, B, C, etc. indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of this approved FSP.

2 Monitoring well 06C08 is also an upgradient well for the ORR. Analyses are also included in Table 4-6.

Monitoring well 06C08 is slated for sampling under both the ORR and the DR because of its upgradient proximity to both sites. Thus, only one ground water sample taken from this well is sufficient for the requirements at both the ORR and the DR.

Section 9 of the approved Ground Water Monitoring Plan contains details on the purposes for which ground water monitoring is being conducted at the DR and the use of the data.

### 4.1.4 Old Jeep Trail

At the time of printing of this approved FSP, monitoring wells that will be sampled at the OJT area have not been selected. Further investigative activities must be performed to determine a proper monitoring network to meet the objectives of this investigation. Once a monitoring well network is determined, the wells selected for ground water sampling will be included as an addendum to this report under corrective action.

## 4.2 FIELD SAMPLING AND ANALYSIS PROCEDURES

This section describes the field sampling and analysis procedures for ground water, surface water, and spring water monitoring at the ABG, and ground water monitoring at the ORR and DR. The NSWC Crane Environmental Protection Department (EPD) must approve any deviations from these procedures before implementation.

### 4.2.1 Inspection of Existing Monitoring Wells

Before each monitoring well is sampled, a brief inspection will be conducted. SOP 1 contains a description of the inspection procedure. Appendix B contains a copy of this SOP.

### 4.2.2 Water-Level Measurements

Water-level measurements will be obtained for each well at each unit (ABG, ORR, and DR) during every sampling event, before purging and sampling activities are conducted. Each unit-specific set of water-level measurements will be obtained within a 24-hour period. SOP 2 contains a description of the water-level measurement procedures. Appendix B contains a copy of SOP 2.

### 4.2.3 Low-Flow Pump Installation

Dedicated 1.66-inch-diameter, low-flow, bladder pumps (Teflon-lined PVC) were installed in all the monitoring wells prior to ground water sampling. Each pump was placed at the midpoint of the saturated well screen and, if possible, no less than 2 feet above the bottom of the well in order not to disturb any sediment that was located at the bottom of the well. Prior to pump installation, all the wells were developed using a surge block and a submersible purge pump capable of reaching depths of 60 feet. In cases where well depths exceeded 60 feet, a bailer was used instead of the submersible pump. The pumps were certified contaminant free; this certification, as well as lot numbers, was provided in an appendix of the initial ground water monitoring report. SOP 3 contains procedures for the installation/replacement of dedicated pumps, if necessary. This SOP also describes procedures for removal and reinstallation of pumps for well maintenance procedures, if necessary. A copy of SOP 3 is contained in Appendix B.

### 4.2.4 Well Purging

Purging will be accomplished by using low-flow techniques in accordance with SOP 4. A copy of this SOP is included in Appendix B. Low-flow purging and sampling are 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.

### 4.2.5 Low-Flow Sampling of Monitoring Wells

Low-flow sampling procedures will be used. The low-flow procedures are based on procedures described in the U.S. EPA ground water flow paper, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (EPA/540/S-95/504). SOP 5, contained in Appendix B, describes the low-flow sampling procedures for ground water wells. Table 4-10 contains a summary of sample analyses and associated container types and volumes, preservation requirements, and holding times.

### 4.2.6 Sampling of Springs and Little Sulphur Creek at the ABG

Springs A and C will be sampled by extracting a sample from the first surface water pool into which each spring discharges. Two samples will be obtained from Little Sulphur Creek. One sample will be collected

# TABLE 4-10

## SUMMARY OF SAMPLE ANALYSES, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA
## PAGE 1 OF 3

| Parameter | Sample Container | Container Volume | Preservation[1] | Maximum Holding Time[2] | Analytical Methodology |
|---|---|---|---|---|---|
| Explosives (all explosives except nitrocellulose, picric acid, picramic acid) | Amber glass, Teflon-lined cap | (2) 1,000 mL[3] | Cool to 4°C, dark | Extraction 7 days; analysis within 40 days of extraction | SW-846[4] Method 8330 |
| Nitrocellulose | Amber glass, Teflon-lined cap | (2) 500 mL | Cool to 4°C | Filtration 7 days; analysis within 40 days of filtration | Modified Army Corps Method[5] |
| Picric acid, Picramic Acid | Amber glass, Teflon-lined cap | (2) 1,000 mL[3] | Cool to 4°C, dark | Extraction 7 days; analysis within 40 days of extraction | Laucks HPLC Method[6] |
| Appendix IX Metals (total and dissolved) | Polyethylene bottle, plastic cap, plastic liner | 1,000 mL[7, 8] | $HNO_3$ to pH < 2 | Within 180 days; mercury within 28 days | SW-846 Method 6020; mercury - SW-846 Method 7470A |
| Calcium, Iron, Magnesium, Manganese, Sodium, and Potassium (total and dissolved) | Polyethylene bottle, plastic cap, plastic liner | 1,000 mL[7] | $HNO_3$ to pH < 2 | 180 days | SW-846 Method 6010B |
| Appendix IX Volatile Organic Compounds | Glass, black phenolic plastic screw cap, Teflon-lined septum | (6) 40 mL[9] | Cool to 4°C, dark, zero headspace, HCl to pH < 2 | 14 days | SW-846 Method 8260B[10] (plus SW-846 Method 8015B for 1,4-dioxane, acetonitrile, isobutyl alcohol, and propionitrile) |
| TCE and Degradation Products | Glass, black phenolic plastic screw cap, Teflon-lined septum | (3) 40 mL[11, 12] | Cool to 4°C, dark, zero headspace, HCl to pH < 2 | 14 days | SW-846 Method 8260B[10] |
| Aromatic and Chlorinated Hydrocarbons | Glass, black phenolic plastic screw cap, Teflon-lined septum | (3) 40 mL[11, 12] | Cool to 4°C, dark, zero headspace, HCl to pH < 2 | 14 days | SW-846 Method 8260B[10] |
| Appendix IX Semivolatile Organic Compounds | Amber glass, Teflon-lined cap | (4) 1000 mL[13] | Cool to 4°C, dark | Extraction 7 days; analysis within 40 days of extraction | SW-846 Method 8270C (plus SW-846 Method 8270C with Selective Ion Monitoring for polynuclear aromatic hydrocarbons [PAHs]) |

# TABLE 4-10

## SUMMARY OF SAMPLE ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA
## PAGE 2 OF 3

| Parameter | Sample Container | Container Volume | Preservation[1] | Maximum Holding Time[2] | Analytical Methodology |
|---|---|---|---|---|---|
| Appendix IX Organochlorine Pesticides/Polychlorinated biphenyls (PCBs) | Amber glass, Teflon-lined cap | (2) 1000 mL[3] | Cool to 4°C, dark | Extraction 7 days; analysis within 40 days of extraction | SW-846 Method 8081 |
| Appendix IX Herbicides | Amber glass, Teflon-lined cap | (2) 1000 mL[3] | Cool to 4°C, dark | Extraction 7 days; analysis within 40 days of extraction | SW-846 Method 8151A |
| Dioxins/Furans | Amber glass, Teflon-lined cap | (2) 1000 mL[3] | Cool to 4°C, dark | Extraction 30 days; analysis within 45 days of extraction | SW-846 Method 8290 |
| Ammonia | Polyethylene bottle, plastic cap, plastic liner | 500 mL[14] | Cool to 4°C, $H_2SO_4$ to pH <2 | 28 days | EPA Method [15] 350.1 |
| Chloride | Polyethylene bottle, plastic cap, plastic liner | 500 mL[16] | Cool to 4°C | 28 days | SW-846 Method 9056 |
| Cyanide | Polyethylene bottle, plastic cap, plastic liner | 500 mL | Cool to 4°C, NaOH to pH > 12 | Within 14 days | SW-846 Method 9012A |
| Dissolved Methane, Ethene, and Ethane | Amber glass, plastic cap Mylar-faced silicon septum | (2) 40 mL | Cool to 4°C, dark, zero headspace | 14 days | Microseeps Method AM18.01[17] |
| Phosphorus (Total and Dissolved) | Polyethylene bottle, plastic cap, plastic liner | 500 mL[14] | Cool to 4°C, $H_2SO_4$ to pH <2 | 28 days | EPA Method 365.2 |
| Sulfate | Polyethylene bottle, plastic cap, plastic liner | 500 mL[16] | Cool to 4°C | 28 days | SW-846 Method 9056 |
| Sulfide | Polyethylene bottle, plastic cap, plastic liner | 500 mL | Cool to 4°C, zinc acetate, NaOH to pH >9 | 7 days | SW-846 Method 9030B/9034 |
| Total Organic Carbon (TOC) | Amber glass, septa cap | 125 mL | Cool to 4°C, $H_2SO_4$ to pH <2 | 28 days | SW-846 Method 9060 |
| Total Organic Halides (TOX) | Amber glass, Teflon-lined cap | 1000 mL | Cool to 4°C, $H_2SO_4$ to pH <2 | 28 days | SW-846 Method 9020B |

# TABLE 4-10

## SUMMARY OF SAMPLE ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA
## PAGE 3 OF 3

1 HCl = Hydrochloric acid, $H_2SO_4$ = Sulfuric Acid, NaOH = Sodium Hydroxide, $HNO_3$ = Nitric Acid
2 All holding times are from date of collection.
3 Two additional 1,000-mL bottles are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).
4 U.S. EPA, 1986. Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd ed, including updates.
5 Based on Indiana Army Ammunition Plant Contamination Survey. "Nitrocellulose in Water". Aqualab, Inc., 1983.
6 Laucks SOP LTL-8308, included in Appendix B of the QAPP.
7 One 1,000-mL bottle of unfilltered ground water will provide sufficient sample volume for the analysis for Appendix IX metals (total) and/or any additional total metals analyses. Likewise, one 1,000-mL bottle of filtered ground water will provide sufficient sample volume for the analysis for Appendix IX metals (dissolved) and/or any additional dissolved metals analyses.
8 One additional 1,000-mL bottle is required for samples designated for matrix spike/duplicate analysis (minimum 1 in 20 samples).
9 Eight additional 40-mL vials are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).
10 Analysis will be performed using a 25-mL sample volume in order to achieve lower quantitation limits for ground water samples.
11 Three 40-mL vials will provide sufficient sample volume for the analysis of trichloroethene and its degradation products (volatile subset B) and aromatic and chlorinated hydrocarbons (volatile subset C). In addition, when samples are collected for analysis of the Appendix IX volatile list (six 40-mL vials), it is not necessary to collect any additional vials for volatile subsets B and C because the analytes included in volatile subsets B and C are completely contained within the Appendix IX volatile list.
12 Four additional 40-mL vials are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).
13 Four additional 1,000-mL bottles are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).
14 Ammonia and total phosphorus samples will be provided for analysis in the same 500-mL bottle.
15 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes.
16 Chloride and sulfate samples will be provided for analysis in the same 500-mL bottle.
17 Microseeps Method AM18.01, included in Appendix B of the QAPP.

below spring A and the second will be collected at the boundary of NSWC Crane. All surface water samples will be extracted by using a dip sampler. SOP 6, contained in Appendix B, describes the procedures for sampling springs and Little Sulphur Creek.

### 4.2.7 Field Analysis

Test kits will be used for the analyses of several parameters in the field for ABG monitoring points, as described in Tables 4-2 and 4-3. These parameters are listed as follows:

- Alkalinity (carbonate, bicarbonate, and hydroxide)
- Carbon Dioxide
- Dissolved Oxygen
- Ferrous Iron
- Hydrogen Sulfide
- Nitrite
- Nitrate

SOP 7, contained in Appendix B, contains procedures for each of these field test kit analyses.

In addition, water-quality parameters (i.e., dissolved oxygen, pH, specific conductance, temperature, turbidity, and ORP) will be measured using a meter for all ground water, surface water, and spring water monitoring points. SOP 4 discusses these field measurements for ground water monitoring points, and SOP 6 discusses these field measurements for surface and spring water sampling points. Water-level measurements will be performed for all monitoring wells. SOP 2 describes the procedure for measurement of water levels.

### 4.2.8 Decontamination of Field Sampling Equipment

Dedicated sampling equipment such as pumps and tubing is used at each well location. Dedicated sampling equipment does not require decontamination. If any non-dedicated equipment is required for field sampling activities, it will be decontaminated prior to and during sampling activities. Any decontamination water that is generated will be handled in the same manner as purge water, as described in Section 4.2.9. SOP 8, contained in Appendix B, describes decontamination procedures.

### 4.2.9 Investigation-Derived Waste Management

Four types of investigation-derived wastes (IDW) [personal protective equipment (PPE); purge water, decontamination solutions, and spent test kit reagents] are expected to be generated during the ground water monitoring program. Based on the activities and types of contaminants present, none of these residues are expected to represent a significant risk to human health or the environment if properly managed. Planned management of each of these residues is provided below:

PPE - All PPE will be placed in double plastic garbage bags and then in the trash dumpsters at the facility. Trash at NSWC Crane is disposed in the on-site permitted Sanitary Waste Landfill.

Purge Water - Purge water will be containerized in polyethylene containers labeled "purge water" and discharged to the NSWC-Crane-permitted sanitary sewer system. Containers will be emptied daily and stored on site at the field trailer. Under no circumstances will purge water containers (empty or full) be transported off site.

Decontamination Solutions - Decontamination solutions will consist of tap and deionized water rinsates and LiquiNox solutions. All decontamination solutions will be collected in polyethylene containers and discharged into the NSWC-permitted sanitary sewer system.

Test Kit Reagents - Test kit reagents will be added to the purge water and discharged along with the purge water into the NSWC-permitted sanitary sewer system.

All IDW disposal at NSWC Crane complies with NSWC Crane EPD procedures.

### 4.2.10 Sample Identification System

Each sample collected at NSWC Crane will be assigned a unique sample tracking number. A detailed description of the sample identification system to be used is outlined in SOP 9. A copy of this SOP is provided in Appendix B.

### 4.2.11 Sample Preservation and Handling

Ground water samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Certain preservatives are

effective on certain chemicals of interest. The sample preservatives required for each of the chemicals of interest are provided in Table 4-10. SOP 10, attached in Appendix B, provides a detailed description of sample preservation and handling procedures required for this sampling plan.

### 4.2.12 Chain-of-Custody/Documentation

Sample custody procedures are designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. Integrity of the samples collected during the site investigation will be the responsibility of identified persons from the time they are collected until they, or their derived data, are incorporated into the final report. Stringent chain-of-custody procedures will be followed to document sample possession. An example of the chain-of-custody form, which will be used to document this procedure, is included in SOP 11. The chain-of-custody procedure will be followed in accordance with SOP 11 included in Appendix B.

All samples taken at NSWC Crane will be properly labeled with a sample label affixed to the sample container and a sample tag secured by a wire tie around the neck of the sample container. Detailed information regarding completion of sample labels and tags, as well as all field record keeping and documentation activities, is also provided in SOP 11.

## 4.3 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

The purpose of this section is to address the data quality objectives of field-quality QA/QC samples such as field blanks, field duplicates, rinsate blanks, trip blanks, ambient blanks, and matrix spikes/matrix spike duplicates. The following tables contain a summary of water sample analyses and field QC samples for each unit (ABG, ORR, and DR) and for each type of sampling event frequency (quarterly, semiannual, annual).

Table 4-11 - ABG quarterly sampling (quarters 1 through 8)
Table 4-12 - ABG quarterly and semiannual sampling (after quarter 8)
Table 4-13 - ABG annual sampling
Table 4-14 - ORR quarterly sampling
Table 4-15 - ORR annual sampling
Table 4-16 - DR semiannual sampling

TABLE 4-11

SUMMARY OF SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES
QUARTERLY MONITORING-QUARTERS 1 THROUGH 8
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2

| Parameter[1] | Samples | Field Duplicates[2] | Trip Blanks[3] | Ambient Blanks[4] | Matrix Spike/Duplicates[5] | Total[6] |
|---|---|---|---|---|---|---|
| **Laboratory:** | | | | | | |
| TCE & degradation products/volatiles | 22 | 3 | TBD | TBD | 2/2 | 29+ |
| Dissolved methane/ethane/ethene | 12 | 2 | NA | TBD | NA | 14+ |
| Explosives – subset A | 22 | 3 | NA | TBD | 2/2 | 29+ |
| Explosives – subset B | 12 | 2 | NA | TBD | 1/1 | 16+ |
| Metals (total) | 22 | 3 | NA | TBD | 2/2 | 29+ |
| Metals (dissolved) | 22 | 3 | NA | TBD | 2/2 | 29+ |
| Cyanide | 22 | 3 | NA | TBD | 2/2 | 29+ |
| Sulfate | 22 | 3 | NA | TBD | 2/2 | 29+ |
| Phosphorus (total) | 22 | 3 | NA | TBD | 2/2 | 29+ |
| Phosphorus (dissolved) | 22 | 3 | NA | TBD | 2/2 | 29+ |
| TOC | 22 | 3 | NA | TBD | 2/2 | 29+ |
| TOX | 22 | 3 | NA | TBD | 2/2 | 29+ |
| Sulfide | 12 | 2 | NA | TBD | 1/1 | 16+ |
| Chloride | 22 | 3 | NA | TBD | 2/2 | 29+ |
| **Field:** | | | | | | |
| Dissolved oxygen[7] | 22 | NA | NA | NA | NA | 22 |
| PH | 22 | NA | NA | NA | NA | 22 |
| Specific conductance | 22 | NA | NA | NA | NA | 22 |
| Temperature | 22 | NA | NA | NA | NA | 22 |
| Turbidity | 22 | NA | NA | NA | NA | 22 |
| ORP | 22 | NA | NA | NA | NA | 22 |
| Alkalinity | 22 | 3 | NA | NA | NA | 25 |
| Carbon Dioxide | 12 | 2 | NA | NA | NA | 14 |
| Dissolved oxygen[8] | 12 | 2 | NA | NA | NA | 14 |
| Ferrous Iron | 12 | 2 | NA | NA | NA | 14 |

TABLE 4-11

SUMMARY OF SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES
QUARTERLY MONITORING-QUARTERS 1 THROUGH 8
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 2

| Parameter[1] | Samples | Field Duplicates[2] | Trip Blanks[3] | Ambient Blanks[4] | Matrix Spike/Duplicates[5] | Total[6] |
|---|---|---|---|---|---|---|
| Hydrogen sulfide | 12 | 2 | NA | NA | NA | 14 |
| Nitrate | 12 | 2 | NA | NA | NA | 14 |
| Nitrite | 12 | 2 | NA | NA | NA | 14 |
| Water level | 18 | NA | NA | NA | NA | 18 |

1 See Table 4-2 of this approved FSP in conjunction with Table 1-3 of the approved QAPP for ABG-specific analysis requirements.
2 Field duplicates will be collected at a minimum frequency of 1 per 10 samples. Field duplicates are not applicable (NA) for field measurements obtained by using a flow-through meter or a water-level meter.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile organics analysis. Because the number of sample coolers shipped varies, totals are to be determined (TBD).
4 Ambient blanks will be collected at the discretion of the FOL, to delineate site conditions. Because site conditions vary, totals are to be determined (TBD). Ambient blanks are not applicable for field analyses (NA).
5 Matrix spike (MS) and duplicate samples will be collected at a frequency of 1 per 20 samples. For inorganics, an MS and a sample duplicate will be collected and, for organics, an MS and a matrix spike duplicate (MSD) will be collected. MS/MSDs and sample duplicates are not applicable for field analyses (NA).
6 Plus sign (+) indicates potential for the total number of samples to increase, due to TBD variables.
7 Dissolved oxygen is measured by a flow-through meter for determination of stabilization conditions.
8 Dissolved oxygen is analyzed by field kit for monitoring of natural attenuation.

NA Not Applicable
TBD To be determined
TCE Trichloroethene
TOC Total organic carbon
TOX Total organic halogens
ORP Oxidation-reduction potential

TABLE 4-12

SUMMARY OF SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES
QUARTERLY AND SEMIANNUAL MONITORING AFTER QUARTER 8
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2

| Parameter[1] | Samples | Field Duplicates[2] | Trip Blanks[3] | Ambient Blanks[4] | Matrix Spike/Duplicates[5] | Total[6] |
|---|---|---|---|---|---|---|
| **Laboratory:** | | | | | | |
| TCE and degradation products | 15 | 2 | TBD | TBD | 1/1 | 19+ |
| Explosives - subset A | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Metals (total) | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Metals (dissolved) | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Cyanide | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Sulfate | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Phosphorus (total) | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Phosphorus (dissolved) | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Chloride | 15 | 2 | NA | TBD | 1/1 | 19+ |
| TOC | 15 | 2 | NA | TBD | 1/1 | 19+ |
| TOX | 15 | 2 | NA | TBD | 1/1 | 19+ |
| **Field:** | | | | | | |
| Dissolved oxygen | 15 | NA | NA | NA | NA | 15 |
| PH | 15 | NA | NA | NA | NA | 15 |
| Specific conductivity | 15 | NA | NA | NA | NA | 15 |
| Temperature | 15 | NA | NA | NA | NA | 15 |
| Turbidity | 15 | NA | NA | NA | NA | 15 |
| ORP | 15 | NA | NA | NA | NA | 15 |
| Alkalinity | 15 | 2 | NA | NA | NA | 17 |
| Water level | 15 | NA | NA | NA | NA | 15 |

1 See Table 4-3 of this approved FSP in conjunction with Table 1-3 of the approved QAPP for the ABG-specific analysis requirements.
2 Field duplicates will be collected at a minimum frequency of 1 per 10 samples. Field duplicates are not applicable (NA) for field analyses obtained using a flow-through meter.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile organics analysis. Because the number of sample coolers shipped varies, totals are to be determined (TBD).

TABLE 4-12

SUMMARY OF SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES
QUARTERLY AND SEMIANNUAL MONITORING AFTER QUARTER 8
AMMUNITION BURNING GROUNDS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 2

4 Ambient blanks will be collected at the discretion of the FOL, to delineate site conditions. Because site conditions vary, totals are TBD. Ambient blanks are not applicable for field analyses (NA).

5 MS and duplicate samples will be collected at a frequency of 1 per 20 samples. For inorganics, an MS and a sample duplicate will be collected, and for organics, an MS and an MSD will be collected. MS/MSDs and sample duplicates are not applicable for field analyses (NA).

6 Plus sign (+) indicates potential for the total number of samples to increase, due to TBD variables.

NA Not Applicable
TBD To be determined
TOC Total organic carbon
TOX Total organic halogens
ORP Oxidation-reduction potential

## TABLE 4-13

## SUMMARY OF ANNUAL SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES
## AMMUNITION BURNING GROUNDS
## ANNUAL APPENDIX IX MONITORING
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Parameter[1] | Samples | Field Duplicates[2] | Trip Blanks[3] | Ambient Blanks[4] | Matrix Spike/Duplicates[5] | Total[7] |
|---|---|---|---|---|---|---|
| **Laboratory:** | | | | | | |
| VOCs | 15 | 2 | TBD | TBD | 1/1 | 19+ |
| SVOCs | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Organochlorine pesticides/PCBs | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Herbicides | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Dioxins/furans | 15 | 2 | NA | TBD | 1/1 | 19+ |
| Sulfide | 15 | 2 | NA | TBD | 1/1 | 19+ |

1 See Table 4-4 of this approved FSP in conjunction with Table 1-3 of the approved QAPP for the ABG-specific analysis requirements.
2 Field duplicates will be collected at a minimum frequency of 1 per 10 samples.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile organics analysis. Because the number of sample coolers shipped varies, totals are TBD.
4 Ambient blanks will be collected at the discretion of the FOL, to delineate site conditions. Because site conditions vary, totals are TBD.
5 MS and duplicate samples will be collected at a frequency of 1 per 20 samples. For inorganics, an MS and a sample duplicate will be collected, and for organics, an MS and an MSD will be collected.
6 Plus sign (+) indicates potential for the total number of samples to increase, due to TBD variables.

NA Not Applicable
TBD To be determined
PCBs Polychlorinated biphenyls
VOCs Volatile organic compounds
SVOCs Semivolatile organic compounds

Note: Annual Appendix IX sampling is to be performed in conjunction with quarterly sampling.

TABLE 4-~~14~~ 15 STET

## SUMMARY OF QUARTERLY SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES
## OLD RIFLE RANGE
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Parameter[1] | Samples | Field Duplicates[2] | Trip Blanks[3] | Ambient Blanks[4] | Matrix Spike/Duplicates[5] | Total[6] |
|---|---|---|---|---|---|---|
| **Laboratory:** | | | | | | |
| Explosives - subsets A and C | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Ammonia | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Metals (total) | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Metals (dissolved) | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Cyanide | 14 | 2 | NA | TBD | 1/1 | 18+ |
| TOC | 14 | 2 | NA | TBD | 1/1 | 18+ |
| TOX | 14 | 2 | NA | TBD | 1/1 | 18+ |
| **Field:** | | | | | | |
| Dissolved oxygen | 14 | NA | NA | NA | NA | 14 |
| PH | 14 | NA | NA | NA | NA | 14 |
| Specific conductivity | 14 | NA | NA | NA | NA | 14 |
| Temperature | 14 | NA | NA | NA | NA | 14 |
| Turbidity | 14 | NA | NA | NA | NA | 14 |
| ORP | 14 | NA | NA | NA | NA | 14 |
| Water level | 14 | NA | NA | NA | NA | 14 |

1 See Table 4-6 of this approved FSP and Table 1-3 of the approved QAPP for the specific quarterly analysis requirements for the Old Rifle Range.
2 Field duplicates will be collected at a minimum frequency of 1 per 10 samples. Field duplicates are not applicable (NA) for field analyses measured by flow-through meters or water level measurements.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile organics analysis. Because the number of sample coolers shipped varies, totals are TBD.
4 Ambient blanks will be collected at the discretion of the Field Operations Leader, to delineate site conditions. Because site conditions vary, totals are to be determined (TBD). Ambient blanks are not applicable for field analyses (NA).
5 Matrix spike (MS) and duplicate samples will be collected at a frequency of 1 per 20 samples. For inorganics, an MS and a sample duplicate will be collected, and for organics, an MS and an MSD will be collected. MS/MSDs and duplicate samples are not applicable for field analyses (NA).
6 Plus sign (+) indicates potential for the total number of samples to increase, due to TBD variables.

NA Not Applicable
TOX Total organic halogens
TBD To be determined
TOC Total organic carbon
ORP Oxidation-reduction potential

STET

TABLE 4-~~15~~ 16

X

**SUMMARY OF ANNUAL SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES**
**OLD RIFLE RANGE**
**NAVAL SURFACE WARFARE CENTER**
**CRANE, INDIANA**

| Parameter[1] | Samples | Field Duplicates[2] | Trip Blanks[3] | Ambient Blanks[4] | Matrix Spike/Duplicates[5] | Total[6] |
|---|---|---|---|---|---|---|
| **Laboratory:** | | | | | | |
| VOCs | 14 | 2 | TBD | TBD | 1/1 | 19+ |
| SVOCs | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Organochlorine pesticides/PCBs | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Herbicides | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Dioxins/furans | 14 | 2 | NA | TBD | 1/1 | 18+ |
| Sulfide | 14 | 2 | NA | TBD | 1/1 | 18+ |

1 See Table 1-3 of the approved QAPP for the specific annual analysis requirements for the Old Rifle Range.
2 Field duplicates will be collected at a minimum frequency of 1 per 10 samples.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile organics analysis. Because the number of sample coolers shipped varies, totals are TBD.
4 Ambient blanks will be collected at the discretion of the Field Operations Leader, to delineate site conditions. Because site conditions vary, totals are to be determined (TBD).
5 MS and duplicate samples will be collected at a frequency of 1 per 20 samples. For inorganics, an MS and a sample duplicate will be collected, and for organics, an MS and an MSD will be collected.
6 Plus sign (+) indicates potential for the total number of samples to increase, due to TBD variables.

NA Not Applicable
TBD To be determined
PCBs Polychlorinated biphenyls
VOCs Volatile organic compounds
SVOCs Semivolatile organic compounds

Note: Annual Appendix IX sampling is to be performed in conjunction with quarterly sampling.

## TABLE 4-16

## SUMMARY OF SEMIANNUAL SAMPLE ANALYSIS AND QUALITY CONTROL SAMPLES
## DEMOLITION RANGE
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| Parameter[1] | Samples | Field Duplicates [2] | Trip Blanks [3] | Ambient Blanks[4] | Matrix Spike/Duplicates[5] | Total[6] |
|---|---|---|---|---|---|---|
| **Laboratory:** | | | | | | |
| Explosives - subset A | 10 | 1 | NA | TBD | 1/1 | 13+ |
| Metals (total) | 10 | 1 | NA | TBD | 1/1 | 13+ |
| Metals (dissolved) | 10 | 1 | NA | TBD | 1/1 | 13+ |
| Cyanide | 10 | 1 | NA | TBD | 1/1 | 13+ |
| TOC | 10 | 1 | NA | TBD | 1/1 | 13+ |
| TOX | 10 | 1 | NA | TBD | 1/1 | 13+ |
| **Field:** | | | | | | |
| Dissolved oxygen | 10 | NA | NA | NA | NA | 10 |
| pH | 10 | NA | NA | NA | NA | 10 |
| Specific conductivity | 10 | NA | NA | NA | NA | 10 |
| Temperature | 10 | NA | NA | NA | NA | 10 |
| Turbidity | 10 | NA | NA | NA | NA | 10 |
| ORP | 10 | NA | NA | NA | NA | 10 |
| Water level | 10 | NA | NA | NA | NA | 10 |

1 See Table 4-9 of this approved FSP and Table 1-3 of the approved QAPP for the specific analysis requirements and constituents for the Demolition Range.
2 Field duplicates will be collected at a minimum frequency of 1 per 10 samples. Field duplicates are not applicable (NA) for field analyses obtained using a flow-through meter or water level meter.
3 Trip blanks are submitted for analysis at a frequency of one per cooler containing samples for volatile organics analysis. Volatile organics are not analyzed for the Demolition Range. Therefore trip blanks are not applicable (NA).
4 Ambient blanks will be collected at the discretion of the Field Operations Leader, to delineate site conditions. Because site conditions vary, totals are to be determined (TBD). Ambient blanks are not applicable for field analyses (NA).
5 MS and duplicate samples will be collected at a frequency of 1 per 20 samples. For inorganics, an MS and a sample duplicate will be collected, and for organics, an MS and an MSD will be collected. MS/MSDs and sample duplicates are not applicable for field analyses (NA).
6 Plus sign (+) indicates potential for the total number of samples to increase, due to TBD variables.

NA Not applicable
TOX Total organic halogens
TBD To be determined
VOCs Volatile organic compounds
TOC Total organic carbon
ORP Oxidation-reduction potential

### 4.3.1 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. The collection of source water blanks is not anticipated since source water blanks are only applicable if decontamination procedures are used in the field for sampling equipment. The use of decontamination procedures is not anticipated because dedicated equipment has been installed and will be used for sampling monitoring wells and the installation of new wells is not anticipated. If non-dedicated sampling equipment is used or if new wells are installed, one source water blank will be collected for each source of water used for decontamination.

### 4.3.2 Field Duplicates

Field duplicates are two samples from a single sampling location collected into two identical sets of sample bottles in the same order as described in SOPs 5 and 6 and analyzed for the same parameters. Field duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis methods employed. Field duplicates will be collected at a minimum frequency of 1 per every 10 samples. Field duplicates are not applicable for field measurements obtained using a meter but are applicable for field measurements obtained using field test kits. Field duplicates will be analyzed for the same parameters in the laboratory and will be labeled in order to make the identity of the duplicate unknown to the laboratory (see SOP 9).

### 4.3.3 Rinsate Blanks

Dedicated equipment will be used for this monitoring program. Therefore, the collection of equipment rinsate blanks is not anticipated unless it becomes necessary to install new monitoring wells or unless the use of non-dedicated equipment (e.g., bailers) for sampling becomes necessary due to unexpected circumstances. Equipment rinsate blanks are obtained under representative field conditions by running analyte-free water through sample collection equipment (bailer, split-spoon, corer, etc.) after decontamination and then placing the water in the appropriate sample containers for analysis. Equipment rinsate blanks are used to assess the effectiveness of decontamination procedures. Equipment rinsate blanks are collected at a frequency of 1 per every 10 samples, with a minimum of one per day of sampling per non-dedicated sampling device/instrument. Rinsate blanks are not required for wells in which dedicated sampling equipment is installed. This includes all the wells at the ABG, ORR, and DR,

as listed in Tables 4-1, 4-5, and 4-8. Rinsate blanks will not be collected for spring and surface water samples because a direct-fill method will be used for collection of spring and surface water samples. Therefore, collection of rinsate blanks will not take place. Rinsate blanks are not applicable for field analyses.

### 4.3.4 Trip Blanks

Trip blanks are used to assess the potential for contamination resulting from contaminant migration into sample bottles/jars during sample shipment and storage. Trip blanks pertain to VOCs only. Trip blanks are prepared by the laboratory prior to the sampling event, shipped to the site with the sample containers, and kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other VOC samples and sent for analysis. One trip blank will be included in each sample shipping container (i.e., cooler) that contains samples for VOC analysis. At no time after trip blank preparation are trip blank sample containers opened before they reach the laboratory. Because the number of sample coolers shipped varies, totals are to be determined in the field.

### 4.3.5 Ambient Blanks

Ambient blanks are collected in the field and analyzed to check for interfering contaminants that could potentially be present in ambient air at the sampling site (e.g., VOCs in an area where fumes are typically present or metal particulates on a windy day in a dry, dusty area). Ambient blanks are collected at the sampling location(s) by placing analyte-free water directly into the same types of containers, preserved, and stored in the same manner as field samples. The exposure of ambient blanks to ambient conditions should be similar to the ambient exposure of field samples. Ambient blanks will be collected based on conditions at the time of sampling, at the discretion of the FOL, as needed to delineate site conditions. Because site conditions vary, totals are to be determined. Ambient blanks are not applicable for field analyses.

### 4.3.6 Matrix Spikes/Duplicates

Matrix spikes are investigative samples analyzed to provide information about the effect of the sample matrix on the digestion and measurement methodology. Matrix spike (MS) and matrix spike or sample duplicate samples will be collected at a frequency of 1 per every 20 samples; for inorganics, an MS and a sample duplicate will be collected; and for organics, an MS and a matrix spike duplicate (MSD) will be collected. Extra sample volume must be collected for samples designated for MS/MSD analyses for VOCs and extractable organics. Specific details regarding extra sample volume required for MS/MSD

samples are provided for each applicable analytical fraction in Table 4-10. MS/MSDs and sample duplicates are not applicable for field analyses.

## 4.4 ANALYTICAL LABORATORY CAPACITY

Careful coordination with the analytical laboratory will be required throughout the project in order not to exceed the capacity of the laboratory to perform the analysis. The schedule for analysis will be developed jointly with the laboratory at the time the bottle request is made for a sampling round.

## 4.5 CALIBRATION PROCEDURES AND FREQUENCY

Instruments used in the field will be calibrated according to the procedures described in the SOPs and equipment manuals appended to this approved FSP. Calibration will be documented on an Equipment Calibration Log (SOP 11). During calibration, an appropriate maintenance check will be performed on each piece of equipment. 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 will be removed from service until the defective parts are repaired or replaced.

Calibration of equipment at the analytical laboratory is addressed in the approved QAPP.

## 4.6 PERFORMANCE AND SYSTEM AUDITS

System audits will be performed, as appropriate, to ensure that the work is being implemented in accordance with the approved project SOPs and in an overall satisfactory manner.

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

- A formal audit of the field sampling procedures will be conducted in accordance with the approved QAPP.

- U.S. EPA, IDEM, and the Navy may perform an audit of field procedures at any time.

## 4.7 PREVENTIVE MAINTENANCE

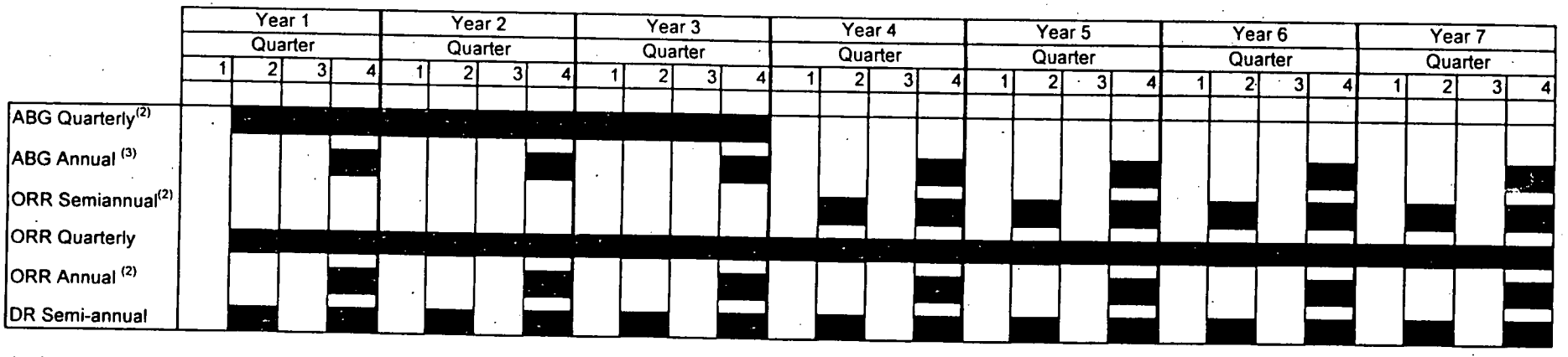
All field measurement equipment is rented from a vendor and is calibrated before use in the field in accordance with the equipment manual. As described in Section 4.5, an appropriate maintenance check will be performed for each piece of equipment during calibration. Any equipment that does not calibrate properly is not used and will be returned to the vendor for replacement. Therefore, preventive maintenance of field equipment is not required while in the field.

# 5.0 PROJECT SCHEDULE

This section provides a project schedule for the implementation of the long-term ground water monitoring at the ABG, including the Surface Impoundments and Waste Pile (both currently in the closure process), ORR, DR, and OJT to be performed at the NSWC-Crane, Indiana. The ground water monitoring plan will be performed during the operating life of the unit and any closure and post-closure periods. Within this period, quarterly, semiannual and annual ground water sampling events will take place for the ABG, quarterly and annual sampling will take place for the ORR and semiannual sampling will take place for the DR. Figure 5-1 shows the milestone sampling events. Dedicated well pumps will be installed during the first quarterly sampling event.

**FIGURE 5-1**

**MONITORING SCHEDULE[1]**
**NAVAL SURFACE WARFARE CENTER**
**CRANE, INDIANA**




1 Monitoring will continue throughout the operating life of the units and the closure and post-closure periods.
2 Quarterly monitoring will take place for a minimum of three years or one year after soil removal and cleanup is complete, whichever is later. Seminannual monitoring will then begin.
3 NSWC Crane will request a modified suite of Annual Appendix IX analytes after the first year of monitoring.

# REFERENCES

Brown & Root Environmental, 1997. RCRA Air Quality Assessment at the Ammunition Burning Grounds, Old Rifle Range, and Demolition Ground, Naval Surface Warfare Center, Crane, Indiana. Pittsburgh, PA.

Dunbar, Joseph B., 1982. Hydrogeologic Investigation of Waste Disposal Sites at the Naval Weapons Support Center, Crane, Indiana. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Hunt, Richard W., 1988. Geology and Hydrogeology of the Ammunition Burning Ground, Crane Naval Weapons Support Center, U.S. Army Corps of Engineers, Waterways Experiment Station.

Murphy, W.L., November 1995. Draft RCRA Facility Investigation, Phase II Ground Water Release Assessment, SWMU 06/09 Demolition Area, and Phase III Release Characterization SWMU 07/09 Old Rifle Range, Naval Warfare Center Crane, Indiana. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Murphy, W.L., and R. Wade, 1995. Draft Report, RCRA Facility Investigation Phase II Ground Water Release Assessment, SWMU 06/09 Demolition Area and Phase III Release Characterization SWMU 07/09 Old Rifle Range, Vol. I, Naval Surface Warfare Center, Crane, Indiana. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Murphy, W.L., and R. Wade, 1995. Draft Report, RCRA Facility Investigation Phase II Ground Water Release Assessment, SWMU 06/09 Demolition Area and Phase III Release Characterization SWMU 07/09 Old Rifle Range, Vol. II Appendices, Naval Surface Warfare Center, Crane, Indiana. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Murphy, William L., 1994. Final Report, RCRA Facility Investigation, Phase III, Ground Water Release Characterization, SWMU 03/10, Ammunition Burning Ground, Vol. 1: Main Text, Figures, Tables, and Appendices. Technical Report GL-94-15, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

NEESA, (Naval Energy and Environmental Support Activity), May 1983. Initial Assessment Study of Naval Weapons Support Center Crane, Indiana. Port Hueneme, CA.

NFESC, February 1996. Naval Installation Restoration Laboratory Quality Assurance Guide. NFESC Interim Guidance Document.

Palmer, Arthur N. 1989. A Hydrologic Study of Indiana Karst, Ph.D. Thesis. Indiana University.

Rust Environment and Infrastructure, July 1997. Environmental Data Assessment Memorandum for SWMUs #03/10, #06/09, and #07/09, Naval Surface Warfare Center, Crane Division. Minneapolis, MN.

Tetra Tech NUS, Inc., 1998a. Quality Assurance Project Plan for RCRA Ground Water Monitoring at the Ammunition Burning Grounds, Old Rifle Range, and Demolition Range, Naval Surface Warfare Center Crane Division, Crane, Indiana. Pittsburgh, PA.

Tetra Tech NUS, Inc., 1998b. Ground Water Monitoring Plan for RCRA Ground Water Monitoring at the Ammunition Burning Grounds, Old Rifle Range, and Demolition Range, Naval Surface Warfare Center Crane Division, Crane, Indiana. Pittsburgh, PA.

U.S. EPA, March 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Environmental Monitoring and Support Laboratory Office of Research and Development. Cincinnati, OH.

U.S. EPA, 1986a. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD). OSWER-9950.1. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA, 1986b. Test Methods for Evaluating Solid Waste; Physical/Chemical Methods (SW-846), 3rd edition, up to and including Update III. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA, August 1994. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Draft Interim Final. EPA QA/R-5. U.S. EPA Quality Assurance Management Staff, Washington, DC.

U.S. EPA, 1994a. U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA-540/R-94/012. Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA, 1994b. U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA-540/R-94/013. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA, 1995. Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, ILM04.0. Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA Region 5, Apirl 1998. Region 5 QAPP Policy. Waste, Pesticides, and Toxics Division, Chicago, IL.

U.S. EPA Region 5, August 1993a. Region 5 Standard Operating Procedure for Validation of CLP Organic Data. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

U.S. EPA Region 5, September 1993b. Region 5 Standard Operating Procedure for Validation of CLP Inorganic Data. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

U.S. EPA Region 5, September 1995. EDQL, PQL Values for All Media. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

U.S. EPA Region 5, December 1995. USEPA Region 5 Waste Management Branch RCRA Data Quality Levels. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

# APPENDIX A

# BORING LOGS

THIS APPENDIX HAS BEEN MOVED TO VOLUME 2 OF THE FSP FOR SPACE CONSIDERATIONS.

# APPENDIX B

# STANDARD OPERATING PROCEDURES

# STANDARD OPERATING PROCEDURES

## TABLE OF CONTENTS


| SOP Number | Title |
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| 3 | PUMP INSTALLATION AND REMOVAL |
| 4 | WELL PURGING AND STABILIZATION |
| 5 | MONITORING WELL SAMPLING |
| 6 | SURFACE AND SPRING WATER SAMPLING |
| 7 | FIELD TEST KIT ANALYSIS |
| 8 | DECONTAMINATION OF FIELD SAMPLING EQUIPMENT |
| 9 | SAMPLE IDENTIFICATION NOMENCLATURE |
| 10 | SAMPLE PRESERVATION, PACKAGING, AND SHIPPING |
| 11 | SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES |

# STANDARD OPERATING PROCEDURE NUMBER 1

# INSPECTION OF EXISTING MONITORING WELLS

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish procedures for the inspection of existing monitoring wells.

The 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 Form**: A copy of the monitoring well inspection form can be found in SOP 11.

**Bound Field Logbook**

**Well keys**

## 3.0 INSPECTION PROCEDURES

3.1 Record the well identification (ID), date, and time on the Monitoring Well Inspection Form. The well identification on the tag for some wells has the prefix WES (Waterways Experiment Station) and the year the well was installed. For example, well 06C02 is identified on the well ID tag as WES 06C02 86. Do not record the prefix or the year installed. Only use the well ID listed in this approved Field Sample Plan. In this example, the ID is 06C02.

3.2 Record the condition of the well ID tag. Is the tag in place and legible?

3.3 Record the condition of the protective casing, caps, and lock. Has the casing, cap, 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 pads (if a pad is present). Some NSWC Crane wells will have concrete pads or gravel pads. Check the condition of the pad and note any changes. Are concrete pads 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 Record the condition of dedicated sampling equipment. All wells have dedicated sample pumps. Confirm that the pump is in place and appears to be in working order (pump will be operated during sampling and this will be a final check).

3.9 Inspect and record the condition of the polyvinyl chloride (PVC) riser pipe and the surveyed reference point. The surveyed reference point is a V-notch on the top of the PVC riser pipe.

3.10 Record the number of the monitoring well inspection form used in the Field Logbook.

# STANDARD OPERATING PROCEDURE NUMBER 2

# MEASUREMENT OF WATER LEVELS IN MONITORING WELLS

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish procedures for determining water levels in monitoring wells.

The 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 Form**: A copy of the Ground Water Level Measurement Form is included in SOP 11.

**Bound Field Logbook**

**Photoionization detector (PID) with an 11.7 eV lamp**: The manual for the operation of the PID 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 feet. General instructions for operation of electronic water-level indicators are provided in Appendix C of this approved Field Sampling Plan.

**Interface meter**: The interface meter must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 feet. The interface meter is required only if analytical data from the previous round indicated the presence of Light Non-Aqueous Phase Liquids (LNAPL). Interface meters would be used in place of the electronic water-level indicators. Instructions for operation of the interface meters are printed on the side of the meter or supplied by the vendor.

**Decontamination supplies**: SOP 8 describes decontamination procedures including decontamination supplies.

## 3.0 WATER-LEVEL MEASUREMENT PROCEDURES

3.1 Check the operation of the electronic water-level indicator or interface meter.

3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water Level Measurement Form. A copy of this form can be found in SOP 11.

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 PVC riser pipe as follows:

1. Calibrate the PID in accordance with the calibration procedures described in the HASP.

2. Insert the PID sample inlet straw through the opening in the pump cap assembly and approximately 3 inches into the riser pipe.

3. Record the meter 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 reading is below the level specified in the HASP before proceeding to step 3.6.

3.6 Insert the water-level meter probe (or interface meter probe) through the opening in the pump cap assembly. (The probe must be decontaminated before use, according to the procedures in SOP 8.)

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. (If the interface probe is used, the first audible and/or visible signal will indicate the LNAPL layer and the second signal will be the water layer.)

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. (If the interface probe is used, the LNAPL and ground water level measurements are both read.)

3.9 Record the water-level measurement on the Ground Water Level Measurement Form. (If the interface probe is used, record the readings for the LNAPL layer and the water layer.)

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 SOP 8.

3.13 Containerize any decontamination fluids and personal protective equipment (PPE) in accordance with the procedures described in Section 4.2.9 of this approved Field Sampling Plan.

# STANDARD OPERATING PROCEDURE NUMBER 3

# PUMP INSTALLATION AND REMOVAL

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish procedures for installation of low-flow bladder pumps into monitoring wells. This SOP also establishes the procedure for the removal of these pumps from wells when necessary for well or pump maintenance and reinsertion of the pump into the well.

The 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 pump installation and removal.

**Bound Field Logbook**

**Plastic sheeting**

**Surgical gloves**

**Well key**

**Teflon®-lined PVC bladder pump**: Well Wizard® Pump model P1150, constructed of polyvinyl chloride (PVC) and Teflon®, manufactured by QED Environmental Systems or equivalent. The pump dimensions are 1.66 inches in diameter and 19.5 inches in length, with a pump volume of 0.130 liters. The equipment manual for this pump can be found in Appendix C of this approved Field Sampling Plan.

**Teflon®-lined polyethylene tubing**

**Sample-line freeze protector**

**Sample discharge adapter**

**2-inch well cap assembly**

## 3.0 PUMP INSTALLATION PROCEDURES

3.1 Obtain information on the total depth of the well, static water level, depth of the screened interval, and the length of the screen.

3.2 Calculate the length of Teflon®-lined tubing necessary to position the pump within the screened interval of the monitoring well (the pump supplier will assist with this task).

3.3 Order the Teflon®-lined bladder pump from the manufacturer with Teflon®-lined tubing factory cut to length and attached to both the pump and well cap. Specify the required tubing length. Also specify that the pump must be tested for United States Environmental Protection Agency (U.S. EPA) priority pollutant parameters.

3.4 When the pump assembly (pump, attached tubing, and well cap) is received from the manufacturer, remove the pump from the protective shipping bag. Examine the pump assembly. Examine all fittings and connections for tightness. Check the threaded PVC screen to insure that it is snug.

3.5 Each pump will be accompanied by a certification from the manufacturer. Record on the certification the identification of the well in which the pump is to be installed. Record in the Field Logbook the manufacturer's name, date of manufacturer's certification, pump model, batch serial number, and identification of the well in which the pump was installed.

3.6 Place the pump assembly into the shipping bag or lay the pump on clean plastic next to the monitoring well into which the pump assembly is to be installed. Wear clean, disposable surgical gloves while handling the pump assembly.

3.7 Unlock the well.

3.8 Insert the pump into the 2-inch PVC 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. Wear clean, disposable surgical gloves while handling the pump assembly.

3.9 Replace the outer protective cap and lock the well.

## 4.0 PUMP REMOVAL AND REPLACEMENT PROCEDURES

4.1 Spread approximately ten square feet of clean plastic sheeting next to the well.

4.2 Unlock and open the well.

4.3 Pulling on the well cap assembly, slowly remove the pump and tubing from the well. As the tubing is being removed from the well, coil the tubing into a manageable size. When the tubing, pump, and cap have been removed from the well, secure the coil of tubing using string or plastic wire ties and lay it on the plastic sheeting. Wear clean, disposable surgical gloves while handling the pump assembly.

4.4 If the pump is to be removed from the site and later reinserted into the well, attach a label to the pump. On the label record the identification of the well from which the pump was removed. Place the pump and tubing into a plastic bag and also label the outside of the bag. Wear clean, disposable surgical gloves while handling the pump assembly.

4.5 If the pump is removed for more than a short time (e.g. a few hours) and will not be removed from the location of the monitoring well, place the pump, tubing, and cap into a clean plastic bag until the pump is reinstalled.

4.5 Reinsertion of the pump is accomplished by following steps 3.7 and 3.8.

4.6 Record activities in the bound Field Log Book.

# STANDARD OPERATING PROCEDURE NUMBER 4

# 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.

The 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 and instructions for its completion are included in SOP 11.

**Ground Water Sample Log Sheet**: A copy of this form and instructions for its completion are included in SOP 11.

**Bound Field Logbook**

**Photoionization detector (PID) with an 11.7 eV lamp:** The manual for the operation of the PID is found in the Health and Safety Guidance Manual.

**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 feet. General instructions for operation of electronic water-level indicators are provided in Appendix C.

**Electronic Programmable Controller, model 400:** This controller regulates the dedicated bladder pump. The manual for the operation of the controller is found in Appendix C.

**Cylinder of compressed nitrogen with regulator:** Compressed gas serves as the power source for the bladder pump.

**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. The manual for operation and calibration of this unit is found in Appendix C.

**Flow-through cell adapter for water quality meter**

**Purge water containers:** Eight-gallon plastic containers with lids.

**Graduated cylinder and stopwatch:** Used to calculate flow rate.

**Decontamination supplies**: SOP 8 describes required decontamination supplies.

## 3.0 PROCEDURES FOR WELL PURGING

3.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate as per manufacturer's requirements the above equipment as necessary (equipment manuals can be found in Appendix C).

3.2 Follow steps 3.1 through 3.9 in SOP 2 to obtain a static-water-level measurement of the well to be purged. Record the information on the Ground Water Sample Log Sheet and the Low-Flow Purge Data Sheet. Leave the water-level meter suspended in the well casing.

3.3 Calculate one well casing volume as follows:

1. Obtain the total depth of the well from Table 3-1 of this approved Field Sampling Plan.

2. Using the static water level determined in 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 that 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 |

Note: For wells of 1-inch radius (4-inch diameter) V = 0.652 gallons per foot of water column.

3.4 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 is contained in Appendix C). The pump controller must be turned off when being connected.

3.5 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.

3.6 Following the instructions found in the water-quality meter manual, connect the flow-through cell to the pump discharge line (at the well cap).

3.7 Place the discharge tubing from the flow-through cell to direct the purge water discharge into the graduated cylinder or purge-water container.

3.8 Following the instructions in the pump controller manual, start pumping water from the well.

3.9 Start with the initial pump rate set at approximately 0.1 liters per minute. Use the graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 feet during purging. If no drawdown is noted, the pump rate may be increased (to a max of 0.4 liters per minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If ground water is drawn down below the top of the well 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 8-hour 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 changes from quarter to quarter
- Varying quality assurance (QA) sample requirements from quarter to quarter
- Variable pump rates

Normally, the time from the start of purging to the end of sampling will be between 1.5 and 6.0 hours.

3.10 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.

3.11 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.

3.12 Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

3.13 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.

3.14 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.

If there is a need to leave a well during purging as a result of Navy activities (e.g. open burning or open detonation) or any other reason, there are two options. One, if the sampler must move for 30 minutes or less but still has a line of sight to the well, the sampler may leave the pump running and watch the well until the sampler is able to return to the well. Two, if, for whatever reason, the sampler must stop purging for an extended period of time or a line of sight cannot be maintained, the pump and cell will be shut-down. All equipment and supplies will be loaded into the sample vehicle, and the well will be secured before departing. In both cases, the time purging was stopped and restarted will be noted on the Low-Flow Purge Data Sheet.

3.15 Rinse the flow-through cell and water quality meter probes with deionized water and pack the cell and meter for transport.

# STANDARD OPERATING PROCEDURE NUMBER 5

# 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 are used for ground water sampling at the Ammunition Burning Grounds (ABG), Old Rifle Range (ORR), and Demolition Range (DR). Each monitoring well sampled at the ABG, ORR, and DR is equipped with a dedicated, 1.66-inch-diameter bladder pump and dedicated Teflon®-lined polyethylene tubing. Therefore, this procedure is designed for sampling using dedicated sampling equipment.

The 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.

**Numbered Ground Water Sample Log Sheet**: A copy of this form along with instructions for its completion are included in SOP 11.

**Bound Field Logbook**

**Labeled sample containers**: See SOP 9 for sample identification procedures and SOP 11 for contents of labels.

**Numbered tag for each sample container**

**0.45 micron filter assembly**: These are single-use filters used to filter samples scheduled for dissolved metals or dissolved phosphorus analysis. The filters are discarded after one use.

**Electronic Programmable Controller, Model 400**: The programmable controller regulates the dedicated bladder pump. The manual for the operation of the controller is found in Appendix C of this approved Field Sampling Plan.

**Cylinder of compressed nitrogen with regulator**: Compressed gas is the power source for the dedicated bladder pump.

**Plastic storage bags**

**Shipping containers**

## 3.0 MONITORING WELL SAMPLING PROCEDURES

3.1 Before the well is sampled, the inspection procedures described in SOP 1, the water-level measurements described in SOP 2, and the well-purging procedures described in SOP 4 must be completed. Initiate sampling when the well is stabilized in accordance with SOP 4.

3.2 Record the sample start time (using military time) on the Ground Water Sample Log Sheet.

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 time that the sample container was filled on the numbered Ground Water Sample Log Sheet and on the numbered sample tag.

3.6 Using a wire tie, secure the associated numbered 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 3.1 through 3.8 for each sample container collected.

3.9 The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Ground Water Sample Log Sheet.

3.10 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. Table 4-10 of this approved Field Sampling Plan includes information on preservation requirements. All samples will be collected in the following sequence (where applicable):

Volatile organic compounds (VOCs)
Dissolved gases (methane, ethene, and ethane)
Sulfide
Total organic halogens (TOX)
Semivolatile organics (SVOCs)
Explosives
Total Metals
Cyanide
Pesticides/PCBs
Herbicides
Dioxins/furans
Total organic carbon (TOC)
Sulfate
Ammonia
Chloride
Total phosphorous
Dissolved phosphorous
Dissolved metals

Samples for field analyses may be taken at any time after the monitoring well is determined to be stable.

3.11 Sample containers for volatile constituents (VOCs, dissolved gases, and TOX) must be completely filled so that no headspace exists in the container.

3.12 Use a single-use, disposable, in-line 0.45-micron filter cartridge to collect filtered samples. Attach the filter cartridge to the discharge end of the pump tubing. Prior to filling containers with filtered

sample, rinse the filter cartridge with approximately 100-ml of water from the well to be sampled. Direct the discharge from the filter cartridge into the sample bottle and collect the filtered sample.

3.13 Types of sample containers, sample volume, preservation requirements, and holding times are summarized in Table 4-10 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.

3.14 After sampling has been completed, follow the instructions in the pump manual How to Use the Freeze Protection Kit and complete the freeze protection steps.

3.15 Remove the sample discharge tubing by unscrewing it from the well cap. Store the tubing in the well (suspended in the well cap access hole). Care must be taken not to contaminate the exterior of the tubing (via contact with the ground or clothing) while conducting this activity. Wear clean, disposable surgical gloves while handling the discharge tubing.

3.16 Replace the outer protective well cap and lock the well.

3.17 Record the number(s) of the Ground Water Sample Log Sheet in the Field Logbook.

3.18 All equipment should be cleaned and packed into the sample vehicle for transport.

# STANDARD OPERATING PROCEDURE NUMBER 6

# 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.

The 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 and spring sampling.

**Numbered Surface Water Sample Log Sheet**: A copy of this form is included in SOP 11.

**Bound Field Logbook**

**Numbered 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 manual for the operation and calibration of this meter is found in Appendix C.

**Dedicated/disposable sample containers**: Dedicated/disposable sample containers are used to fill sample containers and transport sample(s) to a pump for filtering.

**Labeled sample containers**: See SOP 9 for sample identification procedures and SOP 11 for contents of labels.

**0.45 micron filter assembly**: These are single-use filters used to filter samples scheduled for dissolved metals or dissolved phosphorus analysis. The filters are discarded after one use.

**Silicon tubing**

**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 and spring water samples. Sampling will start at the downstream location and proceed to the farthest upstream location. Reference figures for all four locations are included in this SOP for exact sample locations. The sampling sequence will be as follows:

| LOCATION | LOCATION ID |
|---|---|
| Little Sulphur Creek at site Boundary | A CRB |
| Little Sulphur Creek Below Spring A | A CRA |
| SPRING A | A SPRA |
| SPRING C | A SPC |

3.2 Gently remove any leaves or twigs that have accumulated in the sample pool area since the last sampling event in a manner that will not disturb the sediment but will allow for sample volumes to be taken.

3.3 Estimate the flow rate of the stream or spring 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.

3.4 Record the sample time (using military time) on the Surface Water Sample Log Sheet and sample container labels.

3.5 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.

3.6 Record the readings from the Surface Water Sample Log Sheet in the Field Logbook.

3.7 If the sample can be obtained from the shore, begin sampling using a dedicated, clean, unpreserved, 1-liter glass 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.

3.8 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, one-liter glass 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.

3.9 Transfer the contents of the collection bottle to the sample container and cap the sample container.

3.10 Record the time that the sample container was filled on the numbered Surface Water Sample Log Sheet and on the numbered sample tag.

3.11 Using a wire tie, secure the numbered tag to the sample container

3.12 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.

3.13 Repeat steps 3.3 through 3.12 until all the sample bottles have been filled.

3.14 All samples will be collected into pre-preserved bottles (if required for preservation) supplied by an approved laboratory. Table 4-10 of this approved Field Sampling Plan includes information on the preservative requirements. All samples will be collected in the following sequence (where applicable):

- Volatile organic compounds (VOCs)
- Dissolved gases (methane, ethene, and ethane)
- Sulfide
- Total organic halogens (TOX)
- Semivolatile organics (SVOCs)
- Explosives
- Total metals
- Cyanide
- Pesticides/PCBs
- Herbicides
- Dioxins/furans
- Total organic carbon (TOC)
- Sulfate
- Ammonia
- Chloride
- Total phosphorous
- Dissolved phosphorous
- Dissolved metals

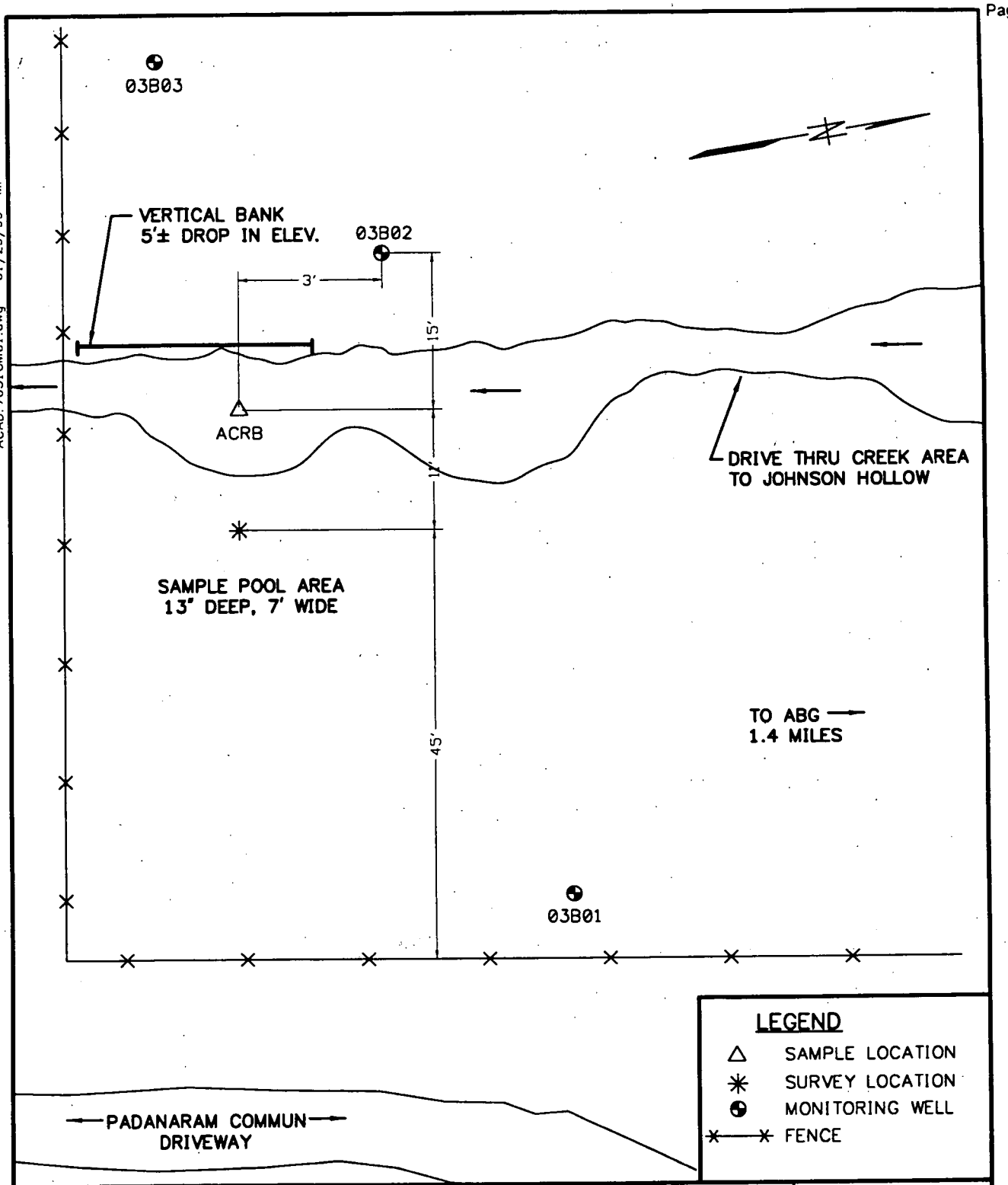
Samples for field analyses may be taken at any time.

3.15 Sample containers for volatile constituents (VOCs, dissolved gases, and TOX) must be completely filled so that no headspace exists in the container.

3.16 Fill two 1-liter unpreserved polyethylene bottles. Use these bottles to transfer sample for field filtering. Set up a peristaltic pump (see manual in Appendix C) for filtering of the dissolved metals and dissolved phosphorus 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.

3.17 All samples will be collected into pre-preserved bottles (if required for preservation) supplied by an approved laboratory. Table 4-10 of this approved Field Sampling Plan includes information on preservative requirements.

3.18 Clean all equipment and load the equipment and the sample cooler in the sample vehicle for transport.

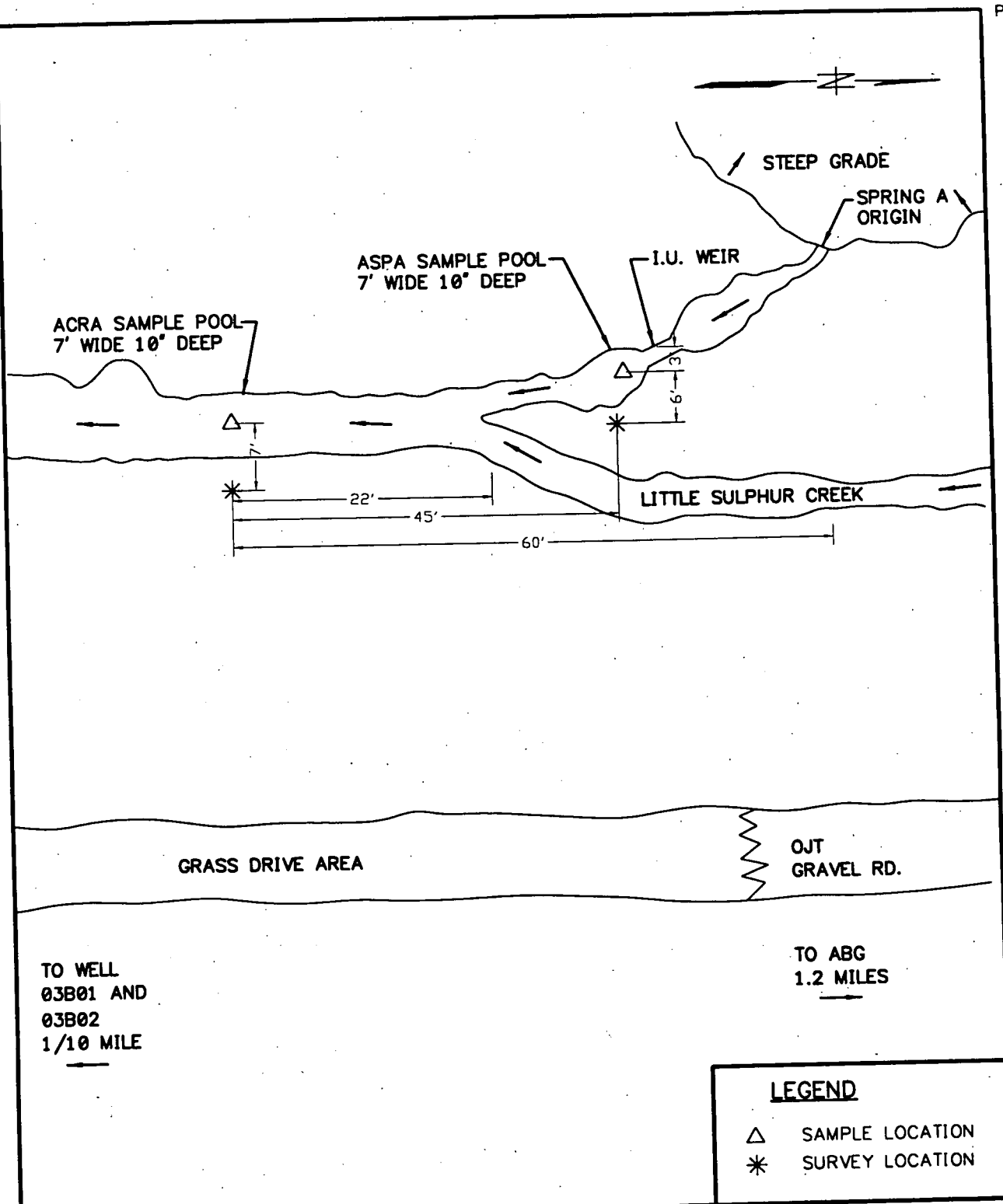



ACAD: 7651CM01.dwg 01/29/99 MF

| | | | |
|---|---|---|---|
| DRAWN BY KW DATE 12/28/98 | Tetra Tech NUS, Inc. | CONTRACT NO. 7651 | OWNER NO. |
| CHECKED BY DATE | LITTLE SULPHUR CREEK AT BOUNDARY NSWC CRANE | APPROVED BY | DATE |
| COST/SCHED-AREA | | APPROVED BY | DATE |
| SCALE NOT TO SCALE | | DRAWING NO. FIGURE 1 | REV. 0 |

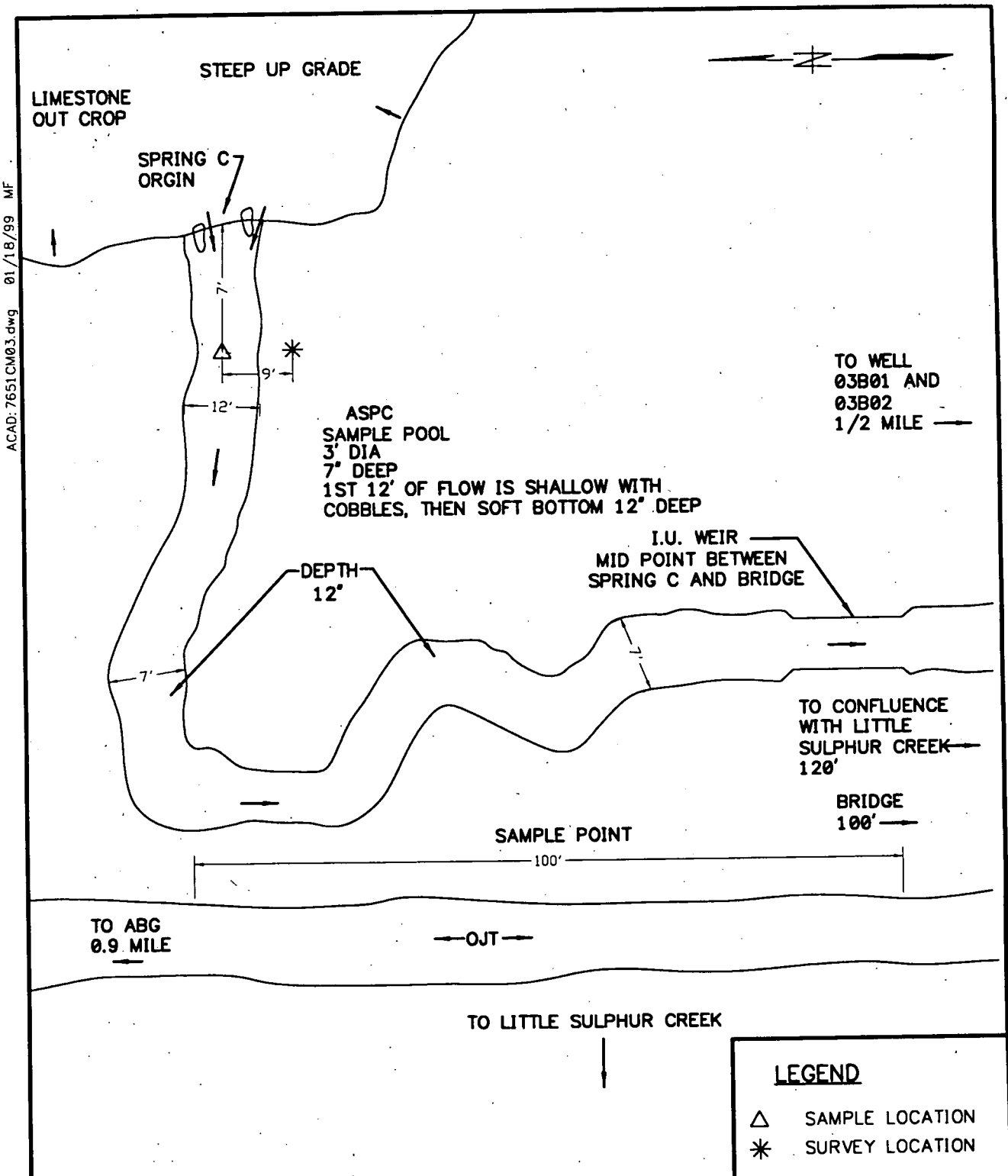
FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

ACAD: 7651CM02.dwg 01/18/99 MF




| | | | |
|---|---|---|---|
| DRAWN BY KW DATE 12/24/98 | Tetra Tech NUS, Inc. | CONTRACT NO. 7651 | OWNER NO. |
| CHECKED BY DATE | SAMPLE LOCATION SPRING A AND LITTLE SULPHUR CREEK BELOW SPRING A NSWC CRANE | APPROVED BY | DATE |
| COST/SCHED-AREA | | APPROVED BY | DATE |
| SCALE NOT TO SCALE | | DRAWING NO. FIGURE 2 | REV. 0 |

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

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|---|---|---|---|
| DRAWN BY KW DATE 12/28/98 | Tetra Tech NUS, Inc. | CONTRACT NO. 7651 | OWNER NO. |
| CHECKED BY DATE | SPRING C NSWC CRANE | APPROVED BY | DATE |
| COST/SCHED-AREA | | APPROVED BY | DATE |
| SCALE NOT TO SCALE | | DRAWING NO. FIGURE 3 | REV. 0 |

FORM CADD NO. TtNUS_AV.DWG - REV 0 - 1/22/98

ACAD: 7651CM03.dwg 01/18/99 MF

CTO 0038

089711/P

# STANDARD OPERATING PROCEDURE NUMBER 7
# 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 groundwater, spring water, and surface water using field test kits. The following parameters are included in this SOP:

- Alkalinity
- Dissolved Carbon Dioxide
- Dissolved Oxygen
- Ferrous Iron
- Nitrite
- Nitrate
- 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, along with instructions for completing this form, can be found in SOP 11.

**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 (copies of procedures are attached in Appendix C).

| Parameter | Make | Model | Method Number | Equipment/ Method Chemistry |
|---|---|---|---|---|
| Alkalinity | HACH | AL-DT | HACH 8203<br>SM 2320 | Digital Titration /<br>Sulfuric Acid, Phenolphthalein |
| Carbon Dioxide | HACH | CA-DT | HACH 8205 | Digital Titration /<br>Sodium Hydroxide, Phenolphthalein |
| Dissolved Oxygen | HACH | OX-DT | HACH 8215<br>EPA 360.1 | Digital Titration/<br>Azide modification to Winkler |

| Parameter | Make | Model | Method Number | Equipment/ Method Chemistry |
|---|---|---|---|---|
| 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 |
| Hydrogen Sulfide | HACH | DR-850 | HACH 8131 EPA 376.2 | Colorimeter / Methylene Blue |

## 3.0 FIELD ANALYTICAL PROCEDURES

### 3.1 GENERAL

For specific analytical procedures, the procedures for each of the individual analyses are attached in Appendix C. The procedures give a detailed explanation on how to perform each particular method, and include information on sampling/storage, accuracy checks, standard additions methods, interference, reagents, and apparatus.

Prior to analysis, ground water samples will be collected in accordance with SOP 5. Surface and spring water samples will be collected in accordance with SOP 6.

### 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 additions, standard solutions, field duplicates, and reagent blank correction. The procedures attached in Appendix C 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 standard additions accuracy checks do not fall within 5 percent of the expected range, the apparatus and procedures will be evaluated. If the apparatus is found faulty, the apparatus will be replaced and the associated data will be flagged as estimated. If new apparatus is immediately available, the samples will be reanalyzed. 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 Addition | Standard Solution | Field Duplicate | Reagent Blank Correction |
|---|---|---|---|---|
| Alkalinity | 1 per round | None | 1 per 10 | None |
| Carbon Dioxide | 1 per round | None | 1 per 10 | None |
| Dissolved Oxygen | None | None | 1 per 10 | None |
| Ferrous Iron | None | None | 1 per 10 | None |
| Nitrite | None | 1 per round | 1 per 10 | 1 per lot |
| Nitrate | 1 per round | 1 per round | 1 per 10 | 1 per lot |
| Hydrogen Sulfide | None | 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. |
| Nitrate | Utilize standard sampling techniques; filter if visibly turbid | May hold for 48 hr. at 4°C; warm to room temperature before analysis. |
| Hydrogen Sulfide | Avoid agitation and exposure to air | Analyze immediately. |

# STANDARD OPERATING PROCEDURE NUMBER 8

# DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedures to be followed when decontaminating non-dedicated field sampling equipment.

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Field Logbook**

**Potable water**

**Deionized water**

**LiquiNox detergent**

**Brushes, spray bottles, paper towels, etc.**

## 3.0 DECONTAMINATION PROCEDURES

3.1 Decontaminate non-dedicated sampling equipment prior to field sampling and between samples.

3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.3 Wash the equipment with a solution of LiquiNox detergent. Prepare the LiquiNox wash solution in accordance with the instructions on the LiquiNox container. Collect the LiquiNox wash solution into a container. Use brushes or sprays as appropriate for the equipment.

3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the deionized water rinsate into a container.

3.6 Remove excess water by air drying, shaking, or by wiping with paper towels as necessary.

3.7 Document decontamination by recording it in the Field Logbook.

3.8 Containerized decontamination solutions will be managed in accordance with the procedures described in section 4.2.9 of this approved Field Sampling Plan.

# STANDARD OPERATING PROCEDURE NUMBER 9

# 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. The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by matrix
- Maintenance of consistency (field, laboratory, and data base sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of identification and direct link to site, location, quarter, event, 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**: Each sample tag will be numbered.

**Sample container labels**: Each label will be numbered the same number as the associated sample tag.

## 3.0 SAMPLE IDENTIFICATION NOMENCLATURE

### 3.1 MONITORING SAMPLES

All monitoring samples taken as part of this approved Field Sampling Plan at NSWC Crane will be properly labeled with a sample label affixed to the sample container and a sample tag tied around the neck of the sample container. Each sample will be assigned a unique sample tracking number. The sample tracking

number will consist of a four- or five-segment alpha-numeric code that identifies the sample site, location, quarter identifier, year, and, where applicable, whether the sample is filtered.

The alphanumeric coding to be used in the NSWC sample system is explained in the diagram and the subsequent definitions:

| **A** | **ANN** or **ANNAN** | **NA** | **NN** | **A** |
|---|---|---|---|---|
| Site ID | Location | Quarter and resample event code | Year | Filtered (When applicable) |

**Character Type:**

A = Alpha
N = Numeric

**Site ID:**

Monitoring locations at the four sites. The site IDs of the four units are

A = Ammunition Burning Grounds (ABG)
O = Old Rifle Range (ORR)
D = Demolition Range (DR)
J = Old Jeep Trail (OJT)

**Location:**

The location is either the well number or the surface location (monitoring point) ID. An alpha code only is used for the four surface locations' character type (see table below). The well number is used to identify the location of monitoring wells. A complete list of well and surface IDs and their corresponding location codes are listed in Table 1. Surface location abbreviations are listed as follows:

CR = Little Sulphur Creek
A = Below Spring A
B = Boundary
SPA = Spring A
SPC = Spring C

**Quarter and Sample Event Code**

The quarter during which a sample is taken shall be noted. The numbers 1, 2, 3, and 4 correspond to the calendar quarter during which the initial sample was taken. Each sample event associated with a quarter is given a letter designation. The first scheduled event is always given the letter A. If it is necessary to conduct a confirmation sampling event for a monitoring point, the second sample associated with the monitoring point will be given the letter B, the third C, etc. The quarter code for confirmation sampling events will be the same as the quarter to which the resampling applies. For example, if there is a need for confirmation sampling for a sample taken in the fourth quarter and the resampling will take place in the first quarter of the next calendar year, the quarter code would remain a four and the year would not change.

**Year**

A two-digit number will be used to denote the year in which the sample was taken. The only exception will be for a confirmation-sampling event associated with the sampling event occurring the previous year. For example,
1999 = 99
2000 = 00 etc.

**Filtered**

F = Filtered dissolved; no entry in this segment signifies an unfiltered (total) sample.

### 3.1.1 Examples of Sample Nomenclature

The ground water sample collected from monitoring well 03C17 at the ABG during the second quarter sampling in 1999 for an unfiltered sample would be designated as

A C17 2A 99.

The ground water sample collected from monitoring well 03C17 at the ABG during the second quarter sampling in 1999 for a filtered sample would be designated as

A C17 2A 99 F.

A confirmation sample of this same well for a filtered sample would be designated as

A C17 2B 99 F.

A surface water sample collected from Spring A at the Ammunition Burning Grounds during the fourth quarter of 2002 for an unfiltered sample would be designated as

A SPA 4A 02.

A ground water sample collected from monitoring well 06C11P2 at the Old Rifle Range during the fourth quarter sampling in 2003 for an unfiltered sample would be designated

O C11P2 4A 03.

A resample of this same location taken in the first quarter of 2004 would be designated

O C11P2 4B 03.

## 3.2 FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SAMPLE NOMENCLATURE

Field quality assurance/quality control (QA/QC) samples are described in Section 4.3 of this approved Field Sampling Plan. 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 taken, and the number of this type of QC sample taken on that date.

| **AA** | **NNNNN** | **NN** | **F** |
|---|---|---|---|
| QC Type | Date | Number per day | Filtered (When applicable) |

The QC types are identified as

RB = Rinsate Blank
TB = Trip Blank
FB = Field Blank
FD = Field Duplicate

AB = Ambient 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).

Matrix Spike and Matrix Spike Duplicate (MS/MSD) samples will be designated on the field documentation forms and chain-of-custody form.

3.2.2 Examples of Field QA/QC Nomenclature

A duplicate of a ground water sample obtained on June 3, 1999 would be designated as

FD 060399 01.

The third duplicate taken of a ground water sample (three different monitoring points) obtained on November 17, 2003 would be designated as

FD 111703 03.

## TABLE 1

## MONITORING POINTS AND LOCATION CODES FOR SAMPLE NOMENCLATURE
## NAVAL SURFACE WARFARE CENTER
## CRANE, INDIANA

| SITE MONITORING POINTS AND CORRESPONDING LOCATION CODE | | | | | |
|---|---|---|---|---|---|
| Ammunition Burning Grounds (ABG) | | Old Rifle Range (ORR) | | Demolition Range DR | |
| Monitoring Points | Location Code | Wells | Location Code | Wells | Location Code |
| 03B02 | B02 | 06C08 | C08 | 06C02 | C02 |
| 03B04 | B04 | 06C11 | C11 | 06C03 | C03 |
| 03C02P2 | C02P2 | 06C11P2 | C11P2 | 06C03P2 | C03P2 |
| 03C03 | C03 | 06C12 | C12 | 06C04 | C04 |
| 03C04 | C04 | 06C13 | C13 | 06C04P2 | C04P2 |
| 03C07 | C07 | 06C13P2 | C13P2 | 06C05 | C05 |
| 03C08P2 | C08P2 | 06C14 | C14 | 06C06 | C06 |
| 03C09P2 | C09P2 | 06C14P2 | C14P2 | 06C06P2 | C06P2 |
| 03C10 | C10 | 06C15 | C15 | 06C07 | C07 |
| 03C11 | C11 | 06C16 | C16 | 06C08 | C08 |
| 03C12 | C12 | 06C18 | C18 | 06C08P2 | C08P2 |
| 03C15 | C15 | 06C18P2 | C18P2 | | |
| 03C17 | C17 | 06C19 | C19 | | |
| 03C20 | C20 | 06C19P2 | C19P2 | | |
| 03C25 | C25 | | | | |
| 03C26 | C26 | | | | |
| 03C27 | C27 | | | | |
| 03C30 | C30 | | | | |
| Little Sulphur Creek Below Spring A | CRA | | | | |
| Little Sulphur Creek at Boundary | CRB | | | | |
| Spring A | SPA | | | | |
| Spring C | SPC | | | | |

# STANDARD OPERATING PROCEDURE NUMBER 10

# SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures for sample preservation, packaging, and shipping to be used in handling ground water, surface water, and spring water samples obtained for chemical analysis at NSWC Crane.

The 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, with preservatives added (if required) 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.

## 3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

3.1 Table 4-10 of this approved Field Sampling Plan establishes requirements for sample preservation. The laboratory provides pre-preserved sample containers (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped at 4°C. This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

3.2 The sampler shall 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 (SOP 9) 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-out 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 (containers will be upright, with the exception of the 40-ml vials). 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. Record the temperature of the temperature blank on the COC. If the cooler contains samples to be analyzed for VOCs, place a trip blank into the cooler.

3.8 Fill the voids in between the bubble-out shipping bags with ice and continue filling the cooler with ice to the top, using a minimum of 8 pounds of ice for a medium-size cooler.

3.9 Complete a COC for each cooler. List on the COC each sample bottle contained in the cooler. Include the air bill number on the COC. Use a ballpoint pen and make sure that all the carbon forms are legible. SOP 11 contains instructions for completing the COC.

3.10 Place the original (top) signed copy of the COC form, listing only those samples contained in that particular cooler, 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, numbered, 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. SOP 11 contains instructions for completing the custody seal.

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.

3.13 All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances will sample hold times be exceeded (see Table 4-10 of the approved FSP).

# STANDARD OPERATING PROCEDURE NUMBER 11

# SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedures for sample custody and documentation of field sampling and field analyses activities. Forms are provided along with instructions on how to complete each form.

The Naval Surface Warfare Center (NSWC) Crane Environmental Protection Department must approve any deviations from this procedure.

## 2.0 FIELD FORMS LIST

The following log books, forms, labels, and tags are required.

**Site Log Book**

**Field Log Book**

**Document Tracking Logbook**

**Sample label and tag**

**Chain-of-Custody**

**Custody seal**

**Equipment Calibration Log**

**Monitoring Well Inspection Form**

**Water Level Measurement Form**

**Low-Flow Purge Data Sheet**

**Ground Water Sample Log Sheet**

**Surface Water Sample Log Sheet**

**Field Chemical Analysis 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 shall 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 shall 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 (FOL).

Upon completion of the fieldwork or when completely filled, the Site Logbook is stored in the NSWC Crane records repository. Attachment 1 contains an example of typical entries found in a Site Logbook.

### 3.2 Field Logbooks

The Field Logbook is a separate dedicated notebook used by field personnel to document his or her 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. Attachment 2 contains an example of typical entries found in a Field Logbook.

### 3.3 Document Tracking Logbook

The Document Tracking Logbook is used to record the numbers of each chain-of-custody (COC) and field form(s) associated with a particular monitoring point. This logbook is hardbound and paginated. The FOL (or designee) is responsible for entry of information into the Document Tracking Logbook.

Upon completion of the field work or when completely filled, Field Logbooks are stored in the NSWC Crane records repository. Attachment 3 contains an example page from the Document Tracking Logbook and instructions for completing the entries for a monitoring point.

### 3.4 Sample Label and Tag

Adhesive sample container labels must be completed and applied to every sample container. Each adhesive label is numbered. A second, identical (including number) adhesive sample label will be completed and affixed onto a tag that will be attached to the neck of the sample container with string.

Once the laboratory receives the sample, the tag will be removed from the sample container and returned to the task manager.

Sample tags will be stored in the NSWC Crane records repository. Attachment 4 contains an example label and tag, along with instructions for entering information on the label and tag.

### 3.5 Chain-of-Custody Form

The Chain-of-Custody form (COC) is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as it is transferred from person to person. Each COC is numbered. This form must be used for any samples collected for laboratory chemical analysis.

The FOL must include the name of the laboratory in the "Remarks" section to ensure that the samples are forwarded to the correct location. If more than one COC is necessary for any cooler, the FOL will indicate "Page __ of __" on each COC. The original (top) signed copy of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent, a separate COC must be included with each cooler and must reflect the sample containers in that particular 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 (bottle breakage, 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.

The number of each COC associated with a monitoring point is recorded in the Document Tracking Logbook. Each COC is placed into a binder and stored in the NSWC Crane records repository. Attachment 5 contains an example COC, along with instructions on completing the COC.

### 3.6 Custody Seal

The Custody Seal is an adhesive-backed label with a number on each seal. It is part of the 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 small 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. The number of each custody seal is recorded on the COC.

Attachment 6 contains an example Custody Seal, along with instructions on completing the Custody Seal.

3.7 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. All Equipment Calibration Logs are numbered. 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.

The number of each Equipment Calibration Log associated with a monitoring point is recorded in the Document Tracking Log Book. Each calibration log is placed into a binder and stored in the NSWC Crane records repository. Attachment 7 contains an example Equipment Calibration Log, along with instructions for its completion.

3.8 Monitoring Well Inspection Form

The Monitoring Well Inspection Form is used to document the inspections conducted in accordance with SOP 1. Each Monitoring Well Inspection Form is numbered.

The number of each Monitoring Well Inspection Form associated with a monitoring point is recorded in the Document Tracking Log Book. Each inspection form is placed into a binder and stored in the NSWC Crane records repository. Attachment 8 contains an example Monitoring Well Inspection Form, along with instructions for its completion.

3.9 Water Level Measurement Form

The Water Level Measurement Form is used to document the determination of water levels in monitoring wells in accordance with SOP 2. Each Water Level Measurement Form is numbered.

The number of each Water Level Measurement Form associated with a monitoring well is recorded in the Document Tracking Log Book. Each form is placed into a binder and stored in the NSWC Crane records repository. Attachment 9 contains an example Water Level Measurement Form, along with instructions for its completion.

## 3.10 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 SOP 3. Each sheet is numbered.

The number of each Low-Flow Purge Data Sheet associated with a monitoring well is recorded in the Document Tracking Log Book. Each data sheet is placed into a binder and stored in the NSWC Crane records repository. Attachment 10 contains an example Low-Flow Purge Data Sheet, along with instructions for its completion.

### 3.11 Ground Water Sample Log Sheet

The Ground Water Sample Log Sheet is used to document the samples taken from a monitoring well after the well is purged. This sheet is used in conjunction with SOP 5.

The number of each Ground Water Sample Log Sheet associated with a ground water monitoring point is recorded in the Document Tracking Log Book. Each log sheet is placed into a binder and stored in the NSWC Crane records repository. Attachment 11 contains an example Ground Water Sample Log Sheet, along with instructions for its completion.

### 3.12 Surface Water Sample Log Sheet

The Surface Water Sample Log Sheet is used to document the samples taken from surface waters. This sheet is used in conjunction with SOP 6.

The number of each Surface Water Sample Log Sheet associated with a surface water monitoring point is recorded in the Document Tracking Log Book. Each log sheet is placed into a binder and stored in the NSWC Crane records repository. Attachment 12 contains an example Surface Water Sample Log Sheet, along with instructions for its completion.

### 3.13 Field Chemical Analytical Log Sheet

The Field Chemical Analytical Log Sheet is used to document information obtained during field chemical analyses. This form is used in conjunction with SOP 7.

The number of each Field Chemical Analytical Log Sheet associated with a monitoring point is recorded in the Document Tracking Log Book. Each log sheet is placed into a binder and stored in the NSWC Crane records repository. Attachment 13 contains an example Field Chemical Analytical Log Sheet, along with instructions for its completion.

# ATTACHMENT 1

# SITE LOGBOOK

# EXAMPLE OF DAILY LOG BOOK COMPLETION

**TITLE** NSWC CRANE

CTO 38
**PROJECT NO.** 7651

MONDAY 2.22.99

**BOOK** 2397

Work continued from Page WEATHER: COOL LT. SNOW, 25-35°F

0700 ON SITE K. SIMPSON & S. NEILL TTNUS
CALIBRATE YSI FLOW-THRU CELL &
PID. PREP. BOTTLES & NOTES FOR
GW SAMPLING @ ABG.

0720 TOM BRENT STOPPED @ TRAILER TO
DISCUSS PHONE HOOK-UP FOR TRAILER.

0735 KS & SN TO ABG FOR GW SAMPLING
CHECKED IN WITH B. TOLBERT OK TO
WORK AT ABG.

0800 START SAMPLING 03C02P2 & 03C27

1410 COMPLETE SAMPLING RETURN TO TRAILER
PACKAGE SAMPLES FOR SHIPMENT
VIA FED EX
KS RUN NA FIELD TEST

1600 SN TO FEDEX 2 COOLERS SHIPPED.
KS UPDATING PAPER WORK

1700 KS CALLED R. BASINSKI TO UP-DATE ON
JOB PROGRESS.

1725 SN RETURNS UNLOAD TRUCKS CLEAN TRAILER

1810 DEPART FOR BOQ (KS & SN)

— DAILY SUMMARY —

- 2 WELLS SAMPLED, 2 COOLERS SHIPPED
- SEE ALSO LOG BOOK #2401, COC's
DATED 2.22.99 & FIELD NOTES.

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605

Work continued to Page —

SIGNATURE K. S. Simpson

DATE 2.22.99

WITNESS

DATE

# ATTACHMENT 2

# FIELD LOGBOOK

# EXAMPLE OF FIELD LOG BOOK COMPLETION

**TITLE** NSWC CRANE

CTO 38
**PROJECT NO.** 7651

MONDAY 2.22.99

**BOOK** 2398

Work continued from Page —

0800 SAMPLING WELL 03C02PR AT ABG
NO QA SAMPLES COLLECTED FROM
THIS LOCATION.
1410 SAMPLING COMPLETE RETURN TO
TRAILER TO PACK SAMPLES FOR
SHIPMENT TO LAB.
1600 DEPART TRAILER FOR FED EX
1715 SHIPPED 2 COOLERS
SEE ALSO: COC'S, SAMPLE
LOG SHEETS AND LOG BOOK
# 2397, DATED 2.22.99

1805 RETURN TO TRAILER
1910 DEPART FOR BOQ

LOG
2.22.99 KES

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605

Work continued to Page —

SIGNATURE K. S. Simpson

DATE 2.22.99

WITNESS

DATE

# ATTACHMENT 3

# DOCUMENT TRACKING LOGBOOK

# INSTRUCTIONS FOR COMPLETION OF THE DOCUMENT TRACKING LOG BOOK

The Document Tracking Logbook is used to record the number of each chain-of-custody (COC) and field form(s) associated with a particular monitoring point. This logbook is hardbound and paginated. The FOL (or designee) is responsible for entry of information into the Document Tracking Log Book.

1 Enter the sample location.
2 Enter the sample date.
3 Enter the sample ID.
4 Enter Equipment Calibration Log number(s).
5 Enter Monitoring Well Inspection Form number.
6 Enter Water Level Measurement Form number.
7 Enter Ground Water Sample Log Form number.
8 Enter Low-Flow Purge Data Form number(s).
9 Enter Surface Water Sample Log Form number.
10 Enter Field Chemical Analytical Log Form number(s).
11 Enter the C.O.C. number(s).

Note: If a form does not apply, enter NA.

# NSWC CRANE
# DOCUMENT TRACKING
**PROJECT NO. _____**

Sample Location: _____ (1) _____

Sample Date: _____ (2) _____

Sample ID: _____ (3) _____

**Associated Documentation**

Equipment Calibration Log Number(s): _____ (4) _____

Monitoring Well Inspection Form Number: _____ (5) _____

Water Level Measurement Form Number: _____ (6) _____

Ground Water Sample Log Form Number: _____ (7) _____

Low Flow Purge Data Form Number(s): _____ (8) _____

Surface Water Sample Log Form Number: _____ (9) _____

Field Chemical Analysis Log Form Number(s): _____ (10) _____

Chain-of-Custody Number(s): _____ (11) _____

Sample Location: _____

Sample Date: _____

Sample ID: _____

**Associated Documentation**

Equipment Calibration Log Number(s): _____

Monitoring Well Inspection Form Number: _____

Water Level Measurement Form Number: _____

Ground Water Sample Log Form Number: _____

Low Flow Purge Data Form Number(s): _____

Surface Water Sample Log Form Number: _____

Field Chemical Analysis Log Form Number(s): _____

Chain-of-Custody Number(s): _____

# ATTACHMENT 4

# SAMPLE LABEL AND TAG

# INSTRUCTIONS FOR COMPLETION OF SAMPLE LABELS AND TAGS

Sample labels and tags are used to document sample ID, date, time, tag number, analysis, preservative, matrix, sampler, and laboratory. For each sample, a label and a tag will be completed and attached to the sample container. The label and tag for each sample container are identical.

1 Enter the sample date.
2 Enter the time that the sample container was filled, in military time.
3 Enter the sampler's initials.

A pre-printed set of labels will be made for each sampling event having the following established:

(A) Tag numbers (sequential)
(B) Laboratory Name (matched to specific analyses)
(C) Sample numbers (based on established set of samples per well location or SW locatoin)
(D) Preservative (based on specific analyses)
(E) Analyses (established analysis per well or SW location based on QAPP parameter list)
(F) Sample matrix (aqueous in all sampling performed under this plan)
(G) Project Number: Stays the same throughout the contracting period
(H) Location: NSWC Crane, Indiana
(I) Contractor

Pre-established tags will reduce the field writing time, but the sampler must be cautious in placing the correct label associated with the taken sample.

| | | | |
|---|---|---|---|
| (I) Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090 | | Project: CTO 038 (G) Location: NSWC CRANE (H) | |
| Sample No: AC172A99 (C) | | | Tag #: A0001 (A) |
| Date: (1) | Time: (2) | Preserve: H2SO4 (D) | |
| Analysis: TOC (E) | | Matrix: AQUEOUS (F) | |
| Sampled by: (3) | | Laboratory: LAUCKS (B) | |

| | | | |
|---|---|---|---|
| (I) Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090 | | Project: CTO 038 Location: NSWC CRANE | |
| Sample No: AC172A99 (C) | | | Tag #: A0001 (A) |
| Date: (1) | Time: (2) | Preserve: H2SO4 (D) | |
| Analysis: TOC (E) | | Matrix: AQUEOUS (F) | |
| Sampled by: (3) | | Laboratory: LAUCKS (B) | |

# ATTACHMENT 5

# CHAIN-OF-CUSTODY

# INSTRUCTIONS FOR COMPLETION OF THE CHAIN OF CUSTODY RECORD

The Chain-of-Custody Record (COC) is a multi-part, standardized form designed 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.

1 Enter the signature of the person(s) that sampled this monitoring point.
2 Enter the date that the sample was collected.
3 Enter the time (in military time) that the sample was collected.
4 Enter the sample's alphanumeric identification.
5 Enter the number of containers associated with the corresponding date and time.
6 Enter the letter (A,B,C, etc.) of the subset associated with the parameter that the sample will be analyzed for. If this parameter does not require analysis, leave this space blank. The list of subsets for all parameters that have subsets can be found in Appendix D of this approved Field Sampling Plan.
7 Enter a check mark if the laboratory is to test for this parameter. If this parameter does not require analysis, leave this space blank.
8 If additional analyses are required that differ from the preprinted analyses, these spaces will serve as a place for that additional analysis.
9 A check mark will be placed here to indicate to the laboratory that this parameter is to be analyzed.
10 Enter the number from the corresponding sample tag that is tied to the neck of the sample container.
11 Enter any remarks (duplicate, MS/MSD, low sample volume, etc.) that relate to anything out of the ordinary with a particular sample. This remarks column is for field personnel comments only.
12 Enter the signature of the person who relinquishes the sample cooler to another person. The first "relinquished by" space should be that of the sampler(s).
13 Enter the date that the sample cooler was relinquished.
14 Enter the time (using military time) that the sample cooler was relinquished.
15 Enter the signature of the person receiving the sample cooler from the relinquisher.
16 Enter the signature of the person receiving the sample cooler for the laboratory.
17 Enter the date that the laboratory received the sample cooler.
18 Enter the time (in military time) that the laboratory received the sample cooler.
19 Enter the airbill number from the courier's shipping label.
20 Enter the temperature of the Temperature Blank (in degrees Celsius) at shipping.
21 Enter the temperature of the Temperature Blank (in degrees Celsius) upon arrival of the sample cooler at the laboratory.
22 Enter the numbers of the cooler custody seals used to ship that cooler.
23 This space is for remarks.
24 Enter project number unless pre-printed.

Pre-printed information on the COC:

(A) COC Form number: sequential
(B) Location: NSWC Crane, Indiana
(C) Contractor used for contracting period

TETRA TECH NUS, INC.
661 Andersen Drive • Pittsburgh, PA 15220

(C)

0001 (A)

# CHAIN OF CUSTODY RECORD

## NSWC CRANE, INDIANA

(B)

PROJECT NO.: (24)

SAMPLERS (SIGNATURE): (1)

| DATE | TIME | SAMPLE ID | NO. OF CONTAINERS | VOLATILES | DISSOLVED GASES | SULFIDE | TOX | SEMIVOLATILES | EXPLOSIVES | METALS | CYANIDE | PESTICIDES/PCBS | HERBICIDES | DIOXINS/FURANS | TOC | SULFATE | AMMONIA | CHLORIDE | PHOSPHORUS | (8) | (8) | TAG NO. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (2) | (3) | (4) | (5) | (6) | (6) | (7) | (7) | (6) | (6) | (6) | (7) | (6) | (6) | (6) | (7) | (7) | (7) | (7) | (7) | (9) | (9) | (10) | (11) |
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| RELINQUISHED BY (SIGNATURE): | DATE/TIME | | RECEIVED BY (SIGNATURE): | RELINQUISHED BY (SIGNATURE): | DATE/TIME | | AIR BILL NO.: (19) |
|---|---|---|---|---|---|---|---|
| (12) | (13) | (14) | (15) | (12) | (13) | (14) | TEMP. BLANK: AT SHIPMENT (20) °C AT LAB (21) °C |
| RECEIVED BY (SIGNATURE): | RELINQUISHED BY (SIGNATURE): | DATE/TIME | | RECEIVED FOR LAB BY (SIGNATURE): | DATE/TIME | | COOLER CUSTODY SEAL NOS: (22) |
| (15) | (12) | (13) | (14) | (16) | (17) | (18) | REMARKS: (23) |

# ATTACHMENT 6

# CUSTODY SEAL

# INSTRUCTIONS FOR COMPLETION OF CUSTODY SEALS

Custody seals are tamper-evident self-sticking labels. The seals are used in conjunction with strapping tape to seal coolers containing samples and COC(s) for shipment to the laboratory.

1 Enter date cooler is sealed.

2 Enter signature.

Note: Four custody seals will be used on a medium size cooler.

Pre-printed on Seal:

(A) Seal tag number: sequential

# ATTACHMENT 7

# EQUIPMENT CALIBRATION LOG

# INSTRUCTIONS FOR COMPLETION OF THE EQUIPMENT CALIBRATION LOG

This field form is used to document equipment calibration. One equipment calibration log will be completed for each piece of equipment calibrated. The calibration log is to be used for all on-site equipment calibration (all columns on the form may not apply to each instrument).

1 Enter instrument make and model.
2 Enter instrument serial number.
3 Enter name of instrument manufacturer.
4 Use this column to enter instrument calibration date.
5 Use this column to enter instrument initial settings.
6 Use this column to enter standards used during calibration.
7 Use this column to enter procedures used during calibration, i.e. as per instrument manual.
8 Use this column to enter any adjustments made to the instruments.
9 Use this column to enter instruments final settings.
10 Enter personnel signature.
11 Enter comments pertaining to the calibration of the instrument.
12 Enter the name of the rental company that the instrument was rented from.
13 Enter project number unless pre-printed.

Pre-printed Equipment Calibration Log information:

(A) Project Name: NSWC Crane

NSWC Crane
Field Form
Revison: 3
September 1999

# EQUIPMENT CALIBRATION LOG

INSTRUMENT NAME/MODEL : _____(1)_____ PROJECT NAME : NSWC Crane (A)

SERIAL NUMBER: _____(2)_____ PROJECT NUMBER : _____(13)_____

MANUFACTURER : _____(3)_____

| CALIBRATION DATE | INITIAL SETTINGS | STANDARDS USED | PROCEDURE | ADJUSTMENTS MADE | FINAL SETTINGS | SIGNATURE | COMMENTS |
|---|---|---|---|---|---|---|---|
| (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
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Instrument Rented From: _____(12)_____

# ATTACHMENT 8

# MONITORING WELL INSPECTION FORM

# INSTRUCTIONS FOR COMPLETION OF THE MONITORING WELL INSPECTION FORM

This field form is used to document the condition, prior to sampling, of monitoring wells.

| | |
|---|---|
| 1 | Enter the well ID number. |
| 2 | Enter the time inspection was performed, using military time. |
| 3 | Enter the date of inspection. |
| 4 | Print the inspector's name. |
| 5 and 6 | Enter a check mark in the appropriate status box: S = satisfactory, U = unsatisfactory; if U, explain. |
| 7 | Enter any observations pertaining to that inspection item. |
| 8 | Enter any comments pertaining to the well inspection. |
| 9 | Enter the sampler's signature(s). |

Pre-printed information on Monitoring Well Inspection form:

| | |
|---|---|
| (A) | Monitoring well inspection form number: sequential |

Sequential Number ___(A)___

NSWC Crane
Field Form
Revision: 3
September 1999

# NSWC CRANE
# MONITORING WELL INSPECTION FORM

**Well ID:** _____(1)_____

**Time:** _____(2)_____ **Date:** ___(3)_____ **Inspector's Name:** _____(4)_____

| Inspection Item | Types of Problems | Status | | Observation |
|---|---|---|---|---|
| | | S | U | |
| Well Tag | Is it in-place, legible | (5) | (6) | (7) |
| 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:** (8)

Signature(s)_____(9)_____

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

# ATTACHMENT 9

# WATER-LEVEL MEASUREMENT FORM

# INSTRUCTIONS FOR COMPLETION OF THE WATER LEVEL MEASURMENT FORM

This field form is used to document monitoring well water levels and associated data. Refer to SOP 2 for water level measurement procedures.

| | |
|---|---|
| 1 | Enter the weather conditions at the time of measurements. |
| 2 | Print personnel name(s). |
| 3 | Enter make, model, and serial number of the instrument. |
| 4 | Enter any pertinent remarks. |
| 5 | Enter the well ID number. |
| 6 | Enter the date measurement was taken. |
| 7 | Enter the time measurement was taken, using military time. |
| 8 | Enter static water level of the well, to the nearest 0.01 foot. |
| 9 | Enter, if applicable, thickness of free product, to the nearest 0.01 foot. |
| 10 and 11 | Enter the PID reading in the riser pipe (2-inch PVC) and in the breathing zone, in ppm. |
| 12 | Enter comments pertaining to water-level measurements and record readings from the interface probe, if used. |
| 13 | Enter personnel signature(s). |
| 14 | Enter proejct number, unless pre-printed. |

Pre-printed information on the Water Level Measurement form:

| | |
|---|---|
| (A) | Project Name: NSWC Crane |
| (B) | Project Location: Crane, Indiana |
| (C) | Water level measurement form number: sequential |

Sequential No. ____(C)____

NSWC Crane
Field Form
Revision: 3
September 1999

# WATER LEVEL MEASUREMENT FORM

**Project Name: NSWC Crane (A)**
**Location: Crane, IN (B)**
**Weather Conditions: _____(1)_____**

**Project No.: _____(14)_____**
**Personnel: _____(2)_____**
**Measuring Device: _____(3)_____**
**Remarks: _____(4)_____**

| Well ID | Date | Time | Water Level * | Thickness of Free Product * | PID Reading ppm | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | RP | BZ | |
| (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
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* All measurements to the nearest 0.01 foot

**Signature(s): _____(13)_____**

# ATTACHMENT 10

# LOW-FLOW PURGE DATA FORM

# INSTRUCTIONS FOR COMPLETION OF THE LOW-FLOW PURGE DATA FORM

This field form is used to document date, times, and data during purging of wells. This form is used in conjunction with the Ground Water Sample Log Form.

| | |
|---|---|
| 1 | Enter the well ID number. |
| 2 | Enter the date purged. |
| 3 | Enter the time that stabilization parameters are taken, typically at 5- to 10-minute intervals, using military time. |
| 4 | Enter water-level reading, measured to the nearest 0.01 foot. |
| 5 | Enter pump rate, in milliliters per minute. |
| 6 through 11 | Record field parameters from Multiple-Parameter Water-Quality meter. |
| 12 | Enter comments (i.e. adjustments/maintenance preformed on meters/equipment, moved off well due to Navy activities, etc.) |
| 13 | Enter sampler's signature(s). |
| 14 | Enter page two and total pages used for sampling and purging, per well. The Ground Water Sample Log Form will always be page one, and the Low-Flow Purge Data Form(s) will be the following page(s). |
| 15 | Enter project number, unless pre-printed. |

Pre-printed information on the Low-Flow Purge Data form:

| | |
|---|---|
| (A) | Project Name: NSWC Crane |
| (B) | Low-flow purge data form number: sequential |

Pre-printed Sequential No. ____(B)_____

NSWC Crane
Field Form
Revision: 3
September 1999

# LOW FLOW PURGE DATA FORM

**PROJECT SITE NAME:** NSWC CRANE (A)

**PROJECT NUMBER:** (15)

**WELL ID.:** (1)

**DATE:** (2)

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
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**SIGNATURE(S):** _____(13)_____

**PAGE___OF___** (14)

# ATTACHMENT 11

# GROUND WATER SAMPLE LOG FORM

# INSTRUCTIONS FOR COMPLETION OF THE GROUND WATER SAMPLE LOG FORM

This field form is used to document date, times, and additional data at ground water sampling locations. This form is used in conjunction with the Low-Flow Purge Data Form.

| | |
|---|---|
| 1 | Enter page one and total pages used for sampling and purging, per well. The Ground Water Sample Log Form will always be page one, and the Low-Flow Purge Data Form(s) will be the following page(s). |
| 2 | Enter the sample ID number. |
| 3 | Enter the sample location (i.e. ABG, ORR, DR). |
| 4 | Print the name of the sampler(s). |
| 5 | Enter the COC number associated with samples taken on this form. |
| 6 | Enter date sampled. |
| 7 | Enter start sample time, using military time. |
| 8 | Enter end sample time, using military time. |
| 9 | Enter color of sample (i.e. clear, cloudy, light tan, etc.). |
| 10 through 15 | Enter final set of field parameters from associated Low-Flow Purge Data Form. |
| 16 | Enter odor of sample, if any (i.e. none, light sulfur, etc.). |
| 17 | Enter date purged. Note: sample and purge date may be different dates. |
| 18 | Enter one casing volume, calculated. |
| 19 | Enter total depth of the well to the nearest 0.01 foot. |
| 20 | Enter static water level of the well to the nearest 0.01 foot. |
| 21 | Enter start purge time, using military time. |
| 22 | Enter end purge time, using military time. |
| 23 | Enter total purge time. |
| 24 | Enter total volume purged, in gallons. |
| 25 | Enter, for each sample container, time of collection, using military time. |
| 26 | Observations, notes (i.e. changes in site conditions from last sampling event, adjustments/maintenance preformed on meters/equipment, etc.). |
| 27 | Enter riser pipe and breathing zone PID readings, in ppm. |
| 28 | Enter reaction of sample water to preservative; if no reaction, enter None. |
| 29 | Enter Yes or No. |
| 30 | Enter, if taken, Duplicate ID number; if none was taken, enter No. |
| 31 | Enter sampler's signature(s). |
| 32 | Enter project number, unless pre-printed. |

Note: Analysis will vary (site-to-site, quarterly, annually, etc.) and will be reflected in the Sample Collection Information section of this form. These variations will not change the instructions for completion of this sample log form.

Pre-printed information on the Ground Water Sample Log form:

(A) Project Site Name: NSWC Crane

NSWC Crane
Field Form
Revision: 3
September 1999

# GROUND WATER SAMPLE LOG FORM

(1)
Page___ of ___

| | | | |
|---|---|---|---|
| Project Site Name: | NSWC CRANE, IN (A) | Sample ID No.: | (2) |
| Project No.: | _____(32)_____ | Sample Location: | (3) |
| | | Sampled By: | (4) |
| | | C.O.C. No.: | (5) |

**SAMPLING DATA:**

| | Color | pH | S.C. | Temp. | Turbidity | DO | ORP | Odor |
|---|---|---|---|---|---|---|---|---|
| Date: (6) | | | | | | | | |
| Time-Start: (7) End: (8) | Visual | Standard | mS/cm | Degrees C | NTU | mg/l | mV | |
| Method: Dedicated Bladder Pump | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |

**PURGE DATA:**

| | | |
|---|---|---|
| Date: (17) | Total Well Depth (TD): (19) | End Purge (hrs): (22) |
| Method: Dedicated Bladder Pump | Static Water Level (WL): (20) | Total Purge Time (min): (23) |
| Well Casing: 2" PVC | Start Purge (hrs): (21) | Total Vol. Purged (gal): (24) |
| One Casing Volume(gal): (18) | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Preservative | Container Requirements | Time Collected |
|---|---|---|---|
| Volatiles (Subsets B&C) | HCl/4°C | (3) 40 mL Glass Vials | (25) |
| Dissolved Methane/Ethane/Ethene | 4°C/Dark | (2) 40 mL Amber Glass Vials | |
| Sulfide | 4°C/Zn($C_2H_3O_2$),NaOH | (1) 500 mL Polyethylene | |
| TOX | $H_2SO_4$/4°C | (1) 1000 mL Amber Glass | |
| Explosives (Subsets A) | 4°C/Dark | (2) 1000 mL Amber Glass | |
| Explosives (Subsets B) | 4°C/Dark | (2) 500 mL Amber Glass | |
| Total Metals (Subsets A & B) | $HNO_3$/4°C | (1) 1000 mL Polyethylene | |
| Cyanide | NaOH/4°C | (1) 500 mL Polyethylene | |
| TOC | $H_2SO_4$/4°C | (1) 125 mL Amber Glass | |
| Chloride & Sulfate | 4°C | (1) 500 mL Polyethylene | |
| Total Phosphorus | $H_2SO_4$/4°C | (1) 500 mL Polyethylene | |
| Dissolved Phosphorus | $H_2SO_4$/4°C/Filtered | (1) 500 mL Polyethylene | |
| Dissolved Metals (Subsets A, C & D) | $HNO_3$/4°C/Filtered | (1) 1000 mL Polyethylene | |
| Natural Attenuation (field test) | Various Parameters & Containers, see SOP 7 | | |
| | | | |

**OBSERVATIONS / NOTES:** (26)

PID reading in PVC riser pipe = (27) (ppm)
PID reading in Breathing Zone = (ppm)

Reaction of sample to preservative: (28)

| QA Samples Collected: | | Signature(s): |
|---|---|---|
| MS/MSD | Duplicate ID No.: | |
| (29) | (30) | (31) |

# ATTACHMENT 12

# SURFACE WATER SAMPLE LOG FORM

# INSTRUCTIONS FOR COMPLETION OF THE SURFACE WATER SAMPLE LOG FORM

This field form is used to document date, times, and additional data at spring and surface water sampling locations.

| | |
|---|---|
| 1 | Enter the sample ID number. |
| 2 | Enter the sample location (i.e. ABG, ORR, DR). |
| 3 | Print the name of the sampler(s). |
| 4 | Enter the COC number associated with samples taken on this form. |
| 5 | Check spring or stream. |
| 6 | Enter date sampled. |
| 7 | Enter start sample time, using military time. |
| 8 | Enter end sample time, using military time. |
| 9 | Enter depth sample was taken, in inches. |
| 10 | Enter color of sample (i.e. clear, cloudy, light tan, etc.). |
| 11 through 16 | Enter field parameters recorded from the Multiple-Parameter Water-Quality meter. |
| 17 | Enter odor of sample, if any (i.e. none, light sulfur, etc.). |
| 18 | Enter, for each sample container, time of collection, using military time. |
| 19 and 20 | Enter any comments, observations, or notes (i.e. changes in sample point from last sampling event, rain, etc.). |
| 21 | Enter reaction of sample water to preservative; if no reaction, enter None. Enter estimated flow rate of stream or spring at sample location, in gallons per minute (gpm). |
| 22 | Enter Yes or No. |
| 23 | Enter, if taken, Duplicate ID number; if none was taken, enter No. |
| 24 | Enter sampler's signature(s). |
| 25 | Enter project number, unless pre-printed. |

Note: Analysis will vary (quarterly, annually, etc.) and will be reflected in the Sample Collection Information section of this form. These variations will not change the instructions for completion of this sample log form.

Pre-printed information on the Surface Water Sample Log form:

(A) Project Site Name: NSWC Crane, IN

NSWC Crane
Field Form
Revision: 3
September 1999

# SURFACE WATER SAMPLE LOG FORM

Project Site Name: NSWC CRANE, IN (A)
Project No.: _____(25)_____

[] Stream (5)
[] Spring

Sample ID No.: (1)
Sample Location: (2)
Sampled By: (3)
C.O.C. No.: (4)

**SAMPLING DATA:**

| Date: (6) | Color | pH | S.C. | Temp. | Turbidity | DO | ORP | Odor |
|---|---|---|---|---|---|---|---|---|
| Time-Start: (7) End: (8) | Visual | Standard | mS/cm | Degrees C | NTU | mg/l | mV | |
| Depth: (9) | | | | | | | | |
| Method: Direct Fill | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Preservative | Container Requirements | Time Collected |
|---|---|---|---|
| Volatiles (Subsets B&C) | HCl/4°C | (3) 40 mL Glass Vials | (18) |
| Dissolved Methane/Ethane/Ethene | 4°C/Dark | (2) 40 mL Amber Glass Vials | |
| Sulfide | 4°C/Zn($C_2H_3O_2$),NaOH | (1) 500 mL Polyethylene | |
| TOX | $H_2SO_4$/4°C | (1) 1000 mL Amber Glass | |
| Explosives (Subsets A) | 4°C/Dark | (2) 1000 mL Amber Glass | |
| Explosives (Subsets B) | 4°C/Dark | (2) 500 mL Amber Glass | |
| Total Metals (Subsets A & B) | $HNO_3$/4°C | (1) 1000 mL Polyethylene | |
| Cyanide | NaOH/4°C | (1) 500 mL Polyethylene | |
| TOC | $H_2SO_4$/4°C | (1) 125 mL Amber Glass | |
| Chloride & Sulfate | 4°C | (1) 500 mL Polyethylene | |
| Total Phosphorus | $H_2SO_4$/4°C | (1) 500 mL Polyethylene | |
| Dissolved Phosphorus | $H_2SO_4$/4°C/Filtered | (1) 500 mL Polyethylene | |
| Dissolved Metals (Subsets A, C & D) | $HNO_3$/4°C/Filtered | (1) 1000 mL Polyethylene | |
| Natural Attenuation (field test) | Various Parameters & Containers, see SOP 7 | | |
| | | | |

**OBSERVATIONS / NOTES:** (19)

Reaction of sample to preservative: (21)

Estimated Flow Rate: (22)

**Comments:** (20)

**QA Samples Collected:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| (23) | (24) |

**Signature(s):**

(25)

# ATTACHMENT 13

# FIELD CHEMICAL ANALYTICAL LOG FORM

# INSTRUCTIONS FOR COMPLETION OF THE FIELD CHEMICAL ANALYTICAL DATA FORM

This field form is used to document the date, time, and results for field geochemical analyses. This form is used in conjunction with the Field Chemical Analytical Log Form.

1 Enter the project site name, as referenced in the Field Log Book.
2 Enter the name of the individual collecting the sample.
3 Enter the ID number, as referenced on the COC form.
4 Enter the sample ID number.
5 Check box if this sample is a duplicate. If so, include the original sample ID number.
6 Enter the date that the sample was taken.
7 Enter the time that the sample was taken.
8 Enter the method used to collect the sample.
9 Enter the sample color, as referenced on the Ground Water/Surface Water Sample Log Form.
10 Enter the sample pH, as referenced on the Ground Water/Surface Water Sample Log Form.
11 Enter the sample specific conductance, as referenced on the Ground Water/Surface Water Sample Log Form.
12 Enter the sample temperature, as referenced on the Ground Water/Surface Water Sample Log Form.
13 Enter the sample turbidity, as referenced on the Ground Water/Surface Water Sample Log Form.
14 Enter the sample dissolved oxygen, as referenced on the Ground Water/Surface Water Sample Log Form.
15 Check the box that matches the sample range(s) used for this particular analysis.
16 Enter the initials of the individual(s) performing the field analysis.
17 Enter the time that the field analysis was performed.
18 Enter the number of digits on the titrator when colorimetric indication is achieved.
19 Enter the results of the multiplication as shown on the form.
20 Enter any comments concerning the sample, equipment, reagents, or results. If the analyst suspects interference or any other problems, they must be noted here. If the data should be estimated based on any quality assurance/quality control issues, it must be noted here with a brief description of the reason.
21 Enter the number of digits on the titrator when colorimetric indication is achieved at Step No. 6 of the HACH Method. If the solution is colorless at Step 6, then no titration is performed at this point and a zero (0) is entered.
22 Enter the number of digits on the titrator when colorimetric indication is achieved at Step No. 9 of the HACH Method.
23 Enter the results of the multiplication as shown on the form. This would be the result of Block 21 added to Block 22 times the multiplier shown for the corresponding range used.
24 Enter the expected concentration relationship for hydroxide alkalinity from Table 3 of the HACH Method.
25 Enter the expected concentration relationship for carbonate alkalinity from Table 3 of the HACH Method.
26 Enter the expected concentration relationship for bicarbonate alkalinity from Table 3 of the HACH Method.
27 Check the box if the sample performed is a quality assurance sample using Standard Additions.
28 Enter the molarity (N) of the titrant selected for the Standard Additions.
29 Enter the number of digits on the titrator required to return the sample back to the same colorimetric end point after the first 0.1 mL Standard Addition, as described in the HACH Method.

30 Enter the number of digits on the titrator required to return the sample back to the same colorimetric end point after the second 0.1 mL Standard Addition (0.2 mL total), as described in the HACH Method.

31 Enter the number of digits on the titrator required to return the sample back to the same colorimetric end after the third 0.1 mL Standard Addition (0.3 mL total), as described in the HACH Method.

32 Enter the resulting value from the colorimeter, representing the concentration of the primary chemical form detected, in units of mg/L.

33 Check the box if the sample was sufficiently turbid to require filtering (at 0.45μ) prior to analysis.

34 Check the box if the sample analysis is being performed using the Reagent Blank Correction option (the sample cell icon will be visible on the colorimeter).

35 Check the box if the sample performed is a quality assurance sample using a Standard Solution.

36 Enter the resulting value from the colorimeter, representing the concentration of the Standard Solution, in units of mg/L.

37 Enter the resulting value from the colorimeter, representing the concentration of the first Standard Addition (0.1 mL total), in units of mg/L.

38 Enter the resulting value from the colorimeter, representing the concentration of the second Standard Addition (0.2 mL total), in units of mg/L.

39 Enter the resulting value from the colorimeter, representing the concentration of the third Standard Addition (0.3 mL total), in units of mg/L.

40 Check the box if the sample required chemical pretreatment to remove interference from nitrite. If chemical pretreatment is required, the value of nitrate indicated on the colorimeter must be subtracted by the previously determined nitrite value.

# FIELD CHEMICAL ANALYTICAL LOG FORM



Project Site Name: (1)

Sampled By: (2)

Sample ID No.: (3)

Sample Location: (4)

Duplicate: ☐ (5)

**SAMPLING DATA:**

| | Color | pH | S.C. | Temp. | Turbidity | DO |
|---|---|---|---|---|---|---|
| Date: (6) | | | | | | |
| Time: (7) | (Visual) | (SU) | (mS/cm) | (°C) | (NTU) | (Meter, mg/l) |
| Method: (8) | (9) | (10) | (11) | (12) | (13) | (14) |

**SAMPLE COLLECTION/ANALYSIS INFORMATION:**

## Dissolved Oxygen:

Equipment: HACH Digital Titrator OX-DT (15) Analyst (16) Analysis Time: (17)

| Range Used: | Range | Sample Vol. | Cartridge | Multiplier |
|---|---|---|---|---|
| ☐ | 1-5 mg/L | 200 ml | 0.200 N | 0.01 |
| ☐ | 2-10 mg/L | 100 ml | 0.200 N | 0.02 |

| (18) Titration Count | Multiplier | (19) Concentration |
|---|---|---|
| _____ | x 0.01 | = |
| _____ | x 0.02 | = |

Notes: (20)

## Alkalinity:

Equipment: HACH Digital Titrator AL-DT (15) Analyst (16) Analysis Time: (17)

| Range Used: | Range | Sample Vol. | Cartridge | Multiplier | (21) & (22) Titration Count | Multiplier | (23) Concentration |
|---|---|---|---|---|---|---|---|
| ☐ | 10-40 mg/L | 100 ml | 0.1600 N | 0.1 | _____ & _____ | x 0.1 | = |
| ☐ | 40-160 mg/L | 25 ml | 0.1600 N | 0.4 | _____ & _____ | x 0.4 | = |
| ☐ | 100-400 mg/L | 100 ml | 1.600 N | 1.0 | _____ & _____ | x 1.0 | = |
| ☐ | 200-800 mg/L | 50 ml | 1.600 N | 2.0 | _____ & _____ | x 2.0 | = |
| ☐ | 500-2000 mg/L | 20 ml | 1.600 N | 5.0 | _____ & _____ | x 5.0 | = |
| ☐ | 1000-4000 mg/L | 10 ml | 1.600 N | 10.0 | _____ & _____ | x 10.0 | = |

| Relationship | Hydroxide | Carbonate | Bicarbonate |
|---|---|---|---|
| Concentration | (24) mg/L | (25) mg/L | (26) mg/L |

Notes: (20)

(27) Standard Additions: ☐ (28) Titrant Molarity:_____ (29) Digits Required: 1st.:_____ (30) 2nd.:_____ (31) 3rd.:_____

## Carbon Dioxide:

Equipment: HACH Digital Titrator CA-DT (15) Analyst (16) Analysis Time: (17)

| Range Used: | Range | Sample Vol. | Cartridge | Multiplier |
|---|---|---|---|---|
| ☐ | 10-50 mg/L | 200 ml | 0.3636 N | 0.1 |
| ☐ | 20-100 mg/L | 100 ml | 0.3636 N | 0.2 |
| ☐ | 100-400 mg/L | 200 ml | 3.636 N | 1.0 |
| ☐ | 200-1000 mg/L | 100 ml | 3.636 N | 2.0 |

| (18) Titration Count | | (19) Concentration |
|---|---|---|
| _____ | x 0.1 | = |
| _____ | x 0.2 | = |
| _____ | x 1.0 | = |
| _____ | x 2.0 | = |

Notes: (20)

(27) Standard Additions: ☐ (28) Titrant Molarity:_____ (29) Digits Required: 1st.:_____ (30) 2nd.:_____ (31) 3rd.:_____

# FIELD CHEMICAL ANALYTICAL LOG FORM



Project Site Name: (1)

Sampled By: (2)

Sample ID No.: (3)

Sample Location: (4)

Duplicate: ☐ (5)

**SAMPLE COLLECTION/ANALYSIS INFORMATION:**

**Sulfide:**

Equipment: HACH DR-850 Colorimeter Analyst (17) Analysis Time: (18)

Program No.: 93

Concentration: (40) mg/L Filtered: ☐ (41)

Notes: (21)

**Ferrous Iron:**

Equipment: HACH DR-850 Colorimeter Analyst (17) Analysis Time: (18)

Program No.: 33

Concentration: (42) mg/L Filtered: ☐ (41)

Notes: (21)

**Nitrite:**

Equipment: HACH DR-850 Colorimeter Analyst (17) Analysis Time: (18)

Program No.: 60

Concentration: (43) mg/L Reagent Blank Correction: ☐ (44)

Standard Solution: ☐ Results: (46)

Notes: (21) (45)

**Nitrate:**

Equipment: HACH DR-850 Colorimeter Analyst (17) Analysis Time: (18)

Program No.: 55

Concentration: (47) mg/L

Nitrite Interference Treatment: ☐ (54)

Standard Solution: ☐ (48) Results: (49) Reagent Blank Correction: ☐ (44)

Standard Additions: ☐ (50) Digits Required: 0.1ml: (51) 0.2ML: (52) 0.3ml: (53)

Notes: (21)

# APPENDIX C

## EQUIPMENT MANUALS

THIS APPENDIX HAS BEEN MOVED TO VOLUME 2 OF THE FSP FOR SPACE CONSIDERATIONS.

# APPENDIX D

# LIST OF FIELD PARAMETER AND ANALYTICAL SUBSETS

## FIELD PARAMETERS SUBSET A

Measured by meter:
Dissolved oxygen (DO)
pH
Specific conductance (SC)
Temperature (T)
Turbidity
Oxidation-reduction potential (ORP)
Water level (by water level meter)

## FIELD PARAMETERS SUBSET B

Measured by test kit:
Alkalinity (carbonate, bicarbonate, hydroxide)

## FIELD PARAMETERS SUBSET C

Measured by test kit:
Carbon dioxide
Dissolved oxygen
Ferrous iron
Hydrogen sulfide
Nitrite
Nitrate

## VOLATILES SUBSET A

Appendix IX volatiles listed in Table 1-3 of the approved QAPP

## VOLATILES SUBSET B

Trichloroethene (TCE)
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
Vinyl chloride

## VOLATILES SUBSET C

Benzene
Toluene
Ethylbenzene
Total xylenes
Tetrachloroethene
1,1,1-Trichloroethane
1,1-Dichloroethane
1,2-Dichloroethane
Carbon tetrachloride
Chloroethane
Chloroform
Methylene chloride

## DISSOLVED GASES SUBSET A

Methane
Ethane
Ethene

**SEMIVOLATILES SUBSET A**

Appendix IX semivolatile organic compounds listed in Table 1-3 of the approved QAPP.

**PESTICIDES/PCBs SUBSET A**

Appendix IX pesticide/PCB compounds listed in Table 1-3 of the approved QAPP.

**HERBICIDES SUBSET A**

Appendix IX herbicides listed in Table 1-3 of the approved QAPP.

**METALS SUBSET A**

Appendix IX metals listed in Table 1-3 of the approved QAPP.

**METALS SUBSET B**

Iron

**METALS SUBSET C**

Potassium
Sodium
Calcium
Magnesium

**METALS SUBSET D**

Manganese

**DIOXINS/FURANS SUBSET A**

Appendix IX dioxins/furans listed in Table 1-3 of the approved QAPP.

**EXPLOSIVES SUBSET A**

1,3,5-Trinitrobenzene
1,3-Dinitrobenzene
TNT
2,4-Dinitrotoluene
2,6-Dinitrotoluene
HMX
2-Nitrotoluene
3-Nitrotoluene
4-Nitrotoluene
4-Amino-2,6-dinitrotoluene
2-Amino-4,6-dinitrotoluene
Tetryl
Nitrobenzene
RDX
Nitroglycerin
PETN
Nitrocellulose

**EXPLOSIVES SUBSET B**

2,4-Diamino-6-nitrotoluene
2,6-Diamino-4-nitrotoluene
2,2',6,6'-Tetranitro-4,4'-azoxytoluene
3,5-Dinitroaniline
TNX
MNX
Picric acid

**EXPLOSIVES SUBSET C**

Picric acid
Picramic acid