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FINAL SAMPLING AND ANALYSIS PLAN FOR PHASE I RCRA FACILITY INVESTIGATION (SWMU 21) DRMO STORAGE LOT (APPENDIX A-D) NSA CRANE IN
08/01/2010
TETRA TECH

**Comprehensive Long-term Environmental Action Navy**

CONTRACT NUMBER N624707-08-D-1001

Rev. 0
08/10

FINAL

# Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan)

## For

# Phase I RCRA Facility Investigation SWMU 21 – DRMO Storage Lot

## Naval Support Activity Crane Crane, Indiana

## Contract Task Order F274

## August 2010

NAVFAC
Naval Facilities Engineering Command

Naval Facilities Engineering Command
Midwest
201 Decatur Avenue
Building 1A, Code EV
Great Lakes, Illinois 60088

TETRA TECH NUS, Inc.

*The following are the appendices to the Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) for Phase I RCRA Facility Investigation SWMU 21 – DRMO Storage Lot, Naval Support Activity Crane, Crane, Indiana dated August 2010 (ARF No. 002271).*

# APPENDIX A

# FIELD STANDARD OPERATING PROCEDURES

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# STANDARD OPERATING PROCEDURE
# SOP-01

# GLOBAL POSITIONING SYSTEM

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the Field Technicians with basic instructions for operating a handheld Global Positioning System (GPS) unit allowing them to set GPS parameters in the receiver, record GPS positions on the field device, and update existing Geographic Information System (GIS) data. This SOP is specific to GIS quality data collection for Trimble-specific hardware and software.

If possible, the Trimble GeoXM or GeoXH Operators Manual should be downloaded onto the operator's personal computer for reference before or while in the field. The manual can be downloaded at http://trl.trimble.com/docushare/dsweb/Get/Document-311749/TerraSyncReferenceManual.pdf

Unless the operator is proficient in the setup and operation of the GPS unit, the Project Manager (or designee) should have the GPS unit shipped to the project-specific contact listed below in the Pittsburgh, Pennsylvania office at least five working days prior to field mobilization so project-specific shape files, data points, background images, and correct coordinate systems can be uploaded into the unit.

Tetra Tech NUS, Inc.
Attn: John Wright
661 Anderson Drive, Bldg #7
Pittsburgh, PA 15220

## 2.0 REQUIRED EQUIPMENT

The following hardware and software should be utilized for locating and establishing GPS points in the field:

### 2.1 Required GPS Hardware

- Hand-held GPS Unit capable of sub-meter accuracy (i.e. Trimble GeoXM or Trimble GeoXH). This includes the docking cradle, a/c adapter, stylus, and USB cable for data transfer.

Optional Accessories:

- External antenna
- Range pole
- Hardware clamp (for mounting Geo to range pole)
- GeoBeacon

- Indelible marker
- Non-metallic pin flags for temporary marking of positions

## 2.2 Required GPS Software

The following software is required to transfer data from the handheld GPS unit to a personal computer:

- Trimble TerraSync version 2.6 or later (pre-loaded onto GPS unit from vendor)

- Microsoft ActiveSync version 4.2 or later. Download to personal computer from: http://www.microsoft.com/windowsmobile/en-us/downloads/eulas/eula_activesync45_1033.mspx?ProductID=76

- Trimble Data Transfer Utility (freeware version 2.1 or later). Download to personal computer from: http://www.trimble.com/datatransfer.shtml

## 3.0 START-UP PROCEDURES

Prior to utilizing the GPS in the field, ensure the unit is fully charged. The unit may come charged from the vendor, but an overnight charge is recommended prior to fieldwork.

The Geo-series GPS units require a docking cradle for both charging and data transfer. The Geo-series GPS unit is docked in the cradle by first inserting the far domed end in the top of the cradled, then gently seating the contact end into the latch. The power charger is then connected to the cradle at the back end using the twist-lock connector. Attach a USB cable as needed between the cradle (B end) and the laptop/PC (A end).

It is recommended that the user also be familiar and check various Windows Mobile settings. One critical setting is the Power Options. The backlight should be set as needed to conserve power when not in use.

Start Up:

1) Power on the GPS unit by pushing the small green button located on the lower right front of the unit.

2) Utilizing the stylus that came with the GPS unit, launch **TerraSync** from the Windows Operating System by tapping on the start icon located in the upper left hand corner of the screen and then tap on **TerraSync** from the drop-down list.

3) If the unit does not default to the Setup screen, tap the Main Menu (uppermost left tab, just below the Windows icon) and select Setup.

4) If the unit was previously shipped to the Pittsburgh office for setup, you can skip directly to Section 4.0. However, to confirm or change settings, continue on to Section 3.1.

## 3.1 Confirm Setup Settings

Use the Setup section to confirm the TerraSync software settings. To open the Setup section, tap the Main Menu and select Setup.

1) Coordinate System
   a. Tap on the Coordinate System.
   b. Verify the project specs are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu. **Note:** It is always best to utilize the Cancel tab rather than the OK tab if no changes are made since configurations are easily changed by mistake.
   c. Tap on the Units.
   d. Verify the user preferences are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   e. Tap Real-time Settings.
   f. Verify the Real-time Settings are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   g. The GPS unit is now configured correctly for your specific project.

## 4.0 ANTENNA CONNECTION

1) If a connection has been properly made with the internal antenna, a satellite icon along with the number of usable satellites will appear at the top of the screen next to the battery icon. If no connection is made (e.g.: no satellite icon), tap on the GPS tab to connect antenna.
2) At this point the GPS unit is ready to begin collecting data.

## 5.0 COLLECTING NEW DATA IN THE FIELD

1) From the Main Menu select Data.
2) From the Sub Menu (located below the Data tab) select New which will bring up the New Data File menu.
3) An auto-generated filename appears and should be edited for your specific project. If the integral keyboard does not appear, tap the small keyboard icon at the bottom of the screen.
4) After entering the file name, tap Create to create the new file.
5) Confirm antenna height if screen appears. Antenna height is the height that the GPS unit will be held from the ground surface (Typically 3 to 4 feet).
6) The Choose Feature screen appears.

### 5.1 Collecting Features

1) If not already open, the Collect Feature screen can be opened by tapping the Main Menu and selecting Data. The Sub Menu should default to Collect.
2) **Do not begin the data logging process until you are at the specific location for which you intend to log the data.**
3) A known reference or two should be shot at the beginning and at the end of each day in which the GPS unit is being used. This allows for greater accuracy during post-processing of the data.
4) Upon arriving at the specific location, tap on Point_generic as the Feature Name.
5) Tap Create to begin data logging.
6) In the Comment Box enter sample ID or location-specific information.
7) Data logging can be confirmed by viewing the writing pencil icon in the upper part of the screen. Also, the logging counter will begin. As a Rule of Thumb, accumulate a minimum of 20 readings on the counter, per point, as indicated by the logging counter before saving the GPS data.
8) Once the counter has reached a minimum number of counts (i.e. 20), tap on OK to save the data point to the GPS unit. Confirm the feature. All data points are automatically saved within the GPS unit.
9) Repeat steps 2 through 8, giving each data point a unique name or number.

**Note:** If the small satellite icon or the pencil icon is blinking, this is an indication the GPS unit is not collecting data. A possible problem may be too few satellites. While still in data collection mode, tap on Main Menu in upper left hand corner of the screen and select Status. Skyplot will display as the default showing the number of available satellites. To increase productivity (number of usable satellites) use the stylus to move the pointer on the productivity and precision line to the left. This will decrease precision, but increase productivity. The precision and productivity of the GPS unit can be adjusted as the number of usable satellites changes throughout the day. To determine if GPS is correctly recording data, see Section 5.2.

## 5.2 Viewing Data or Entering Additional Data Points to the Current File

1) To view the stored data points in the current file, tap on the Main Menu and select Map. Stored data points for that particular file will appear. Use the +/- and <-/-> icons in lower left hand corner of screen to zoom in/out and to manipulate current view.
2) To return to data collection, tap on the Main Menu and select Data. You are now ready to continue to collect additional data points.

## 5.3 Viewing Data or Entering Data Points from an Existing File

1) To view data points from a previous file, tap on Main Menu and select Data, then select File Manager from the Sub Menu.
4) Highlight the file you want to view and select Map from the Main Menu.
5) To add data points to this file, tap on Main Menu and select Data. Continue to collect additional data points.

## 6.0 NAVIGATION

This section provides instructions on navigating to saved data points in an existing file within the GPS unit.

1) From the Main Menu select Map.
2) Using the Select tool, pick the point on the map to where you want to navigate.
3) The location you select will have a box placed around the point.
4) From the Options menu, choose the Set Nav Target (aka set navigation target).
5) The location will now have double blue flags indicating this point is you navigation target.
6) From the Main Menu select Navigation.

7) The dial and data on this page will indicate what distance and direction you need to travel to reach the desired target.
8) Follow the navigation guide until you reach the point you select.
9) Repeat as needed for any map point by going back to Step 1.

## 7.0 PULLING IN A BACKGROUND FILE

This section provides instructions on pulling in a pre-loaded background file. These files are helpful in visualizing your current location.

1) From the Main Menu select Map, then tap on Layers, select the background file from drop down list.
2) Select the project-specific background file from the list of available files.
3) Once the selected background file appears, the operator can manipulate the screen utilizing the +/- and <-/-> functions at the bottom of the screen.
4) In operating mode, the operator's location will show up on the background file as a floating "x".

## 8.0 DATA TRANSFER

This section provides instructions on how to transfer stored data on the handheld GPS unit to a personal computer. Prior to transferring data from the GPS unit to a computer, Microsoft ActiveSync and Trimble Data Transfer Utility software must be downloaded to the computer from the links provided in Section 2.2 (Required GPS Software). If a leased computer is utilized in which the operator can not download files, see the Note at the end of Section 8.0.

1) See Attachment A at the end of this SOP for instructions on how to transfer data from the GPS to a personal computer.

**Note:** If you are unable to properly transfer data from the GPS unit to a personal computer, the unit should be shipped to the project-specific contact listed in Section 1.0 where the data will be transferred and the GPS unit then shipped back to the vendor.

## 9.0 SHUTTING DOWN

This section provides instruction for properly shutting down the GPS unit.

1) When shutting down the GPS unit for the day, first click on the "X" in the upper right hand corner.

2) You will be prompted to ensure you want to exit TerraSync. Select Yes.
3) Power off the GPS unit by pushing the small green button located on the bottom face of the unit.
4) Place the GPS unit in its cradle to recharge the battery overnight. Ensure the green charge light is visible on the charging cradle.

# ATTACHMENT A

**How to Transfer Trimble GPS Data between Data Collector and PC**
original 11/21/06 (5/1/08 update) – John Wright

***Remember – Coordinate System, Datum, and Units are critical!!!***

**Trimble Data Collection Devices:**
Standard rental systems include the Trimble ProXR/XRS backpack and the newer handheld GeoXT or GeoXH units. Some of the older backpack system may come with either a RECON “PDA-style” or a TSCe or TSC1 alpha-numeric style data collector.

The software on all of the above units should be Trimble TerraSync (v 2.53 or higher – current version is 3.20) and to the user should basically look and function similar. The newer units and software versions (which should always be requested when renting) include enhancements for data processing, real-time display functions, and other features.

**Data Transfer:**
Trimble provides a free transfer utility program to aid in the transfer of GIS and field data. The Data Transfer Utility is a standalone program that will run on a standard office PC or laptop.

To connect a field data collector such as a RECON, GeoXM, GeoXT, GeoXH, or ProXH, you must first have Microsoft ActiveSync installed to allow the PC and the data collector to talk to one another. A standard USB cable is also needed to connect the two devices.

A CD or USB drive is provided with the data collector for use in data transfer. If needed, these programs are also available without charge via the web at:

• **Trimble Data Transfer Utility** (v 1.38) program to download the RECON or GeoXH field data to your PC: http://www.trimble.com/datatransfer.shtml

• **ActiveSync** from Microsoft to connect the data collector to the PC. The latest version (v4.5) can be found at: http://www.microsoft.com/windowsmobile/activesync/default.mspx
**(see page 2 for data transfer instructions)**

**To Transfer Data Collected in the Field:**

• Install the Data Transfer and ActiveSync software installed on your PC
• Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
• ActiveSync should auto-detect the connection and recognize the data collector
• Make sure the data file desired is CLOSED in TerraSync prior to transfer
• Connect via ActiveSync as a guest (not a partnership)
• Run the Trimble Data Transfer Utility program on your PC
• Select "***GIS Datalogger on Windows CE***" or similar selection
• Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
• Select the "***Receive***" data tab (under device)
• Select "***Data***" from file types on the right
• Find the file(s) needed for data transfer. You can sort the data files by clicking on the date/time header
• Select or browse to a C-drive folder you can put this file for emailing
• When the file appears on the list, hit the "***Transfer All***"
• Go to your Outlook or other email, send a message to: John.Wright@tetratech.com (or GIS department)
• Attach the file(s) you downloaded from your C-drive. For each TerraSync data file created you should have a packet of multiple data files. All need to be sent as a group – make sure you attach all files (the number of files may vary – examples include: ssf, obx, obs, gix, giw, gis, gip, gic, dd, and car)

**To Transfer GIS Data from PC to the Field Device (must be converted in Pathfinder Office):**

• Obtain GIS file(s) desired from GIS Department and have converted to Trimble extension
• Contact John Wright (John.Wright@tetratech.com) if needed for file conversion and upload support
• The GIS file(s) can be quickly converted if requested and sent back to the field user in the needed "Trimble xxx.imp" extension via email – then quickly downloaded from Outlook to your PC for transfer
• Install the Data Transfer and ActiveSync software installed on your PC
• Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
• ActiveSync should auto-detect the connection and recognize the data collector
• Connect via ActiveSync as a guest (not a partnership)
• Run the Trimble Data Transfer Utility program on your PC
• Select "***GIS Datalogger on Windows CE***" or similar selection
• Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
• Select the "**Send**" data tab (under device)
• Select "**Data**" from file types on the right (you can also send background files)
• Browse to the location of the data on your PC (obtain the file from Pathfinder Office or from the person who converted the data for field use)
• Select the options as appropriate for the name and location of the data file to go on the data collector (usually you can choose main memory or a data storage card)
• When the file(s) appears on the list, hit the "***Transfer All***"
• Run TerraSync on the field device and open the existing data files. Your transferred file should appear (make sure you have selected Main Memory, Default, or Storage Card as appropriate)

# STANDARD OPERATING PROCEDURE

# SOP-02

# SAMPLE LABELING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling sample containers. Sample labels are used to document the sample ID, date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label will be attached to each sample container.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Writing utensil (preferably black pen with indelible ink)**
**Disposable medical-grade gloves (e.g. latex, nitrile)**
**Sample log sheets**
**Required sample containers**: All sample containers for analysis by fix-based laboratories will be supplied and deemed certified clean by the laboratory.
**Sample labels**
**Chain-of-custody records**
**Sealable polyethylene bags**
**Heavy-duty cooler**
**Ice**

## 3.0 PROCEDURES

3.1 The following information will be electronically printed on each sample label prior to mobilizing for field activities. Additional "generic" labels will also be printed prior to mobilization to be used for field QC and backups.

- Project Number
- Sample Location ID
- Contract Task Order Number (CTO F274)
- Sample ID
- Matrix

- Preservative
- Analysis to be Performed
- Laboratory Name

3.2 Select the container(s) that are appropriate for a given sample. Select the sample-specific ID label(s), complete date, time, and sampler name, and affix to the sample container(s).

3.3 Fill the appropriate containers with sample material. Securely close the container lids without overtightening.

3.4 Place the sample container in a sealable polyethylene bag and place in a cooler containing ice.

Example of a sample label is attached at the end of this SOP.

## 4.0 ATTACHMENTS

1. Sample Label

**ATTACHMENT 1**

**SAMPLE LABEL**

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

# STANDARD OPERATING PROCEDURE

# SOP-03

# SAMPLE IDENTIFICATION NOMENCLATURE

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management at the Naval Support Activity (NSA) Crane. The sample nomenclature system has been devised such that the following objectives can be attained.

- Sorting of data by site, location, or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of sample identification

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

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Pen with indelible ink**
**Sample tags**
**Sample container labels**

## 3.0 SAMPLE IDENTIFICATION NOMENCLATURE

### 3.1 Samples

All samples will be properly labeled with a sample label affixed to the sample container. Each sample will be assigned a unique sample tracking number.

### 3.1.1 Confirmation Sample Numbering Scheme

The sample tracking number will consist of a four- or five-segment alpha-numeric code that identifies the sample's associated Solid Waste Management Unit (SWMU) number, sample type, location, and sample depth. For soil samples, the final four tracking numbers will identify the depth in units of feet below ground surface (bgs) at which the sample was collected (rounded to the nearest foot). For sediment samples, the final four tracking numbers will identify the depth in units of inches bgs at which the sample was collected.

The alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

| NN | AA | AA(A)NN | NNNN (Soils and Sediment only) |
|---|---|---|---|
| SWMU Number | Matrix | Sample Location Number | Sequential depth interval from freshly exposed surface |

**Character Type:**

A = Alpha

N = Numeric

**SWMU Number (NN):**

21 = SWMU 21

**Matrix Code (AA):**

SS = Surface Soil Sample

SB = Subsurface Soil Sample

SD = Sediment Sample

GW = Groundwater Sample

SW = Surface Water Sample

**Location Number (AA(A)NN):**

Location ID is optional (not all samples will have this code), sequential number beginning with "01" for each matrix. The location may contain two letters (e.g., GP for Gravel Pad) or three (e.g., IA1 for Investigation Area 1).

**Depth Interval (NNNN):**

This code section will be used for soil and sediment samples only. For soil samples, the final four tracking numbers will identify the depth in units of feet. Surface soil samples will be collected from 0- to 2-feet bgs. Subsurface soil samples will be collected at depths greater than 2-feet bgs. For sediment samples, the final four tracking numbers will identify the depth in units of inches. Sediment samples will be collected from 0- to 6-inches below the sediment/water interface.

The depth code is used to note the depth bgs at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval of the sample depth. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc

### 3.1.2 Examples of Sample Nomenclature

The first grab surface soil sample collected from the Gravel Pad Area at SWMU 21, at a depth of 0- to 2-feet bgs would be labeled as “21SS-GP01-0002”.

The composite sediment sample collected from sampling location 01 at SWMU 21 would be labeled as 21SD010006.

## 3.3 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC samples are described in the UFP-SAP. They will be designated using a different coding system than the one used for regular field samples.

### 3.3.1 QC Sample Numbering

The QC code will consist of a four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

| NN | AA | NNNNNN | NN |
|---|---|---|---|
| SWMU Number | QC Type | Date | Sequence Number (per day) |

The QC types are identified as:

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

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be "0000" so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

### 3.3.2 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day at SWMU 32 for a surface soil sample collected on October 25, 2009 would be designated as 32FD10250901.

The third duplicate of the day taken at SWMU 32 of a surface soil sample collected on November 3, 2009 would be designated as FD11030903.

The first rinsate blank associated with samples collected on November 3, 2009 would be designated as RB11030901.

# STANDARD OPERATING PROCEDURE
# SOP-04

# SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for sample custody and documentation of field sampling and field analyses activities.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following logbooks, forms, labels, and equipment are required.

**Writing utensil (preferably black pen with indelible ink)**
**Site logbook**
**Field logbook**
**Sample label**
**Chain-of-Custody Form**
**Custody seals**
**Equipment calibration log**
**Soil and Sediment Sample Log Sheet**

## 3.0 PROCEDURES

This section describes custody and documentation procedures. All entries made into the logbooks, custody documents, logs, and log sheets described in this SOP must be made in indelible ink (black is preferred). No erasures are permitted. If an incorrect entry is made, the entry will be crossed out with a single strike mark, initialed, and dated.

### 3.1 Site Logbook

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

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day
- Sample pickup information
- Health and safety issues
- Weather conditions

The site logbook is initiated at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that on-site activities take place.

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

- Project name
- Project number
- Book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). At the completion of each day's entries, the site logbook must be signed and dated by the Tetra Tech Field Operations Leader (FOL).

## 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.

## 3.3 Sample Labels

Adhesive sample container labels must be completed and applied to every sample container. Information on the label includes the project name, location, sample number, date, time, preservative, analysis, matrix, sampler's initials, and the name of the laboratory performing the analysis.

### 3.4 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 accompany any samples collected for laboratory chemical analysis. A copy of a blank COC form is attached at the end of this SOP.

The FOL must include the name of the laboratory in the upper right hand corner 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 will be placed inside a sealable polyethylene bag and taped inside the lid of the shipping cooler. Once the samples are received at the laboratory, the sample custodian checks the contents of the cooler(s) against the enclosed COC(s). Any problems are noted on the enclosed COC Form (bottle breakage, discrepancies between the sample labels, COC form, etc.) and will be resolved through communication between the laboratory point-of-contact and the Tetra Tech Project Manager (PM). The COC form is signed and retained by the laboratory and becomes part of the sample's corresponding analytical data package.

### 3.5 Custody Seal

The custody seal is an adhesive-backed label, and 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 (two seals per cooler) containing environmental samples. The laboratory sample custodian will examine the custody seal for evidence of tampering and will notify the Tetra Tech PM if evidence of tampering is observed.

### 3.6 Equipment Calibration Log

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

### 3.7 Sample Log Sheets

The Soil and Sediment Sample Log Sheets are used to document the sampling of soil and sediment (see SOPs -07, -08, and -09).

## 4.0 ATTACHMENTS

1. Chain-of-Custody Record
2. Equipment Calibration Log
3. Soil and Sediment Sample Log

# ATTACHMENT 1

# CHAIN-OF-CUSTODY RECORD

CHAIN OF CUSTODY | NUMBER | PAGE ____ OF ______

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

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

CONTAINER TYPE PLASTIC (P) or GLASS (G)

PRESERVATIVE USED

| DATE YEAR ____ | TIME | SAMPLE ID | MATRIX | GRAB (G) COMP (C) | No. OF CONTAINERS | TYPE OF ANALYSIS | | | | | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 1. RELINQUISHED BY | DATE | TIME | 1. RECEIVED BY | DATE | TIME |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |
| COMMENTS | | | | | |

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

3/99
FORM NO. TtNUS-001

# ATTACHMENT 2

# EQUIPMENT CALIBRATION LOG

Tetra Tech NUS, Inc.

## EQUIPMENT CALIBRATION LOG

PROJECT NAME : ____________ INSTRUMENT NAME/MODEL: ____________

SITE NAME: ____________ MANUFACTURER: ____________

PROJECT No.: ____________ SERIAL NUMBER: ____________

| Date of Calibration | Instrument I.D. Number | Person Performing Calibration | Instrument Settings | | Instrument Readings | | Calibration Standard (Lot No.) | Remarks and Comments |
|---|---|---|---|---|---|---|---|---|
| | | | Pre-calibration | Post-calibration | Pre-calibration | Post-calibration | | |
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# ATTACHMENT 3

## SOIL AND SEDIMENT SAMPLE LOG SHEET

### SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ____________________
Project No.: ____________________

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

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

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

**GRAB SAMPLE DATA:**

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

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

# STANDARD OPERATING PROCEDURE
# SOP-05

# SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for sample preservation, packaging, and shipping to be used in handling soil, sediment, and aqueous samples.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Shipping labels**
**Custody seals**
**Chain-of-custody (COC) form(s)**
**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, sealable polyethylene bags, strapping tape, etc.

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

3.1 The laboratory provides sample containers with preservative already included (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped at 4 degrees Celcius (°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 each sample container is properly labeled, the container lid is securely fastened, and the container is sealed in a polyethylene bag.

3.4 If the container is glass, 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, both inside and outside of the cooler. If the cooler is questionable for shipping, the cooler must be discarded.

3.6 Line the cooler with large plastic bag, and line the bottom of the cooler with a layer of bubble wrap. Place the sample containers into the shipping cooler in an upright position (containers will be upright, with the exception of any 40-milliliter vials). Continue filling the cooler with ice until the cooler is nearly full and the movement of the sample containers is limited.

3.7 Wrap the large plastic bag closed and secure with tape.

3.8 Place the original (top) signed copy of the COC form inside a sealable polyethylene bag. Tape the bag to the inside of the lid of the shipping cooler.

3.9 Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (one per side). Cover the custody seal with the last wrap of tape. This will provide a tamper evident custody seal system for the sample shipment.

3.10 Affix shipping labels to each of the coolers, ensuring all of the shipping information is filled in properly. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments.

3.11 All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances should sample hold times be exceeded.

# STANDARD OPERATING PROCEDURE
# SOP-06

# DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Writing utensil (preferably black pen with indelible ink)**
**Non-latex rubber or plastic gloves**
**Cotton gloves**
**Field logbook**
**Potable water**
**Deionized water**
**Isoproponal (optional)**
**LiquiNox detergent**
**Brushes, spray bottles, paper towels, etc.**
**Container to collect and transport decontamination fluids**

## 3.0 DECONTAMINATION PROCEDURES

3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) 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. If oily residue has accumulated on the sampling equipment, remove the residue with an isopropanol wash and repeat the LiquiNox wash.

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 SOP-10 and this UFP-SAP.

# STANDARD OPERATING PROCEDURE
# SOP-07

# SOIL CORING AND SAMPLING USING HAND AUGER TECHNIQUES

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for collecting surface and subsurface soil cores from unconsolidated overburden materials using hand augering techniques.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Disposable medical-grade gloves (e.g., latex, nitrile)**
**Writing utensil (preferably black pen with indelible ink)**
**Indelible marker**
**Stainless Steel Auger Buckets**
**Stainless Steel Extension Rods**
**Cross Handle**
**Required decontamination materials**
**Bentonite pellets**
**Sealable polyethylene bags**
**Sample labels**
**Shipping containers** (containing ice)
**Disposable plastic trowels or stainless steel trowels**
**Stainless steel mixing bowls**
**Sample containers:** Sample containers are certified clean by the laboratory supplying the containers.
**Soil Sample Log Forms**
**Daily Activity Logs**
**Chain-of-Custody Form**

## 3.0 SOIL SAMPLING USING A HAND AUGER

Hand augers and/or a DPT rig will be employed to collect the soil cores. Please reference SOP-11 for Direct-Push Technology Standard Operating Procedure. A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e. cylinders 6-1/2” long and 2-3/4”, 3-1/4”, and 4” in diameter), a series of extension rods (available in 2’, 3’, 4’ and 5’ lengths), a cross handle.

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

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

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

3.3. Turn hand auger sampler into the ground to a depth of 2 feet. The 0- to 2-feet depth soil interval is considered to be the surface soil.

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

3.4 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a sealable polyethylene bag. Note in a field notebook or on a standardized data sheet any changes in the color, texture or odor of the soil.

3.5 Thoroughly homogenize the sample material and write sample ID, date, and time on the bag with an indelible marker.

3.6 Complete required information on the Soil Sample Log Sheet (copy attached at the end of this SOP). Update the Chain-of-Custody (COC) Form.

3.7 Excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole, and hydrated with potable water.

3.8 Decontaminate all soil sampling equipment in accordance with SOP-06 before collecting the next sample.

3.9 Soil samples shipped to a fixed-base laboratory for analysis will be in sample containers supplied by the laboratory. The sample labels will be completed and affixed to the sample container. The samples will then be packaged and shipped to the fixed-base laboratory in accordance with SOP-05.

## 4.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

# ATTACHMENT 1

# SOIL AND SEDIMENT SAMPLE LOG SHEET

## SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ____________
Project No.: ____________

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

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

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

**GRAB SAMPLE DATA:**

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

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

**MS/MSD**

**Duplicate ID No.:**

**Signature(s):**

# STANDARD OPERATING PROCEDURE
# SOP-08

# SOIL SAMPLE LOGGING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil samples.

## 2.0 FIELD FORMS AND EQUIPMENT

**Knife**
**Ruler** (marked in tenths and hundredths of feet)
**Boring Log:** An example of this form is attached.
**Writing utensil (preferably black pen with indelible ink)**

## 3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all activities and assuring that each soil sample is properly and completely logged.

## 4.0 PROCEDURES FOR SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understands and accurately uses the field classification system described in this SOP. This identification is based on visual examination and manual tests.

### 4.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (attached to this SOP).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no distinguishable size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils will be divided into categories: rock fragments, sand, or gravel. The terms "sand" and "gravel" not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" will be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges that are typically observed indicate little or no transport from their source area; and therefore, the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

## 4.2 Color

Soil colors will be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Because color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

The term "mottled" will be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

## 4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are non-cohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in the following table.

**CONSISTENCY FOR COHESIVE SOILS**

| Consistency | Standard Penetration Resistance (Blows per Foot) | Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration) | Field Identification |
|---|---|---|---|
| Very soft | 0 to 2 | Less than 0.25 | Easily penetrated several inches by fist. |
| Soft | 2 to 4 | 0.25 to 0.50 | Easily penetrated several inches by thumb. |
| Medium stiff | 4 to 8 | 0.50 to 1.0 | Can be penetrated several inches by thumb with moderate effort. |
| Stiff | 8 to 15 | 1.0 to 2.0 | Readily indented by thumb but penetrated only with great effort. |
| Very stiff | 15 to 30 | 2.0 to 4.0 | Readily indented by thumbnail. |
| Hard | Over 30 | More than 4.0 | Indented with difficulty by thumbnail. |

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample. The sample will be broken in half and the thumb pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. One of the other methods will be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

## 4.4 <u>Weight Percentages</u>

In nature, soils are consist of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

| Terms of Identifying Proportion of the Component | Defining Range of Percentages by Weight |
|---|---|
| Trace | 0 - 10 percent |
| Some | 11 - 30 percent |
| Adjective form of the soil type (e.g., sandy) | 31 - 50 percent |

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

## 4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the gloved hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire field activity.

## 4.6 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, the following table will be used.

| Gross Soil Grain Size Classification | USCS Abbreviation | Description |
|---|---|---|
| Clay | CL | inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. |
| | CH | inorganic clays of high plasticity, fat clays. |
| | OH | organic clays of medium to high plasticity, organic silts. |
| Silt | ML | inorganic silts and very fine sands, rock four, silty or clayey fine sands with slight plasticity. |
| | OL | organic silts and organic silty clays of low plasticity. |
| | MH | inorganic silts, micaceous or diatomaceous fine sand or silty soils. |
| Sand | SW | well graded sands, gravelly sands, little or no fines. |

| Gross Soil Grain Size Classification | USCS Abbreviation | Description |
|---|---|---|
| | SP | poorly graded sands, gravelly sands, little or no fines. |
| | SM | silty sands, sand-silt mixtures. |
| | SC | clayey sands, sand-clay mixtures. |

## 4.7 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features
- Grain size
- Depositional environment

# 5.0 ATTACHMENTS

1. Figure 1 - Unified Soil Classification System
2. Boring Log

## ATTACHMENT 1

## FIGURE 1 - UNIFIED SOIL CLASSIFICATION SYSTEM

### Unified Soil Classification System

| | | | |
|---|---|---|---|
| Coarse Grained Soils (more than half of soil > No. 200 sieve) | Gravels (More than half of coarse fraction > no. 4 sieve size) | GW | Well graded gravels or gravel-sand mixtures, little or no fines |
| | | GP | Poorly graded gravels or gravel-sand mixtures, little or no fines |
| | | GM | Sandy gravels, gravel-sand-silt mixtures |
| | | GC | Clayey gravels, gravel-sand-silt mixtures |
| | Sands (More than half of coarse fraction < no. 4 sieve size) | SW | Well graded sands or gravelly sands, little or no fines |
| | | SP | Poorly graded sands or gravelly sands, little or no fines |
| | | SM | Silty sands, sand-silt mixtures |
| | | SC | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity |
| Fine Grained Soils (more than half of soil < No. 200 sieve) | Silts and Clays LL = < 50 | ML | Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays |
| | | OL | Organic silts and organic silty clays of low plasticity |
| | Silts and Clays LL = > 50 | MH | Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts |
| | | CH | Inorganic silts of high plasticity, fat clays |
| | | OH | Organic clays of high plasticity, organic silty clays, organic silts |
| Highly Organic Soils | | Pt | Peat and other highly organic soils |

### Grain Size Chart

| Classification | Range of Grain Sizes: U.S. Standard Sieve Size | Range of Grain Sizes: Grain Size In Millimeters |
|---|---|---|
| Boulders | Above 12" | Above 305 |
| Cobbles | 12" to 3" | 305 to 76.2 |
| Gravel | 3" to No. 4 | 76.2 to 7.76 |
| coarse | 3" to 3/4" | 76.2 to 4.76 |
| fine | 3/4"to No.4 | 19.1 to 4.76 |
| Sand | No. 4 to No. 200 | 4.76 to 0.074 |
| coarse | No.4 to No. 10 | 4.76 to 2.00 |
| medium | No. 10 to No. 40 | 2.00 to 0.420 |
| fine | No. 40 to No. 200 | 0.420 to 0.074 |
| Silt and Clay | Below No. 200 | Below 0.074 |

### Relative Density (SPT)

| SANDS AND GRAVELS | BLOWS/FOOT |
|---|---|
| VERY LOOSE | 0 – 4 |
| LOOSE | 4 – 10 |
| MEDIUM DENSE | 10 – 30 |
| DENSE | 32 – 50 |
| VERY DENSE | OVER 50 |

### Consistency (SPT)

| SILTS AND CLAYS | BLOWS/FOOT |
|---|---|
| VERY SOFT | 0 – 2 |
| SOFT | 2 – 4 |
| MEDIUM STIFF | 4 – 8 |
| STIFF | 8 – 16 |
| VERY STIFF | 16 – 22 |
| HARD | OVER 32 |

# ATTACHMENT 2

# BORING LOG

Tetra Tech NUS, Inc.

## BORING LOG

Page ___ of ___

PROJECT NAME: ______________ BORING No.: ______________
PROJECT NUMBER: ______________ DATE: ______________
DRILLING COMPANY: ______________ GEOLOGIST: ______________
DRILLING RIG: ______________ DRILLER: ______________

| | | | | | MATERIAL DESCRIPTION | | | | | PID/FID Reading (ppm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample No. and Type or RQD | Depth (Ft.) or Run No. | Blows / 6" or RQD (%) | Sample Recovery / Sample Length | Lithology Change (Depth/Ft.) or Screened Interval | Soil Density/ Consistency or Rock Hardness | Color | Material Classification | U S C S * | Remarks | Sample | Sampler BZ | Borehole** | Driller BZ** |
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* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: ______________________________

Converted to Well: Yes ______ No ______ Well I.D. #: ______________

# STANDARD OPERATING PROCEDURE

# SOP-09

# SEDIMENT SAMPLING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for sediment sampling in streams and other waterways.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for sediment sampling.

**Sediment Sample Log Forms**: A copy of this form is attached at the end of this SOP.
**Writing utensil (preferably black pen with indelible ink)**
**Indelible marker**
**Bound field logbook**
**Disposable plastic trowels**
**Survey stakes and flagging:** Used to mark sampling locations after completion of sampling.
**Labeled sample containers**: See SOP-02 for sample identification procedures. Sample containers are certified clean by the laboratory supplying the containers.
**Sealable polyethylene bags**
**Shipping containers** (containing ice)
**Disposable medical-grade gloves (e.g., latex, nitrile)**
**Chain-of-Custody Form**

## 3.0 SEDIMENT SAMPLE LOCATION SELECTION

In general, sediments composed of fine-grained materials with greater surface area available for adsorption are more desirable for sample selection. The fined-grained materials may act as a sink or reservoir for adsorbing heavy metals and organic contaminants even if surface runoff concentrations are below detection limits. Therefore, it is important to locate the specific sampling points where the sediment has the greatest percentage of fine particles. The sampling personnel will determine specific sampling locations with these goals in mind.

## 4.0 SEDIMENT SAMPLING PROCEDURES

4.1 The sampler will wear clean, disposable medical-grade gloves. Clear vegetative matter or debris, if present, from the sample location using a disposable sampling trowel or spoon. Use the trowel to dig up and homogenize the sediment in an 18-inch-diameter circular area that is 6 inches deep. If site conditions do not allow for an 18-inch-diameter and/or 6 inches depth, the circular area will be reduced to no less than 12-inch-diameter and/or 3 inches deep, and the circular area size will be notated on the Sediment Sample Log Sheet. Stir the sediment within the circular area; do not move the sediment outside the circle. Also, do not dig or stir sediment that is deeper than 6 inches below the ground surface, until the next depth interval is sampled.

- Use the same trowel to scoop the homogenized sediment into the requisite labeled sample container(s).

4.2 Record the sample time (using military time) on the Sediment Sample Log Form and sample container labels. Record all other information required on the labels as specified by SOP-02.

4.3 Place the labeled sample container into a sealable polyethylene bag and then place the bag holding the sample container into a cooler containing ice.

4.4 Record date, sampling site, site conditions, location map, and other information (e.g., presence and flow rate of water in channel) on the Sediment Collection Log Sheet. Enter the sample information onto the Chain-of-Custody Form in accordance with SOP-04.

4.5 Using an indelible marker, write the sample identification on a survey stake, and drive the stake into the ground at the sample location. Tack a piece of brightly colored flagging to the stake. In addition, tie a piece of flagging to an overhead tree branch or other eye-level object to improve the ability to relocate the sampling site in the future.

## 5.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

# ATTACHMENT 1

## SOIL AND SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

**SOIL & SEDIMENT SAMPLE LOG SHEET**

**Page___ of ___**

Project Site Name: ____________________
Project No.: ____________________

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

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

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

**GRAB SAMPLE DATA:**

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

**COMPOSITE SAMPLE DATA:**

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

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
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| | | | |
| | | | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

# STANDARD OPERATING PROCEDURE
# SOP-10

# MANAGEMENT OF INVESTIGATION-DERIVED WASTE

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations at Naval Support Activity (NSA) Crane. The following types of IDW will be generated during this investigation:

- Soil sampling residues
- Monitoring well development and well purge waters
- Decontamination solutions
- Personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Health and safety equipment (with PPE)**
**Hand augers, plastic or stainless steel trowels**
**Bucket (**with collected development/purge water)
**Decontamination equipment**
**Field logbook**
**Writing utensil (preferably black pen with indelible ink)**
**Plastic sheeting and/or tarps**
**55-gallon drums with sealable lids**
**IDW labels for drums**
**Plastic garbage bags**

## 3.0 PROCEDURES

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities if necessary.

## 3.1 Liquid Wastes

Liquid wastes that will be generated during the site activities include decontamination solutions from sampling equipment. These wastes will be collected and containerized in a central location at NSA Crane for proper disposal.

## 3.2 Solid Wastes

Solid wastes that may be generated during site activities include soil and sediment sampling residues. Excess soil core/sampling materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole, and hydrated with potable water. Excess sediment sampling materials will be returned to the point of collection. The disposition of this materials will be carried out in a manner such as not to contribute further environmental degradation or pose a threat to public health or safety.

## 3.3 PPE and Incidental Trash

All PPE wastes and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSA Crane.

# STANDARD OPERATING PROCEDURE
# SOP-11

# SUBSURFACE SOIL AND GROUNDWATER SAMPLING USING DIRECT-PUSH TECHNOLOGY

## 1.0 PURPOSE

This procedure provides general guidance and reference information on direct-push technology (DPT). DPT is designed to collect soil and groundwater samples without using conventional drilling techniques. The advantage of using DPT over conventional drilling includes the generation of little or no drill cuttings, ability to sample in locations with difficult accessibility, reduced overhead clearance requirements, no fluid introduction during probing, and typical lower costs per sample than with conventional techniques. Disadvantages include a maximum penetration depth of approximately 15 to 40 feet in dense soils (although it may be as much as 60 to 80 feet in certain types of geological environments), reduced capability of obtaining accurate water-level measurements, and the inability to install permanent groundwater monitoring wells.

The methods described herein are specific for soil, groundwater, and soil gas samples at Naval Support Activity (NSA) Crane. Guidelines by Southern Division, Naval Facilities Engineering Command (South Div NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 (Water Well Drillers) of Chapter 310 of the Indiana Administrative Code (310 IAC 16) should be consulted.

## 2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction.

Field Geologist - The Tetra Tech Field Geologist supervises and documents DPT activity performed by the driller, and insures that the soil and groundwater samples collected accurately representative the desired media and sample interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

All Field Personal – All field personal including, the drilling contractor personnel and other field staff, must have all of the health and safety training required to perform the work, as specified in the Health and

Safety Plan (HASP). All field personnel shall be aware of the potential presence of underground utilities. Proper utility clearance must be obtained by the Tetra Tech Project Manager (PM) prior to any DPT activity.

If the potential of Unexploded Ordnance (UXO) is present at the site, UXO clearance to six feet will be required for subsurface samples. Every two feet the drill rig shall be withdrawn and a downhole magnetometer used to check for UXO. If the presence of any UXO is suspected, the drilling location will be shifted two feet and drilling resumed. A trained UXO technician will be part of the Tetra Tech field team.

## 3.0 REQUIRED EQUIPMENT/ITEMS

The list of equipment and items required for DPT sampling includes, but is not limited to:

Health and safety equipment as required by the HASP and the Site Safety Officer.

DPT Rig is supplied by the drilling subcontractor and may include the following:

- 4-foot x 2-inch diameter macrocore sampler
- Probe sampling adapters
- Disposable acetate liners for soil macrocore sampler
- Cast aluminum or steel drive points
- Geoprobe® AT-660 Series Large Bore Soil Sampler, or equivalent
- Stainless steel screen point groundwater sampler (Geoprobe®, HydroPunch™, or equivalent)

55-gallon drums to containerize IDW (supplied by the drilling subcontractor).

Required decontamination materials including distilled water, deionized water, paper towels, and stainless steel clamps.

Writing utensil (preferably black ink), non-latex gloves, bound field logbook, chain-of-custody forms, sample labels, boring log, sample logsheets, engineer's tape (or equivalent), and stainless-steel spoon or trowel.

Required sample containers with appropriate preservative: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory. Additional sampling equipment as needed, such as photo-ionization detector (PID), flame-ionization detector (FID), Ziplock bags, calculator, wristwatch, and timer, and cooler (containing ice), peristaltic pump, inertial lift pump, silicon tubing, polyethylene (PE) tubing, water quality meter with a flow through cell, LaMotte 2020 Turbidity Meter (or equivalent), water level indicator, 0.45 micron filter cartridge, trip blanks, and bucket to collect development/purge water.

## 4.0 GLOSSARY

Direct Push Technologies (DPT) -DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional drilling equipment. DPT typically utilizes hydraulic pressure and/or percussion hammers to advance the sampling tools.

Geoprobe® is a manufacturer of a hydraulically-powered, percussion/probing machines utilizing DPT to collect subsurface environmental samples. Geoprobe® relies on a relatively small amount of static weight (vehicle) combined with percussion as the energy for advancement of a tool string. The Geoprobe® equipment can be mounted in a multitude of vehicles for access to all types of environmental sites.

HydroPunch™ is a manufacturer of stainless steel and Teflon® sampling tools that are capable of collecting representative groundwater and/or soil samples without requiring the installation of a groundwater monitoring well or conventional soil boring. HydroPunch™ is an example of DPT sampling equipment.

Flame Ionization Detector (FID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts per million levels. The basis for the detection is the ionization of gaseous species utilizing a flame as the energizing source.

Photoionization Detector (PID) - A portable instrument for the measurement of many combustible organic compounds and a few inorganic compounds in air at parts per million levels. The basis for the detection is the ionization of gaseous species utilizing ultraviolet radiation as the energizing source.

## 5.0 DPT SOIL SAMPLING PROCEDURES

### General

The common methodology for the investigation of the vadose zone is soil boring drilling and soil sampling. However, drilling soil borings can be very expensive. Generally the advantage of DPT for subsurface soil sampling is the reduced cost of disposal of drilling cuttings and shorter sampling times.

**DPT Sampling Methodologies**

There are several methods for the collection of soil samples using DPT drilling. The most common method is discussed in the following section. Variations of the following method may be conducted upon approval of the Tetra Tech PM in accordance with the project-specific plan.

Macrocore samplers fitted with detachable aluminum or steel drive points are driven into the ground using hydraulic pressure. If there is concrete or pavement over a sampling location, a Roto-hammer is used to drill a minimum 1.5-inch diameter hole through the surface material. A Roto-hammer may also be used if very dense soils are encountered.

The sampler is advanced continuously in 4-foot intervals, or less if desired. No soil cuttings are generated because the soil which is not collected in the sampler is displaced within the formation.

The sampler is retracted from the hole, and the 4-foot continuous sample is removed from the outer coring tube. The sample is contained within an inner acetate liner.

- Attach the metal trough from the Geoprobe® Sampling Kit (or equivalent) firmly to the tail gate of a vehicle. If a vehicle with a tail gate is not available, secure the trough on another suitable surface.
- Place the acetate liner containing the soils in the trough.
- While wearing cut-resistant gloves (constructed of leather or other suitable material), cut the acetate liner through its entire length using the double-bladed knife. Then remove the strip of acetate from the trough to gain access to the collected soils. **Do not** attempt to cut the acetate liner while holding it in your hand.
- Field screen the sample with an FID or PID (according to manufacturer's Standard Operating Procedure [SOP]) and observe/examine the sample. If appropriate, transfer the sample to sample bottles for laboratory analysis. If additional volume is required, push an additional boring adjacent to the first and composite/mix the same interval. Field compositing is usually not acceptable for sample requiring volatile organic compounds (VOCs) analysis.
- Once sampling has been completed, the hole is backfilled with bentonite chips or bentonite cement grout, depending upon project requirements. Asphalt or concrete patch is used to cap holes through paved or concrete areas. All holes should be finished smooth to existing grade.
- In the event the direct push van, truck, or track mounted rig cannot be driven to a remote location or a sampling location with difficult accessibility, sampling probes may be advanced and sampled manually or with air/electric operated equipment (e.g., jack hammer).
- Sampling equipment is decontaminated prior to collecting the next sample.

# 6.0 GROUNDWATER SAMPLING PROCEDURES

The most common methodology for the investigation of groundwater is the installation and sampling of permanent monitoring wells. If only groundwater screening is required, the installation and sampling of temporary well points may be performed. The advantage of temporary well point installation using DPT is reduced cost due to no or minimal disposal of drilling cuttings and well construction materials, and shorter installation/times sampling. Two disadvantages of DPT drilling for well point installation are:

- In aquifers with low yields, well points may have to be sampled without purging or development.
- If volume requirements are high, this method can be time consuming for low yield aquifers.

## 6.1 Sampling Equipment

Equipment needed for temporary well installation and sampling using DPT includes, but is not limited to the following:

- 2-foot x 1 -inch diameter mill-slotted (0.005 to 0.02-inch) well point Connecting rods
- Roto-hammer with 1.5-inch bit Mechanical jack
- 1/4-inch outside diameter (OD) PE tubing
- 3/8-inch OD PE tubing
- Peristaltic pump
- Standard decontamination equipment and solutions

## 6.2 DPT Sampling Methodologies

Once the water table has been encountered, a stainless steel screen point groundwater sampler (Geoprobe®, HydroPunch™, or equivalent) will be driven by DPT to collect a groundwater sample at the water table.

- Field screening of VOC vapors in the borehole shall be done using a FID or PID.
- The screen point will be allowed to equilibrate for at least 15 minutes.
- Once equilibration occurs, measurement of the static water level will be taken. This initial water level measurement will be used to assess the amount of water present in the screen point and to determine the amount of silt and/or sand infiltration.
- Development of the screen point will be accomplished using a peristaltic pump.

- Insert the intake end of a length of dedicated PE tubing to the bottom of the screen point and attach a length of silicon tubing (approximately 1 foot) to the discharge end of the PE tubing. The silicon tubing will be threaded around the rotor of the pump and out of the pump.
- The PE tubing will be lifted and lowered slightly while the pump is operating. The maximum pump rate will be approximately 2 liters per minute during development; however the yield of the formation will dictate the pumping rate.
- Measurement of pH, specific conductance, turbidity, dissolved oxygen, eH, salinity, and temperature shall be recorded every 5 to 10 minutes during the development process using a water quality meter and flow-through cell, with the exception of turbidity. Turbidity measurements will be taken with a Lamotte Turbidity Meter from water collected from a T-connector with a valve inserted in the pump discharge tubing prior to entering the flow-through cell.
- After removal of sediment from the bottom of the screen point, the screen point will be pumped until discharge water is visibly clear and no further sediments are being generated.
- Stabilization is achieved after two consecutive readings taken at 5 to 10 minutes intervals of the following field parameters has occurred:

    - pH +/- 0.1 standard units
    - Turbidity +/- 10% for values greater than 1 NTU
    - Specific conductance +/- 3%
    - Temperature +/- 3%
    - eH +/- 10 millivolts
    - Dissolved oxygen +/- 10%

- Samples will be collected using the peristaltic pump set at 0.2 liters per minute or lower, depending on the yield of the formation. Samples (with the exception of samples to be analyzed for VOCs) will be collected directly from the pump discharge. The pump shall continuously operate between development, purging, and sampling.

- If the above condition(s) have not been met after three well volumes have been removed, this will be recorded on the field sample form and the groundwater sample will be collected.

- Record the sample date and time (using military time) on a Tetra Tech Groundwater Sample Log Sheet and on a chain-of-custody form.

- Record the sample date and time (using military time) on an adhesive-backed sample label and affix the sample label securely to the sample container.

- With the pump continuing to run, allow the pump discharge to flow gently down the inside of the sample container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled.

- Cap each container immediately after filling.

- Place the sample container into a ziplock bag and then into a cooler containing ice.

- Repeat the last four steps for each sample container collected.

- 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 Tetra Tech Groundwater Sample Log Sheet.

- All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. The hierarchy of filling sample containers is as follows:

  - VOCs
  - Explosives
  - Total metals
  - Dissolved metals
  - Perchlorates

- This hierarchy takes into consideration the volatilization sensitivity of groundwater samples. The only deviation from this order will be the collection of samples for VOC analysis. The collection of VOCs will be the final parameter collected due to the fact that VOCs will not be collected using the peristaltic pump.

- A single-use, disposable, in-line 0.45-micron filter cartridge shall be used to collect dissolved metals 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 milliliters (mL) of water from the boring to be sampled. Direct the discharge from the filter cartridge into the sample bottle and collect the filtered sample. The laboratory will supply all sample containers, and the laboratory will pre-preserve sample containers where appropriate.

- Once all of the sample containers have been filled (with the exception of those sample containers for VOC analysis), the pump shall be shut off. Record the sample date and time (in military time) on an adhesive-backed sample label and affix the sample label securely to the sample container. Sample containers for VOCs will be filled by crimping the discharge end of the PE tubing (immediately after shutting off the pump). Remove the inlet end of the PE tubing from the well, suspend the inlet tubing above the VOC sample container (pre-preserved 40 mL vial), and slowly allow water to fill each VOC sample container by gravity flow. The discharge of sample from the PE tubing shall be accomplished in a manner that allows the water to gently flow down the inside of the sample container. Sample containers for VOCs must be completely filled so that no headspace exists in the container. Record the end time for sampling on a Tetra Tech Groundwater Sample Log Sheet.

- Once collection of samples is complete, the driller shall remove the screen point and the screen point will be decontaminated in accordance with the procedures outlined in the decontamination SOP.

- If needed, continuous soil and groundwater sampling using DPT below the water table shall be done in accordance with those procedures outlined above.

- After the groundwater samples have been collected, the driller shall retract the screen point sampler from the borehole and proceed to abandon the borehole with a grout pump using a cement bentonite grout mix from the bottom up to the ground surface.

- When advancing a boring using DPT and refusal is encountered, the boring shall be deemed complete, drilling shall cease, and the borehole shall be abandoned with a grout pump using a cement bentonite grout mixture.

# STANDARD OPERATING PROCEDURE
# SOP-12

# MONITORING WELL INSTALLATION

## 1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper design and installation of ground water monitoring wells. The methods described herein are specific for monitoring well construction at Naval Support Activity (NSA) Crane. Guidelines by Southern Division, Naval Facilities Engineering Command (South Div NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 (Water Well Drillers) of Chapter 310 of the Indiana Administrative Code (310 IAC 16) should be consulted.

## 2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The drilling contractor personnel must have all of the health and safety training required to perform the work, as specified in the Health and Safety Plan (HASP).

Field Geologist - The Tetra Tech Field Geologist supervises and documents well installation and construction performed by the driller, and insures that the screen interval for each monitoring well is properly placed to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

## 3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the Site Safety Officer.

Well drilling and installation equipment with associated materials (typically supplied by the driller).

Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineer’s rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, boring logs, soil sample log forms, chain-of-custody records, sample coolers with ice, and a field notebook).

## 4.0 WELL DESIGN AND CONSTRUCTION

New wells will be installed only with Navy concurrence. Based on observations and information gathered during the drilling of each hole, the total depth of the hole and the placement of the well screen will be determined at the discretion of the Tetra Tech Field Geologist or the Tetra Tech Field Operations Leader (FOL). The decision concerning the monitored interval and well depth will be based on the following (and possibly other) information collected while the well bore is being drilled and logged:

- The specific depths where poorly-cemented sandstone units, fractured rock, or other permeable rock zones are encountered,
- The specific depths where above-average rates of ground water were brought to the surface during drilling,
- The specific depth interval where contaminants (i.e., VOCs), if any, are encountered during drilling.

All of this information will be recorded on the borehole log as the hole is drilled.

Overburden drilling followed by diamond coring (if necessary) will be performed at borehole locations. For each well, the coring will proceed to the final depth of the borehole. Once the coring has been completed and the core has been logged, then the hole will be reamed out with a 6 to 8-inch diameter air rotary bit. The air rotary equipment must have a filter on the compressed air line going to the borehole to prevent oil and other organics from being introduced. Once the hole has been completed to depth, the boring shall be cleaned out using the compressed air of the rig. Note: all drilling equipment must be decontaminated before it is placed in a borehole.

A 6-inch diameter steel isolation casing will be installed and pressure grouted in the deep wells to seal the upper groundwater from deep groundwater. The grout will be allowed to cure for a minimum of 24 hours before resuming coring and reaming to the total depth of the borehole.

All monitoring wells will be constructed of schedule-40, flush-joint threaded, 2-inch inside diameter (ID) polyvinyl chloride (PVC) riser pipe and flush joint threaded, factory slotted well screen with a threaded end cap. The well screens will be factory slotted to 0.020-inch size. Each section of well casing and screen shall be National Sanitation Foundation (NSF) approved. Well screens will be 10-feet long, but may be longer or shorter based on the subsurface conditions encountered. A PVC cap will be placed on the bottom and will also be flush-threaded. Thermoplastic pipe shall comply with ASTM F-480 (1981). Other means of joining casings using glue, gaskets, pop rivets or screws are not allowed. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material.

Monitoring wells will be installed immediately upon completion of drilling. A well screen section with bottom cap and the proper amount of riser pipe will be assembled and lowered down the borehole. Spacers may be used to ensure that the casing and screen are centered and are aligned straight. Clean silica sand pack will be installed through the borehole. The sand pack will be extended from 0.5 feet below the well screen to 2.0 feet above the top of the well screen. Clean silica sand of U.S. Standard Sieve Size No. 20 to 40 will be used.

A minimum 2-foot thick bentonite pellet seal will be installed above the filter pack and allowed to hydrate as determined by field geologist before grout is added above the seal. Only 100-percent, certified pure, sodium bentonite will be used for well construction. The depths of backfill materials will be constantly monitored during well installation using a weighted stainless steel or fiberglass tape measure.

The remaining annulus above the hydrated bentonite seal will be backfilled to the surface using a tremie pipe, with a 20:1 cement/bentonite grout. A maximum of 10 gallons of water per 94-pound bag of Type-1 cement will be used. The grout mixture should be blended in an above-ground rigid container or mixer to produce a thick lump-free mixture.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets extending to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward, to prevent bridging, and to provide a better seal. However, in shallow boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

When the well is completed and grouted to the surface, a protective steel surface casing is placed over the top of the well. The finished well casing shall extend at least 2 ft above the ground level. This casing will have a cap that will be locked to prevent vandalism. A vent hole shall be provided in the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the riser pipe and is set into the wet cement grout over the riser upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

Four barrier posts shall be placed at the corner of a 3 foot by 3 foot by 6 inch thick concrete pad located at the ground surface.

## 5.0 DOCUMENTATION OF FIELD ACTIVITIES

A critical part of monitoring well installation is recording of significant details and events in the site logbook, on field forms, and a field logbook.

All installed wells must be registered with the NSA Crane Environmental Protection Department. The following information must be supplied to NSA Crane for each well as soon as this information is known:

- Tag number
- Installation Name (i.e., NSA Crane)
- Contract Task Order number (CTO F274)
- Tetra Tech project number
- Well identification number
- Date installed
- Installer (i.e., Tetra Tech)
- Total well depth
- Screened interval
- Elevation (Top of casing)
- Northing coordinate (ft)
- Easting coordinate (ft)
- Survey coordinate reference system
- Information point of contact

## 6.0 ATTACHMENTS

1. Bedrock Monitoring Well Sheet
2. Overburden Monitoring Well Sheet

# ATTACHMENT 1

# BEDROCK MONITORING WELL SHEET

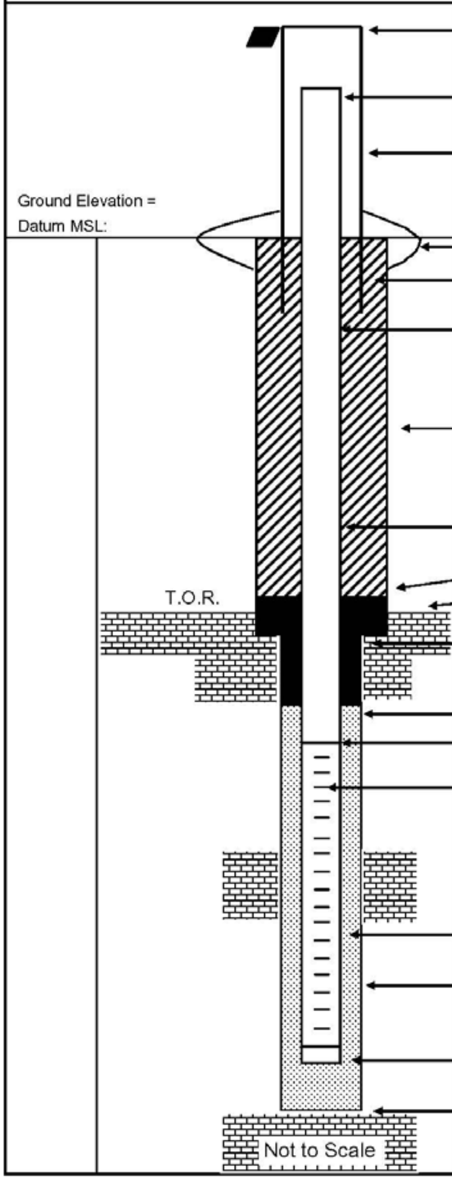
**BEDROCK**

**MONITORING WELL SHEET**

WELL No.: ____________

PERMIT No: ____________

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | ______ | DRILLING Co.: | ______ | BORING No.: | ______ |
| PROJECT No.: | ______ | DRILLER: | ______ | DATE COMPLETED: | ______ |
| SITE: | ______ | DRILLING METHOD: | ______ | NORTHING: | ______ |
| GEOLOGIST: | ______ | DEV. METHOD: | ______ | EASTING: | ______ |




Elevation of Top of Casing: ____________

Stick Up of Casing Above Ground Surface: ____________

Elevation of Top of Riser: ____________

I.D. of Surface Casing: ____________

Type of Surface Casing: ____________

Type of Surface Seal: ____________

I.D. of Permanent Casing: ____________

I.D. of Riser: ____________

Type of Riser: ____________

Borehole Diameter: ____________

Type of Backfill: ____________

Elevation / Depth Top of Seal: ______ / ______

Elevation / Depth Top of Bedrock: ______ / ______

Type of Seal: ____________

Elevation / Depth of Top of Fine Sand: ______ / ______

Elevation / Depth of Top of Filter Pack: ______ / ______

Elevation / Depth of Top of Screen: ______ / ______

Type of Screen: ____________

Slot Size x Length: ____________

I.D. of Screen: ____________

Type of Filter Pack: ____________

Diameter of Hole in Bedrock: ____________

Core / Ream: ____________

Elevation / Depth of Bottom of Screen: ______ / ______

Elevation / Total Depth of Borehole: ______ / ______

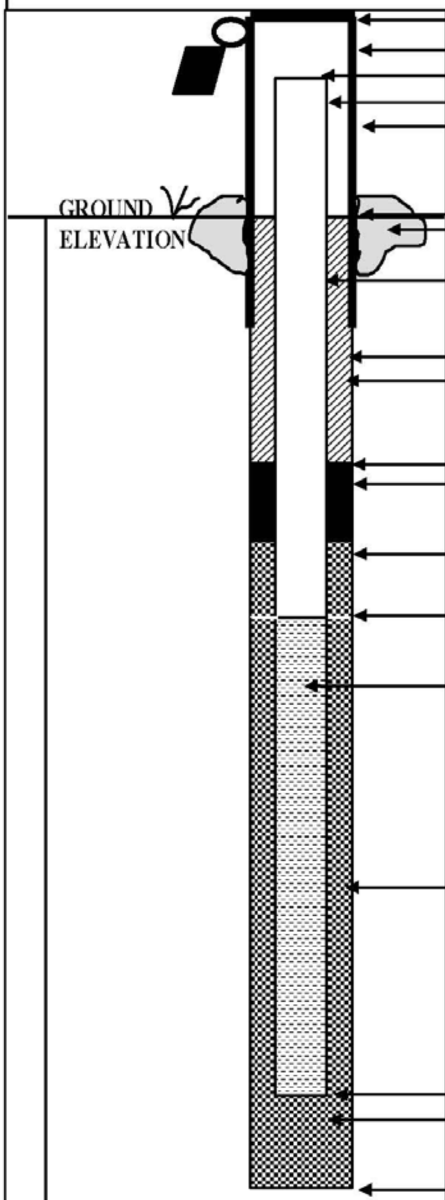
# ATTACHMENT 2

# OVERBURDEN MONITORING WELL SHEET

BORING NO.: ________

## OVERBURDEN MONITORING WELL SHEET

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | ________ | DRILLING Co.: | ________ | BORING No.: | ________ |
| PROJECT No.: | ________ | DRILLER: | ________ | DATE COMPLETED: | ________ |
| SITE: | ________ | DRILLING METHOD: | ________ | NORTHING: | ________ |
| GEOLOGIST: | ________ | DEV. METHOD: | ________ | EASTING: | ________ |




ELEVATION OF TOP OF SURFACE CASING: ________
STICK -UP TOP OF SURFACE CASING: ________
ELEVATION OF TOP OF RISER PIPE: ________
RISER STICK-UP ABOVE GROUND SURFACE: ________
I.D. OF SURFACE CASING: ________
TYPE OF SURFACE CASING: ________

GROUND ELEVATION: ________
TYPE OF SURFACE SEAL: ________

RISER PIPE I.D.: ________
TYPE OF RISER PIPE: ________

BOREHOLE DIAMETER: ________
TYPE OF SEAL: ________

ELEVATION / DEPTH OF SEAL: ____ / ____
TYPE OF SEAL: ________

ELEVATION / DEPTH TOP OF FILTER PACK: ____ / ____

ELEVATION / DEPTH TOP OF SCREEN: ____ / ____

TYPE OF SCREEN: ________

SLOT SIZE X LENGTH: ________

I.D. OF SCREEN: ________

TYPE OF FILTER PACK: ________

ELEVATION / DEPTH BOTTOM OF SCREEN: ____ / ____
ELEVATION / DEPTH BOTTOM OF FILTER PACK: ____ / ____
TYPE OF BACKFILL BELOW WELL: ________
ELEVATION / DEPTH OF BOREHOLE: ____ / ____

# STANDARD OPERATING PROCEDURE
# SOP-13

# MONITORING WELL DEVELOPMENT

## 1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper development of new and existing monitoring wells. The methods described herein are specific for monitoring wells located at Naval Support Activity (NSA) Crane. Guidelines by Southern Division, Naval Facilities Engineering Command (South Div NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 (Water Well Drillers) of Chapter 310 of the Indiana Administrative Code (310 IAC 16) should be consulted.

## 2.0 RESPONSIBILITIES

The drilling contractor will provide adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing the development of monitoring wells. The drilling contractor personnel must have all of the health and safety training required to perform the work, as specified in the Health and Safety Plan (HASP).

## 3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the Site Safety Officer.

Well development equipment with associated materials (typically supplied by the driller).

Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).

## 4.0 WELL DEVELOPMENT METHODS

The development of new wells shall not occur until at least 24 hours after the well has been installed and grouted. This time is required so that the grout in the annulus can set and harden. The purpose of well development is to stabilize and increase the permeability of the sand pack and the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water, if any, is removed from the well.

Sequential measurements of pH, specific conductance, turbidity, and temperature will be taken during development. Development should proceed until criteria are met as stated in Navy Guidelines.

Vigorous on-and-off pumping or a surge block will be used for development.

A surge block that is approximately the same diameter as the well riser will be used to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. Site-specific conditions will dictate which type will be used. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Development should proceed until three consecutive pH, specific conductance, and temperature readings are within 10 percent of each other and three consecutive turbidity readings are within 5 Nephelometric Turbidity Units (NTUs) of each other. If these criteria cannot be met after five volumes of water have been removed, then one additional well volume will be removed and well development will be considered complete.

If for any reason the above criteria cannot be met, the site geologist should document the event in writing and consult with the Tetra Tech Project Manager (PM) regarding an alternate plan of action.

Well development must be completed at least 24 hours before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to sufficiently equilibrate to their new environment and for that new environment to re-stabilize after the disturbance of drilling.

## 5.0 ATTACHMENTS

1. Monitoring Well Development Record

# ATTACHMENT 1

# MONITORING WELL DEVELOPMENT RECORD

## MONITORING WELL DEVELOPMENT RECORD

Page ___ of _____

Well: ________________________ Depth to Bottom (ft.): _______________ Responsible Personnel: ____________________________

Site: ________________________ Static Water Level Before (ft.): ________ Drilling Co.: ____________________________

Date Installed: __________________ Static Water Level After (ft.): _________ Project Name: ____________________________

Date Developed: ________________ Screen Length (ft.): ________________ Project Number: ____________________________

Dev. Method: ___________________ Specific Capacity: _________________

Pump Type: ____________________ Casing ID (in.): ____________________

| Time | Estimated Sediment Thickness (Ft.) | Cumulative Water Volume (Gal.) | Water Level Readings (Ft. below TOC) | Temperature (Degrees C) | pH | Specific Conductance (Units _____) | Turbidity (NTU) | Remarks (odor, color, etc.) |
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# STANDARD OPERATING PROCEDURE
# SOP-14

# MEASUREMENT OF WATER LEVELS

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for determining water levels in monitoring wells.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for determining water levels in monitoring wells.

**Groundwater Level Measurement Form**: A copy of the Water Level Measurement Sheet is attached.
**Bound Field Log Book**
**Photoionization Detector (PID)**
**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.
**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 Water Level Measurement Sheet.

3.3 Unlock the well and remove the well cap.

3.4 Place the well cap on a clean piece of plastic.

3.5 Check the well for the presence of organic vapors in the 2-inch PVC riser pipe as follows:

1. Calibration of the PID shall be done in accordance with appropriate calibration procedures.

2. Insert the PID sample inlet straw approximately three inches into the riser pipe.

3. Record the PID reading on the Water Level Measurement Sheet. If the reading is less than concentrations specified in the site-specific Health and Safety Plan (HASP), proceed to step 3.6. If the reading is greater than the concentration specified in the HASP, measure the concentration in the breathing zone. If the concentration in the breathing zone is less than the concentration specified in the HASP, proceed to Step 3.6. If the reading is greater than the specified concentration, allow the riser pipe to ventilate for ten minutes and repeat the measurement of breathing zone concentrations until the concentrations fall below the level specified in the HASP before proceeding to step 3.6.

3.6 Ensure that the water level indicator probe has been decontaminated before use.

3.7 Slowly lower the probe into the well riser pipe (or into the surface water for staff gages) until an audible and/or visible signal is produced, indicating contact with the water surface.

3.8 Read the water level measurement from the top of the inner casing (or from the staff gage reference point) at the surveyed reference point to the nearest 0.01-foot.

3.9 Record the water level measurement on the Water Level Measurement Sheet.

3.10 Wind the meter cable measuring tape back onto the spool.

3.11 Replace the well cap and lock.

3.12 Decontaminate the meter's probe and cable.

## 4.0 ATTACHMENTS

1. Water Level Measurement Sheet

# ATTACHMENT 1

## WATER LEVEL MEASUREMENT SHEET

WATER LEVEL MEASUREMENT SHEET

**Project Name:** ______________________ **Project No.:** ______________________

**Location:** ______________________ **Personnel:** ______________________

**Weather Conditions:** ______________________ **Measuring Device:** ______________________

**Tidally Influenced:** Yes ___ No ___ **Remarks:** ______________________

| Well or Piezometer Number | Date | Time | Elevation of Reference Point (feet)* | Total Well Depth (feet)* | Water Level Indicator Reading (feet)* | Thickness of Free Product (feet)* | Groundwater Elevation (feet)* | Comments |
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* All measurements to the nearest 0.01 foot

Page ____ of ____

# STANDARD OPERATING PROCEDURE
# SOP-15

# LOW-FLOW WELL PURGING AND STABILIZATION

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for well purging and stabilization utilizing low-flow techniques.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow purging.

**Low-Flow Purge Data Sheet:** A copy of this form is attached at the end of this SOP.

**Ground Water Sample Log Sheet**: A copy of this form and instructions for its completion are included in SOP-16.

**Bound Field Log Book**

**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.

**Electronic Programmable Controller, model 400 or comparable:** This controller regulates air flow in a bladder pump.

**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 (DO), oxidation-reduction potential (ORP), temperature, and specific conductance.

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

**LaMotte Turbidity Meter or comparable:** Used to measure turbidity.

**Purge water containers**

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

## 3.0 PROCEDURES FOR WELL PURGING

3.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate as per manufacturer requirements above equipment as necessary.

3.2 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.

2. Using the static water level determined in Step 3.2 of this SOP and the total depth of the well, calculate the well casing volume using the following formula:

$$\mathbf{V = (0.163)(T)(r^2)}$$

where:

| | | |
|---|---|---|
| V | = | Static casing volume of well (in gallons). |
| T | = | Vertical height of water column (linear feet of water). |
| 0.163 | = | A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi. |
| r | = | Inside radius of the well casing (in inches). |

Note: For wells of 1-inch radius (2-inch diameter) V = 0.163 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. 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/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/minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 Nephelometric Turbidity Units (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, such as:

- Stabilization of parameters
- Possible draw down
- 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 to 4 hours.

3.10 Measure the well water level using the water level meter every five to ten minutes. Record the well water level on the Low-Flow Purge Data Sheet (attached at the end of this SOP).

3.11 Record on the Low-Flow Purge Data Sheet every five to ten minutes the water quality parameters (pH, specific conductance, temperature, turbidity, ORP, and DO) measured by the water quality meter and turbidity meter. 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 is 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 ± 1.0 ºC
Turbidity less than 10 NTUs

If the above conditions have still not been met after the well has been purged for four hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data Sheet onto the Ground Water Sample Log Sheet.

If there is a need to leave a well during purging, there are two options:

- One, if the sampler must move for 30 minutes or less but still has a clear 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 clear 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 Once sampling activities have been completed, turn the pump off. Remove pump, hoses, cables, and other equipment from the well.

3.16 Decontaminate pumps, hoses, cables, flow-through cell, and other equipment.

## 4.0 ATTACHMENTS

1. Low-Flow Purge Data Sheet

## ATTACHMENT 1

## LOW-FLOW PURGE DATA SHEET

### LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: ____________________ WELL ID: ____________________

PROJECT NUMBER: ____________________ DATE: ____________________

| Time (Hrs.) | Water Level (Ft. below TOC) | Flow (mL/Min.) | pH (S.U.) | Cond. (mS/cm) | Turb. (NTU) | DO (mg/L) | Temp. (Celcius) | ORP mV | Comments |
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PAGE___OF___

# STANDARD OPERATING PROCEDURE
# SOP-16

# MONITORING WELL SAMPLING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for monitoring well sampling. Low-flow sampling techniques will be used for ground water sampling at Naval Support Activity (NSA) Crane.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells:

**Ground Water Sample Log Sheet**: A copy of this form is attached at the end of this SOP.

**Bound field log book**

**Chain-of-Custody Form**

**Bladder Pump**

**Surgical Gloves**

**Labeled sample containers**: Sample containers are certified clean by the laboratory supplying the sample containers.

**Tag for each sample container**

**Plastic storage bags**

**Shipping containers with ice**

## 3.0 MONITORING WELL SAMPLING PROCEDURES

3.1 Ground water sampling may be initiated when the monitoring well has been purged and stabilized.

3.2 Record the sample start time (using military time) on the Ground Water Sample Log Sheet. Record the field measurements for pH, oxidation-reduction potential (ORP), specific conductance, temperature, dissolved oxygen (DO), and turbidity.

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. All sample containers will be supplied by the laboratory, and the laboratory will pre-preserve all sample containers, where appropriate.

3.4 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. Sample containers for volatile organic compounds (VOCs) must be completely filled so that no headspace exists in the container. The VOC vials shall be filled to the top so that a convex meniscus is formed. Gently secure the cap, turn the vial upside down, and check to see if any air has been trapped inside the vial. If so, open the cap, reform the meniscus, and attempt again to secure the lid without trapping air in the sample. All other sample containers can have air space included when the container lid is secured.

3.5 Cap each container immediately after filling.

3.6 Record the sample time on the Ground Water Sample Log Sheet, the sample tag, and on the sample label.

3.7 Secure the associated tag to each sample container.

3.8 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.

3.9 Enter the proper information on the Chain-of-Custody form for each sample container.

3.10 Repeat steps 3.3 through 3.9 for each sample container collected.

3.11 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.

3.12 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. All samples will be collected in the following sequence (where applicable):

VOCs
Polycyclic Aromatic Hydrocarbons (PAHs)
Polychlorinated Biphenyls (PCBs)
Total Metals

Dissolved Metals

Total Organic Carbon (TOC)

3.13 If the last turbidity measurement prior to the commencement of sampling showed turbidity to be greater than 5 Nephelometric Turbidity Units (NTUs), then filtered aliquots of ground water will be collected and analyzed for dissolved metals and dissolved thorium isotopes. Without turning off the pump, attach a disposable, inline, 0.45-um filter cartridge at the end of the discharge tube. Fill sample containers marked for "dissolved metals" so that the laboratory knows that these aliquots are distinct sample fractions and that the results should be reported as dissolved analytes. Samples scheduled for VOC analysis shall not be filtered.

3.14 Repeat steps 3.5 through 3.9 for the filtered sample containers.

3.15 After completion of sample collection, remove the bladder pump from well and decontaminate.

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

3.17 All equipment should be cleaned and packed into the sample vehicle, along with the sample cooler for transport. Disposable gloves and other equipment should be placed in a plastic trash bag and handled as investigation derived waste.

## 4.0 ATTACHMENTS

1. Ground Water Sample Log Sheet

# ATTACHMENT 1

# GROUND WATER SAMPLE LOG SHEET

## GROUND WATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ____________________
Project No.: ____________________

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: ____________________
[] QA Sample Type: ____________________

Sample ID No.: ____________________
Sample Location: ____________________
Sampled By: ____________________
C.O.C. No.: ____________________
Type of Sample:
[] Low Concentration
[] High Concentration

**SAMPLING DATA:**

| Date: | Color | pH | S.C. | Temp. | Turbidity | DO | TBD | TBD |
|---|---|---|---|---|---|---|---|---|
| Time: | Visual | Standard | mS/cm | $^0C$ | NTU | mg/l | | |
| Method: | | | | | | | | |

**PURGE DATA:**

| Date: | Volume | pH | S.C. | Temp. (C) | Turbidity | DO | TBD | TBD |
|---|---|---|---|---|---|---|---|---|
| Method: | | | | | | | | |
| Monitor Reading (ppm): | | | | | | | | |
| Well Casing Diameter & Material | | | | | | | | |
| Type: | | | | | | | | |
| Total Well Depth (TD): | | | | | | | | |
| Static Water Level (WL): | | | | | | | | |
| One Casing Volume(gal/L): | | | | | | | | |
| Start Purge (hrs): | | | | | | | | |
| End Purge (hrs): | | | | | | | | |
| Total Purge Time (min): | | | | | | | | |
| Total Vol. Purged (gal/L): | | | | | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Preservative | Container Requirements | Collected |
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**OBSERVATIONS / NOTES:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

TBD: To Be Determinec

# STANDARD OPERATING PROCEDURE
# SOP-17

# CALIBRATION AND CARE OF WATER QUALITY METERS

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for the calibration and maintenance of field instruments used to measure water quality and for the proper documentation of calibration and maintenance. The YSI 600-Series Environmental Monitoring System or the Horiba U20–Series multi-parameter water quality monitoring system will be used to measure pH, temperature, oxidation-reduction potential (ORP), specific conductance (SC), and dissolved oxygen (DO) in water. A LaMotte turbidity meter will be used in conjunction with the water quality meter to measure turbidity. The water quality meter will have a multiprobe sensor that can be used in conjunction with a flow-through cell attached to a pump discharge tube to measure water-quality parameters in a groundwater discharge or can be immersed in a surface water body such as a stream, pond, or drainage ditch. The LaMotte is a hand held meter that uses a multi-detector optical configuration to assure long term stability and minimize stray light and color interferences. All comparable equipment used in place of the equipment items identified in Section 2.0 below must be comparable in terms of sensitivity, accuracy, and precision.

## 2.0 FIELD FORMS AND EQUIPMENT LIST

The following logbooks, forms, equipment, and supplies are required:

**Site logbook**
**Equipment calibration log sheet**
**YSI Model 600 Series and Sonde or Horiba U20 Series, or comparable**: multi-parameter water-quality meter with flow through cell.
**LaMotte Turbidity Meter, or comparable**
**Equipment manual**
**Calibration kit**
**Deionized water, paper towels, spray bottle, etc.**
**Disposable medical-grade gloves (e.g., latex, nitrile)**

## 3.0 PROCEDURES

This section describes the calibration procedures for the YSI Model 600 series, the Horiba U20 series, and the LaMotte. Each meter is supplied with an instruction manual and will be on-site and will be used as the calibration guidance documents. These procedures will list requirements for frequency of calibration and checks to be performed on the meter.

### 3.1 YSI Model 600 Series and Horiba U20 Series

The YSI Model 600 series and Sonde and the Horiba U20 series are multi-parameter, water-quality meters that may be used to measure open water bodies (streams, ponds, springs, etc.) with the probe guard installed. With the flow through cell attached, the meters have the ability to measure water-quality parameters in groundwater via a pump discharge line. By performing the measurements in the discharge line coming directly from the well, the parameters are measured before the groundwater comes in contact with the atmosphere. The parameters measured by the YSI or the Horiba for this field effort are as follows:

- DO
- SC
- Temperature
- pH
- ORP
- Turbidity

#### 3.1.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

#### 3.1.2 Calibration

All the parameters listed in Section 3.0 must be calibrated prior to the start of each field effort. After this initial calibration, the meter will be checked each day that it is used. If the check shows any out-of-specification readings, the specific probe will be recalibrated. Meter specifications can be found in the equipment manual, starting on page 248 (YSI) or page 93 (Horiba). Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration buffers and standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of the rental company will also be recorded on the equipment calibration form.

#### 3.1.3 Tips for Good Calibration

- The DO calibration is a water-saturated air calibration. Make certain to loosen the calibration cup seal to allow pressure to equilibrate before calibrating.

- Make certain that sensors are completely submersed in solution and readings are stable when calibration values are entered.

- Use a small amount of calibration solution (previously used solution may be used, then discarded for this purpose) to pre-rinse the sonde.

- Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.

- Make sure to rinse and dry the probe between calibration solutions. This will reduce carry-over contamination and increase the accuracy of the calibration.

### 3.2 Lamotte Turbidity Meter

The Lamotte turbidity meter is a hand held meter that measures the amount of suspended matter in water using the Nephelometric method.

#### 3.2.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

### 3.2.2 Calibration

Turbidity must be calibrated prior to the start of each field effort. After this initial calibration, the LaMotte will be calibrated each day that it is used. If the check shows any out-of-specification readings, the meter will be recalibrated. Meter specifications can be found in the equipment manual. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of the rental company will also be recorded on the equipment calibration form.

### 3.2.3 Tips for Good Calibration

- Thoroughly clean the standard vial with a chem wipe to remove finger prints.
- Make sure that the vial is properly aligned according the manual recommendations.

## 4.0 MAINTENANCE

The YSI and/or Horiba Meter and LaMotte will be rented for the duration of each brief field effort. Therefore, little field maintenance will be required. For any maintenance other than the routine cleaning, calibrating, or battery charging, the instrument should be returned to the vendor and a replacement sent immediately to the job site.

### 4.1 Meter Storage for the YSI and Horiba

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. During these breaks, the meter will be charged. One-half inch of tap or distilled water will be placed in the meter calibration cup and the cup threaded onto the sonde. The key for short-term storage of probes is to use a minimal amount of water so the calibration cup will remain at 100 percent humidity. The water level must be low enough so that none of the probes are actually immersed. Proper storage of the sonde between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

**Multi-parameter short term storage key points:**

- Use enough water to provide humidity but not enough to cover the probe surfaces.
- Make sure the storage vessel is sealed to minimize evaporation.
- Check periodically to make certain that water is still present.

### 4.2 Probe Cleaning

- Rinse the probe thoroughly with potable water.
- Wash the probe in a mild solution of Liquinox and water and wipe with paper towels and/or cotton swabs.
- Rinse and soak the probe in deionized water.
- If stronger cleaning is required, consult Section 2.10 on page 89 (YSI) or Section 7.1 on page 86 (Horiba) of the equipment manual.

Note: Reagents that are used to calibrate and check the water quality meter may be hazardous. Review the health and safety plan and Material Safety Data Sheets (MSDSs), all of which are on file in the field trailer.

### 4.3 Meter Storage for the LaMotte

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. Proper storage of the meter between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

**Short term storage key points:**

- Make sure the storage vessel is moisture free and sealed.

### 4.4 Sample Vial Cleaning

- Rinse the vial thoroughly with potable water to remove sediments.
- Wipe with chem-wipes or cotton swabs.

## 5.0 ATTACHMENTS

1. Equipment Calibration Log

# ATTACHMENT 1

# EQUIPMENT CALIBRATION LOG

## EQUIPMENT CALIBRATION LOG

PROJECT NAME : ____________ INSTRUMENT NAME/MODEL: ____________

SITE NAME: ____________ MANUFACTURER: ____________

PROJECT No.: ____________ SERIAL NUMBER: ____________

| Date of Calibration | Instrument I.D. Number | Person Performing Calibration | Instrument Settings | | Instrument Readings | | Calibration Standard (Lot No.) | Remarks and Comments |
|---|---|---|---|---|---|---|---|---|
| | | | Pre-calibration | Post-calibration | Pre-calibration | Post-calibration | | |
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# STANDARD OPERATING PROCEDURE
# SOP-18

# SURFACE WATER SAMPLING

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting surface water samples at the Naval Support Activity (NSA) Crane facility.

## 2.0 REQUIRED FIELD FORMS AND EQUIPMENT

**Surface Water Sample Log Sheet**: A copy of this form is attached at the end of this SOP.
**Field logbook**
**Writing utensil**
**Multi-parameter water-quality meter**: The water-quality meter is used for the measurement of dissolved oxygen, pH, specific conductance, temperature, and oxidation-reduction potential (see SOP-17).
**LaMotte Turbidity Meter:** Used to measure turbidity in the field (see SOP-17).
**Disposable sample containers**: Disposable sample containers are used to fill sample containers and transport sample(s) to a pump for filtering.
**Labeled sample containers**: Prelabeled, certified-clean sample containers will be provided by the laboratory that performs the analyses.
**0.45-micron filter assembly**: These are single-use filter cartridges used to filter samples scheduled for dissolved metals analyses. The filters become investigation-derived waste (IDW) after one use.
**Peristaltic pump**
**Silicon tubing**
**Ziploc-type plastic storage bags**
**Shipping containers (coolers)**
**Trip blank sample** (only if Volatile Organic Compounds [VOCs] samples are being collected)
**Temperature blank**

## 3.0 SURFACE WATER SAMPLING PROCEDURES

3.1 The same methods will be used to collect surface water and seep samples. Sampling will start at the downstream end of a stream and proceed to the farthest upstream location.

3.2 While standing downstream or from the bank, gently remove any floating leaves or twigs that may be present in a sample pool area in a manner that will not disturb the bottom sediment.

3.3 While standing downstream or from the bank, place the sample container in the water at the sampling location at a 45-degree angle and lower it to approximately half the sample pool depth. With the mouth of the container facing upstream, fill the container with water, being careful not to disturb the sediment.

3.4 All samples will be collected into certified-clean, pre-preserved bottles (if preservation is required for the analysis to be performed) supplied by the laboratory performing the analyses. Sample containers for VOCs must be completely filled so no headspace exists in the container. Other sample containers should not be filled completely; a small amount of air should be left at the top. Sample containers will be collected in the following sequence:

VOCs
Other Organics
Total metals
Nitrate
Nitrite
Total suspended solids (TSS)
Dissolved metals

3.5 Record the date and time that the sample containers are filled on the Surface Water Sample Log Sheet, the sample labels, and the Chain-of-Custody Form.

3.6 After the sample label is completed and checked, place the sample container into a ziploc-type plastic storage bag and place the plastic storage bag holding the sample container into a cooler containing ice.

3.7 Repeat steps 3.3 through 3.6 until all the sample bottles containing unfiltered samples have been filled.

3.8 Fill two 1-liter unpreserved polyethylene bottles. Use these bottles to transfer the sample for field filtering. Set up a peristaltic pump for filtering of the dissolved metals samples. Using new, clean, 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 50 milliliters of sample water prior to filling the sample containers.

3.9 Using the discharge from the filter cartridge, fill one 1-liter polyethylene sample bottle for dissolved metals. Repeat steps 3.8 and 3.9 for these sample containers.

3.10 Obtain measurements of dissolved oxygen, pH, specific conductance, temperature, turbidity, and oxidation-reduction potential using the multi-parameter water-quality meter and LaMotte Turbidity Meter (see SOP-17). Record the readings in the appropriate fields on the Surface Water Sample Log Sheet.

3.11 Estimate the flow rate of the stream or spring. 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.

3.12 Decontaminate all equipment and load the equipment and the sample cooler in the sample vehicle for transport.

## 4.0 ATTACHMENTS

1. Surface Water Sample Log Sheet

# ATTACHMENT 1

# SURFACE WATER SAMPLE LOG SHEET

## SURFACE WATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ______________________  Sample ID No.: ______________
Project No.: ______________________  Sample Location: ______________
Sampled By: ______________
C.O.C. No.: ______________

[] Stream
[] Spring
[] Pond
[] Lake
[] Other: ______________________
[] QA Sample Type: ______________________

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

**SAMPLING DATA:**

| | Color | pH | S.C. | Temp. | Turbidity | DO | Salinity | ORP |
|---|---|---|---|---|---|---|---|---|
| Date: | Visual | Standard | mS/cm | Degrees C | NTU | mg/l | % | mV |
| Time: | | | | | | | | |
| Depth: | | | | | | | | |
| Method: | | | | | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

# APPENDIX B

# LABORATORY STANDARD OPERATING PROCEDURES

## TABLE OF CONTENTS

# APPENDIX B

# LABORATORY STANDARD OPERATING PROCEDURES

## TABLE OF CONTENTS (CONTINUED)

# APPENDIX C

# DATA QUALITY OBJECTIVES MEETING MINUTES

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# NAVAL SUPPORT ACTIVITY (NSA) CRANE
# DATA QUALITY OBJECTIVE (DQO) MEETING SUMMARY
# SWMU 21

Meeting Date: July 22, 2009
Meeting Time: 8:30 a.m.
Meeting Place: IDEM Headquarters, Indianapolis, IN

| | Name | Organization |
|---|---|---|
| Attendance: | Doug Griffin | IDEM |
| | Tom Brent | Navy |
| | Ralph Basinski | Tetra Tech |
| | Tony Klimek | Tetra Tech |
| | Tom Johnston | Tetra Tech |
| | Mark Traxler | Tetra Tech |

**SWMU 21 History and Status Summary**

Doug Griffin, IDEM Remedial Project Manager (RPM), and Ralph Basinski, Tetra Tech Activity Coordinator for NSA Crane, opened the meeting. Tony Klimek, Tetra Tech Project Manager (PM), provided handouts and presented a summary of SWMU 21 locations, features, and a history of previous investigations. An overview of SWMU 21 was intended to provide meeting attendees with the basic Conceptual Site Model (CSM) information available that is needed to support the decision-making process during the DQO Scoping Meeting.

**Overview of UFP-SAP Process**

Tom Johnston, serving as the DQO Facilitator for the DQO Meeting, provided an overview of the process to be followed to develop a Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) using a Team-based approach. The UFP-SAP captures and documents project goals, objectives, pertinent site issues, schedule, and identifies the resources needed for success.

One of the first steps in the development of the SAP is to create or update the CSM. The Tetra Tech PM supplied existing site-specific data for this purpose.

This Team DQO Scoping Meeting gives interested stakeholders from the Navy and regulatory agency (IDEM) the opportunity to provide input needed by the contractor (Tetra Tech) to complete and populate the 37 Worksheets and implement the UFP-SAP.

The following notes summarize the discussions and the consensus reached for each of the seven DQO steps. During the meeting, Action Items were developed, which are listed at the end of these notes.

**Problem Definition**

DQO development is a seven-step process that is typically addressed in the following order:

1. Define the Problem
2. Identify the Goals of the Study
3. Identify Information Inputs that are Required
4. Define the Boundaries of the Study
5. Develop the Decision Rule
6. Specify Performance Criteria
7. Optimize the Design of the Study

Step 1 Problem Statement

Historical activities may have released metals, organics (oil, PCB, VOCs, SVOCs) to surface soil with subsequent migration. Not sure how extensive contamination is. Contaminants could pose an unacceptable risk, but not sure which contaminants (need to find which ones).

Data gaps for SWMU 21 include the identification of contaminants which are currently present on the site and the locations of contaminants. The source and form of lead that was historically stored on the Site is also unknown and lead could be present in either powder (more of an environmental concern) or chunk form.

IDEM suggested the use of RISC User's Guide Appendix 4.1 to obtain a contaminant list to comply with IDEM standards.

The Problem Statement was defined as: Tetra Tech shall determine which contaminants are present in SWMU 21 and their locations and confirm the presence/absence of contaminants relative to IDEM standards.

Step 2 Study Goals

In Phase I, Tetra Tech will determine whether SWMU 21 contaminant levels resulting from site operations are greater than Project Screening Levels (PSL). If results are less than PSLs, no further action is required. If results are greater than PSLs, the 95% Upper Confidence Limit (UCL) will be determined for potential risk to Human Health and Ecological receptors. Human Health receptors will be considered for both Industrial and Residential exposures. Risk to ecological receptors will be considered along appropriate Lines of Evidence (LOE). If the 95% UCL is greater than PSLs or ecological LOE indicates potential risk, the Project Team will reconvene to evaluate data and determine the appropriate path of action.

In Phase II, the nature and extent of contamination and risk to Human Health and Ecological receptors will be considered.

Step 3 Inputs

What information do we need in order to measure risks?

A cross-section diagram of the Site needs to be developed. The cross-section will be used to determine soil permeability in various layers to help understand contaminant transport. The profile of the site is expected to include a gravel layer at the surface, moved soil, and then original soil as depth increases. Said gravel layer may encumber Direct Push Technology (DPT), which will be used to collect soil samples. To adequately address the gravel layer, the cross-section may be determined using a Geoprobe with auger capability, or a backhoe may be used to collect soil samples.

It was decided that samples will not be collected in the location of the former Aboveground Storage Tank (formerly IA 6).

Samples collected at the site will not be tested for creosote or associated SVOC constituents of creosote, copper chromium arsenate (CCA), pentachlorophenol (PCP), or other wood preservatives based on IDEM experience with such sites.

Tetra Tech will determine if the scales located on the Site (Structures 1940 and 2943) are mechanical or hydraulic in nature. If the scales are mechanical (which they were determined to be), then no samples will be collected from the areas currently referred to as IA 8 and IA 10.

Surface soil (SS), subsurface soil (SB), and sediment (SD) will all be analyzed for all of the constituents of potential concern (COPCs). Surface water (SW) will be analyzed for all of the COPCs except for the PCBs. Groundwater (GW) samples will not be collected or analyzed during Phase I of this study. COPCs for SWMU 21 are primarily comprised of:

- Oil—PAHs, hydraulic fluids (alkanes, alkenes)
- Solvents—Chlorinated and non-chlorinated solvents
- PCBs—7 Aroclors
- Metals—23 Target Analyte List (TAL) metals

It was decided that field screening to determine sample locations will be performed using a flame ionization detector (FID) rather than a photoionization detector (PID). Field screening using FID will be performed where the quantitation level (QL) is greater than PSL criteria.

It was decided that additional samples, beyond those described in the sampling plan, will be collected at the discretion of the Field Operations Leader (FOL) without a detailed plan when obvious visual signs of contamination are observed.

Ecological risk assessments will be based on appropriate LOE on a species specific level.

Step 4 Study Boundaries

SS and SB samples collected during this study will be aligned. Soil samples will be collected throughout the site, including the grassed area. Samples will be collected in the middle of the swale in the grassed area at 100' intervals and one sample will be collected at the discharge pipe to Haynes Branch. The gravel area will be treated as its own Decision Unit; risk to ecological receptors will not be considered for the gravel area.

SS (according to location):

- gravel area = top 2' of soil under gravel (depth to soil in gravel area must be recorded)
- grassed area = 0' – 2' of soil in swale

SB (according to selection process):

- Area of FID/staining
- Original top foot of soil below 2' to depth of water table
- 4' - 5' feet bgs

SW and SD samples will be collected as previously described; however, SD samples from Haynes Branch are preferable to SW samples.

Fall is the preferred sampling time.

Step 5 Decision Rule

If a contaminant concentration is measured in any sample as exceeding the PSL, then plan for Phase II based on Phase I results. Phase II will be to evaluate the nature and exent of contaminants and risk to Human Health and Ecological Risk receptors.

Step 6 Performance Criteria

We could make the following decision errors:
β (beta) = Think the site is dirty, when it is actually clean.
α (alpha) = Think the site is clean, when it is actually dirty.
The Null Hypothesis (or Baseline Condition) is typically to conservatively assume the site is dirty, unless proven clean.

Tom Johnston presented charts and a well-explained summary on how statistics are used in environmental remediation projects to scientifically defend conclusions that are made based on the statistical evaluation of the data, and described how alpha, beta, delta (the difference between the Action Level [AL] and the Mean for a particular analyte), sigma (the variability, or standard deviation, associated with the Mean for a particular analyte), the Action Level, and the “Lower Bound of the Gray Region” all have an effect on the tolerances for making scientifically valid conclusions following the Systematic Planning (DQO) approach.

Performance criteria will be biased for individual units, and no statistics will be used to scientifically defend conclusions that are made based on the statistical evaluation of the data. All scheduled data will be required, but anomalies will be addressed on a case by case basis.

Consensus input regarding perceived “acceptable” tolerances for making incorrect decisions based on the true average (which is unknowable in site investigations) when it is compared to a defined multiple of an AL were as follows for the Gravel Area Decision Unit:

$\Delta$ = 0.2*AL
$\alpha$ = 10%
$\beta$ = 20%
S = Range / 6

Approximately 30 soil samples from the gravel area and 6 samples from the grassed area will be collected for this study.

Step 7 Optimize the Sample Design

Sampling will occur in a hybrid of a grid design with random orientation and a bias toward higher probability areas. Extra samples will be taken at the discretion of the FOL in areas that can be visually identified as containing contamination. This flexibility to collect step-out samples extends both horizontally and vertically.

Samples will be collected from 3 points in each Investigation Area. Sampling points in the gravel area will be statistics-based using EPA’s Visual Sample Plan (VSP).

**Action Items**

Information needs – complete lithology and soil characterization data, including one or two cross-section diagrams (using geoprobe to bedrock), surface water levels in Haynes Branch, the GPS locations of sampling points, and FID screening criteria.

# APPENDIX D

# PROJECT SCREENING LEVEL SUPPORT DOCUMENTATION

## Project Screening Levels

This project requires chemical data that can be used to characterize the site and to conduct a screening level Human Health Risk Assessment (HHRA) and a screening level Ecological Risk Assessment (ERA). The surface soil, subsurface soil, sediment, surface water, and groundwater (if required in Phase II) Project Screening Level (PSLs) are set at the lowest matrix-specific, risk-based or regulatory human health and ecological screening criteria that are appropriate for the site.

To identify constituents of potential concern (COPCs) and conduct a human health risk screening, laboratory results will be compared against the current United States Environmental Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM) residential surface and subsurface soil, sediment, surface water, and groundwater risk-based screening criteria. To identify ecological COPCs and conduct an ecological risk screening, laboratory results will be compared against the current USEPA and IDEM surface and subsurface soil, sediment, and surface water ecological benchmarks.

A comprehensive listing of the relevant environmental and medium-specific PSLs for the target analytes is required for the following:

- Surface and subsurface soil samples will be analyzed for specific chlorinated and non-chlorinated Volatile Organic Compounds (VOCs), specific Polycyclic Aromatic Hydrocarbons (PAHs), Target Compound List (TCL) Aroclors and Total Polychlorinated Biphenyls (PCBs), and Target Analyte List (TAL) Metals.
- Surface water samples will be analyzed for specific chlorinated and non-chlorinated VOCs, specific PAHs, and TAL Metals.
- Sediment samples will be analyzed for specific chlorinated and non-chlorinated VOCs, specific PAHs, TCL Aroclors and Total PCBs, and TAL Metals.
- Groundwater samples may be analyzed for specific chlorinated and non-chlorinated VOCs, specific PAHs, TCL Arochlors and Total PCBs, and TAL Metals, based on the initial results from the Phase I sampling event.

The risk and regulatory criteria applicable to SWMU 21 includes the IDEM Risk Integrated System of Closure (RISC) Default Closure Tables - Residential, Industrial, and Groundwater Closure Level (R-DCL, I-DCL, and G-DCL) criteria; the USEPA Regions 3, 6 and 9 Residential Regional Screening Level (R-RSL), Risk-Based Migration to Groundwater Soil Screening Level (SSL), and Tapwater (T-RSL) values; and appropriate ecological criteria, as identified below.

The criteria for surface and subsurface soil and sediment are compiled from the following sources:

- IDEM RISC R-DCLs and I-DCLs - Default Closure Tables, Residential and Industrial Levels, Soil criteria (updated May 1, 2009).
- EPA R-RSLs - Residential Direct Contact, Soil/Sediment criteria (updated May 19, 2009).
- EPA Risk-Based SSLs - Protection of Groundwater, Subsurface Soil criteria (updated May 19, 2009).
- Surface soil ecological risk criteria, which include (in hierarchal order):
    - EPA Ecological Soil Screening Levels (Eco SSLs) (2005).
    - EPA Region 5 RCRA Ecological Screening Levels (R5 ESLs) (August 22, 2003).
    - National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs), Soil Benchmarks (updated November 13, 2008).
- Sediment ecological risk criteria, which include (in hierarchal order):
    - EPA Region 5 RCRA Ecological Screening Levels (R5 ESLs) (August 22, 2003).
    - EPA Region 3 Biological Technical Assistance Group (BTAG) Freshwater Sediment Screening Benchmarks (R3 FW SED) (updated August 2006).
    - NOAA SQuiRTs, Sediment Benchmarks (updated November 13, 2008).

The criteria for surface water and groundwater are compiled from the following sources:

- IDEM RISC Default Closure Tables, Residential Levels, Groundwater criteria (G-DCLs) (updated May 1, 2009).
- EPA Maximum Contaminant Levels (MCLs), National Primary Drinking Water Regulations, Groundwater criteria (May 2009).
- EPA Tapwater RSLs (T-RSLs), Tapwater, Groundwater and Surface Water criteria (updated May 19, 2009).
- IDEM Minimum Surface Water Quality Standards, Indiana Administrative Code (IAC) 2-1-6, Surface Water criteria (IDEM SW) (2002).
- Surface water ecological risk criteria, which include (in hierarchal order):
    - EPA National Recommended Water Quality Criteria (RWQC) Table (2009).
    - IDEM Minimum Surface Water Quality Standards, IAC 2-1-6 (IDEM SW) (2002).
    - EPA Region 5 RCRA Ecological Screening Levels, Water (R5 ESL) (August 22, 2003).
    - EPA Region 3 BTAG Freshwater Screening Benchmarks (R3 FW) (updated July 2006).
    - NOAA SQuiRTs, Water Benchmarks (updated November 13, 2008).

## NSA Crane SWMU 21 Human Health Screening Criteria - Surface Soil Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil [1] (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil [2] (mg/kg) | 2009 IDEM RISC Residential Closure Levels for Soil (mg/kg) | | | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | EPA Regional Screening Level, Industrial Soil [1] (mg/kg) | 2009 IDEM RISC Industrial Closure Levels for Soil (mg/kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Residential Direct Contact [3] | Migration to Groundwater [3] | Residential Default Closure Level | | | | Industrial Direct Contact [3] | Migration to Groundwater [3] | Industrial Default Closure Level |
| **Volatile Organic Compounds** | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 9000 N | 900 N | 5000 | 1.9 | 1.9 | 1.9 | IDEM-RDCL | 39000 N | 6700 | 280 | 280 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.59 C | 0.59 C | 5 | 0.007 | 0.007 | 0.007 | IDEM-RDCL | 2.9 C | 8.7 | 0.11 | 0.11 |
| 1,1,2-Trichloroethane | 79-00-5 | 1.1 C | 1.1 C | 9.4 | 0.03 | 0.03 | 0.03 | IDEM-RDCL | 5.5 C | 15 | 0.3 | 0.3 |
| 1,1-Dichloroethane | 75-34-3 | 3.4 C | 3.4 C | 1300 | 5.6 | 5.6 | 3.4 | R-RSL | 17 C | 1700 | 58 | 58 |
| 1,1-Dichloroethene | 75-35-4 | 250 N | 25 N | 310 | 0.058 | 0.058 | 0.058 | IDEM-RDCL | 1100 N | 410 | 42 | 42 |
| 1,2-Dichloroethane | 107-06-2 | 0.45 C | 0.45 C | 3.7 | 0.024 | 0.024 | 0.024 | IDEM-RDCL | 2.2 C | 5.8 | 0.15 | 0.15 |
| Benzene | 71-43-2 | 1.1 C | 1.1 C | 8.4 | 0.034 | 0.034 | 0.034 | IDEM-RDCL | 5.6 C | 14 | 0.35 | 0.35 |
| Chloroethane | 75-00-3 | 15000 N | 1500 N | 80 | 0.65 | 0.65 | 0.65 | IDEM-RDCL | 62000 N | 120 | 10 | 10 |
| Chloromethane | 74-87-3 | 120 N | 12 N | NA | NA | NA | 12 | R-RSL | 510 N | NA | NA | NA |
| cis-1,2-Dichloroethene | 156-59-2 | 780 N | 78 N | 110 | 0.4 | 0.4 | 0.4 | IDEM-RDCL | 10000 N | 140 | 5.8 | 5.8 |
| Ethylbenzene | 100-41-4 | 5.7 C | 5.7 C | 4600 | 13 | 13 | 5.7 | R-RSL | 29 C | 6800 | 200 | 160 |
| Tetrachloroethene | 127-18-4 | 0.57 C | 0.57 C | 9.9 | 0.058 | 0.058 | 0.058 | IDEM-RDCL | 2.7 C | 16 | 0.64 | 0.64 |
| Toluene | 108-88-3 | 5000 N | 500 N | 8800 | 12 | 12 | 12 | IDEM-RDCL | 46000 N | 16000 | 96 | 96 |
| trans-1,2-Dichloroethene | 156-60-5 | 110 N | 11 N | 180 | 0.68 | 0.68 | 0.68 | IDEM-RDCL | 500 N | 230 | 14 | 14 |
| Trichloroethene | 79-01-6 | 2.8 C | 2.8 C | 4.9 | 0.057 | 0.057 | 0.057 | IDEM-RDCL | 14 C | 24 | 0.35 | 0.35 |
| Vinyl chloride | 75-01-4 | 0.06 C | 0.06 C | 1.5 | 0.013 | 0.013 | 0.013 | IDEM-RDCL | 1.7 C | 6.4 | 0.027 | 0.027 |
| Xylenes (total) | 1330-20-7 | 600 N | 60 N | 690 | 210 | 170 | 60 | R-RSL | 2600 N | 890 | 430 | 170 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 310 N | 31 N | 630 | 3.1 | 3.1 | 3.1 | IDEM-RDCL | 4100 N | 1600 | 42 | 42 |
| Acenaphthene | 83-32-9 | 3400 N | 340 N | 9500 | 130 | 130 | 130 | IDEM-RDCL | 33000 N | 24000 | 1800 | 1800 |
| Acenaphthylene | 208-96-8 | 3400 N[4] | 340 N[4] | 1100 | 18 | 18 | 18 | IDEM-RDCL | 33000 N[4] | 2800 | 180 | 180 |
| Anthracene | 120-12-7 | 17000 N | 1700 N | 47000 | 2700 | 2000 | 1700 | R-RSL | 170000 N | 120000 | 36000 | 2000 |
| Benzo(a)anthracene | 56-55-3 | 0.15 C | 0.15 C | 5 | 19 | 5 | 0.15 | R-RSL | 2.1 C | 15 | 62 | 15 |
| Benzo(a)pyrene | 50-32-8 | 0.015 C | 0.015 C | 0.5 | 8.2 | 0.5 | 0.015 | R-RSL | 0.21 C | 1.5 | 16 | 1.5 |
| Benzo(b)fluoranthene | 205-99-2 | 0.15 C | 0.15 C | 5 | 57 | 5 | 0.15 | R-RSL | 2.1 C | 15 | 190 | 15 |
| Benzo(g,h,i)perylene | 191-24-2 | 1700 N[5] | 170 N[5] | NA | NA | NA | 170 | R-RSL | 17000 N[5] | NA | NA | NA |
| Benzo(k)fluoranthene | 207-08-9 | 1.5 C | 1.5 C | 50 | 570 | 50 | 1.5 | R-RSL | 21 C | 150 | 1900 | 150 |
| Chrysene | 218-01-9 | 15 C | 15 C | 500 | 1900 | 500 | 15 | R-RSL | 210 C | 1500 | 6200 | 1500 |
| Dibenzo(a,h)anthracene | 53-70-3 | 0.015 C | 0.015 C | 0.5 | 18 | 0.5 | 0.015 | R-RSL | 0.21 C | 1.5 | 60 | 1.5 |
| Fluoranthene | 206-44-0 | 2300 N | 230 N | 6300 | 6300 | 2000 | 230 | R-RSL | 22000 N | 16000 | 18000 | 2000 |
| Fluorene | 86-73-7 | 2300 N | 230 N | 6300 | 170 | 170 | 170 | IDEM-RDCL | 22000 N | 16000 | 2300 | 2000 |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 0.15 C | 0.15 C | 5 | 160 | 5 | 0.15 | R-RSL | 2.1 C | 15 | 540 | 15 |
| Naphthalene | 91-20-3 | 3.9 C | 3.9 C | 3200 | 0.7 | 0.7 | 0.7 | IDEM-RDCL | 20 C | 8000 | 170 | 170 |
| Phenanthrene | 85-01-8 | 1700 N[5] | 170 N[5] | 470 | 13 | 13 | 13 | IDEM-RDCL | 17000 N[5] | 1200 | 170 | 170 |
| Pyrene | 129-00-0 | 1700 N | 170 N | 4700 | 4600 | 2000 | 170 | R-RSL | 17000 N | 12000 | 13000 | 2000 |
| **Polychlorinated Biphenyls** | | | | | | | | | | | | |
| Aroclor-1016 | 12674-11-2 | 3.9 N | 0.39 N | NA | NA | NA | 0.39 | R-RSL | 0.74 N | NA | NA | NA |
| Aroclor-1221 | 11104-28-2 | 0.17 C | 0.17 C | NA | NA | NA | 0.17 | R-RSL | 0.62 C | NA | NA | NA |
| Aroclor-1232 | 11141-16-5 | 0.17 C | 0.17 C | NA | NA | NA | 0.17 | R-RSL | 0.62 C | NA | NA | NA |
| Aroclor-1242 | 53469-21-9 | 0.22 C | 0.22 C | NA | NA | NA | 0.22 | R-RSL | 0.74 C | NA | NA | NA |
| Aroclor-1248 | 12672-29-6 | 0.22 C | 0.22 C | NA | NA | NA | 0.22 | R-RSL | 0.74 C | NA | NA | NA |
| Aroclor-1254 | 11097-69-1 | 1.1 N[6] | 0.11 N[6] | NA | NA | NA | 0.11 | R-RSL | 0.74 N[6] | NA | NA | NA |
| Aroclor-1260 | 11096-82-5 | 0.22 C | 0.22 C | NA | NA | NA | 0.22 | R-RSL | 0.74 C | NA | NA | NA |
| Total PCBs | - | NA | NA | 1.8 | 6.2 | 1.8 | 1.8 | IDEM-RDCL | 0.74 C | 5.3 | 18 | 5.3 |
| **Metals** | | | | | | | | | | | | |
| Aluminum | 7429-90-5 | 77000 N | 7700 N | NA | NA | NA | 7700 | R-RSL | 990000 N | NA | NA | NA |
| Antimony | 7440-36-0 | 31 N | 3.1 N | 140 | 5.4 | 5.4 | 3.1 | R-RSL | 410 N | 620 | 37 | 37 |
| Arsenic | 7440-38-2 | 0.39 C | 0.39 C | 3.9 | 5.8 | 3.9 | 0.39 | R-RSL | 1.6 C | 20 | 5.8 | 5.8 |

## NSA Crane SWMU 21 Human Health Screening Criteria - Surface Soil Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil [1] (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil [2] (mg/kg) | 2009 IDEM RISC Residential Closure Levels for Soil (mg/kg) | | | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | EPA Regional Screening Level, Industrial Soil [1] (mg/kg) | 2009 IDEM RISC Industrial Closure Levels for Soil (mg/kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Residential Direct Contact [3] | Migration to Groundwater [3] | Residential Default Closure Level | | | | Industrial Direct Contact [3] | Migration to Groundwater [3] | Industrial Default Closure Level |
| Barium | 7440-39-3 | 15000 N | 1500 N | 63000 | 1600 | 1600 | 1500 | R-RSL | 190000 N | 230000 | 17000 | 10000 |
| Beryllium | 7440-41-7 | 160 N | 16 N | 680 | 63 | 63 | 16 | R-RSL | 2000 N | 2900 | 3200 | 2300 |
| Cadmium | 7440-43-9 | 70 N | 7 N | 12 | 7.5 | 7.5 | 7 | R-RSL | 800 N | 990 | 77 | 77 |
| Calcium | 7440-70-2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chromium | 7440-47-3 | 230 N[6, 7] | 23 N[6, 7] | 430[7] | 38[7] | 38[7] | 23 | R-RSL | 3100 N[6, 7] | 650[7] | 120[7] | 120[7] |
| Cobalt | 7440-48-4 | 23 N | 2.3 N | NA | NA | NA | 2.3 | R-RSL | 300 N | NA | NA | NA |
| Copper | 7440-50-8 | 3100 N | 310 N | 14000 | 920 | 920 | 310 | R-RSL | 41000 N | 62000 | 2900 | 2900 |
| Iron | 7439-89-6 | 55000 N | 5500 N | NA | NA | NA | 5500 | R-RSL | 720000 N | NA | NA | NA |
| Lead | 7439-92-1 | 400 [8] | 400 [8] | 400 | 81 | 81 | 81 | IDEM-RDCL | 800 [8] | 1300 | 230 | 230 |
| Magnesium | 7439-95-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Manganese | 7439-96-5 | 1800 N | 180 N | NA | NA | NA | 180 | R-RSL | 23000 N | NA | NA | NA |
| Mercury | 7439-97-6 | 23 N[9] | 2.3 N[9] | 100 | 2.1 | 2.1 | 2.1 | IDEM-RDCL | 310 N[9] | 470 | 32 | 32 |
| Nickel | 7440-02-0 | 1500 N | 150 N | 6900 | 950 | 950 | 150 | R-RSL | 20000 N | 31000 | 2700 | 2700 |
| Potassium | 7440-09-7 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Selenium | 7782-49-2 | 390 N | 39 N | 1700 | 5.2 | 5.2 | 5.2 | IDEM-RDCL | 5100 N | 7800 | 53 | 53 |
| Silver | 7440-22-4 | 390 N | 39 N | 1700 | 31 | 31 | 31 | IDEM-RDCL | 5100 N | 7800 | 87 | 87 |
| Sodium | 7440-23-5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Thallium | 7440-28-0 | 5.1 N | 0.51 N | 24 | 2.8 | 2.8 | 0.51 | R-RSL | 66 N | 110 | 10 | 10 |
| Vanadium | 7440-62-2 | 390 N[10] | 39 N[10] | NA | NA | NA | 39 | R-RSL | 5200 N[10] | NA | NA | NA |
| Zinc | 7440-66-6 | 23000 N | 2300 N | 100000 | 14000 | 10000 | 2300 | R-RSL | 310000 N | 470000 | 38000 | 10000 |

Notes:

1 - The residential soil screening level from the EPA Regions 3, 6, and 9 Regional Screening Levels (R-RSLs) for Chemical Contaminants at Superfund Sites, May 19, 2009 are available online at http://epa-prgs.ornl.gov/chemicals/index.shtml. The risk-based screening level is based on a target hazard quotient of 1 for non-carcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag).

2 - The EPA R-RSL (May 19, 2009) residential soil screening level for non-carcinogens is adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The residential soil screening level for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3 - The guidelines are from IDEM's RISC Default Closure Tables 2006 (Revised May 1, 2009) available online at: http://www.in.gov/idem/files/risctech_appendix1_2006_r1.pdf.

4 - Value is for acenapththene.

5 - Value is for pyrene.

6 - One tenth the noncarcinogenic value is less than the carinogenic value; therefore, the noncarcinogenic value is presented.

7 - Value is for hexavalent chromium.

8 - Office of Solid Waste and Emergency Response soil screening level (EPA, 1994b).

9 - Value is for mercury, inorganic salts.

10 - Value is for vanadium and compounds.

Abbreviations:

-- - Not applicable

C - Carcinogen

EPA - U.S. Environmental Protection Agency

N - Noncarcinogen

NA - Not available

SSL - Soil Screening Level

## NSA Crane SWMU 21 Human Health Screening Criteria - Subsurface Soil Samples

| Analyte | CAS Number | EPA Regional Screening Level, Migration to Groundwater [1] (mg/kg) | Adjusted EPA Regional Screening Level, Migration to Groundwater [2] (mg/kg) | 2009 IDEM RISC Residential Closure Levels for Soil (mg/kg) | | | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | 2009 IDEM RISC Industrial Closure Levels for Soil (mg/kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Residential Direct Contact [3] | Migration to Groundwater [3] | Residential Default Closure Level | | | Industrial Direct Contact [3] | Migration to Groundwater [3] | Industrial Default Closure Level |
| **Volatile Organic Compounds** | | | | | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 3.3 N | 66 N | 5000 | 1.9 | 1.9 | 1.9 | IDEM-RDCL | 6700 | 280 | 280 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.000028 C | 0.00056 C | 5 | 0.007 | 0.007 | 0.00056 | USEPA SSL | 8.7 | 0.11 | 0.11 |
| 1,1,2-Trichloroethane | 79-00-5 | 0.000082 C | 0.00016 C | 9.4 | 0.03 | 0.03 | 0.00016 | USEPA SSL | 15 | 0.3 | 0.3 |
| 1,1-Dichloroethane | 75-34-3 | 0.0007 C | 0.014 C | 1300 | 5.6 | 5.6 | 0.014 | USEPA SSL | 1700 | 58 | 58 |
| 1,1-Dichloroethene | 75-35-4 | 0.12 N | 2.4 N | 310 | 0.058 | 0.058 | 0.058 | IDEM-RDCL | 410 | 42 | 42 |
| 1,2-Dichloroethane | 107-06-2 | 0.000044 C | 0.00088 C | 3.7 | 0.024 | 0.024 | 0.00088 | USEPA SSL | 5.8 | 0.15 | 0.15 |
| Benzene | 71-43-2 | 0.00023 C | 0.0046 C | 8.4 | 0.034 | 0.034 | 0.0046 | USEPA SSL | 14 | 0.35 | 0.35 |
| Chloroethane | 75-00-3 | 6 N | 120 N | 80 | 0.65 | 0.65 | 0.65 | IDEM-RDCL | 120 | 10 | 10 |
| Chloromethane | 74-87-3 | 0.049 N | 0.98 N | NA | NA | NA | 0.98 | USEPA SSL | NA | NA | NA |
| cis-1,2-Dichloroethene | 156-59-2 | 0.11 N | 2.2 N | 110 | 0.4 | 0.4 | 0.4 | IDEM-RDCL | 140 | 5.8 | 5.8 |
| Ethylbenzene | 100-41-4 | 0.0019 C | 0.038 C | 4600 | 13 | 13 | 0.038 | USEPA SSL | 6800 | 200 | 160 |
| Tetrachloroethene | 127-18-4 | 0.000052 C | 0.00104 C | 9.9 | 0.058 | 0.058 | 0.00104 | USEPA SSL | 16 | 0.64 | 0.64 |
| Toluene | 108-88-3 | 1.7 N | 34 N | 8800 | 12 | 12 | 12 | IDEM-RDCL | 16000 | 96 | 96 |
| trans-1,2-Dichloroethene | 156-60-5 | 0.034 N | 0.68 N | 180 | 0.68 | 0.68 | 0.68 | IDEM-RDCL | 230 | 14 | 14 |
| Trichloroethene | 79-01-6 | 0.00061 C | 0.0122 C | 4.9 | 0.057 | 0.057 | 0.0122 | USEPA SSL | 24 | 0.35 | 0.35 |
| Vinyl chloride | 75-01-4 | 0.0000056 C | 0.000112 C | 1.5 | 0.013 | 0.013 | 0.000112 | USEPA SSL | 6.4 | 0.027 | 0.027 |
| Xylenes (total) | 1330-20-7 | 1.6 N | 32 N | 690 | 210 | 170 | 32 | USEPA SSL | 890 | 430 | 170 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 0.9 N | 18 N | 630 | 3.1 | 3.1 | 3.1 | IDEM-RDCL | 1600 | 42 | 42 |
| Acenaphthene | 83-32-9 | 27 N | 540 N | 9500 | 130 | 130 | 130 | IDEM-RDCL | 24000 | 1800 | 1800 |
| Acenaphthylene | 208-96-8 | 27 N[4] | 540 N[4] | 1100 | 18 | 18 | 18 | IDEM-RDCL | 2800 | 180 | 180 |
| Anthracene | 120-12-7 | 450 N | 9000 N | 47000 | 2700 | 2000 | 2000 | IDEM-RDCL | 120000 | 36000 | 2000 |
| Benzo(a)anthracene | 56-55-3 | 0.014 C | 0.28 C | 5 | 19 | 5 | 0.28 | USEPA SSL | 15 | 62 | 15 |
| Benzo(a)pyrene | 50-32-8 | 0.0046 C | 0.092 C | 0.5 | 8.2 | 0.5 | 0.092 | USEPA SSL | 1.5 | 16 | 1.5 |
| Benzo(b)fluoranthene | 205-99-2 | 0.047 C | 0.94 C | 5 | 57 | 5 | 0.94 | USEPA SSL | 15 | 190 | 15 |
| Benzo(g,h,i)perylene | 191-24-2 | 150 N[5] | 3000 N[5] | NA | NA | NA | 3000 | USEPA SSL | NA | NA | NA |
| Benzo(k)fluoranthene | 207-08-9 | 0.46 C | 9.2 C | 50 | 570 | 50 | 9.2 | USEPA SSL | 150 | 1900 | 150 |
| Chrysene | 218-01-9 | 1.4 C | 28 C | 500 | 1900 | 500 | 28 | USEPA SSL | 1500 | 6200 | 1500 |
| Dibenzo(a,h)anthracene | 53-70-3 | 0.015 C | 0.3 C | 0.5 | 18 | 0.5 | 0.3 | USEPA SSL | 1.5 | 60 | 1.5 |
| Fluoranthene | 206-44-0 | 210 N | 4200 N | 6300 | 6300 | 2000 | 2000 | IDEM-RDCL | 16000 | 18000 | 2000 |
| Fluorene | 86-73-7 | 33 N | 660 N | 6300 | 170 | 170 | 170 | IDEM-RDCL | 16000 | 2300 | 2000 |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 0.16 C | 3.2 C | 5 | 160 | 5 | 3.2 | USEPA SSL | 15 | 540 | 15 |
| Naphthalene | 91-20-3 | 0.00055 C | 0.011 C | 3200 | 0.7 | 0.7 | 0.011 | USEPA SSL | 8000 | 170 | 170 |
| Phenanthrene | 85-01-8 | 150 N[5] | 3000 N[5] | 470 | 13 | 13 | 13 | IDEM-RDCL | 1200 | 170 | 170 |
| Pyrene | 129-00-0 | 150 N | 3000 N | 4700 | 4600 | 2000 | 2000 | IDEM-RDCL | 12000 | 13000 | 2000 |
| **Polychlorinated Biphenyls** | | | | | | | | | | | |
| Aroclor-1016 | 12674-11-2 | 0.052 N | 1.04 N | NA | NA | NA | 1.04 | USEPA SSL | NA | NA | NA |
| Aroclor-1221 | 11104-28-2 | 0.00014 C | 0.0028 C | NA | NA | NA | 0.0028 | USEPA SSL | NA | NA | NA |
| Aroclor-1232 | 11141-16-5 | 0.00014 C | 0.0028 C | NA | NA | NA | 0.0028 | USEPA SSL | NA | NA | NA |
| Aroclor-1242 | 53469-21-9 | 0.003 C | 0.06 C | NA | NA | NA | 0.06 | USEPA SSL | NA | NA | NA |
| Aroclor-1248 | 12672-29-6 | 0.003 C | 0.06 C | NA | NA | NA | 0.06 | USEPA SSL | NA | NA | NA |
| Aroclor-1254 | 11097-69-1 | 0.0051 N[6] | 0.102 N[6] | NA | NA | NA | 0.102 | USEPA SSL | NA | NA | NA |
| Aroclor-1260 | 11096-82-5 | 0.014 C | 0.28 C | NA | NA | NA | 0.28 | USEPA SSL | NA | NA | NA |
| Total PCBs | - | NA | NA | 1.8 | 6.2 | 1.8 | 1.8 | IDEM-RDCL | 5.3 | 18 | 5.3 |

## NSA Crane SWMU 21 Human Health Screening Criteria - Subsurface Soil Samples

| Analyte | CAS Number | EPA Regional Screening Level, Migration to Groundwater [1] (mg/kg) | Adjusted EPA Regional Screening Level, Migration to Groundwater [2] (mg/kg) | 2009 IDEM RISC Residential Closure Levels for Soil (mg/kg) | | | Lowest Human Health Criterion | Lowest Human Health Criterion Reference | 2009 IDEM RISC Industrial Closure Levels for Soil (mg/kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Residential Direct Contact [3] | Migration to Groundwater [3] | Residential Default Closure Level | | | Industrial Direct Contact [3] | Migration to Groundwater [3] | Industrial Default Closure Level |
| **Metals** | | | | | | | | | | | |
| Aluminum | 7429-90-5 | 55000 N | 1100000 N | NA | NA | NA | 1100000 | USEPA SSL | NA | NA | NA |
| Antimony | 7440-36-0 | 0.66 N | 13.2 N | 140 | 5.4 | 5.4 | 5.4 | IDEM-RDCL | 620 | 37 | 37 |
| Arsenic | 7440-38-2 | 0.0013 C | 0.026 C | 3.9 | 5.8 | 3.9 | 0.026 | USEPA SSL | 20 | 5.8 | 5.8 |
| Barium | 7440-39-3 | 300 N | 6000 N | 63000 | 1600 | 1600 | 1600 | IDEM-RDCL | 230000 | 17000 | 10000 |
| Beryllium | 7440-41-7 | 58 N | 1160 N | 680 | 63 | 63 | 63 | IDEM-RDCL | 2900 | 3200 | 2300 |
| Cadmium | 7440-43-9 | 1.4 N | 28 N | 12 | 7.5 | 7.5 | 7.5 | IDEM-RDCL | 990 | 77 | 77 |
| Calcium | 7440-70-2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chromium | 7440-47-3 | 2.1 N[6, 7] | 42 N[6, 7] | 430[7] | 38[7] | 38[7] | 38 | IDEM-RDCL | 650[7] | 120[7] | 120[7] |
| Cobalt | 7440-48-4 | 0.49 N | 9.8 N | NA | NA | NA | 9.8 | USEPA SSL | NA | NA | NA |
| Copper | 7440-50-8 | 51 N | 1020 N | 14000 | 920 | 920 | 920 | IDEM-RDCL | 62000 | 2900 | 2900 |
| Iron | 7439-89-6 | 640 N | 12800 N | NA | NA | NA | 12800 | USEPA SSL | NA | NA | NA |
| Lead | 7439-92-1 | 400 [8] | 8000 [8] | 400 | 81 | 81 | 81 | IDEM-RDCL | 1300 | 230 | 230 |
| Magnesium | 7439-95-4 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Manganese | 7439-96-5 | 57 N | 1140 N | NA | NA | NA | 1140 | USEPA SSL | NA | NA | NA |
| Mercury | 7439-97-6 | 0.03 N[9] | 0.6 N[9] | 100 | 2.1 | 2.1 | 0.6 | USEPA SSL | 470 | 32 | 32 |
| Nickel | 7440-02-0 | 48 N | 960 N | 6900 | 950 | 950 | 950 | IDEM-RDCL | 31000 | 2700 | 2700 |
| Potassium | 7440-09-7 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Selenium | 7782-49-2 | 0.95 N | 19 N | 1700 | 5.2 | 5.2 | 5.2 | IDEM-RDCL | 7800 | 53 | 53 |
| Silver | 7440-22-4 | 1.6 N | 32 N | 1700 | 31 | 31 | 31 | IDEM-RDCL | 7800 | 87 | 87 |
| Sodium | 7440-23-5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Thallium | 7440-28-0 | 0.17 N | 3.4 N | 24 | 2.8 | 2.8 | 2.8 | IDEM-RDCL | 110 | 10 | 10 |
| Vanadium | 7440-62-2 | 180 N[10] | 3600 N[10] | NA | NA | NA | 3600 | USEPA SSL | NA | NA | NA |
| Zinc | 7440-66-6 | 680 N | 13600 N | 100000 | 14000 | 10000 | 10000 | IDEM-RDCL | 470000 | 38000 | 10000 |

Notes:

1 - The subsurface protection of groundwater soil screening level from the EPA Regions 3, 6, and 9 Regional Screening Levels (USEPA SSLs) for Chemical Contaminants at Superfund Sites, May 19, 2009 are available online at http://epa-prgs.ornl.gov/chemicals/index.shtml. The risk-based screening level is based on a target hazard quotient of 1 for non-carcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag).

2 - The USEPA SSL (May 19, 2009) subsurface soil screening level for non-carcinogens is adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The subsurface soil screening level for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3 - The guidelines are from IDEM's RISC Default Closure Tables 2006 (Revised May 1, 2009) available online at: http://www.in.gov/idem/files/risctech_appendix1_2006_r1.pdf.

4 - Value is for acenapththene.

5 - Value is for pyrene.

6 - One tenth the noncarcinogenic value is less than the carinogenic value; therefore, the noncarcinogenic value is presented.

7 - Value is for hexavalent chromium.

8 - Office of Solid Waste and Emergency Response soil screening level (EPA, 1994b).

9 - Value is for mercury, inorganic salts.

10 - Value is for vanadium and compounds.

Abbreviations:

-- - Not applicable
C - Carcinogen
EPA - U.S. Environmental Protection Agency
N - Non-carcinogen
NA - Not available
SSL - Soil Screening Level

# NSA Crane SWMU 21 Human Health Screening Criteria - Sediment Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil (1) (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil (2) (mg/kg) | 2009 IDEM RISC Residential Closure Levels for Soil (mg/kg) | | | Lowest Human Health Criterion | Lowest Human Health Criterion Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | Residential Direct Contact (3) | Migration to Groundwater (3) | Residential Default Closure Level | | |
| **Volatile Organic Compounds** | | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 9000 N | 900 N | 5000 | 1.9 | 1.9 | 1.9 | IDEM-RDCL |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.59 C | 0.59 C | 5 | 0.007 | 0.007 | 0.007 | IDEM-RDCL |
| 1,1,2-Trichloroethane | 79-00-5 | 1.1 C | 1.1 C | 9.4 | 0.03 | 0.03 | 0.03 | IDEM-RDCL |
| 1,1-Dichloroethane | 75-34-3 | 3.4 C | 3.4 C | 1300 | 5.6 | 5.6 | 3.4 | R-RSL |
| 1,1-Dichloroethene | 75-35-4 | 250 N | 25 N | 310 | 0.058 | 0.058 | 0.058 | IDEM-RDCL |
| 1,2-Dichloroethane | 107-06-2 | 0.45 C | 0.45 C | 3.7 | 0.024 | 0.024 | 0.024 | IDEM-RDCL |
| Benzene | 71-43-2 | 1.1 C | 1.1 C | 8.4 | 0.034 | 0.034 | 0.034 | IDEM-RDCL |
| Chloroethane | 75-00-3 | 15000 N | 1500 N | 80 | 0.65 | 0.65 | 0.65 | IDEM-RDCL |
| Chloromethane | 74-87-3 | 120 N | 12 N | NA | NA | NA | 12 | R-RSL |
| cis-1,2-Dichloroethene | 156-59-2 | 780 N | 78 N | 110 | 0.4 | 0.4 | 0.4 | IDEM-RDCL |
| Ethylbenzene | 100-41-4 | 5.7 C | 5.7 C | 4600 | 13 | 13 | 5.7 | R-RSL |
| Tetrachloroethene | 127-18-4 | 0.57 C | 0.57 C | 9.9 | 0.058 | 0.058 | 0.058 | IDEM-RDCL |
| Toluene | 108-88-3 | 5000 N | 500 N | 8800 | 12 | 12 | 12 | IDEM-RDCL |
| trans-1,2-Dichloroethene | 156-60-5 | 110 N | 11 N | 180 | 0.68 | 0.68 | 0.68 | IDEM-RDCL |
| Trichloroethene | 79-01-6 | 2.8 C | 2.8 C | 4.9 | 0.057 | 0.057 | 0.057 | IDEM-RDCL |
| Vinyl chloride | 75-01-4 | 0.06 C | 0.06 C | 1.5 | 0.013 | 0.013 | 0.013 | IDEM-RDCL |
| Xylenes (total) | 1330-20-7 | 600 N | 60 N | 690 | 210 | 170 | 60 | R-RSL |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 310 N | 31 N | 630 | 3.1 | 3.1 | 3.1 | IDEM-RDCL |
| Acenaphthene | 83-32-9 | 3400 N | 340 N | 9500 | 130 | 130 | 130 | IDEM-RDCL |
| Acenaphthylene | 208-96-8 | 3400 N(4) | 340 N(4) | 1100 | 18 | 18 | 18 | IDEM-RDCL |
| Anthracene | 120-12-7 | 17000 N | 1700 N | 47000 | 2700 | 2000 | 1700 | R-RSL |
| Benzo(a)anthracene | 56-55-3 | 0.15 C | 0.15 C | 5 | 19 | 5 | 0.15 | R-RSL |
| Benzo(a)pyrene | 50-32-8 | 0.015 C | 0.015 C | 0.5 | 8.2 | 0.5 | 0.015 | R-RSL |
| Benzo(b)fluoranthene | 205-99-2 | 0.15 C | 0.15 C | 5 | 57 | 5 | 0.15 | R-RSL |
| Benzo(g,h,i)perylene | 191-24-2 | 1700 N(5) | 170 N(5) | NA | NA | NA | 170 | R-RSL |
| Benzo(k)fluoranthene | 207-08-9 | 1.5 C | 1.5 C | 50 | 570 | 50 | 1.5 | R-RSL |
| Chrysene | 218-01-9 | 15 C | 15 C | 500 | 1900 | 500 | 15 | R-RSL |
| Dibenzo(a,h)anthracene | 53-70-3 | 0.015 C | 0.015 C | 0.5 | 18 | 0.5 | 0.015 | R-RSL |
| Fluoranthene | 206-44-0 | 2300 N | 230 N | 6300 | 6300 | 2000 | 230 | R-RSL |
| Fluorene | 86-73-7 | 2300 N | 230 N | 6300 | 170 | 170 | 170 | IDEM-RDCL |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 0.15 C | 0.15 C | 5 | 160 | 5 | 0.15 | R-RSL |

## NSA Crane SWMU 21 Human Health Screening Criteria - Sediment Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil [1] (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil [2] (mg/kg) | 2009 IDEM RISC Residential Closure Levels for Soil (mg/kg) | | | Lowest Human Health Criterion | Lowest Human Health Criterion Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | Residential Direct Contact [3] | Migration to Groundwater [3] | Residential Default Closure Level | | |
| Naphthalene | 91-20-3 | 3.9 C | 3.9 C | 3200 | 0.7 | 0.7 | 0.7 | IDEM-RDCL |
| Phenanthrene | 85-01-8 | 1700 N[5] | 170 N[5] | 470 | 13 | 13 | 13 | IDEM-RDCL |
| Pyrene | 129-00-0 | 1700 N | 170 N | 4700 | 4600 | 2000 | 170 | R-RSL |
| **Polychlorinated Biphenyls** | | | | | | | | |
| Aroclor-1016 | 12674-11-2 | 3.9 N | 0.39 N | NA | NA | NA | 0.39 | R-RSL |
| Aroclor-1221 | 11104-28-2 | 0.17 C | 0.17 C | NA | NA | NA | 0.17 | R-RSL |
| Aroclor-1232 | 11141-16-5 | 0.17 C | 0.17 C | NA | NA | NA | 0.17 | R-RSL |
| Aroclor-1242 | 53469-21-9 | 0.22 C | 0.22 C | NA | NA | NA | 0.22 | R-RSL |
| Aroclor-1248 | 12672-29-6 | 0.22 C | 0.22 C | NA | NA | NA | 0.22 | R-RSL |
| Aroclor-1254 | 11097-69-1 | 1.1 N[6] | 0.11 N[6] | NA | NA | NA | 0.11 | R-RSL |
| Aroclor-1260 | 11096-82-5 | 0.22 C | 0.22 C | NA | NA | NA | 0.22 | R-RSL |
| Total PCBs | - | NA | NA | 1.8 | 6.2 | 1.8 | 1.8 | IDEM-RDCL |
| **Metals** | | | | | | | | |
| Aluminum | 7429-90-5 | 77000 N | 7700 N | NA | NA | NA | 7700 | R-RSL |
| Antimony | 7440-36-0 | 31 N | 3.1 N | 140 | 5.4 | 5.4 | 3.1 | R-RSL |
| Arsenic | 7440-38-2 | 0.39 C | 0.39 C | 3.9 | 5.8 | 3.9 | 0.39 | R-RSL |
| Barium | 7440-39-3 | 15000 N | 1500 N | 63000 | 1600 | 1600 | 1500 | R-RSL |
| Beryllium | 7440-41-7 | 160 N | 16 N | 680 | 63 | 63 | 16 | R-RSL |
| Cadmium | 7440-43-9 | 70 N | 7 N | 12 | 7.5 | 7.5 | 7 | R-RSL |
| Calcium | 7440-70-2 | NA | NA | NA | NA | NA | NA | NA |
| Chromium | 7440-47-3 | 230 N[6, 7] | 23 N[6, 7] | 430[7] | 38[7] | 38[7] | 23 | R-RSL |
| Cobalt | 7440-48-4 | 23 N | 2.3 N | NA | NA | NA | 2.3 | R-RSL |
| Copper | 7440-50-8 | 3100 N | 310 N | 14000 | 920 | 920 | 310 | R-RSL |
| Iron | 7439-89-6 | 55000 N | 5500 N | NA | NA | NA | 5500 | R-RSL |
| Lead | 7439-92-1 | 400 [8] | 400 [8] | 400 | 81 | 81 | 81 | IDEM-RDCL |
| Magnesium | 7439-95-4 | NA | NA | NA | NA | NA | NA | NA |
| Manganese | 7439-96-5 | 1800 N | 180 N | NA | NA | NA | 180 | R-RSL |
| Mercury | 7439-97-6 | 23 N[9] | 2.3 N[9] | 100 | 2.1 | 2.1 | 2.1 | IDEM-RDCL |
| Nickel | 7440-02-0 | 1500 N | 150 N | 6900 | 950 | 950 | 150 | R-RSL |
| Potassium | 7440-09-7 | NA | NA | NA | NA | NA | NA | NA |
| Selenium | 7782-49-2 | 390 N | 39 N | 1700 | 5.2 | 5.2 | 5.2 | IDEM-RDCL |
| Silver | 7440-22-4 | 390 N | 39 N | 1700 | 31 | 31 | 31 | IDEM-RDCL |
| Sodium | 7440-23-5 | NA | NA | NA | NA | NA | NA | NA |

## NSA Crane SWMU 21 Human Health Screening Criteria - Sediment Samples

| Analyte | CAS Number | EPA Regional Screening Level, Residential Soil (1) (mg/kg) | Adjusted EPA Regional Screening Level, Residential Soil (2) (mg/kg) | 2009 IDEM RISC Residential Closure Levels for Soil (mg/kg) | | | Lowest Human Health Criterion | Lowest Human Health Criterion Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | Residential Direct Contact (3) | Migration to Groundwater (3) | Residential Default Closure Level | | |
| Thallium | 7440-28-0 | 5.1 N | 0.51 N | 24 | 2.8 | 2.8 | 0.51 | R-RSL |
| Vanadium | 7440-62-2 | 390 N(10) | 39 N(10) | NA | NA | NA | 39 | R-RSL |
| Zinc | 7440-66-6 | 23000 N | 2300 N | 100000 | 14000 | 10000 | 2300 | R-RSL |

Notes:

1 - The residential soil screening level from the EPA Regions 3, 6, and 9 Regional Screening Levels (R-RSLs) for Chemical Contaminants at Superfund Sites, May 19, 2009 are available online at http://epa-prgs.ornl.gov/chemicals/index.shtml. The risk-based screening level is based on a target hazard quotient of 1 for non-carcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag).

2 - The EPA R-RSL (May 19, 2009) residential soil screening level for non-carcinogens is adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The residential soil screening level for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3 - The guidelines are from IDEM's RISC Default Closure Tables 2006 (Revised May 1, 2009) available online at: http://www.in.gov/idem/files/risctech_appendix1_2006_r1.pdf.

4 - Value is for acenapththene.

5 - Value is for pyrene.

6 - One tenth the non-carcinogenic value is less than the carinogenic value; therefore, the non-carcinogenic value is presented.

7 - Value is for hexavalent chromium.

8 - Office of Solid Waste and Emergency Response soil screening level (EPA, 1994b).

9 - Value is for mercury, inorganic salts.

10 - Value is for vanadium and compounds.

Abbreviations:

-- - Not applicable

C - Carcinogen

EPA - U.S. Environmental Protection Agency

N - Non-carcinogen

NA - Not available

SSL - Soil Screening Level

## Crane SWMU 21 Human Health Screening Criteria - Surface Water Samples

| Analyte | CAS Number | EPA Regional Screening Level, Tap Water (1) (ug/L) | Adjusted EPA Regional Screening Level, Tap Water (2) (ug/L) | 10x Adjusted EPA Regional Screening Level, Tap Water (3) (ug/L) | IDEM SW Minimum (4) (ug/L) | Minimum Criteria (ug/L) | Minimum Criterion Reference |
|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 9100 N | 910 N | 9100 | 18400 | 9100 | T-RSL |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.067 C | 0.067 C | 0.67 | 1.7 | 0.67 | T-RSL |
| 1,1,2-Trichloroethane | 79-00-5 | 0.24 C | 0.24 C | 2.4 | 6 | 2.4 | T-RSL |
| 1,1-Dichloroethane | 75-34-3 | 2.4 C | 2.4 C | 24 | 70 | 24 | T-RSL |
| 1,1-Dichloroethene | 75-35-4 | 340 N | 34 N | 340 | 0.33 | 0.33 | IDEM SW |
| 1,2-Dichloroethane | 107-06-2 | 0.15 C | 0.15 C | 1.5 | 9.4 | 1.5 | T-RSL |
| Benzene | 71-43-2 | 0.41 C | 0.41 C | 4.1 | 6.6 | 4.1 | T-RSL |
| Chloroethane | 75-00-3 | 21000 N | 2100 N | 21000 | -- | 21000 | T-RSL |
| Chloromethane | 74-87-3 | 190 N | 19 N | 190 | -- | 190 | T-RSL |
| cis-1,2-Dichloroethene | 156-59-2 | 370 N | 37 N | 370 | -- | 370 | T-RSL |
| Ethylbenzene | 100-41-4 | 1.5 C | 1.5 C | 15 | 1400 | 15 | T-RSL |
| Tetrachloroethene | 127-18-4 | 0.11 C | 0.11 C | 1.1 | 8 | 1.1 | T-RSL |
| Toluene | 108-88-3 | 2300 N | 230 N | 2300 | 14300 | 2300 | T-RSL |
| trans-1,2-Dichloroethene | 156-60-5 | 110 N | 11 N | 110 | 140 | 110 | T-RSL |
| Trichloroethene | 79-01-6 | 1.7 C | 1.7 C | 17 | 27 | 17 | T-RSL |
| Vinyl chloride | 75-01-4 | 0.016 C | 0.016 C | 0.16 | 20 | 0.16 | T-RSL |
| Xylenes (total) | 1330-20-7 | 200 N | 20 N | 200 | -- | 200 | T-RSL |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 150 N | 15 N | 150 | -- | 150 | T-RSL |
| Acenaphthene | 83-32-9 | 2200 N | 220 N | 2200 | -- | 2200 | T-RSL |
| Acenaphthylene | 208-96-8 | 2200 N(5) | 220 N(5) | 2200 | -- | 2200 | T-RSL |
| Anthracene | 120-12-7 | 11000 N | 1100 N | 11000 | -- | 11000 | T-RSL |
| Benzo(a)anthracene | 56-55-3 | 0.029 C | 0.029 C | 0.29 | -- | 0.29 | T-RSL |
| Benzo(a)pyrene | 50-32-8 | 0.0029 C | 0.0029 C | 0.029 | 0.05 | 0.029 | T-RSL |
| Benzo(b)fluoranthene | 205-99-2 | 0.029 C | 0.029 C | 0.29 | -- | 0.29 | T-RSL |
| Benzo(g,h,i)perylene | 191-24-2 | 1100 N(6) | 110 N(6) | 1100 | -- | 1100 | T-RSL |
| Benzo(k)fluoranthene | 207-08-9 | 0.29 C | 0.29 C | 2.9 | -- | 2.9 | T-RSL |
| Chrysene | 218-01-9 | 2.9 C | 2.9 C | 29 | -- | 29 | T-RSL |
| Dibenzo(a,h)anthracene | 53-70-3 | 0.0029 C | 0.0029 C | 0.029 | -- | 0.029 | T-RSL |
| Fluoranthene | 206-44-0 | 1500 N | 150 N | 1500 | -- | 1500 | T-RSL |
| Fluorene | 86-73-7 | 1500 N | 150 N | 1500 | -- | 1500 | T-RSL |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 0.029 C | 0.029 C | 0.29 | -- | 0.29 | T-RSL |
| Naphthalene | 91-20-3 | 0.14 C | 0.14 C | 1.4 | 14 | 1.4 | T-RSL |
| Phenanthrene | 85-01-8 | 1100 N(6) | 110 N(6) | 1100 | -- | 1100 | T-RSL |
| Pyrene | 129-00-0 | 1100 N | 110 N | 1100 | -- | 1100 | T-RSL |
| **Metals** | | | | | | | |
| Aluminum | 7429-90-5 | 37000 N | 3700 N | 37000 | -- | 37000 | IDEM SW |
| Antimony | 7440-36-0 | 15 N | 1.5 N | 15 | 146 | 15 | T-RSL |
| Arsenic | 7440-38-2 | 0.045 C | 0.045 C | 0.45 | 0.022 | 0.022 | T-RSL |
| Barium | 7440-39-3 | 7300 N | 730 N | 7300 | 1000 | 1000 | IDEM SW |
| Beryllium | 7440-41-7 | 73 N | 7.3 N | 73 | 0.068 | 0.068 | IDEM SW |
| Cadmium | 7440-43-9 | 18 N | 1.8 N | 18 | 10 | 10 | IDEM SW |
| Calcium | 7440-70-2 | -- | -- | -- | -- | -- | -- |
| Chromium | 7440-47-3 | 110 N(7) | 11 N(7) | 110 | 50 | 50 | IDEM SW |
| Cobalt | 7440-48-4 | 110 N | 11 N | 110 | -- | 110 | T-RSL |
| Copper | 7440-50-8 | 1500 N | 150 N | 1500 | -- | 1500 | T-RSL |
| Iron | 7439-89-6 | 26000 N | 2600 N | 26000 | -- | 26000 | T-RSL |
| Lead | 7439-92-1 | 15 (8) | 15 (8) | 150 | 50 | 50 | IDEM SW |
| Magnesium | 7439-95-4 | -- | -- | -- | -- | -- | -- |
| Manganese | 7439-96-5 | 880 N | 88 N | 880 | -- | 880 | T-RSL |
| Mercury | 7439-97-6 | 11 N(9) | 1.1 N(9) | 11 | 0.14 | 0.14 | IDEM SW |
| Nickel | 7440-02-0 | 730 N | 73 N | 730 | 13.4 | 13.4 | IDEM SW |
| Potassium | 7440-09-7 | -- | -- | -- | -- | -- | -- |
| Selenium | 7782-49-2 | 180 N | 18 N | 180 | 10 | 10 | IDEM SW |
| Silver | 7440-22-4 | 180 N | 18 N | 180 | 50 | 50 | IDEM SW |
| Sodium | 7440-23-5 | -- | -- | -- | -- | -- | -- |
| Thallium | 7440-28-0 | 2.4 N | 0.24 N | 2.4 | 13 | 2.4 | T-RSL |
| Vanadium | 7440-62-2 | 180 N(10) | 18 N(10) | 180 | -- | 180 | T-RSL |
| Zinc | 7440-66-6 | 11000 N | 1100 N | 11000 | -- | 11000 | T-RSL |

Notes:

1 - The tapwater screening level from the EPA Regions 3, 6, and 9 Regional Screening Levels (T-RSLs) for Chemical Contaminants at Superfund Sites, May 19, 2009 are available online at http://epa-prgs.ornl.gov/chemicals/index.shtml. The risk-based screening level is based on a target hazard quotient of 1 for non-carcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag).
2 - The EPA T-RSLs (May 19, 2009) tapwater screening level from the risk-based screening level for non-carcinogens is adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The risk-based screening level for carcinogens is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3 - A factor of 10 is used with surface water to compare against the adjusted tapwater risk-based screening level.

4 - Indiana Minimum Surface Water Quality Standards, 327 IAC 2-1-6 (IDEM SW) (IAC, 2002). For human health, it is the most stringent of the continuous criterion concentrations (CCC).

5 - Value is for acenapththene.

6 - Value is for pyrene.

7 - Value is for hexavalent chromium.

8 - Action level under Safe Drinking Water Act.

9 - Value is for mercury, inorganic salts.

10 - Value is for vanadium and compounds.

Abbreviations:

-- - Not available or not applicable

**Crane SWMU 21 Human Health Screening Criteria - Groundwater Samples**

| Analyte | CAS Number | EPA Regional Screening Level, Tap Water (1) (ug/L) | Adjusted EPA Regional Screening Level, Tap Water (2) (ug/L) | EPA Maximum Contaminant Level (3) (ug/L) | IDEM GW (4) (ug/L) | IDEM GW Default Closure Level (4) (ug/L) | Minimum Applicable Criteria (5) (ug/L) | Minimum Criterion Reference |
|---|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 9100 N | 910 N | 200 | 3800 | 200 | 200 | MCL |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.067 C | 0.067 C | NA | 0.9 | 0.9 | 0.9 | IDEM DCL |
| 1,1,2-Trichloroethane | 79-00-5 | 0.24 C | 0.24 C | 5 | 3.2 | 5 | 5 | MCL |
| 1,1-Dichloroethane | 75-34-3 | 2.4 C | 2.4 C | NA | 990 | 990 | 990 | IDEM DCL |
| 1,1-Dichloroethene | 75-35-4 | 340 N | 34 N | 7 | 430 | 7 | 7 | MCL |
| 1,2-Dichloroethane | 107-06-2 | 0.15 C | 0.15 C | 5 | 2 | 5 | 5 | MCL |
| Benzene | 71-43-2 | 0.41 C | 0.41 C | 5 | 5.5 | 5 | 5 | MCL |
| Chloroethane | 75-00-3 | 21000 N | 2100 N | NA | 62 | 62 | 62 | IDEM DCL |
| Chloromethane | 74-87-3 | 190 N | 19 N | NA | NA | NA | 19 | T-RSL |
| cis-1,2-Dichloroethene | 156-59-2 | 370 N | 37 N | 70 | 77 | 70 | 70 | MCL |
| Ethylbenzene | 100-41-4 | 1.5 C | 1.5 C | 700 | 1600 | 700 | 700 | MCL |
| Tetrachloroethene | 127-18-4 | 0.11 C | 0.11 C | 5 | 6.5 | 5 | 5 | MCL |
| Toluene | 108-88-3 | 2300 N | 230 N | 1000 | 2400 | 1000 | 1000 | MCL |
| trans-1,2-Dichloroethene | 156-60-5 | 110 N | 11 N | 100 | 150 | 100 | 100 | MCL |
| Trichloroethene | 79-01-6 | 1.7 C | 1.7 C | 5 | 0.45 | 5 | 5 | MCL |
| Vinyl chloride | 75-01-4 | 0.016 C | 0.016 C | 2 | 0.53 | 2 | 2 | MCL |
| Xylenes (total) | 1330-20-7 | 200 N | 20 N | 10000 | 270 | 10000 | 10000 | MCL |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 150 N | 15 N | NA | 31 | 31 | 31 | IDEM DCL |
| Acenaphthene | 83-32-9 | 2200 N | 220 N | NA | 460 | 460 | 460 | IDEM DCL |
| Acenaphthylene | 208-96-8 | 2200 N(6) | 220 N(6) | NA | 71 | 71 | 71 | IDEM DCL |
| Anthracene | 120-12-7 | 11000 N | 1100 N | NA | 2300 | 43 | 43 | IDEM DCL |
| Benzo(a)anthracene | 56-55-3 | 0.029 C | 0.029 C | NA | 1.2 | 1.2 | 1.2 | IDEM DCL |
| Benzo(a)pyrene | 50-32-8 | 0.0029 C | 0.0029 C | 0.2 | 0.12 | 0.2 | 0.2 | MCL |
| Benzo(b)fluoranthene | 205-99-2 | 0.029 C | 0.029 C | NA | 1.2 | 1.2 | 1.2 | IDEM DCL |
| Benzo(g,h,i)perylene | 191-24-2 | 1100 N(7) | 110 N(7) | NA | NA | NA | 110 | T-RSL |
| Benzo(k)fluoranthene | 207-08-9 | 0.29 C | 0.29 C | NA | 12 | 0.8 | 0.8 | IDEM DCL |
| Chrysene | 218-01-9 | 2.9 C | 2.9 C | NA | 120 | 1.6 | 1.6 | IDEM DCL |
| Dibenzo(a,h)anthracene | 53-70-3 | 0.0029 C | 0.0029 C | NA | 0.12 | 0.12 | 0.12 | IDEM DCL |
| Fluoranthene | 206-44-0 | 1500 N | 150 N | NA | 1500 | 210 | 210 | IDEM DCL |
| Fluorene | 86-73-7 | 1500 N | 150 N | NA | 310 | 310 | 310 | IDEM DCL |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 0.029 C | 0.029 C | NA | 1.2 | 0.022 | 0.022 | IDEM DCL |
| Naphthalene | 91-20-3 | 0.14 C | 0.14 C | NA | 8.3 | 8.3 | 8.3 | IDEM DCL |
| Phenanthrene | 85-01-8 | 1100 N(7) | 110 N(7) | NA | 23 | 23 | 23 | IDEM DCL |
| Pyrene | 129-00-0 | 1100 N | 110 N | NA | 1100 | 140 | 140 | IDEM DCL |
| **Metals** | | | | | | | | |
| Aluminum | 7429-90-5 | 37000 N | 3700 N | NA | NA | NA | 3700 | T-RSL |
| Antimony | 7440-36-0 | 15 N | 1.5 N | 6 | 15 | 6 | 6 | MCL |
| Arsenic | 7440-38-2 | 0.045 C | 0.045 C | 10 | 0.57 | 10 | 10 | MCL |
| Barium | 7440-39-3 | 7300 N | 730 N | 2000 | 7300 | 2000 | 2000 | MCL |
| Beryllium | 7440-41-7 | 73 N | 7.3 N | 4 | 73 | 4 | 4 | MCL |
| Cadmium | 7440-43-9 | 18 N | 1.8 N | 5 | 18 | 5 | 5 | MCL |
| Calcium | 7440-70-2 | -- | -- | NA | NA | NA | -- | -- |
| Chromium | 7440-47-3 | 110 N(8) | 11 N(8) | 100 | 55000 | 100 | 100 | MCL |
| Cobalt | 7440-48-4 | 110 N | 11 N | NA | NA | NA | 11 | T-RSL |
| Copper | 7440-50-8 | 1500 N | 150 N | 1300 | 1500 | 1300 | 1300 | MCL |
| Iron | 7439-89-6 | 26000 N | 2600 N | NA | NA | NA | 2600 | T-RSL |
| Lead | 7439-92-1 | 15 (9) | 15 (9) | 15 | 15 | 15 | 15 | MCL |
| Magnesium | 7439-95-4 | -- | -- | NA | NA | NA | -- | -- |
| Manganese | 7439-96-5 | 880 N | 88 N | NA | NA | NA | 88 | T-RSL |
| Mercury | 7439-97-6 | 11 N(10) | 1.1 N(10) | 2 | NA | NA | 1.1 | T-RSL |
| Nickel | 7440-02-0 | 730 N | 73 N | NA | 730 | 730 | 730 | IDEM DCL |
| Potassium | 7440-09-7 | -- | -- | NA | NA | NA | -- | -- |
| Selenium | 7782-49-2 | 180 N | 18 N | 50 | 18 | 50 | 50 | MCL |
| Silver | 7440-22-4 | 180 N | 18 N | NA | 180 | 180 | 180 | IDEM DCL |
| Sodium | 7440-23-5 | -- | -- | NA | NA | NA | -- | -- |
| Thallium | 7440-28-0 | 2.4 N | 0.24 N | 2 | 2.6 | 2 | 2 | MCL |
| Vanadium | 7440-62-2 | 180 N(11) | 18 N(11) | NA | NA | NA | 18 | T-RSL |
| Zinc | 7440-66-6 | 11000 N | 1100 N | NA | 11000 | 11000 | 11000 | IDEM DCL |

Notes:

1 - The tapwater screening level from the EPA Regions 3, 6, and 9 Regional Screening Levels (T-RSLs) for Chemical Contaminants at Superfund Sites, May 19, 2009 are available online at http://epa-prgs.ornl.gov/chemicals/index.shtml. The risk-based screening level is based on a target hazard quotient of 1 for non-carcinogens (denoted with a "N" flag), or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted with a "C" flag).

2 - The EPA T-RSLs (May 19, 2009) tapwater screening level from the risk-based screening level for non-carcinogens is adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The risk-based screening level for carcinogens is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

3- The EPA MCLs - Federal Maximum Contaminant Level from EPA 822-R-06-013, 2006 Edition of the Drinking Water Standard And Health Advisories. August 2006.

4 - The guidelines are from IDEM's RISC Default Closure Tables 2006 (Revised May 1, 2009) available online at: http://www.in.gov/idem/files/risctech_appendix1_2006_r1.pdf.

5 - The minimum applicable criteria for risk screening on this project is the IDEM GW DCL.

6 - Value is for acenapththene.

7 - Value is for pyrene.

8 - Value is for hexavalent chromium.

9 - Action level under Safe Drinking Water Act.

10 - Value is for mercury, inorganic salts.

11 - Value is for vanadium and compounds.

Abbreviations:

-- - Not available or not applicable

## NSA Crane SWMU 21 Ecological Screening Criteria - Surface Soil Samples

| Analyte | CAS Number | Ecological Soil Screening Level [1] (mg/kg) | Source of Ecological Soil Screening Level | EPA Eco SSL (mg/kg) | EPA R5 ESL (mg/kg) | NOAA SQUIRT (mg/kg) |
|---|---|---|---|---|---|---|
| Phenanthrene | 85-01-8 | 29 | Eco SSL | 29 | 45.7 | 45.7 |
| Pyrene | 129-00-0 | 1.1 | Eco SSL | 1.1 | 78.5 | 78.5 |
| **Polychlorinated Biphenyls** | | | | | | |
| Aroclor-1016 | 12674-11-2 | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| Aroclor-1221 | 11104-28-2 | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| Aroclor-1232 | 11141-16-5 | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| Aroclor-1242 | 53469-21-9 | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| Aroclor-1248 | 12672-29-6 | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| Aroclor-1254 | 11097-69-1 | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| Aroclor-1260 | 11096-82-5 | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| Total PCBs | - | 0.000332 | R5 ESL | NA | 0.000332 | 0.000332 |
| **Metals** | | | | | | |
| Aluminum | 7429-90-5 | pH>5.5 | Eco SSL | pH>5.5 | NA | NA |
| Antimony | 7440-36-0 | 0.27 | Eco SSL | 0.27 | 0.142 | 0.142 |
| Arsenic | 7440-38-2 | 18 | Eco SSL | 18 | 5.7 | 5.7 |
| Barium | 7440-39-3 | 330 | Eco SSL | 330 | 1.04 | 1.04 |
| Beryllium | 7440-41-7 | 21 | Eco SSL | 21 | 1.06 | 1.06 |
| Cadmium | 7440-43-9 | 0.36 | Eco SSL | 0.36 | 0.00222 | 0.00222 |
| Calcium | 7440-70-2 | -- | -- | NA | NA | NA |
| Chromium | 7440-47-3 | 26 | Eco SSL | 26 | 0.4 | 0.4 |
| Cobalt | 7440-48-4 | 13 | Eco SSL | 13 | 0.14 | 0.14 |
| Copper | 7440-50-8 | 28 | Eco SSL | 28 | 5.4 | 5.4 |
| Iron | 7439-89-6 | 5<pH<8 | Eco SSL | 5<pH<8 | NA | NA |
| Lead | 7439-92-1 | 11 | Eco SSL | 11 | 0.0537 | 0.0537 |
| Magnesium | 7439-95-4 | -- | -- | NA | NA | NA |
| Manganese | 7439-96-5 | 220 | Eco SSL | 220 | NA | 220 |
| Mercury | 7439-97-6 | 0.1 | R5 ESL | NA | 0.1 | 0.1 |
| Nickel | 7440-02-0 | 38 | Eco SSL | 38 | 13.6 | 13.6 |
| Potassium | 7440-09-7 | -- | -- | NA | NA | NA |
| Selenium | 7782-49-2 | 0.52 | Eco SSL | 0.52 | 0.0276 | 0.52 |
| Silver | 7440-22-4 | 4.2 | Eco SSL | 4.2 | 4.04 | 2 |
| Sodium | 7440-23-5 | -- | -- | NA | NA | NA |
| Thallium | 7440-28-0 | 0.0569 | R5 ESL | NA | 0.0569 | 0.0569 |
| Vanadium | 7440-62-2 | 7.8 | Eco SSL | 7.8 | 1.59 | 1.59 |

# NSA Crane SWMU 21 Ecological Screening Criteria - Surface Soil Samples

| Analyte | CAS Number | Ecological Soil Screening Level [1] (mg/kg) | Source of Ecological Soil Screening Level | EPA Eco SSL (mg/kg) | EPA R5 ESL (mg/kg) | NOAA SQUIRT (mg/kg) |
|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 29.8 | R5 ESL | NA | 29.8 | 29.8 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.127 | R5 ESL | NA | 0.127 | 0.127 |
| 1,1,2-Trichloroethane | 79-00-5 | 28.6 | R5 ESL | NA | 28.6 | 28.6 |
| 1,1-Dichloroethane | 75-34-3 | 20.1 | R5 ESL | NA | 20.1 | 20.1 |
| 1,1-Dichloroethene | 75-35-4 | 8.28 | R5 ESL | NA | 8.28 | 8.28 |
| 1,2-Dichloroethane | 107-06-2 | 21.2 | R5 ESL | NA | 21.2 | 21.2 |
| Benzene | 71-43-2 | 0.255 | R5 ESL | NA | 0.255 | 0.255 |
| Chloroethane | 75-00-3 | -- | -- | NA | NA | NA |
| Chloromethane | 74-87-3 | 10.4 | R5 ESL | NA | 10.4 | 10.4 |
| cis-1,2-Dichloroethene | 156-59-2 | 0.784 | R5 ESL | NA | 0.784 | 0.784 |
| Ethylbenzene | 100-41-4 | 5.16 | R5 ESL | NA | 5.16 | 5.16 |
| Tetrachloroethene | 127-18-4 | 9.92 | R5 ESL | NA | 9.92 | 9.92 |
| Toluene | 108-88-3 | 5.45 | R5 ESL | NA | 5.45 | 5.45 |
| trans-1,2-Dichloroethene | 156-60-5 | 0.784 | R5 ESL | NA | 0.784 | 0.784 |
| Trichloroethene | 79-01-6 | 12.4 | R5 ESL | NA | 12.4 | 12.4 |
| Vinyl chloride | 75-01-4 | 0.646 | R5 ESL | NA | 0.646 | 0.646 |
| Xylenes (total) | 1330-20-7 | 10 | R5 ESL | NA | 10 | 10 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 29 | Eco SSL | 29 | 3.24 | 3.24 |
| Acenaphthene | 83-32-9 | 29 | Eco SSL | 29 | 682 | 682 |
| Acenaphthylene | 208-96-8 | 29 | Eco SSL | 29 | 682 | 682 |
| Anthracene | 120-12-7 | 29 | Eco SSL | 29 | 1480 | 1480 |
| Benzo(a)anthracene | 56-55-3 | 1.1 | Eco SSL | 1.1 | 5.21 | 5.21 |
| Benzo(a)pyrene | 50-32-8 | 1.1 | Eco SSL | 1.1 | 1.52 | 1.52 |
| Benzo(b)fluoranthene | 205-99-2 | 1.1 | Eco SSL | 1.1 | 59.8 | 59.8 |
| Benzo(g,h,i)perylene | 191-24-2 | 1.1 | Eco SSL | 1.1 | 119 | 119 |
| Benzo(k)fluoranthene | 207-08-9 | 1.1 | Eco SSL | 1.1 | 148 | 148 |
| Chrysene | 218-01-9 | 1.1 | Eco SSL | 1.1 | 4.73 | 4.73 |
| Dibenzo(a,h)anthracene | 53-70-3 | 1.1 | Eco SSL | 1.1 | 18.4 | 18.4 |
| Fluoranthene | 206-44-0 | 29 | Eco SSL | 29 | 122 | 122 |
| Fluorene | 86-73-7 | 29 | Eco SSL | 29 | 122 | 122 |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 1.1 | Eco SSL | 1.1 | 109 | 109 |
| Naphthalene | 91-20-3 | 29 | Eco SSL | 29 | 0.0994 | 0.0994 |

## NSA Crane SWMU 21 Ecological Screening Criteria - Surface Soil Samples

| Analyte | CAS Number | Ecological Soil Screening Level [1] (mg/kg) | Source of Ecological Soil Screening Level | EPA Eco SSL (mg/kg) | EPA R5 ESL (mg/kg) | NOAA SQUIRT (mg/kg) |
|---|---|---|---|---|---|---|
| Zinc | 7440-66-6 | 46 | Eco SSL | 46 | 6.62 | 6.62 |

1- The following hierarchy was used for selecting the Ecological Soil Screening Level, in order of preference:
EPA Ecological Soil Screening Levels (Eco SSL) (EPA, 2003, 2005, 2006, 2007). The lower of the plant, invertebrate, or wildlife Eco SSL is selected as the screening level.
EPA Region 5 Ecological Sediment Screening Levels (R5 ESL) (EPA, 2003).
Lowest of National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQUIRT) surface soil benchmarks (Buchman, 2008), unless value is the Dutch Target Value.

Shaded cells are values that were selected as the overall soil screening level

## NSA Crane SWMU 21 Ecological Screening Criteria - Sediment Samples

| Analyte | CAS Number | Ecological Soil Screening Level [1] (mg/kg) | Source of Ecological Soil Screening Level | EPA Eco SSL (mg/kg) | EPA R5 ESL (mg/kg) | EPA R3 BTAG (mg/kg) | NOAA SQUIRT (mg/kg) |
|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 0.213 | R5 ESL | NA | 0.213 | 0.302 | NA |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.85 | R5 ESL | NA | 0.85 | 1.36 | NA |
| 1,1,2-Trichloroethane | 79-00-5 | 0.518 | R5 ESL | NA | 0.518 | 1.24 | NA |
| 1,1-Dichloroethane | 75-34-3 | 0.000575 | R5 ESL | NA | 0.000575 | NA | NA |
| 1,1-Dichloroethene | 75-35-4 | 0.0194 | R5 ESL | NA | 0.0194 | 0.031 | NA |
| 1,2-Dichloroethane | 107-06-2 | 0.26 | R5 ESL | NA | 0.26 | NA | NA |
| Benzene | 71-43-2 | 0.142 | R5 ESL | NA | 0.142 | NA | NA |
| Chloroethane | 75-00-3 | NA | -- | NA | NA | NA | NA |
| Chloromethane | 74-87-3 | NA | -- | NA | NA | NA | NA |
| cis-1,2-Dichloroethene | 156-59-2 | 0.209 | R5 ESL | NA | 0.209 | NA | NA |
| Ethylbenzene | 100-41-4 | 0.175 | R5 ESL | NA | 0.175 | 1.1 | NA |
| Tetrachloroethene | 127-18-4 | 0.99 | R5 ESL | NA | 0.99 | 0.468 | NA |
| Toluene | 108-88-3 | 1.22 | R5 ESL | NA | 1.22 | NA | NA |
| trans-1,2-Dichloroethene | 156-60-5 | 0.654 | R5 ESL | NA | 0.654 | 1.05 | NA |
| Trichloroethene | 79-01-6 | 0.112 | R5 ESL | NA | 0.112 | NA | NA |
| Vinyl chloride | 75-01-4 | 0.202 | R5 ESL | NA | 0.202 | NA | NA |
| Xylenes (total) | 1330-20-7 | 0.433 | R5 ESL | NA | 0.433 | NA | NA |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 29 | Eco SSL | 29 | 0.0202 | 0.0202 | NA |
| Acenaphthene | 83-32-9 | 29 | Eco SSL | 29 | 0.00671 | 0.0067 | 0.00671 |
| Acenaphthylene | 208-96-8 | 29 | Eco SSL | 29 | 0.00587 | 0.0059 | 0.00587 |
| Anthracene | 120-12-7 | 29 | Eco SSL | 29 | 0.0572 | 0.0572 | 0.001 |
| Benzo(a)anthracene | 56-55-3 | 1.1 | Eco SSL | 1.1 | 0.108 | 0.108 | 0.01572 |
| Benzo(a)pyrene | 50-32-8 | 1.1 | Eco SSL | 1.1 | 0.15 | 0.15 | 0.0319 |
| Benzo(b)fluoranthene | 205-99-2 | 1.1 | Eco SSL | 1.1 | 10.4 | NA | NA |
| Benzo(g,h,i)perylene | 191-24-2 | 1.1 | Eco SSL | 1.1 | 0.17 | 0.17 | 0.17 |
| Benzo(k)fluoranthene | 207-08-9 | 1.1 | Eco SSL | 1.1 | 0.24 | 0.24 | 0.0272 |
| Chrysene | 218-01-9 | 1.1 | Eco SSL | 1.1 | 0.166 | 0.166 | 0.02683 |
| Dibenzo(a,h)anthracene | 53-70-3 | 1.1 | Eco SSL | 1.1 | 0.033 | 0.033 | 0.00622 |
| Fluoranthene | 206-44-0 | 29 | Eco SSL | 29 | 0.423 | 0.423 | 0.03146 |
| Fluorene | 86-73-7 | 29 | Eco SSL | 29 | 0.0774 | 0.0774 | 0.01 |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 1.1 | Eco SSL | 1.1 | 0.2 | 0.017 | 0.01732 |
| Naphthalene | 91-20-3 | 29 | Eco SSL | 29 | 0.176 | 0.176 | 0.01465 |
| Phenanthrene | 85-01-8 | 29 | Eco SSL | 29 | 0.204 | 0.204 | 0.01873 |
| Pyrene | 129-00-0 | 1.1 | Eco SSL | 1.1 | 0.195 | 0.195 | 0.04427 |

## NSA Crane SWMU 21 Ecological Screening Criteria - Sediment Samples

| Analyte | CAS Number | Ecological Soil Screening Level (1) (mg/kg) | Source of Ecological Soil Screening Level | EPA Eco SSL (mg/kg) | EPA R5 ESL (mg/kg) | EPA R3 BTAG (mg/kg) | NOAA SQUIRT (mg/kg) |
|---|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls** | | | | | | | |
| Aroclor-1016 | 12674-11-2 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1221 | 11104-28-2 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1232 | 11141-16-5 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1242 | 53469-21-9 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1248 | 12672-29-6 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1254 | 11097-69-1 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1260 | 11096-82-5 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1262 | 37324-23-5 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Aroclor-1268 | 11100-14-4 | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.06 |
| Total PCBs | - | 0.0598 | R5 ESL | NA | 0.0598 | NA | 0.03162 |
| **Metals** | | | | | | | |
| Aluminum | 7429-90-5 | pH>5.5 | Eco SSL | pH>5.5 | NA | NA | 25500 |
| Antimony | 7440-36-0 | 0.27 | Eco SSL | 0.27 | NA | 2 | NA |
| Arsenic | 7440-38-2 | 18 | Eco SSL | 18 | 9.79 | 9.8 | 5.9 |
| Barium | 7440-39-3 | 330 | Eco SSL | 330 | NA | NA | NA |
| Beryllium | 7440-41-7 | 21 | Eco SSL | 21 | NA | NA | NA |
| Cadmium | 7440-43-9 | 0.36 | Eco SSL | 0.36 | 0.99 | 0.99 | 0.583 |
| Calcium | 7440-70-2 | -- | -- | NA | NA | NA | NA |
| Chromium | 7440-47-3 | 26 | Eco SSL | 26 | 43.4 | 43.4 | 26 |
| Cobalt | 7440-48-4 | 13 | Eco SSL | 13 | 50 | 50 | 50 |
| Copper | 7440-50-8 | 28 | Eco SSL | 28 | 31.6 | 31.6 | 16 |
| Iron | 7439-89-6 | 5<pH<8 | Eco SSL | 5<pH<8 | NA | 20000 | 20000 |
| Lead | 7439-92-1 | 11 | Eco SSL | 11 | 35.8 | 35.8 | 31 |
| Magnesium | 7439-95-4 | NA | -- | NA | NA | NA | NA |
| Manganese | 7439-96-5 | 220 | Eco SSL | 220 | NA | 460 | 460 |
| Mercury | 7439-97-6 | 0.174 | R5 ESL | NA | 0.174 | 0.18 | 0.174 |
| Nickel | 7440-02-0 | 38 | Eco SSL | 38 | 22.7 | 22.7 | 16 |
| Potassium | 7440-09-7 | NA | -- | NA | NA | NA | NA |
| Selenium | 7782-49-2 | 0.52 | Eco SSL | 0.52 | NA | 2 | NA |
| Silver | 7440-22-4 | 4.2 | Eco SSL | 4.2 | 0.5 | 1 | 0.5 |
| Sodium | 7440-23-5 | NA | -- | NA | NA | NA | NA |
| Thallium | 7440-28-0 | NA | -- | NA | NA | NA | NA |
| Vanadium | 7440-62-2 | 7.8 | Eco SSL | 7.8 | NA | NA | NA |
| Zinc | 7440-66-6 | 46 | Eco SSL | 46 | 121 | 121 | 98 |

## NSA Crane SWMU 21 Ecological Screening Criteria - Sediment Samples

| Analyte | CAS Number | Ecological Soil Screening Level [1] (mg/kg) | Source of Ecological Soil Screening Level | EPA Eco SSL (mg/kg) | EPA R5 ESL (mg/kg) | EPA R3 BTAG (mg/kg) | NOAA SQUIRT (mg/kg) |
|---|---|---|---|---|---|---|---|

1- The following hierarchy was used for selecting the Ecological Screening level in order of preference:
EPA Ecological Soil Screening Levels (Eco SSL) (EPA, 2003, 2005, 2006, 2007). The lower of the plant, invertebrate, or wildlife Eco SSL is selected as the screening level.
EPA Region 5 Ecological Sediment Screening Levels (R5 ESL) (EPA, 2003).
EPA Region 3 Biological Technical Assistance Group Ecological Sediment Benchmarks (R3 FW SED) (EPA, 2006).
Lowest of National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQUIRT) surface soil benchmarks (Buchman, 2008) unless value is the Dutch Target Value.

Shaded cells are values that were selected as the overall soil screening level

# NSA Crane SWMU 21 Ecological Screening Criteria - Surface Water Samples

| Analyte | CAS Number | Ecological Surface Water Screening Level [1] (ug/L) | Source of Ecological Surface Water Screening Level | EPA RWQC (ug/L) | IDEM SW (ug/L) | EPA R5 ESL (ug/L) | EPA R3 BTAG (ug/L) | NOAA SQUIRT (ug/L) |
|---|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | | | |
| 1,1,1-Trichloroethane | 71-55-6 | 76 | R5 ESL | NA | NA | 76 | 11 | 11 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 380 | R5 ESL | NA | NA | 380 | 610 | 111 |
| 1,1,2-Trichloroethane | 79-00-5 | 500 | R5 ESL | NA | NA | 500 | 1200 | 500 |
| 1,1-Dichloroethane | 75-34-3 | 47 | R5 ESL | NA | NA | 47 | 47 | 47 |
| 1,1-Dichloroethene | 75-35-4 | 65 | R5 ESL | NA | NA | 65 | 25 | 25 |
| 1,2-Dichloroethane | 107-06-2 | 910 | R5 ESL | NA | NA | 910 | 100 | 100 |
| Benzene | 71-43-2 | 114 | R5 ESL | NA | NA | 114 | 370 | 46 |
| Chloroethane | 75-00-3 | -- | -- | NA | NA | NA | NA | NA |
| Chloromethane | 74-87-3 | 10.4 | NOAA | NA | NA | NA | NA | 10.4 |
| cis-1,2-Dichloroethene | 156-59-2 | 590 | NOAA | NA | NA | 590 | NA | 0.784 |
| Ethylbenzene | 100-41-4 | 14 | R5 ESL | NA | NA | 14 | 90 | 7.3 |
| Tetrachloroethene | 127-18-4 | 45 | R5 ESL | NA | NA | 45 | 111 | 45 |
| Toluene | 108-88-3 | 253 | R5 ESL | NA | NA | 253 | 2 | 2 |
| trans-1,2-Dichloroethene | 156-60-5 | 970 | R5 ESL | NA | NA | 970 | 970 | 590 |
| Trichloroethene | 79-01-6 | 47 | R5 ESL | NA | NA | 47 | 21 | 21 |
| Vinyl chloride | 75-01-4 | 930 | R5 ESL | NA | NA | 930 | 930 | 930 |
| Xylenes (total) | 1330-20-7 | 27 | R5 ESL | NA | NA | 27 | 13 | 13 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | | | |
| 2-Methylnaphthalene | 91-57-6 | 330 | R5 ESL | NA | NA | 330 | 4.7 | 330 |
| Acenaphthene | 83-32-9 | 38 | R5 ESL | NA | NA | 38 | 5.8 | 5.8 |
| Acenaphthylene | 208-96-8 | 4840 | R5 ESL | NA | NA | 4840 | NA | 4840 |
| Anthracene | 120-12-7 | 0.035 | R5 ESL | NA | NA | 0.035 | 0.012 | 0.012 |
| Benzo(a)anthracene | 56-55-3 | 0.025 | R5 ESL | NA | NA | 0.025 | 0.018 | 1.8 |
| Benzo(a)pyrene | 50-32-8 | 0.014 | R5 ESL | NA | NA | 0.014 | 0.015 | 0.014 |
| Benzo(b)fluoranthene | 205-99-2 | 9.07 | R5 ESL | NA | NA | 9.07 | NA | 9.07 |
| Benzo(g,h,i)perylene | 191-24-2 | 7.64 | R5 ESL | NA | NA | 7.64 | NA | 7.64 |
| Benzo(k)fluoranthene | 207-08-9 | NA | -- | NA | NA | NA | NA | NA |
| Chrysene | 218-01-9 | NA | -- | NA | NA | NA | NA | NA |
| Dibenzo(a,h)anthracene | 53-70-3 | NA | -- | NA | NA | NA | NA | NA |
| Fluoranthene | 206-44-0 | 1.9 | R5 ESL | NA | NA | 1.9 | 0.04 | 0.04 |
| Fluorene | 86-73-7 | 19 | R5 ESL | NA | NA | 19 | 3 | 3.9 |
| Indeno(1,2,3-c,d)pyrene | 193-39-5 | 4.31 | R5 ESL | NA | NA | 4.31 | NA | 4.31 |
| Naphthalene | 91-20-3 | 13 | R5 ESL | NA | NA | 13 | 1.1 | 1.1 |
| Phenanthrene | 85-01-8 | 3.6 | R5 ESL | NA | NA | 3.6 | 0.4 | 3.6 |
| Pyrene | 129-00-0 | 0.3 | R5 ESL | NA | NA | 0.3 | 0.025 | 0.025 |
| **Metals** | | | | | | | | |
| Aluminum | 7429-90-5 | 87 | RWQC | 87 | NA | NA | 87 | 87 |
| Antimony | 7440-36-0 | 80 | R5 ESL | NA | NA | 80 | 30 | 30 |
| Arsenic | 7440-38-2 | 150 | RWQC | 150 | 720 | 148 | 5 | 150 |
| Barium | 7440-39-3 | 220 | R5 ESL | NA | NA | 220 | 4 | 3.9 |

## NSA Crane SWMU 21 Ecological Screening Criteria - Surface Water Samples

| Analyte | CAS Number | Ecological Surface Water Screening Level [1] (ug/L) | Source of Ecological Surface Water Screening Level | EPA RWQC (ug/L) | IDEM SW (ug/L) | EPA R5 ESL (ug/L) | EPA R3 BTAG (ug/L) | NOAA SQUIRT (ug/L) |
|---|---|---|---|---|---|---|---|---|
| Beryllium | 7440-41-7 | 3.6 | R5 ESL | NA | NA | 3.6 | 0.66 | 0.66 |
| Cadmium | 7440-43-9 | 0.25 | RWQC | 0.25 | 3.4 | 0.15 | 0.25 | 0.25 |
| Calcium | 7440-70-2 | 116000 | R3 BTAG | NA | NA | NA | 116000 | NA |
| Chromium | 7440-47-3 | 11 | RWQC | 11 | 32 | 42 | 74 | 11 |
| Cobalt | 7440-48-4 | 240 | R5 ESL | NA | NA | 240 | 23 | 3 |
| Copper | 7440-50-8 | 9 | RWQC | 9 | 17.8 | 1.58 | 9 | 9 |
| Iron | 7439-89-6 | 1000 | RWQC | 1000 | NA | NA | 300 | 1000 |
| Lead | 7439-92-1 | 2.5 | RWQC | 2.5 | 60 | NA | NA | 2.5 |
| Magnesium | 7439-95-4 | 2000 | R3 BTAG | NA | NA | NA | 2000 | NA |
| Manganese | 7439-96-5 | 120 | R3 BTAG | NA | NA | NA | 120 | 80 |
| Mercury | 7439-97-6 | 0.77 | RWQC | 0.77 | 2.4 | 0.0013 | 0.026 | 0.77 |
| Nickel | 7440-02-0 | 52 | RWQC | 52 | 1580 | 28.9 | 52 | 52 |
| Potassium | 7440-09-7 | 53000 | R3 BTAG | NA | NA | NA | 53000 | NA |
| Selenium | 7782-49-2 | 5 | RWQC | 5 | 130 | 5 | 1 | 5 |
| Silver | 7440-22-4 | 1.04 | IDEM SW | NA | 1.04 | 0.12 | 3.2 | 0.36 |
| Sodium | 7440-23-5 | 680000 | R3 BTAG | NA | NA | NA | 680000 | NA |
| Thallium | 7440-28-0 | 10 | R5 ESL | NA | NA | 10 | 0.8 | 0.03 |
| Vanadium | 7440-62-2 | 12 | R5 ESL | NA | NA | 12 | 20 | 19 |
| Zinc | 7440-66-6 | 120 | RWQC | 120 | 128 | 65.7 | 120 | 120 |

1- The following hierarchy was used for selecting the Ecological Surface Water Screening Level, in order of preference:
EPA National Recommended Water Quality Criteria (RWQC) (EPA, 2009). The freshwater criterion continuous concentration (CCC) is selected as the screening level.
Indiana Minimum Surface Water Quality Standards, 327 IAC 2-1-6 (IDEM SW) (IAC, 1990). For aquatic life, it is the final acute value (FAV), or 2x the acute aquatic criterion (AAC).
EPA Region 5 Ecological Surface Water Screening Levels (R5 ESL) (EPA, 2003).
EPA Region 3 Biological Technical Assistance Group Ecological Freshwater Benchmarks (R3 BTAG) (EPA, 2006).
Lowest of National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQUIRT) surface soil benchmarks (Buchman, 2008) unless value is the Dutch Target Value.

Shaded cells are values that were selected as the overall soil screening level