RESPONSE ACTION CONTRACT
FOR REMEDIAL RESPONSE, ENFORCEMENT OVERSIGHT, CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR THREATENED RELEASE OF HAZARDOUS SUBSTANCES IN EPA REGION II

FINAL QUALITY ASSURANCE PROJECT PLAN ADDENDUM
OU1 TREATABILITY STUDY
PUCHACK WELL FIELD SUPERFUND SITE
PENNSAUKEN, NEW JERSEY

Work Assignment No. 102-RICO-02JL

U.S. EPA CONTRACT NO. 68-W-98-210
Document Control No.: 3223-102-PP-QAPP-04669

May 6, 2004

Prepared for:
U.S. Environmental Protection Agency
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PROJECT: RAC II Contract No.: 68-W-98-210
Work Assignment No.: 102-RICO-02JL

DOC. CONTROL NO.: 3223-102-PP-QAPP-04669

SUBJECT: Final Quality Assurance Project Plan Addendum
OU1 Treatability Study
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Dear Ms. Granger:

CDM Federal Programs Corporation (CDM) is pleased to submit this Final Quality Assurance Project Plan Addendum for the OU1 Treatability Study at the Puchack Well Field Superfund Site in Pennsauken Township, New Jersey as partial fulfillment of Subtask No. 1.7 of the Statement of Work.

If you have any questions regarding this submittal, please contact Mr. Frank Tsang or myself at 212-785-9123.

Very truly yours,

CDM FEDERAL PROGRAMS CORPORATION

Jeanne Litwin, REM
RAC II Technical Operations Manager

Enclosure

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Crosswalk Between EPA QA/R-5 and Puchack Well Field Superfund Site QAPP Format

QA/R-5 ELEMENTS	PUCHACK WELL FIELD SITE QAPP SECTION
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A5 Problem Definition/Background A6 Project/Task Description	Section 1.0 - Includes Project Description, Site Location, Site Description, Geology and Hydrogeology, Site History, and Objectives and Scope Section 3.1 - Schedule
A7 Quality Objectives and Criteria	Section 6.1 - Data Quality Requirements
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1 Section One

Section 1 Introduction

CDM Federal Programs Corporation (CDM) received Work Assignment Number 102-RICO-02JL, under the Response Action Contract (RAC II) to perform a remedial investigation (RI) and feasibility study (FS), including a risk assessment (RA) for the United States Environmental Protection Agency (EPA), Region II at the Puchack Well Field Superfund site (the Site) located in Pennsauken Township, New Jersey. Pacific Northwest National Laboratory (PNNL) is conducting an in situ remedial technology treatability study for Operable Unit 1 (OU1), which covers groundwater at the Site, for the EPA. CDM has been tasked by EPA to perform the field activities to support the PNNL treatability study.

The field activities discussed in this Quality Assurance Project Plan (QAPP) are based on the requirements set forth by PNNL in their Sampling and Analysis Plan, dated February 2004 (PNNL 2004) and discussed by EPA, PNNL, and CDM during a scoping meeting on February 10, 2004.

This QAPP is the governing document for the collection of subsurface sediment and groundwater samples required for the in situ remedial technology treatability study, as described in CDM's Work Plan letter dated February 21, 2004. This QAPP outlines specific field investigation, sampling, and quality assurance/quality control (QA/QC) procedures for the sample collection activities. For presentation purposes, figures and tables are presented at the end of this document. Per RAC II contract requirements, the official approved QAPP is maintained in the RAC II Document Control Files; a copy is also kept in the official project files.

The procedures described herein provide for the collection, transport, and analysis of representative environmental samples in a manner that meets the requirements of EPA Region II. This QAPP is consistent with the EPA Compendium of Superfund Field Operation Methods, the Region II Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Quality Assurance Manual, Revision 1 (EPA 1989), Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA 2001), CDM's RAC II Quality Assurance Management Plan (QMP) Revision 5 (December 2003) and CDM's Technical Standard Operating Procedures (TSOPs).

In the event that anticipated conditions are different from those encountered once the site field work is under way, it may be necessary to implement a deviation from the approved QAPP. When such changes are required, the proposed change will be discussed with the EPA Remedial Project Manager (RPM), then documented on a Field Change Request (FCR) form and approved by the CDM Field Team Leader (FTL) and the CDM Site Manager (SM). An e-mail copy of the FCR form will be sent to the EPA RPM and will serve as documentation of communication with EPA. Copies of the FCR will be kept on site along with the approved QAPP, and will be distributed to the authorizing parties, the field staff, and the CDM Regional Quality Assurance Coordinator (RQAC) in order to keep all staff informed of the change and to allow RQAC oversight of any changes. A copy of the FCR form is included in Section 2.0.

When significant field changes occur, the QAPP will be revised. Modifications will be carried out via revised pages to the QAPP. Minor changes will be made through formal memoranda from the CDM SM to the EPA RPM and will be included as addendum to the QAPP. The complete sign-off procedure will be followed if, in the judgment of the CDM SM, major revisions to the QAPP are required. All revisions will be subject to CDM's internal review process, and all such changes will be approved by EPA prior to their implementation.

1.1 Project Description

PNNL has been contracted by EPA to perform treatability studies of in situ remedial technologies being considered for deployment at OU1. The PNNL treatability studies will be conducted to determine the feasibility of using an abiotic or biotic technology to create a chemically reducing environment in the aquifer that will reduce and permanently immobilize hexavalent chromium species. Natural processes such as chromate adsorption and reduction will be assessed with Puchack aquifer sediments for two reasons: 1) to determine how much hexavalent chromium mass may be immobilized naturally in the subsurface with no treatment; and 2) to quantify the effects of these natural processes on in situ reductive treatment. The treatability study will also assess the effectiveness of an abiotic or biotic technology to treat volatile organic compound (VOC) contamination [i.e., trichloroethene (TCE)]. In order to assess these technologies, sediment and groundwater samples are needed. PNNL has designed the sampling plan has defined the data quality objectives (DQOs) for this data. The sample results will be reviewed, evaluated, and presented in a treatability study report to be prepared by PNNL.

CDM has been directed by EPA to perform the field activities and limited data validation required for the PNNL treatability study. Based on PNNL's sampling plan, CDM will perform sonic drilling, subsurface sediment sampling (samples will be packaged and shipped under anoxic and aseptic conditions), discrete-depth groundwater sampling, monitoring well installation, and monitoring well sampling activities to obtain the required data. This QAPP details sampling and analysis requirements for these field investigation activities. A health and safety plan (HSP) will be submitted separately.

1.2 Site Location

The Site is located in a commercial/industrial and residential neighborhood of Pennsauken Township, Camden County, New Jersey (Figure 1-1). The Site is located in the Coastal Plain physiographic province of New Jersey and is situated in the outcrop area of the Potomac-Raritan-Magothy (PRM) aquifer system. The PRM aquifers have been identified as part of a critical water supply area by the NJDEP.

1.3 Site Description

The Puchack Well Field Superfund Site includes the Puchack well field, OU1, and Operable Unit 2 (OU2) (potential source areas in the vicinity of the well field) (Figure 1-2). The Puchack well field is located within OU1 and consists of six closed municipal supply wells that are owned and were operated by the City of Camden. During operation, these six wells had a combined capacity of six million gallons per day (mgd). The Site also includes residential, commercial, and industrial areas. Several hundred single and multi-family residential buildings, commercial buildings, and industrial facilities are located near the Puchack well field (Figures 1-1).

OU1 is defined by the 100 micrograms per liter (μg/L) chromium isoconcentration line (Figure 1-2). The 100 μg/L chromium isoconcentration line was chosen because this is the EPA and the New Jersey Department of Environmental Protection (NJDEP) Maximum Contaminant Level (MCL) for chromium. Groundwater sampling data obtained in 2000 and 2001 were used to draw a 100 μg/L isoconcentration line, which shows that the chromium contaminated groundwater is situated in an area roughly bounded to the north by Route 90, to the east by Westfield Avenue, to the south by Cove Road, and to the west by River Road and the Conrail railroad track. Residences, schools, churches, commercial buildings, industrial development, and two cemeteries occupy this area (Figure 1-2).

1.4 Geology and Hydrogeology

1.4.1 Geology

The following sections describe the regional and site-specific geologic characteristics of the area. This information was originally prepared by the United States Geological Service (USGS) and CDM and presented in the draft RI report for OU1 (CDM 2002c).

1.4.1.1 Regional Geology

Sediments of the Coastal Plain in Maryland, Delaware, and New Jersey range in age from Cretaceous through Quaternary, and lie unconformably on weathered basement rocks of Precambrian, early Paleozoic, and Triassic age. They form an eastward-thickening wedge that is composed of unconsolidated and partly consolidated sediments formed in shallow marine, deltaic, and fluviatile depositional environments (Owens and Sohl 1969). During Pleistocene time, dissection of the uppermost beds by streams and rivers led to the present topography, which, in the central and western part of the New Jersey Coastal Plain, consists of uplands that slope eastward to the Atlantic Ocean and westward to lowlands along the Delaware River. These lowlands are thought to have been created through down cutting by a large river, the course of which ran parallel to the inner boundary of the Coastal Plain (Owens and Sohl 1969). Cretaceous sediments of the Potomac Group, Raritan, and Magothy Formations are thus exposed along part of the course of the present-day Delaware River and along the Fall Line.

1.4.1.2 Site Geology

The oldest unconsolidated sediments in the area are sands and gravels of the Potomac Group which lie unconformably upon weathered mica schist or clays, the latter presumably derived from the schist. Sediments of the Potomac Group are interbedded sand, clayey silt, and silty clay. The overlying Raritan Formation is composed of interbedded light-colored sands and red, white, or yellow silty clays (Owens and Sohl 1969). The quartzose sands of both formations contain micas (muscovite and biotite) and lignite; lignite is also present in clay layers. Clays are predominantly kaolinite, with some illite and mixed-layer clays present. Montmorillonite also is reported. Other minerals include goethite and a mica-glauconite mixture (Owens and Sohl 1969).

The youngest of the Cretaceous sediments is the Magothy Formation, which, in the study area, is composed of light-colored quartzose sands and lenses of dark clay. Clays are kaolinite, illite, and mixed-layer; montmorillonite and vermiculite are reported in some samples (Owens and Sohl 1969). Lignite is present, in some cases as thin layers.

The outcrops of the Cretaceous deposits in the Inner (western) Coastal Plain are overlain unconformably by younger sediments in many areas. The focus of the current study, Pennsauken Township, is a type location for one of the Tertiary Coastal Plain deposits, the Pensauken (old spelling) Formation of Late Miocene age. The Pensauken Formation is composed of sands and coarse gravels in the study area. Iron-cemented feldspathic sands overlie thin beds of reworked glauconite sand. The weathered gravels of the Pensauken Formation are arkosic, containing weathered crystalline and metamorphic rocks, sandstones and shale, as well as quartz, quartzite, and chert (Owens and Minard 1979). Overlying Quaternary deposits of Pleistocene age are composed of gravels, greywacke sand, and clayey silt, which probably are, in part, reworked materials from morainal deposits (Owens and Minard 1979).

1.4.2 Hydrogeology

The following sections describe the regional and site-specific hydrogeologic characteristics of the area. This information was originally prepared by the USGS and CDM and presented in the draft RI report for OU1 (CDM 2002c).

1.4.2.1 Regional Hydrogeology

The Potomac-Raritan-Magothy aquifer system is composed of a wedge-shaped sequence of sediments of the Potomac Group and the Raritan and Magothy Formations. These sediments constitute sand and gravel aquifers with intervening silt and clay confining units that thicken and dip from the western edge of the Coastal Plain at the Fall Line toward the southeast (Zapecza 1989). The sediments are of fluvial-deltaic-marginal marine origin (Farlekas et al. 1976), and are indicative of a complex depositional and erosional environment. The basal unit of the Potomac Group lies directly on the erosional, pre-Cretaceous bedrock surface.

Farlekas et al. (1976) divided the Potomac-Raritan-Magothy aquifer system in the Camden County area into five layers described as Upper, Middle, and Lower aquifers separated by two confining units. The Upper aquifer consists of sands of the Magothy Formation, and the Middle and Lower aquifers are composed of sands of the Raritan Formation and Potomac Group. These sediments crop out as thin bands along both sides of the Delaware River in Pennsylvania and New Jersey, and are exposed in the bed of the Delaware River through fluvial dissection and through dredging. Recharge to the aquifer system is primarily through incident precipitation on the outcrop areas and from the Delaware River and surface water bodies where they intersect the aquifer system. In downdip areas to the east, the sediments that compose the Potomac-Raritan-Magothy aquifer system are overlain by successively younger Cretaceous and Tertiary sediments. Thus, the aquifer system is confined over much of its extent, and recharge to downdip areas is through groundwater flow from outcrop areas and leakage from overlying units.

1.4.2.2 Site Hydrogeology

In Pennsauken Township and vicinity, permeable layers of sand and gravel of the Pensauken Formation and Quaternary deposits cap most of the extent of the outcrops of the Cretaceous sediments that form the Potomac-Raritan-Magothy aquifer system (Owens and Denny 1979; Farlekas et al. 1976). Sands and gravels of the Pensauken Formation are believed to have been deposited in a fluvial environment in which a series of down cutting channels were incised into the sediments below (Owens and Minard 1979). The Quaternary deposits grade from gravels and gravelly sand at Trenton to clayey silt at Philadelphia; the variability in these deposits probably represents a change in depositional environment from fluviatile through deltaic to estuarine. The Tertiary and Quaternary surficial units, which are of variable thickness, are hydraulically connected to the underlying Cretaceous sediments and, therefore, are considered to be part of the Potomac-Raritan-Magothy aquifer system. The Potomac-Raritan-Magothy aquifer system receives recharge through surface infiltration of precipitation on the outcrop areas, and from the Delaware River, Pennsauken Creek, and other local surface water bodies that are present in the outcrop areas.

Because of the fluviatile/deltaic depositional environment of the sediments that compose the aquifer system, discontinuities in individual units are common. Throughout the thickness of the Cretaceous sediments, channels have been cut and filled. Thus, major confining units and aquifers can contain either sand lenses that are local water-bearing zones or clay lenses that serve as local confining units. Major confining units also are found to pinch out in some areas. As a result, the hydraulic connections between the sedimentary units are complex.

Hydrostratigraphic Framework

A more detailed structural framework of the five-layer Potomac-Raritan-Magothy aquifer system in Burlington, Camden, and Gloucester Counties (Navoy and Carleton 1995) was built on the regional hydrogeologic framework of the Potomac-Raritan-

Magothy aquifer system in the New Jersey Coastal Plain, defined by Zapecza (1989). Walker and Jacobsen (in press) used geologic and geophysical data from 26 new monitoring wells drilled in 1997 to build on the commonly accepted five-layer aquifer system model described by Farlekas et al. (1976). The previously delineated Middle and Lower aquifers and their intervening confining units were subdivided to account for some of the apparent structural variability of the confining units and aquifers, and to provide additional detail needed for groundwater flow and contaminant transport modeling purposes. The subdivided hydrostratigraphic framework by Walker and Jacobsen (in press) is shown in Figure 1-3, together with the five-layer framework developed by previous investigators. The subdivided framework provides the foundation for the more detailed framework developed during the RI (CDM 2002c).

The interpretation of the hydrostratigraphic framework presented in the RI is consistent with that described by Walker and Jacobsen (in press). The framework defined by the Walker and Jacobson study is based on previous investigations and data collected during the RI, and includes the following significant findings:

- As described previously, the Upper Potomac-Raritan-Magothy aquifer and the underlying confining unit correlate directly with layer A-1 and layer C-1 respectively (Figure 1-3). Layer A-1 contains clay lenses throughout its extent. The clays of confining unit C-1) do not extend throughout the thickness of the unit as a result of cut and fill. C-1 clays are largely absent in the area of well cluster Camden County Water Department (CCWD) MW-1 and cluster Puchack MW-14, where the unit is composed mostly of sands (Figure 1-4). In this area, the sands of the Upper aquifer may be hydraulically connected directly to the sands of the Middle aquifer. Confining unit C-1 is thin and effectively absent in the area near the western edge of the Pennsauken Landfill.

- The Middle aquifer is divided into two sand layers (A-2a and A-2b), separated by a thin, discontinuous confining layer (A-2C1) of variable composition. In the area encompassed by the chromium contaminant plume, cut and fill at the top of the Middle aquifer at well cluster Puchack MW-1 has created about 25 feet of silty clays with lenses of silt, sand, and fine gravel that penetrate layer A-2a and confining unit A-2C1 into a thin (5-foot) sand layer, A-2b. To the east and down dip, layer A-2C1 is of variable composition at well cluster Puchack MW-26 (Figure 1-4); it is composed of silts and sand with some lenses of clay, reflecting another area of cut and fill. Farther down dip, at cluster CCWD MW-1, layer A-2C1 is almost entirely sand.

- The confining unit separating the Middle aquifer layers from the Lower aquifer is subdivided from top to bottom into an upper clay unit, C-2a; an Intermediate Sand layer, C-2AI; and a lower sandy/silty clay unit, C-2b. The Intermediate Sand is physically separated from both the Middle and the Lower aquifers by the confining units C-2a and C-2b, respectively, in most parts of the study area; it is, however, hydraulically connected to both aquifers in several areas. Northwest of the Puchack well field near the Delaware River, both confining units, C-2a and C-2b, pinch out. In an area contained within the contaminant plume in the Intermediate Sand, layer C-2a clays thin from about 28 feet at well cluster Puchack MW-26 to lenses less than 8 feet thick interspersed with sands at well cluster Puchack MW-14 (Figure 1-4). Between these two clusters, at well cluster CCWD MW-1, C-2a becomes a 22 foot silt and clay unit with some fine sand layers. Lower layer C-2b clays thin to lenses less than 2 feet thick interspersed with sands and silts at well cluster Puchack MW-27; the lenses are only slightly thicker (less than 4 feet) at well clusters CCWD MW-1 and Puchack MW-14 (Figure 1-5).

- The Lower aquifer was subdivided into three zones that were differentiated based on distinctive grain-size textures. These zones generally grade into each other; however, in some locations, thin clay layers mark their contacts. The zones were characterized from top to bottom as a silt-clay-sand sequence, a sand-and-gravel zone, and a very coarse gravel zone. These zones were identified in the framework as layers A-3a, A-3b, and A-3c, respectively. Sandy or silty clay lenses, some areally extensive, are common in layer A-3a. Clay lenses occur sporadically in layer A-3b. The gravelly layer A-3c persists throughout much of the study area, but apparently pinches out in the area of the Morris well field, where there is a bedrock high.

- The confining unit beneath the Lower aquifer is referred to as layer C-3, as before, and consists of clays derived from the weathered schist bedrock or the weathered bedrock itself.

Groundwater Levels and Flow

The groundwater levels and flow in the study area are controlled to a large extent by the pumping of groundwater from the Middle and Lower aquifers and recharge from precipitation and from the tide-influenced Delaware River. The spatial and vertical extent to which water levels are affected by recharge and pumping is, in part, a function of the complex hydrostratigraphy described previously. In the study area, these conditions result in variable hydraulic gradients that control the flow of groundwater throughout the aquifer system.

The outcrop of the Upper aquifer, the least used of the Potomac-Raritan-Magothy aquifers in the vicinity of Pennsauken Township, covers a large part of the study area. Unconfined conditions generally prevail in this part of the aquifer. The Upper aquifer is unsaturated in the vicinity of the Puchack well field as a result of the downward movement of water caused by pumping from the underlying, more heavily used aquifers. Where the Upper aquifer is unconfined and saturated, water levels are variable, indicating that, locally, perched conditions may occur (Walker and Jacobsen, in press).

In the Middle and Lower aquifers, groundwater is present under water-table conditions in the outcrop areas and changes gradually to artesian conditions in areas to the southeast where the aquifers are confined. In Pennsauken Township and vicinity, over 98 percent of the groundwater is pumped from the Lower aquifer (Walker and Jacobsen, in press). Most of the recharge in areas closest to the Delaware River reaches the Lower aquifer from the river. Farther to the southeast, proportionately larger amounts of recharge reach the Lower aquifer through vertical leakage from the overlying Middle aquifer. Leakage from the confining units between the major aquifers, including the C-1 confining unit, leads to the unsaturated conditions in the Upper aquifer described above.

A comparison of the heads in the Upper aquifer with those in the underlying Middle aquifer indicates the presence of a downward hydraulic gradient between these aquifers; however, data for the Upper aquifer are limited and therefore are insufficient to make a direct comparison of heads at a common location.

Based on the synoptic water-level data, the heads in the Middle and Lower aquifers indicate a downward hydraulic gradient between these aquifers. Heads in the Intermediate Sand and the Lower aquifer are similar; thus, at most locations where water-level measurements were made in wells in both units, a small downward hydraulic gradient was usually observed. The head difference between the Intermediate Sand and the Lower aquifer is so small that slight head changes in either of these units appear to cause an occasional reversal in the hydraulic gradient.

Groundwater in the Upper, Middle and Lower aquifers generally flows to the southeast, but well fields in the study area control local groundwater flow directions. The lowest potentiometric heads in the aquifer system are centered on large cones of depression in the Upper, Middle, and Lower aquifers about six miles southeast of the study area (Lacombe and Rosman 1997). The Middle aquifer is little used in the study area; therefore, its potentiometric surface (Figure 1-6) reflects the combined effects of the regional cones of depression in the Middle and Lower aquifers (Lacombe and Rosman 1997) and the downward hydraulic gradient between the Middle and Lower aquifers. Local areas of depressed water levels in the Lower aquifer (Figure 1-7) are centered at well fields operated by the City of Camden and the Merchantville-Pennsauken Water Supply Commission.

In the Middle aquifer the orientation of the potentiometric contours has changed little since March of 1998 (Walker and Jacobsen, in press). Accordingly, the direction of groundwater flow generally remains in a southeasterly direction as illustrated by the flow arrows shown in Figure 1-6. Flow directions in the vicinity of the Puchack well field are generally in a more easterly direction. In this area, and to the north, groundwater flow direction varies locally from northeasterly to easterly to southeasterly as influenced by the local recharge conditions and losses from vertical leakage induced by nearby pumping in the Lower aquifer. Water levels also indicate some influence from pumping in the underlying Lower aquifer in the up-dip areas near the active Morris and Delair well fields (Figure 1-4). These well fields are generally located in the outcrop of the Middle aquifer but are screened in the Lower aquifer.

In the Lower aquifer, local flow directions have changed in the vicinity of the Puchack well field since pumping ceased in 1998. Although the effects of pumping from the National Highway wells and those at the Morris and Delair well fields can be seen in current water levels, flow in the vicinity of the Puchack well field generally has shifted more to the southeast rather than toward that well field (Figure 1-7). As with the Middle aquifer, the increased density of wells also affords a more detailed look at the groundwater flow directions locally. Groundwater flow in the down dip areas of the Lower aquifer is generally unchanged since 1998.

1.5 Site History

Groundwater contamination, consisting of TCE, 1,2-DCA, PCE, and chromium, was first detected at Puchack Well No. 6 in the early 1970s. Further sampling indicated the presence of hexavalent chromium (with relatively high solubility and toxicity) and trivalent chromium (with relatively low solubility and toxicity) at concentrations above the EPA MCL of 100 µg/L. In 1978, chromium was detected in Puchack Well No. 5. In 1982, chromium was detected in Puchack Well Nos. 2, 3, and 7. Historical chromium concentrations ranged from 1,500 to 3,000 µg/L. In 1984, general use of the well field was terminated. However, NJDEP allowed the continued controlled pumping of Well No. 1 to act as a temporary plume containment measure. The pumping was terminated in 1998 due to concerns about the requirements of treating water withdrawn from the well.

In 1986, CDM investigated the chromium contamination in the well field on behalf of the NJDEP. CDM found chromium concentrations up to 1,000 µg/L, mercury concentrations up to 5.8 µg/L, and TCE concentrations up to 70 µg/L.

In 1992, CDM was tasked by NJDEP to conduct a pilot scale treatability study of the contaminated groundwater at the Site, which had an average hexavalent chromium concentration of 2,500 µg/L. Over a two month period, 1.7 million gallons of groundwater was treated. The pilot scale system demonstrated that chromium levels in treated water below 50 µg/L could be consistently achieved, and levels below 20 µg/L were reached for most of the pilot test conditions using ferrous iron as the reducing agent. Groundwater withdrawn from the nearby Morris well field, which contained 30 to 45 milligrams per liter (mg/L) of iron, was considered as a potential source of ferrous iron.

In March of 1996, NJDEP collected samples from the Puchack supply wells and monitoring wells. Analytical results indicated chromium, mercury, and TCE in all of the supply wells.

In the early 1980s, NJDEP identified several contaminated sites in Pennsauken Township as potential chromium source areas for the Site; these included SGL Modern Hard Chrome Service (SGL Chrome), King Arthur, Mercon, and Supertire, among others. The SGL Chrome site was used for chromium plating and is currently a parking lot with no historical structural features remaining.

In 1997, the USGS, in cooperation with the NJDEP, initiated a field investigation of the groundwater contamination of the Pennsauken Township area. Groundwater contaminated with chromium was found in the Middle aquifer in two isolated areas, one located at the SGL Chrome property and one located to the north near the Pennsauken Landfill. (Groundwater contamination at the Pennsauken Landfill is not related to the Puchack Site.) The SGL Chrome site is also the location of the highest hexavalent chromium groundwater contamination in the Middle aquifer at 11,540 µg/L. Based on sampling results from the 1997-98 investigation, total chromium levels in the Middle aquifer, Intermediate Sand, and Lower aquifer generally ranged from non-detect to 10,250 µg/L, from 2 to 9,070 µg/L, and from non-detect to 3,454 µg/L, respectively.

The findings of the 1997-1998 sampling indicated that VOC contamination was more widespread, with multiple sources, and was present in pockets near contaminant source areas. VOC contamination in the three aquifers has commingled with the chromium plume and is generally larger in size. TCE, with estimated concentrations up to 140 µg/L, was the most frequently detected VOC. Other frequently detected VOCs included 1,1,1-TCA with estimated concentrations up to 12,500 µg/L; 1,1-DCE with estimated concentrations up to 3,580 µg/L; PCE with estimated concentrations up to 280 µg/L; and benzene with estimated concentrations up to 1,200 µg/L.

The Puchack Well Field Site was placed on the National Priorities List (NPL) on March 6, 1998.

EPA conducted an RI for OU1 at the Site. USGS provided direction for the OU1 RI field program. The OU1 field program included the completion of soil borings, subsurface soil and aquifer sediment sampling, downhole geophysical surveys, monitoring well installation and development, groundwater sampling, and synoptic and continuous water level measurements. The following activities were completed during the OU1 RI field program:

- A total of 16 borings were advanced using hollow stem auger methods at selected potential source areas. A total of 60 soil and geologic sediment samples were collected for chemical analyses.
- A total of 28 borings were advanced using mud rotary drilling methods.
- A total of 47 subsurface soil and geologic sediment samples (and 6 duplicate samples) were collected from 43 monitoring well borings for chemical analysis.
- Downhole geophysical logging was conducted by the USGS at 27 locations.

- A total of 64 monitoring wells were installed and developed at 27 clusters during the RI field investigation.
- Thirteen groundwater samples from 13 monitoring and water supply wells were collected for chemical analyses from October 1999 to December 1999.
- 135 groundwater samples from 88 monitoring wells were collected for chemical analyses from August 2000 to April 2001.

1.6 Objectives and Scope

The objective of the sediment and groundwater sampling is to collect samples required for the treatability studies of in situ remedial technologies being conducted by PNNL. The following field activities will be performed to collect these samples:

In Situ Remedial Technology Pilot Test Site (at the old Mercon facility, Figure 1-2):

- Drilling - advance 2 borings using sonic drilling techniques
- Sediment Sampling - collect sediment samples, package and ship under anoxic and aseptic conditions for analysis at PNNL of physical, geochemical, and microbial parameters
- Groundwater Sampling - collect discrete-depth groundwater samples for the following analyses: Low Detection Limit (LDL) VOCs through CLP, trace metals through the CDM subcontract laboratory, and ferrous iron through PNNL
- Groundwater Screening - collect discrete-depth groundwater samples for onsite field screening of ferrous iron and hexavalent chromium
- Well Installation - install two monitoring wells, MW-36 and MW-37, in the Intermediate Sand (layer C-2AI)
- Monitoring Well Sampling - collect water samples from both new monitoring wells

Downgradient Plume Attenuation Study Area:

- Drilling - advance two borings, D1 and D2, using sonic drilling techniques
  - D1 will be located in the vicinity of monitoring well clusters Puchack MW-12 and cluster Puchack MW-30 (Figure 1-4)
  - D2 will be located on the high school property, about 0.75 miles east of D1
  - Both borings will be abandoned after completion
- Sediment Sampling - collect sediment samples, package and ship under anoxic conditions for analysis at PNNL of physical and geochemical parameters
- Groundwater Sampling - collect discrete-depth groundwater samples for the following analyses: trace metals through the CDM subcontract laboratory and ferrous iron through PNNL
- Groundwater Screening - collect discrete-depth groundwater samples for onsite field screening of ferrous iron and hexavalent chromium
- Monitoring Well Sampling - collect a water sample from one monitoring well, such as MW-30I, downgradient of the In Situ Remedial Technology Pilot Test Site (Figure 1-4)

Section 2

Section Two

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Section 2
Project Organization and Responsibility

2.1 Overview

The organization for the Puchack Well Field treatability study (Figure 2-1) is designed to provide a clear line of functional and program responsibility and authority supported by a management control structure. The control structure involves the RAC II Program Manager and the CDM SM. Overall responsibilities include:

- Establishing clearly defined lines of communication and coordination
- Monitoring project budget and schedule
- Providing progress reports
- Quality control
- Health and safety
- Project coordination

The following personnel are assigned to this project:

Overall Project Coordination (SM)	Frank Tsang, PE
Procurement/Subcontract Management	Vernon Wimberly
Procurement Specialist	Sandra Dietrich
Corporate Health and Safety Officer	Chuck Myers, CIH
Senior Geologist	Susan Schofield, PG
Treatability Study Task Leader	John Dougherty
Field Team Leader (FTL)	Noel Anderson
Field Geologist (FG)	Seth Richardson
Field Scientist 1 (FS 1)	Allison Perry
Field Scientist 2 (FS 2)	Melissa Reindl
Site Health and Safety Coordinator	Noel Anderson
Analytical Services Coordinator (ASC)	Scott Kirchner, CHMM
Regional Quality Assurance Coordinator (RQAC)/Project Chemist	Jeniffer Oxford
RAS Laboratory Analyses	EPA CLP Laboratory
RAS Laboratory QC	EPA CLP Laboratory
RAS Data Validation	Environmental Service Assistant Team (ESAT)
Non-Ras Laboratory Analyses	CDM Subcontract Laboratory
Non-RAS Laboratory QC	CDM Subcontract Laboratory
Non-RAS Data Validation	CDM
Data Processing Activities	Walter Jaslanek
Data Processing QC	Melinda Olsen
Quality Assurance Manager	George DeLullo

RQAC Designee	Sharon Budney
Technical System Audits	Jeniffer Oxford or designee
Internal System Audits	Jeniffer Oxford or designee
Performance Audits	EPA or CDM
Receipt of CLP Analytical Data	Scott Kirchner, CHMM
Receipt of non-CLP Analytical Data	Scott Kirchner, CHMM
Data Validator	Tony Uwakwe
Database Manager	Walter Jaslanek
Draftsperson	Denise Waldron

2.2 Responsibility

The SM, Mr. Frank Tsang, PE, is responsible for coordinating the work effort with the EPA RPM, Ms. Michelle Granger, and is directly responsible for the technical content, schedule adherence, subcontract management, and financial management of the work assignment.

The Treatability Study Task Manager, Mr. John Dougherty, will be responsible for all aspects of the field investigation including staffing and physical resource requirements, coordination of subcontractors, coordination of sample analysis, interpretation and presentation of data collected, and the preparation of reports. He works closely with the SM to ensure that the field investigation generates the proper type and quantity of data for use in the development, screening, and evaluation of remedial alternatives.

The FTL, Ms. Noel Anderson, is directly responsible for the coordination and execution of all field activities outlined in this QAPP. It is her responsibility to ensure that all field tasks are conducted in strict compliance with this QAPP. All RAC II field personnel will report directly to Ms. Anderson on all matters relating to the field investigation. Ms. Anderson also will be responsible for sampling QC, as well as ensuring that all paperwork is completed correctly, that duplicates and blanks are collected, and that samples are stored, labeled, and shipped in accordance with the applicable requirements described in this QAPP.

Mr. Scott Kirchner, the CDM ASC, is responsible for obtaining laboratory space for samples sent to EPA's Contract Laboratory Program (CLP), providing project staff with required sampling documentation forms and CLP numbers, coordinating any required performance evaluation samples, overseeing contract compliance screening, tracking the data packages through the EPA Division of Environmental Science and Assessment (DESA) validation process, and providing the sampling results to the CDM SM. The ASC will communicate with project personnel and the RAC II RQAC regarding quality problems identified during these activities. Regarding the procurement of subcontractor laboratory services for non-routine analytical services analysis, the ASC will provide assistance to the project staff in accordance with the Analytical Services Delivery Plan.

The Corporate Health and Safety Manager, Mr. Chuck Myers, certified Industrial Hygienist (CIH), is responsible for the review and approval of the project-specific HSP that governs the field activities outlined in this QAPP (submitted under a separate cover to this QAPP).

The Site Health and Safety Coordinator, Ms. Noel Anderson, or designee, is responsible for ensuring that the protocols specified in the HSP are carried out during field activities. She will also ensure that copies of the HSP and the CDM Health and Safety Manual are maintained at the site at all times. She is responsible for conducting daily safety meetings and, based on existing site conditions, upgrading or downgrading of the level of personal protection in accordance with the HSP. The Health and Safety Coordinator must also give an overview of the HSP to all field personnel and have them sign it. She will contact the Site Health and Safety Manager if any questions or issues, that she cannot address, arise during field activities.

Ms. Jeniffer Oxford, the RQAC, is responsible for quality assurance audits (technical system audits) and correction of any noncompliance discovered. She is responsible for an internal system audit of project files. A technical and/or internal system audit may be performed during this assignment (see Section 6.16). She is also responsible for participation in field planning meetings, QA review, and approval of any measurement reports, and QA review of procurement documents and the project work plan.

Samples for routine analytical services (RAS) LDL VOCs will be analyzed through the EPA CLP; EPA will be responsible for validation of CLP data. Trace metals analysis will be performed by an analytical laboratory under subcontract to CDM; CDM will be responsible for the validation of subcontract non-RAS data. Remaining analyses will be performed and validated by PNNL. As per the Field and Analytical Services Teaming Advisory Committee (FASTAC) criteria adopted by EPA Region 2, CLP was considered for trace metals analysis; however, in order to ensure that all analytes are analyzed in one laboratory using one method and that the required reporting limits are met, a subcontract laboratory was eventually chosen for the trace metals analysis. All validation activities will be performed according to Region II data validation protocols, as described in Section 6.12.

Data management activities will be performed by Mr. Walter Jaslanek, who will use an appropriate database program and standard industry spreadsheet software programs to manage all data related to the sampling program. He is responsible for coordinating the entry of data from the laboratory into a usable format (i.e., tables, graphics, spreadsheets, etc.). During the data entry process, 100 percent of the data entered will be QC checked. Ms. Melinda Olsen is responsible for data processing QC and will provide the QC check on a minimum of ten percent of the tabulated data.

2.3 Subcontractors

The services of the following subcontractors will be procured for this project.

- A New Jersey state licensed surveyor to map the locations and elevations of all sampling points and monitoring wells, and subsequently locate these points on the site base map.
- A driller capable of drilling and sampling soil borings and installing monitoring wells using sonic drilling techniques.
- An investigation-derived waste (IDW) subcontractor to remove and properly dispose of all wastes (e.g., waste soils, liquids, solids, and personal protective equipment).
- An analytical laboratory subcontractor to perform aqueous trace metals analysis.

All subcontractor procurement packages will be subject to CDM's technical and quality assurance reviews. Evidence of review of any subcontractor laboratory Quality Assurance Plan or Quality Management Plan will be submitted to EPA.

2.4 Documentation and Records

This QAPP will be available to all CDM field personnel during sampling operations for use as a reference. Any significant changes to the QAPP will be made in writing and sent to EPA for approval. Minor deviations to the QAPP will be communicated verbally to the EPA RPM. All field changes will be documented on FCR Forms (Figure 2-2) and approved by the FTL, and the CDM SM. The EPA RPM will be informed of the change by e-mail. Copies of FCR forms will be distributed to the RQAC and to all field personnel.

All reports generated during this assignment are subject to internal quality control checks and by approved reviewers. Measurement reports are subject to internal QC checks and technical and QA review by approved reviewers. Review procedures are outlined in the CDM RAC II Quality Management Plan and incorporated by reference into the Puchack Well Field Site Work Plan.

CDM will maintain a document control system that is linked to the RAC Management Information System (RACMIS). The document control system assigns a unique number to each document. The system provides a verification database to ensure consistency in such items as work assignment number and project name.

All project documentation will be maintained in the project files by the CDM SM until the project undergoes final closeout procedures. Copies of all deliverables submitted to EPA will be maintained in the RAC II document control files. In accordance with the RAC II contract, documents will be stored by CDM for ten years following the final closeout of the RAC II program.

2.5 Special Training Requirements or Certification

CDM field personnel will have the 40 hour Hazardous Waste Operations Training, as required by the Occupational Health and Safety Act (OSHA), and medical certification, as described in the CDM Health and Safety Program Manual. Additionally, if hazardous materials are moved off site, compliance with the training requirements for shipping hazardous materials, as mandated by the Department of Transportation (DOT) in association with the International Air Transportation Association, will be required. Training documentation will be kept in the project files on site. Annual refresher training and medical monitoring will be required as described in the CDM Health and Safety Program Manual (CDM 2000). A field planning meeting will be conducted at the start of field activities. No other special training or certification is necessary for this project.

2.6 Reports to Management

The RAC II QMP outlines the QA system established to meet the requirements defined above. Project status is provided through monthly progress reports prepared by the CDM SM for submission to the CDM RAC II program management, and EPA project and program management. Office, technical, and management system audit reports will be provided to CDM and EPA project, program, and QA management as specified in the RAC II QMP.

Measurement reports will include QA sections that provide information regarding data quality, including adherence to QC procedures, ability to meet project DQOs, and any qualifications to the data. The measurement reports will include the data quality assessment and discuss solutions to remedy any problems identified in the sampling and analytical system. A discussion on audit reports is provided in Section 6.16.

The frequency and types of audits are shown on Table 9-1 of the RAC II QMP (CDM December 2002c). Audit reports will document whether the audited activities were performed in compliance with this QAPP and all other governing documents.

3 Section Three

Section 3

Section 3
Schedule and Site Management Plan

3.1 Schedule

A draft schedule for the treatability study is submitted with this QAPP (Figure 3-1). After EPA approval of this QAPP and procurement of the required subcontractors, treatability study field activities can begin. One to two months lead time is required to complete the procurement and mobilization of the drilling services, analytical laboratory, IDW, and surveying subcontractors. Prior to sampling, a minimum of two weeks lead time is required to schedule CLP laboratories for RAS analyses. When the CLP RAS laboratories have been identified by the Contract Laboratory Analytical Support Services (CLASS), samples can be collected.

3.2 Access

EPA shall be responsible for obtaining all necessary access agreements for properties where work will be performed. This includes all agreements necessary to perform the work described in this document.

Prior to initiating intrusive activities, CDM will establish work zones to ensure the health and safety of the field team members and to prevent the offsite migration of contaminants as a result of field activities. CDM will establish the following work zones:

- Exclusion Zone: The exclusion zone is defined as the area where intrusive activities are conducted. The zone will be clearly flagged and delineated. No personnel will be allowed into the exclusion zone without the proper personal protective equipment, site training, and medical authorization.
- Contaminant Reduction Zone: A contaminant reduction zone will be established between the exclusion and support zones. Decontamination of personnel and equipment will occur in this area.
- Support Zone: The support zone will be established in an uncontaminated area of the site. Sanitary facilities, safety and support equipment, and the field trailer will be located in this area. Site operations and site access will be controlled from this work zone.

3.3 Waste Disposal

IDW staging and storage areas will be identified during the mobilization phase of the field activities. In selecting the location of the drum storage and staging areas, consideration will be given to logistics (the location of the area with respect to the points of waste generation); safety and stability (the location will be stable and will not impact the safety of workers); and interference with site activities. IDW, including liquid waste (e.g., purge water from wells), waste decontamination fluids, disposal material related to site activities (e.g., used Tyvek coveralls and gloves), and all semi-solid wastes (e.g., drilling muds, drill cuttings) will be contained and placed in the designated storage area, unless it is able to be disposed of on site. Stored wastes will be segregated by matrix and type (e.g., solid-soil cuttings, liquid-decontamination fluids, solids-personal protective equipment) in order to facilitate analysis and disposal. Containers in the storage area will be labeled and numbered, and a log of their contents will be maintained on site. All IDW will be disposed of by the waste disposal subcontractor.

Several volatile fuels, solvents, and gases will be required in small quantities for the field investigation. In order to minimize the potential for cross contamination of sample containers and analyte-free water, fuels, solvents, and gases will be stored separately. Waste solvents also will be disposed of by CDM's waste disposal subcontractor.

Section 4

4 Section Four

Section 4
Sampling Program Rationale

The field program for the OU1 treatability study has been developed to collect the required samples for treatability studies of in situ remedial technologies being considered for deployment at the Site. The sampling program rationale is based on the requirements of the PNNL treatability study as presented in their Sampling and Analysis Plan (PNNL 2004). EPA has tasked CDM with implementing the sample collection program. To do this, CDM will advance soil borings, collect subsurface sediment and groundwater samples, install two monitoring wells, and sample three monitoring wells to support the study objectives described in Section 1.6. These field investigation activities have been developed to meet DQOs, as discussed in Section 4.1.

The primary objective of the bench scale treatability studies is to determine the feasibility of using an abiotic or biotic technology to create a subsurface reduced zone in the aquifer that will reduce and permanently immobilize hexavalent chromium species. A secondary objective of the treatability study is to assess the technologies effectiveness for the treatment of VOC contamination (i.e., TCE). In addition, natural processes such as chromate adsorption and reduction will be assessed with Puchack aquifer sediments for two reasons: 1) to determine how much hexavalent chromium mass may be immobilized naturally in the subsurface with no treatment; 2) quantify the effects of these natural processes on in situ reductive treatment.

4.1 Data Quality Objectives

The DQO process is a seven-step planning mechanism based on the scientific method and designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for their intended application. DQOs are qualitative and quantitative statements derived from the outputs of each step of the DQO process that:

- Clarify the study objective
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions under which to collect the data
- Specify acceptable levels of decision errors to be used as the basis for establishing the quantity and quality of data needed to support the decision

The goal of the DQO process is to "help assure that data of sufficient quality are obtained to support remedial response decisions, reduce overall costs of data sampling and analysis activities, and accelerate project planning and implementation."

The DQO process consists of seven steps; the output from each step influences the choices that will be made later in the process. These steps include:

Step 1: State the problem
Step 2: Identify the decision
Step 3: Identify the inputs to the decision
Step 4: Define the study boundaries
Step 5: Develop a decision rule
Step 6: Specify tolerable limits on decision errors
Step 7: Optimize the design

PNNL specified the sampling requirements and methods to meet DQOs for the treatability study. CDM will conduct field activities accordingly to ensure that the required samples are collected and analyzed. A summary of the DQO process for the treatability study field activities is presented in Table 4-1.

4.2 Boring, Drilling, and Testing

Boring, drilling, and testing activities for the treatability study field activities include advancing four deep borings using sonic drilling techniques, and collecting subsurface sediment samples, as described in the following sections.

4.2.1 Deep Borings/Sediment Sampling

CDM will advance up to four deep borings and collect subsurface sediment samples in order to obtain in situ physical, geochemical and microbiological data for the treatability study. Borings will be advanced to approximately 250 to 300 feet below ground surface (bgs) using sonic drilling techniques. Subsurface sediment samples will be collected during borehole advancement, from designated hydrostratigraphic layers using 2-foot by 4-inch diameter split spoons outfitted with Lexan™ liners.

4.2.1.1 In-Situ Remedial Technology Pilot Test Site Borings

Two borings, designated MW-36 and MW-37, will be advanced to approximately 250 feet bgs at the in situ remedial technology pilot test site (Mercon property) as shown in Figure 4-1. The boring locations will be adjusted based on field conditions, access, and the feasibility of delivering the inert gas (liquified argon [cryogenic], mole percent >99% argon, <1% impurities [CAS No. 7440-37-1]) to the location. At each boring, approximately 20 sediment samples will be collected under anoxic and aseptic conditions from designated hydrostratigraphic layers. The exact depth interval at which samples will be collected will be based on observations of the hydrostratigraphic layers by the CDM field geologist. Table 4-2 summarizes the hydrostratigraphic layers to be sampled, and the number of samples to be collected within each layer.

Each Lexan liner will be cut into 6-in long sections prior to loading it into the split-spoon sampler. For each sample, one 6-inch core section will be collected for geochemical analyses, one 6-inch core section will be collected for microbial analyses, and one 6-inch core section will be collected for physical property analyses (grain size distribution, bulk density, and porosity). Remaining core sections may be archived with the USGS for future study. See Table 4-3 for a summary of the sediment sampling analytical program.

To maintain the integrity of the sediment core samples for geochemical and microbial analysis, samples will be removed from the split-spoon sampler, and capped under anoxic and aseptic conditions. In cases where poor recovery limits the number of representative core sections, priority will be given to the collection of geochemical and microbial samples. Samples for physical property analyses do not require adherence to the anoxic or aseptic sampling protocol. However, since all analyses will be collected from the same split spoon, the physical property samples will also be collected using these more rigorous protocols. The only requirement for physical property samples is that core sections must be completely full of sediment.
All sediment samples will be collected following procedures outlined in Section 5.1.1, and sent to PNNL for analysis.

4.2.1.2 Downgradient Plume Attenuation Study Borings

Two borings, designated D1 and D2, will be advanced to about 300 feet bgs at the downgradient plume attenuation study area, as shown in Figure 4-1. The boring locations will be adjusted based on field conditions, access, and the feasibility of delivering the inert gas (liquified argon [cryogenic], mole percent >99% argon, <1% impurities [CAS No. 7440-37-1]) to the location. At each boring, approximately 20 sediment samples will be collected under anoxic conditions from designated hydrostratigraphic layers, as shown on Table 4-2. The exact depth interval at which samples will be collected will be based on observations of the hydrostratigraphic layers by the CDM field geologist. Table 4-2 summarizes the hydrostratigraphic layers to be sampled, and the number of samples to be collected within each layer.

Each Lexan liner will be cut into 6-in long sections prior to loading it into the split-spoon sampler. For each sample, one 6-inch core section will be collected for geochemical analyses and one 6-inch core section will be collected for physical property analyses (grain size distribution, bulk density, and porosity). Additional core sections may be archived with the USGS for future study. See Table 4-3 for a summary of the sediment sampling analytical program.

To maintain the integrity of the sediment core samples collected for geochemical analysis, samples will be removed from the split-spoon sampler and capped under anoxic conditions. For cases where poor recovery limits the number of representative core sections, priority will be given to the collection of geochemical samples. Samples for physical property analyses do not require adherence to the anoxic sampling protocol. However, since all analyses will be collected from the same split spoon, the physical property samples will also be collected using these more rigorous protocol. The only requirement for physical property samples is that core sections must be completely full of sediment.

All sediment samples will be collected following procedures outlined in Section 5.5.1, and sent to PNNL for analysis.

4.3 Hydrogeological Assessment

The hydrogeological assessment at the Site will include discrete-interval groundwater sampling, monitoring well installation and development, and monitoring well sampling, as described in the following sections.

4.3.1 Discrete-Depth Groundwater Sampling

Discrete-depth groundwater samples will be collected at the two in situ remedial technology pilot test site borings and the two downgradient plume attenuation study borings to provide a baseline for the analytes, to determine the effectiveness of the in situ remedial technology, and to determine if analytes will interfere with the planned in situ technologies. Groundwater samples will be collected from designated hydrostratigraphic layers, as the borehole is advanced. The exact depth interval at which samples will be collected will be based on lithologic observations of hydrostratigraphic layers, and decided by the CDM field geologist. Table 4-2 summarizes the hydrostratigraphic layers to be sampled, and the number of samples to be collected within each layer. Table 4-3 summarizes the groundwater field screening and analytical program.

Sonic drilling techniques will be used to advance an 8-inch casing sleeve to the bottom of the desired groundwater sample interval. A screened drive point will be lowered through the casing to the bottom of the interval, and the casing sleeve will be withdrawn to approximately 20 feet above the sample interval, allowing the formation to collapse around and above the screen. Samples will be collected using either a 2-inch or a 4-inch diameter electric submersible pump with a variable speed motor; the larger diameter pump will only be used if large amounts of sediment are present within the aquifer, preventing the use of a smaller diameter pump. The pump will be lowered into the drive point casing and the interval will be purged and sampled. The volume of water to be purged prior to sampling will be determined by field personnel at the time of sampling and will be based on stabilization of monitored field parameters and the time required to obtain an acceptable turbidity level. Field parameter measurements will include DO, pH, ORP, temperature, turbidity, and conductivity. Section 5.6.1 presents the procedures for the discrete-depth groundwater sampling activity.

4.3.1.1 In Situ Remedial Technology Pilot Test Site Borings

Ten discrete-depth groundwater samples will be collected at each boring for laboratory analysis of LDL VOCs (CLP), trace metals (including sodium, magnesium, potassium, calcium, aluminum, chromium, manganese, iron, nickel, copper, zinc, arsenic, selenium, molybdenum, silver, cadmium, tin, antimony, barium, lead, and uranium) (CDM subcontract laboratory), and ferrous iron (PNNL), as shown in Table 4-2. Note that samples for LDL VOCs are only collected at eight of the ten samples from the two boring in the in situ remedial technology pilot test site. All samples will be analyzed using the most current EPA-approved methods. In addition, CDM will also collect samples for onsite field screening of hexavalent chromium and ferrous iron. Note that *two* ferrous iron samples will be collected per location ; one for laboratory analysis at PNNL and one for onsite field screening. Frrous iron samples will be sent to PNNL for analysis using a PNNL-specific method for use in the treatability study. Ferrous iron samples will also be analyzed in the field and the results used to check dissolved oxygen measurements (ferrous iron should only be present when dissolved oxygen is low) and to supplement PNNL's laboratory analytical results. Field measurements [dissolved oxygen (DO), oxidation reduction potential (ORP), pH, temperature, conductivity, and turbidity] will also be collected in the field and recorded in the field logbook. Table 4-3 summarizes the groundwater field screening and analytical program. Table 4-4 summarizes the QA/QC sampling requirements. See Table 4-5 for a summary of analytical procedures for the discrete-depth groundwater samples.

4.3.1.2 Downgradient Plume Attenuation Study Area Borings

At each of the two downgradient plume attenuation study area borings, D1 and D2, ten discrete-depth groundwater samples will be collected for laboratory analysis of trace metals (CDM subcontract laboratory) and ferrous iron (PNNL), as described in Table 4-2. In addition, as noted above, CDM will collect samples for onsite field screening of hexavalent chromium and ferrous iron. Field measurements (DO, ORP, pH, temperature, conductivity, and turbidity) will also be collected in the field and recorded in the field logbook. Table 4-3 summarizes the groundwater field screening and analytical program. Table 4-4 summarizes the QA/QC sampling requirements. See Table 4-5 for a summary of analytical procedures for the discrete-depth groundwater samples.

4.3.2 Monitoring Well Installation

After drilling and sampling activities are completed at the in situ remedial technology pilot test site borings, CDM will install permanent monitoring wells in the two borings to monitor groundwater quality at the site. Wells will be installed through the casing used during sonic drilling. CDM anticipates that as the borings are advanced a temporary casing will set, using rotasonic drill casing, at about 140 feet bgs. The temporary casing will be set into layer C-2a to seal off the underlying Intermediate aquifer (C-2AI) from any overlying contaminated groundwater. After the temporary casing is set a hydrostatic test will be conducted to ensure a good seal. Then rotasonic drilling will continue to depth. CDM estimates that the wells will be screened from about 160 to 170 feet bgs. As the borehole backfill is placed, the temporary casing will be withdrawn.

Monitoring wells will be constructed of 4-inch diameter polyvinyl chloride (PVC) casing and screen. Wells will include a 5 or 10-foot long, No. 10-slot PVC screen and a 5-foot sump. Monitoring wells will be installed in accordance with NJDEP requirements and CDM SOPs. CDM personnel will perform field oversight and health and safety monitoring during all well installation activities. Section 5.6.2 of this QAPP details the monitoring well installation procedures.

4.3.3 Monitoring Well Development

Monitoring well and piezometer installation will not be considered complete until the wells have been fully developed. Well development will be performed to remove silt from the well screen and sand pack and to provide a good hydraulic connection between the well and the aquifer materials. Well development procedures are described in Section 5.6.3 of this QAPP.

4.3.4 Monitoring Well Sampling

Following the installation and development of the two monitoring wells at the in situ remedial technology pilot test site, groundwater samples will be collected from the two newly-installed monitoring wells and one existing monitoring well located outside of the chromium plume. The existing monitoring well will be in the downgradient plume attenuation study area and will be completed in either the C-2AI or A-3a hydrostratigraphic layer (Figure 1-5). This third well location should be in the vicinity of one of the selected downgradient borehole locations (e.g., MW-30) (Figure 4-1). Monitoring wells will be purged and sampled using a 2-inch diameter submersible electric pump with a variable speed motor, following an EPA-approved low-flow, minimal drawdown sampling procedure, as described in Section 5.6.4 of this QAPP. The site-specific low-flow procedure is provided as Appendix A.

Samples from three monitoring wells will be collected for laboratory analysis of LDL VOCs (CLP), trace metals (sodium, magnesium, potassium, calcium, aluminum, chromium, manganese, iron, nickel, copper, zinc, arsenic, selenium, molybdenum, silver, cadmium, tin, antimony, barium, lead, and uranium) (CDM subcontract laboratory), and ferrous iron (PNNL). All samples will be analyzed using the methods outlined in Table 4-3. In addition, CDM will also collect samples for onsite field screening of hexavalent chromium and ferrous iron. Note that *two* ferrous iron samples will be collected; one for laboratory analysis at PNNL and one for onsite field screening. Field measurements (DO, ORP, pH, temperature, conductivity, and turbidity) will also be collected in the field and recorded in the field logbook. Table 4-3 summarizes the groundwater field screening and analytical program. Table 4-4 summarizes the QA/QC sampling requirements. See Table 4-5 for a summary of analytical procedures for the discrete-depth groundwater samples.

These well locations will also be used to provide larger volumes of groundwater for the planned bench scale treatability testing. During the monitoring well sampling activities, CDM will collect approximately 10 liter (L) (in 1 or 2 L bottles) of chromium contaminated groundwater from one of the two pilot test site wells, and approximately 30 L of uncontaminated groundwater from the downgradient well (10 L in 1 or 2 L bottles and the remaining 20 L in larger carboys if advantageous). These groundwater samples will be sent to PNNL.

4.3.5 Topographic Survey

After sampling activities are completed, the location and elevation of all soil borings and newly installed monitoring wells will be surveyed by a surveyor licensed by the State of New Jersey under subcontract to CDM.

4.4 Analytical Procedures

Table 4-3 summarizes the number of samples and associated analytical parameters for all media that will be sampled during the treatability study. Groundwater samples for low detection limit VOCs will be analyzed in accordance with the most current EPA CLP statement of work for low concentration organics (OLC03.2). Groundwater samples for trace metals will be analyzed by CDM's analytical laboratory subcontractor. Aqueous ferrous iron samples will be analyzed by PNNL. All sediment samples will be analyzed by PNNL. The trace metals analysis is being subcontracted to ensure that all analytes are measured in one laboratory using one method and that the required reporting limits are met. PNNL is performing the ferrous iron analysis at their laboratory because this is the best way to meet the data quality objectives for the project.

Quality control samples will be collected in addition to the environmental samples discussed below. The number and type of quality control samples will be in accordance with the EPA Region II CERCLA QA Manual (EPA 1989). A summary of the proposed QA/QC samples are presented in Table 4-4. Table 4-5 presents a summary of laboratory analytical methods, containers, sample preservation, and sample holding times.

CLP LDL VOC procedures are outlined in the relevant EPA SOW. For non-RAS trace metals parameters, specific and detailed sample analysis protocols are defined in SW-846 and additional QA/QC procedures will be identified in the subcontract statement of work. Documentation of subcontract laboratory QA procedures will be requested as part of the laboratory technical response to any bid package. CDM will perform a thorough technical and quality review of the laboratory submittal prior to awarding the subcontract. Upon review and acceptance of the documents, CDM will submit to EPA written evidence of the review and approval in the form a signed checklist. Upon review and acceptance of the documents, CDM will submit copies to EPA when requested.

4.4.1 Sample Identification and Tracking

A coding system will be used to identify each sample collected for laboratory analysis. This coding system will provide a tracking record to allow retrieval of information about a particular sample and ensure that each sample is uniquely identified. Each sample is identified by a unique code which indicates the sample type, sample number, and sample depth. Sample identifications will consist of the following:

- Sample type and location number
- Hydrostratigraphic layer identification

- Sample matrix identifier
- Sample interval depth identifier

For example, MW37-C2AI-A-C. The sample identification codes are discussed in the following sections.

4.4.2 Sample Type and Location Number

All sediment and groundwater environmental samples collected during field activities will begin with the prefix "MW" (for monitoring well), followed by a monitoring well location identification number and then a dash (i.e. MW37-) or "D" for downgradient boring.

4.4.3 Sample Layers

The sample type and location number will be followed by a three- to four-character alphanumeric identifier to designate the hydrostratigraphic layer in which the sample was collected, followed by a dash (i.e. C2AI-).

4.4.4 Sample Matrix and Depth Identifiers

The sample layer identification will be followed by the sample matrix designation, a dash, and then the sample depth identifier. Aqueous samples will be designated "A" and sediment samples will be designated "S". The sample depth within each boring will be designated by an alphabetic character; "A" will designate the first sample interval within the hydrostratigraphic layer, "B" will designate the second sample interval, "C" will designate the third, etc. The actual sampling depth interval will not appear in the sample name; however, the depth interval at which the sample was collected will be noted in the field logbook and written on the sediment sample Lexan liner.

4.4.5 QC Sample Numbering System

Each duplicate sample will be submitted "blind" to the laboratory by using a different sample number than the associated environmental sample. The actual collection time will be recorded for both the environmental sample and its duplicate.

Trip blanks will be numbered by using the prefix "TB" in front of the date as follows: TB070204 for July 2, 2004.

Equipment blanks, using the prefix "EB", will be numbered similarly. However, an additional code will be necessary if multiple field sampling events occur in parallel. For example, an equipment blank collected on July 2, 2004, in association with an existing monitoring well sampling event will be labeled as EB070204-MW.

4.4.6 Sample Labels

Sample bottles will be pre-labeled prior to sample collection. All pertinent sample information will be noted on the label including the sample identification number, date and time the sample was collected, the type of sample, initials of person collecting the sample, preservation used, and the analysis for which that sample is being submitted. Groundwater sample labels will be generated using the CLP labeling system, FORMS II Lite. Sampler, date, and time will be filled out with indelible ink on the sample labels or entered into the application. Labels will be filled out with indelible ink and protected with clear tape.

Sediment samples will be collected in Lexan liners and will be labeled by writing the following information on each core:

- Date and time sample collected
- Sample identifier as defined in the QAPP
- Depth interval of the sample
- Sampler's initials
- Analysis: "Geochem", "Microb", or "Phys"
- With an arrow mark the"up" direction on the sample

4.5 On-going Quality Control

Field personnel are responsible for knowing how to correctly perform field operations and for checking their own performance during implementation. The FTL is responsible for assuring that this correct performance is maintained by the field crew. Should a failure in the system occur, either through equipment or operator error, the FTL will be notified. As a method of corrective action, the FTL or other experienced field personnel will discuss the error and provide additional instruction on the correct performance of the operation. The FTL will observe the corrective action to assure that the field method is understood by the field crew. Upon correction of the error, the location will be re-sampled. If this is not feasible, a determination of impact to the data needs for the project will be made by the FTL. If necessary, the CDM SM and the EPA RPM may be involved with the determination. If not re-sampled, any qualifications to the data will be noted in the field logbook and addressed in the measurement report submitted to EPA.

Section 6.16 addresses other corrective actions as required.

5

Section Five

Section 5

Section 5 Field Procedures

5.1 Mobilization

Prior to the mobilization for field activities, a field planning meeting will be conducted by the CDM SM and attended by the field staff, the CDM RQAC (or designee), the CDM Corporate Health and Safety Officer, and PNNL. A field planning meeting may be held in the field instead of the office if this is more convenient for the personnel involved. In this case, the PM will forward the agenda to the QAC for review before the meeting or conduct the meeting via teleconference. The meeting will briefly discuss and clarify:

- Objectives of the fieldwork
- Equipment and training needs
- Field operating procedures, schedules of events, and individual assignments
- Responsibilities of CDM and PNNL
- Required QC and health and safety measures
- Documents governing field work that must be on site

A written agenda, reviewed by the QAC, will be distributed and an attendance list signed. Copies of these documents will be maintained in the project files by the CDM SM. Additional meetings will be held when the documents governing field work require it, when the scope of the assignment changes significantly, when the field staff changes, or if the QAC determines that maintenance of QC protocol requirements merits another meeting.

Additionally, before initiating the sample collection activities, the following preparatory activities must be completed:

- Procure subcontractor services prior to the initiation of field activities.
- Before arriving on site, the field team will review and discuss elements of this QAPP and the HSP. Personal protective equipment and health and safety guidelines are specified for each activity in the HSP.
- Ensure that all sample analyses are scheduled through the EPA CLP laboratory, the CDM subcontractor laboratory, and PNNL.
- Obtain required sample containers and preservatives. Additional sample bottles will be taken into the field to allow for breakage.
- The identification number, maintenance and calibration dates (by the supplier or CDM Equipment Coordinator/FTL), and the person(s) assigned to perform field calibrations and checks for each field instrument used will be documented in the field logbook.
- Obtain demonstrated analyte-free water for trip and equipment blank preparation and other field operations.

- Locate the FedEx, or other reliable overnight delivery service nearest the site and note its hours of operation. Determine whether this office location will provide sample pick-up services.
- Obtain all necessary field sampling equipment, including required equipment for the collection of geochemical samples under anoxic conditions and microbial samples under aseptic conditions.
- Arrange for containerization of disposable material and clothing.
- Obtain all personnel protective and field instrument decontamination equipment.
- Confirm that access permission has been obtained for all field activities.
- Visit each work location with the inert gas vendor to finalize boring location to ensure that the cryogenic liquid container can be delivered and transferred to the CDM work truck safely. Ideally, the CDM truck will be positioned so that it does not have to be moved after the cryogenic liquid container is delivered.
- Complete a utility locate at each drilling location (drilling subcontractor)
- Set-up field trailer and hook up all utilities.
- Notify local police and fire of where, when, and what activities will be conducted including the use of cryogenic liquid in bulk.
- Construct a decontamination pad for sampling equipment and arrange for the drilling subcontractor to construct a decontamination pad for heavy equipment.

5.2 Decontamination Procedures

Field decontamination will be performed on all personnel and equipment that enters the exclusion zone. Personnel decontamination procedures will be implemented to prevent worker exposure to site contaminants. General equipment decontamination procedures will be implemented to prevent cross-contamination of environmental samples and prevent offsite migration of contaminants as a result of site investigation activities. General decontamination procedures are presented in TSOP 4-5. Equipment decontamination procedures for samples for microbial characterization will require additional steps, as described in Section 5.2.4.

5.2.1 Personal Protective Equipment

All personal protective equipment should be decontaminated using the following procedure:

- Non-residual detergent (Alconox™) and tap water rinse
- Respirator sanitizer (for respirator or self contained breathing apparatus (SCBA) facepiece)
- Potable water rinse
- Air dry

5.2.2 Field Monitoring Equipment

Instruments should be cleaned per manufacturer's instructions. The electronic water level indicators and water quality parameter probes *cannot* be rinsed with solvents or acids. The electronic water level indicators will be decontaminated with a non-phosphate detergent, tap water rinse, and a final distilled/deionized water rinse prior to use at each well. The water quality parameter probes will be rinsed prior to and after each use with deionized/distilled water *only*.

5.2.3 Drilling Equipment and Other Large Pieces of Equipment

All drilling equipment that comes in contact with the soil must be brushed off and then steam cleaned before use, and after drilling each borehole. This includes drill rods, bits and augers, dredges, or any other large piece of equipment. Sampling devices such as split-spoons must be decontaminated, after each use, by the procedure listed below.

5.2.4 Sampling Apparatus

All sampling apparatus must be properly decontaminated prior to its use in the field to prevent cross-contamination. Decontamination procedures for sampling equipment used to collect anoxic sediment samples are presented in Appendix B. Decontamination procedures for equipment used to collect anoxic and aseptic sediment samples are presented in Appendix C. Decontamination procedures for equipment used to collect groundwater samples are presented in Appendix A and CDM TSOP 4-5 (in Appendix E).

Equipment should be decontaminated after before each usage. Decontamination will be performed in an area outside the contamination zone. Enough equipment will be available to be dedicated to the sampling points planned each day. While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result in cross-contamination of the samples.

Sampling equipment shall be decontaminated using the following procedures:

5.2.5 Decontamination Equipment

The following equipment will be used for general decontamination of split spoons and submersible pumps:

- Distilled/deionized water
- Demonstrated analyte-free water
- Potable water
- Polyethylene sheeting

- Utility knife
- Deep basins
- Brush
- Non-phosphate detergent (i.e., Alconox™)
- 10 percent nitric acid rinse (ultra pure)
- Isopropanol rinse (pesticide grade)
- Aluminum foil
- Personnel protective equipment
- Air monitoring equipment and calibration gas

5.3 Field Notations

Field notations will be taken in accordance with TSOP 4-1 Field Logbook Content and Control (Appendix E). Photologs will be prepared for photographs of site activities in accordance with TSOP 4-2, Photographic Documentation of Field Activities.

5.4 Topographic Survey

The topographic survey is described in Section 4.3.5 of this QAPP and will be conducted by a surveyor licensed by the State of New Jersey under subcontract to CDM. The topographic survey will be conducted by the subcontractor in accordance with the technical SOW prepared by CDM for the procurement of the surveyor. Calibration of field instruments, in accordance with the SOW, will be the responsibility of the subcontractor.

CDM will prepare the technical statement of work and initiate the procurement of the survey subcontractor. CDM personnel will perform field oversight and health and safety monitoring during all surveying field activities.

5.5 Soil Boring, Drilling, and Testing

Specific procedures for sediment sampling within the deep borings are presented in the following sections.

5.5.1 Deep Borings and Sediment Sampling

The sediment sampling methods have been specified by PNNL in their Sampling and Analysis Plan (PNNL 2004). The methods are based on PNNL's requirements for the treatability study they are conducting for EPA. EPA has tasked CDM with implementing the sample collection program. Sediment samples at the in situ remedial technology pilot test site borings, MW-36 and MW-37, will be collected using rotasonic drilling techniques and processed under anoxic and aseptic conditions. Project-specific Standard Operating Procedure (PSOP) 1 has been developed to describe the sampling procedures, handling, packaging, shipping, and decontamination for sediment sampling under anoxic conditions (Appendix B). Sediment samples at the downgradient plume attenuation study area borings, D1 and D2, will be collected and processed under anoxic conditions. PSOP 2 has been developed to describe the sampling procedures, handling, packaging, shipping, and decontamination for sediment sampling under anoxic and aseptic conditions (Appendix C).

5.5.1.1 Preparatory Activities

Prior to initiating any field activities, the field team will review and discuss in detail the HSP, appropriate QAPP sections, and PSOP 1 and PSOP 2. All monitoring and protective equipment will be thoroughly checked at this time. Refer to the site-specific low-flow, minimal drawdown sampling SOP (Appendix A) for a description of preparatory activities, required equipment, and the procedures for well purging, monitoring of indicator parameters (pH, conductivity, Eh, turbidity, and dissolved oxygen), and groundwater sample collection. Sediment samples will be packaged and shipped in accordance with the procedures described in PSOP 1 and PSOP 2. In the field and before the start of drilling, the anoxic/aseptic sediment sample handling system will be set up and field personnel will train in the handling and processing of samples including the use of inert gas (liquified argon [cryogenic], mole percent >99% argon, <1% impurities [CAS No. 7440-37-1]) . This will ensure that once the actual work starts the process will run smoothly. This field training will be documented. Finally, the drilling subcontractor will obtain a drilling permit for each location.

5.5.1.2 Field Equipment

The equipment required for sediment sampling is listed in Appendices B and C.

5.5.1.3 Procedures for Sediment Sampling

The boreholes will be advanced using sonic drilling techniques by the drilling subcontractor. Samples will be collected as follows:

- At locations MW-36 and MW-37, a 10 or 12-inch diameter borehole will be advanced with a sonic drilling rig to the an estimated depth of 140 feet bgs into layer C-2a to seal off the underlying Intermediate aquifer (C-2AI) from any overlying groundwater contamination. After the temporary casing is set a hydrostatic test will be conducted to ensure a good seal.
- Rotosonic drilling will continue to the estimated completion depth of 250 feet using an 8-inch casing at locations MW-36 and MW-37.
- At locations D1 and D2 a 6 or 8-inch diameter borehole will be advanced with a sonic drilling rig to the an estimated depth of 300 feet bgs.
- Sediment samples will be collected at designated depths using a 4-inch diameter, 2-foot long split barrel sampler fitted with Lexan liners.
- When boreholes D1 and D2 are completed they will be backfilled using cement bentonite grout to a depth 3 feet below ground surface in accordance with NJDEP requirements.
- When completed the borings at locations MW-36 and MW-37 will be converted to monitoring wells as discussed in Subsection 5.6.2.

- At borings D1 and D2, the grout will be allowed to set for 12 to 24 hours and will then be topped off. After the grout has set the original surface conditions will be restored at each location.
- All drill cuttings will be stored in a secure onsite storage area(s), designated by the RAC II field geologist, for later offsite disposal.
- All boreholes will be secured when not in use.

Figure 5-1 shows the soil boring log that will be completed for each boring.

5.6 Hydrogeological Assessment

Specific procedures for discrete-depth groundwater sampling, monitoring well installation and development, and monitoring well sampling are presented in the following sections.

5.6.1 Discrete-Depth Groundwater Sampling

The discrete-depth groundwater sampling methods have been specified by PNNL in their Sampling and Analysis Plan (PNNL 2004). The methods are based on PNNL's requirements for the treatability study they are conducting for EPA. EPA has tasked CDM with implementing the sample collection program. Discrete-depth groundwater samples will be collected from the two in situ remedial technology pilot test site borings and the two downgradient plume attenuation study borings during borehole advancement with sonic drilling techniques. Groundwater samples will be collected with an electric submersible pump as per the site-specific low-flow groundwater sampling procedure (Appendix A).

5.6.1.1 Preparatory Activities

Prior to initiating any field activities, the field team will review and discuss, in detail, the appropriate QAPP sections. All equipment will be thoroughly checked at this time. Preparatory activities which apply to the discrete-depth groundwater sampling activity are as follows:

- A drilling subcontractor will be procured to collect groundwater samples
- An analytical subcontractor will be procured to perform trace metal analysis from samples collected from the borings

5.6.1.2 Field Equipment

The equipment required for low-flow groundwater sampling is listed in Appendix A. However, the following additional equipment will be required:

- Polyethylene sheeting
- Utility knife
- Camera and film
- Paper towels
- Water level indicator

- Demonstrated analyte-free water
- Horiba U-22 or U-10 water quality checker

5.6.1.3 Procedures for Discrete-Depth Groundwater Sampling

The boreholes will be advanced using sonic drilling techniques by the drilling subcontractor. Samples will be collected as follows:

- The borehole will be advanced to the desired groundwater sampling interval. CDM expects to alternate between sediment sampling, described in Subsection 5.5.1 and groundwater sampling
- A screened drive point will be lowered through the casing to the bottom of the interval, and the casing sleeve will be withdrawn to approximately 20 feet above the sample interval, allowing the formation to collapse around and above the screen.
- A submersible electric with a variable speed motor pump will be lowered into the drive point casing and the interval will be purged and sampled according to the site-specific low-flow groundwater sampling procedure (Appendix A).
- Once completed, the borehole will be abandoned, as described under Subsection 5.5.1.3 or converted into a monitoring well as described under subsection 5.6.2.

5.6.2 Monitoring Well Installation

Two monitoring wells, MW-36 and MW-37, will be installed with sonic drilling techniques at the in situ remedial technology pilot test site. Wells will be installed through the temporary casing used during sonic drilling to complete each borehole; general procedures for well installation are outlined in TSOP 4-4; lithologic logging procedures are outlined in TSOP 3-5. It is anticipated that the wells will be single-cased.

5.6.2.1 Preparatory Activities

Prior to initiating any field activities, the field team will review and discuss in detail the HSP and appropriate QAPP and/or QAPP Addendum sections. All monitoring and protective equipment will be thoroughly checked at this time.

The following activities will be performed prior to well installation activities:

- Drilling equipment, including the drill rig, temporary casing, drill rods, and bits will be steam cleaned upon arrival and between each location at the site.
- PVC screen and riser will be steam cleaned.
- Health and safety protection requirements will be based on monitoring measurements and visible contamination.

Finally, the drilling subcontractor will obtain a drilling permit for each location.

5.6.2.2 Field Equipment

All drilling equipment, supplies, and materials will be supplied by the drilling contractor. The health and safety equipment, the soil sampling equipment and the borehole logging supplies will be provided by the RAC II field team for monitoring well activities. General procedures for installation of monitoring wells are described in TSOP 4-4. Specific procedures are outlined in sections below.

5.6.2.3 Procedures for Monitoring Well Installation

The two monitoring wells will be installed as single-cased wells, using sonic drilling techniques. Monitoring wells will be constructed of 4-inch diameter polyvinyl chloride (PVC) casing and No. 10 slot screen. The general monitoring well installation procedures are described in TSOP 4-4. Figure 5-2 shows the construction diagram for a single-cased monitoring well. Monitoring wells will be installed as follows:

- A 10 or 12-inch diameter borehole will be advanced with a sonic drilling rig to the an estimated depth of 140 feet bgs into layer C-2a to seal off the underlying Intermediate aquifer (C-2AI) from any overlying groundwater contamination. After the temporary casing is set a hydrostatic test will be conducted to ensure a good seal.
- Rotasonic drilling will continue to the estimated completion depth of 250 feet using an 8-inch casing.
- When the borehole is completed it will be partially backfilled using cement bentonite grout to a depth 10 feet below the planned screened depth. CDM estimates that the screened intervals of each well will be in the rang of 160 to 170 feet bgs. The exact depth of the screened interval will be determined in the field by the field geologist.
- Once the borehole backfill requirements are determined cement/bentonite grout will be placed from the bottom of the borehole using a tremie pipe. The grout will be allowed to sit for 12 to 24 hours. The final depth of the grout will be checked and if the level is with in a few feet of the target then the remainder of the interval will be backfilled with No. 00 Sand via a tremie pipe to provide a seal between the cement/bentonite grout and the screened interval. Additional grout will only be added if the level is well below the target level. If additional grout is added it will be allowed to set for 12 to 24 hours before the No. 00 Sand seal is emplaced.
- The base of the well will be secured a minimum of one foot above the bottom of the borehole. Graded, washed sand will be added to the annulus using a tremie pipe until a continuous filter pack forms beneath and around the well screen. A filter pack of Morrie No. 1 grade sand or equivalent will be used.
- The filter pack will extend from one foot below the base of the well screen to two feet above the top of the well screen.
- No. 00 Sand will be used to seal the annulus a minimum of three feet above the filter pack. The No. 00 Sand will be added using a tremie pipe. The remaining annular space will be measured to confirm that the sand did not bridge at a shallower depth. Sufficient time will be allowed for the sand to settle prior to

the installation of grout (approximately 1 hour).

- The remaining annulus will be filled with a cement-bentonite grout installed by the tremie method above the No. 00 Sand seal to just below the ground surface. The grout will be allowed to set for a minimum of 24 hours before well development proceeds.
- Where the well will be finished with a flush mount protective well cover, the riser casing will extend approximately 6 inches below the existing grade. At wells where stick-up protective casings are used, the well will be finished such that the riser will extend approximately two feet above the existing grade. Riser casing caps will be provided for each well.
- Following monitoring well installation, the wells will be developed with a portable electric submersible or air lift pump. Development water will be containerized, transported to a designated onsite storage area, and stored in a Baker tank prior to offsite disposal.
- Each well will be provided with keyed-alike padlocks to match the existing wells at the site. Each well will be numbered on the inside of the protective casing. Each well will be equipped with an identification tag which will include the well name, NJDEP permit number, date installed, screened interval and total depth.
- All drill cuttings will be stored in a secure onsite storage area(s), designated by the RAC II field geologist, for later offsite disposal.

5.6.3 Monitoring Well Development

Prior to initiating any field activities, the field team will review and discuss in detail the HSP and appropriate QAPP sections. All monitoring and protective equipment will be thoroughly checked at this time. Refer to the SOP 4-3, Well Development and Purging, (Appendix E) for a description of preparatory activities, required equipment, and the procedures for well development and monitoring of indicator parameters (pH, conductivity, Eh, turbidity, and dissolved oxygen).

The wells will be developed by continuously pumping to improve the hydraulic connection with the aquifer. Well development will occur as soon as possible/practical after installation, but not sooner than 24 hours after grouting is completed (EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9360.4-06). The drilling subcontractor will be responsible for carrying out the well development. Development will be considered complete when a visually sediment-free discharge is achieved and pH, temperature and specific conductivity remain consistent within a ±10% range. Refer to the attached TSOP 4-3 for further guidance. CDM will attempt to meet the 5 nephelometric turbidity units (NTU) guidance value for turbidity (EPA 1992) during development of Site monitoring wells. The 5 NTU turbidity was also the goal during development of the wells installed in the RI, therefore to be consistent with previous field efforts, CDM will pursue the same goal and will devote one full day to development at each well. However, it is CDM's experience that it is often impractical to achieve such a low turbidity value during well development. Consequently, well development will be considered complete when development water is clear and turbidity values have stabilized (turbidity within a 10% range). Development water will be containerized by the drilling subcontractor and stored onsite for later disposal. Offsite disposal will be performed by a separate subcontractor.

5.6.4 Monitoring Well Sampling

Three monitoring wells will be sampled with submersible electric pumps with variable speed motors, using the site-specific low-flow, minimal drawdown sampling method (Appendix A) which follows the EPA SOP, *Ground Water Sampling Procedure, Low Stress (Low Flow) Purging and Sampling* (EPA 1996). Monitoring wells will be sampled no sooner than two weeks after well development. The groundwater sampling requirements have been specified by PNNL in their Sampling and Analysis Plan (PNNL 2004) and are based on PNNL's requirements for the treatability study they are conducting for EPA. EPA has tasked CDM with implementing the sample collection program. Specific analytical methods and requirements for sample preservation, holding time, and sample containers for both rounds of sampling are described in Section 6.

Prior to initiating any field activities, the field team will review and discuss in detail the HSP and appropriate QAPP sections. All monitoring and protective equipment will be thoroughly checked at this time. Refer to the site-specific low-flow, minimal drawdown sampling SOP (Appendix A) for a description of preparatory activities, required equipment, and the procedures for well purging, monitoring of indicator parameters (pH, conductivity, Eh, turbidity, and dissolved oxygen), and groundwater sample collection. Samples will be packaged and shipped in accordance with the procedures described in TSOP 2-1 Packaging and Shipping of Environmental Samples.

5.6.4.1 Sample Collection and Container Filling Procedures

Sample containers will be filled following the procedures.

Sample Container Filling Procedures for LDL VOAs

1. Remove the cap from the 40-ml volatile organic analysis (VOA) sample vial, avoiding contact with cap liner.
2. The first VOA vial will be used to determine the minimum amount of hydrochloric acid (HCl) required to bring the sample pH to < 2. Fill the vial with sample water, then add 1:1 HCl drop by drop into the VOA vial and test pH until it is less than 2. Do not dip the pH paper into the sample container or cap. Record the amount of HCl added and set aside this VOA vial for disposal.
3. Add the established amount of HCl to the remaining VOA vials. After adding the water from the sampler, quickly replace the cap making sure it is screwed on tightly. Inspect the vial for air bubbles to check

that zero headspace has been achieved.

4. While filling each vial, hold it at an angle to minimize water turbulence.
4. Clean the outside of the sample containers with clean water and paper towels.

Sample Container Filling Procedures for Trace Metals

1. One sample for trace metals analyses will be collected from each sample location.
2. Attach a 0.45 micron filter to the end of the sample discharge line (change filters between each sample location.) Flush water through the filter.
3. Fill the metals bottle about 90% and preserve to a pH < 2 with nitric acid (HNO_3). Pour excess sample over pH paper into a separate container to test the pH. Do not dip the pH paper into the sample container or cap.
4. Replace the cap tightly, attach sample label, seal in zip-lock bag and place the sample bottle in the cooler with ice.

Sample Container Filling Procedures for Ferrous Iron

1. Attach a 0.45 micron filter to the end of the sample discharge line (change filters between each sample location.) Flush water through the filter.
2. Fill the bottle with filtered water to about 90% and preserve to a pH < 2 with HNO_3. Pour excess sample over pH paper into a separate container to test the pH. Do not dip the pH paper into the sample container or cap.
3. Replace the cap tightly, attach sample label, seal in zip-lock bag and place the sample bottle in the cooler with ice.

6 Section Six

Section 6
Quality Assurance Project Plan

This section discusses the QA/QC requirements for the Puchack Well Field drilling and sampling activities relating to the treatability study, and the means by which quality will be measured and documented. A full set of referenced procedures will be on site during all field activities. The procedures used at the Site will be in accordance with EPA's Region II CERCLA Quality Assurance Manual, Revision 1 (EPA 1989); EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations - EPA QA/R-5 (EPA 2001); and CDM's RAC II Quality Management Plan, Revision 5 (CDM 2003).

6.1 Data Quality Requirements and Assessment

6.1.1 Accuracy, Precision and Sensitivity of Analysis

Objectives of the analytical QC requirements are to ensure adequate accuracy, precision, and sensitivity of analysis. Aqueous samples collected for LDL VOCs analysis will be analyzed through the CLP. Rigorous QA/QC procedures have been established for the CLP laboratories. Analytical QC procedures are detailed in the most current revisions of the following CLP RAS statements of work (SOW): OLC03.2 for LDL VOCs in water. The RAS parameter data quality indicators (DQIs) required for this project will be as provided in the above cited SOWs and as stated on Table 6-1. Blind duplicate samples will be collected and analyzed as part of the field program to assess the precision of sample collection and analytical processes. The goal is to determine if there is mutual agreement among individual measurements of the same property taken under prescribed similar conditions.

Non-RAS aqueous trace metals parameters will be analyzed by the CDM subcontract laboratory, using method 6020. The CDM subcontractor laboratory will be selected based on the ability to meet the EPA and analytical QA and QC requirements that will be specified in the technical statements of work for non-RAS analytical services. These specified QA/QC requirements will govern the analytical work performed by the laboratory subcontractor. CDM shall provide EPA with the results of the technical and quality review of the documentation provided by the selected laboratory in response to the CDM's laboratory procurement SOW. CDM will monitor the subcontractor laboratory's analytical performance and its maintenance of the SOW-specified QA/QC criteria. CDM will submit the "Analytical Services Tracking System (ANSETS) Data Requirement" form (Figure 6-12) to EPA each month for the non-RAS data. Non-RAS parameters and methods are listed in Table 6-1.

Aqueous ferrous iron samples and all sediment samples will be analyzed by PNNL, using PNNL procedures.

Potential site contaminants include those known to have been used or disposed of onsite, and/or have been detected in soil and/or groundwater samples from onsite source areas. These potential site contaminants include VOCs (primarily TCE and DCE) heavy metals (primarily chromium) in groundwater.

Definitive-level data will include groundwater samples sent to the EPA CLP and CDM subcontract laboratory and PNNL data. Onsite field screening data, which includes ferrous iron and hexavalent chromium, are considered non-definitive. The field screening data will have less stringent QC requirements than those of the definitive-level data. Water quality parameters including pH, conductivity, temperature, DO, ORP, and turbidity will be collected during groundwater sampling. The field instrument water measurements will be considered non-definitive, screening-level data.

As part of the procurement process, the subcontract analytical laboratory is required to submit sample preparation and analytical method SOPs, laboratory QA Plan or quality management plan, state or national certifications, and results of the performance evaluation (PE) sample analysis for the required parameters. During the laboratory procurement process, CDM reviews these submittals to ensure that they have met all of CDM's Quality Assurance and technical requirements. The results of CDM's technical and quality review of the laboratory documentation will be provided to EPA's RAC II QA offices and to the EPA RPM, once the procurement process is completed and the subcontract is awarded.

6.1.2 Field Representativeness, Completeness and Comparability

The following discussion covers the DQOs of representativeness, completeness and comparability and how these DQOs may be achieved through field operations and the analytical process.

Representativeness

Representativeness expresses the degree to which the sample portrays the population characteristics of process/environmental conditions at a given location and point in time. The use of dedicated, decontaminated sampling equipment constructed with required material such as Teflon and stainless steel contributes to the sample's representativeness. Samples will be refrigerated upon collection and maintained at cool temperatures at or below 4 degrees Celsius (° C) throughout the sample shipment and analytical steps.

In groundwater sampling, representativeness will be assured by employing well evacuation techniques that introduce fresh-formation groundwater into the well screen interval. For the project-specific low-flow purging and sampling method, this will be achieved by performing the sampling operation within the required criteria for water quality measurements, minimal drawdown and low flow rate. For further details, see the attached project-specific SOP entitled, Puchack Well Field, Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling" in Appendix A. The pump intake will be placed within the targeted horizon of the screened interval of the well (normally the middle or just above the middle of the screen interval). The water will be evacuated until water quality parameters have stabilized. The purging rate will be kept to less than 500 milliliters per minute (ml/min), and drawdown will be monitored to remain less than 0.1 meter (0.3 foot or four inches). Care will be taken to maintain sufficient pressure so as not to introduce air into the pump tubing. Samples will be collected using the low-flow sampling method directly from dedicated tubing constructed of appropriate material (Teflon or Teflon-lined tubing). Turbidity will be measured; a goal of 5 to 10 nephalometric turbidity units (NTUs) has been established for water clarity during purging. However, it is CDM's experience that it is often impractical to achieve such a low turbidity value during sampling. Consequently, purging will be considered complete when turbidity values have decreased to a relatively static level, with turbidity within a 10% range. The use of the low flow sampling method should produce samples with less suspended solids than other groundwater sampling methods.

Sediment sample representativeness will be achieved by using procedures detailed in Appendices B and C.

Completeness
Completeness is defined as a measure of the amount of valid data obtained from a measurement system. It is expected that the CLP and the subcontractor laboratory will provide data meeting acceptance criteria for 90 percent of the samples analyzed. The 90 percent completeness criteria applies to all parameters for all sample locations at the Site. Valid data will be the data that have not been rejected during data validation. Any data set less than 90 percent complete will be evaluated individually to determine whether additional samples should be collected. The 90 percent completeness criteria is considered sufficient for the Site. This DQI is included on Table 6-1.

Comparability
The environmental data for the site will be generated in a way that assures comparability. Standardized sampling and analytical procedures will be used. Data will be reported in standardized formats using consistent units of measurements.

6.1.3 Field Quality Control Samples

Table 4-4 lists the estimated number and type of QC samples that will be collected. These samples will be analyzed in the same manner as the investigative samples.

Duplicates
Field duplicate samples are collected and analyzed to assess the overall precision of the field sampling technique. Duplicate samples, of a similar matrix, will be collected

at a rate of five percent or at least one per every 20 samples. These duplicates will be submitted "blind" to the laboratories by using sample numbers that differ from their associated environmental samples. Note that no duplicates are required for sediment samples. PNNL does not use duplicates due to the heterogenous nature of sediment samples. Instead, they run multiple analyses on the samples they receive and evaluate the reproducibility of the method statistically.

Trip Blanks
Trip blanks are used to verify the presence or absence of contamination in VOC samples during handling and shipment from the field to the laboratory. It is also used to verify cross-contamination from sampling procedures, containers, and preservatives during sample collecting, preservation, and shipment, as well as in the laboratory.

A trip blank will be prepared by the CDM sampling team at the start of each day on which aqueous samples will be collected for analysis of VOCs by CLP. A trip blank consists of demonstrated analyte-free water sealed in 40-ml Teflon septum vials with no headspace (including bubbles) in the vials. Trip blank water will be considered analyte-free when TCL analysis results for low detection level analysis (OLC03.2) are below Contract Required Quantitation Limits (CRQLs). Certification of blank water quality will be kept on site and will be filed in the CDM RAC II project files once field work is completed. Further definition of what constitutes "demonstrated analyte-free water" may be found in the EPA Region II CERCLA Quality Assurance Manual, Revision 1 (EPA 1989), Section 10-A.2 (pages 59-60). A sample of the blank water lot used in the field will be submitted for confirmatory analysis.

Trip blanks are to be kept in close proximity to the samples being collected and will be maintained at 4°C and handled in the same manner as the other VOC aqueous samples. Preservation of trip blanks is presented in Table 4-5. One trip blank will be included with each daily shipment that contains aqueous samples collected for VOC analysis by CLP. Trip blanks will be analyzed by the same VOC method as the associated set of VOC samples.

Equipment Blanks
An equipment (or rinsate) blank is used to verify field decontamination procedures. One equipment blank will be collected daily for each equipment type per decontamination event and will be analyzed for the same constituents as the environmental samples. Equipment blanks, also known as "rinsate blanks" or "equipment blanks," are used to assess the effectiveness of equipment decontamination. Equipment blanks will be collected before the use of the decontaminated equipment for sampling. The frequency for equipment blanks is one per decontamination event, not to exceed one per day, for each equipment type and for each sample matrix. Equipment blanks are generated by pouring demonstrated analyte-free water over or through the decontaminated sampling tool. The definition of demonstrated analyte-free water is found in Section 6.8 and discussed in the

previous section. Equipment blanks will be collected in a way that will minimize potential contamination from the ambient air. The use of the same aliquot of water on all equipment associated with a particular matrix for the required analyses is permissible. However, a separate field rinse blank must be collected for each piece of equipment associated with a particular sample matrix that will be analyzed for VOCs. Preservation of equipment blanks is specified on Table 4-5. Equipment blanks will accompany the set of samples collected by the decontaminated sampling equipment and will be kept at 4° C. Note that no equipment (rinsate) blanks are required for sediment samples. PNNL does not use rinsates due to the heterogenous nature of sediment samples.

Cooler Temperature Indicators

Cooler temperature indicators are used to verify that samples have been maintained at 4° C. One cooler temperature indicator or "temperature blank" will be placed in each cooler containing samples (solid and aqueous) being sent to the CLP or DESA laboratories for analysis. The temperature blank will consist of a sample container filled with non-preserved water (potable or distilled). The container will be labeled "EPA COOLER TEMPERATURE INDICATOR" and dated. Upon receipt, the laboratory will immediately record the temperature of the blank on the chain of custody form, prior to inventory and refrigeration.

Matrix Spikes

Matrix spikes (MS) are laboratory QC samples drawn from excess volumes of existing samples to demonstrate the accuracy of laboratory analysis. In accordance with EPA's Region II CERCLA QA Manual (EPA 1989), matrix spikes will be designated on environmental samples at a rate of one per sample delivery group (SDG). This designation will be noted on the sample container labels and the sample paperwork. As per direction from EPA, and SDG is defined as one of the following:

1. All samples of an analytical case if the sample number is less than 20 (including environmental duplicates and QC blanks) and if sampling is completed within 7 calendar days.

2. Each group of 20 samples within an analytical case (including environmental duplicates and QC blanks) if the number is greater than 20.

3. Each 7-day calendar day period during which samples within an analytical case are received. This period begins with the receipt of the first sample in the SDG.

Since no extractable organics are being analyzed, the calendar day frequency criteria in items 1 and 3 will be based on 7 days. These SDGs include field or trip blanks. However, one extra vial is required for the multi-concentration VOC matrix spike/matrix spike duplicate (MS/MSD). An aqueous MS/MSD sample for extractable organics requires the collection of three times the sample volume from the designated sample location. Inorganics will be collected in double volume. The water quality parameters do not require extra volume unless identified on Table 4-5. Note that no MS/MSDs are required for sediment samples. PNNL does not use MS/MSDs due to the heterogenous nature of sediment samples. Instead, they run multiple analyses on the samples they receive and evaluate the reproducibility of the method statistically.

6.2 Laboratory Scheduling

CLP RAS Scheduling

CDM has a designated RAC II Primary Authorized Requester who can obtain laboratory space through the CLP. The RAC II Primary Authorized Requester is Scott Kirchner who is in CDM's Edison, New Jersey office and can be reached at (732) 225-7000. If Scott Kirchner is unavailable, his designated alternate is Jeniffer Oxford, who is in the same office.

Laboratory space cannot be scheduled until this QAPP has been approved by EPA. Following approval of the QAPP, the SM, or designee, will contact the Primary Authorized Requester to schedule laboratory space. The Primary Authorized Requester will submit a Laboratory Booking and Job Tracking request form to the Regional Sample Control Center (RSCC). The RSCC will then contact the CLASS for booking RAS laboratory space. One case number will be assigned for all RAS analyses to be performed within a two week time frame.

A lead time of two weeks, or more, is required to schedule CLP laboratory space. To schedule laboratory space, the following information must be supplied by the SM to the Primary Authorized Requester:

- Name of the requester, affiliation, and telephone number
- Name and location (city and state) of the site to be sampled
- Superfund site/spill identification (ID) number (4 digit alphanumeric code)
- CERCLA Information System (CERCIS) ID Number and matrix of samples to be collected
- Type of analysis required (e.g., organics, total metals)
- Schedule of sample collection and shipment dates
- Type of sampling event (e.g., RI sampling)
- Any known or suspected hazards associated with the samples

The Primary Authorized Requester must be notified of any changes in the sampling scheme or schedule occurring before or after issuance of the laboratory. Only the Primary Authorized Requester may contact the RSCC with these changes. Field personnel are required to contact the contract Laboratory Analytical Support Services (CLASS) daily with sample shipment information (see Section 6.5.5). Any information provided to CLASS also must be relayed to the Primary Authorized Requester; however, this may occur after the sampling event.

Samples sent through the CLP will have a range of turnaround time options for organics (7-, 14-, and 21-day and a preliminary results option as offered under OLM04.3), to be determined at the time of sample booking. The need for quick turnaround less than 35 days will be determined by the specific field event and data needs of the project. Following the turnaround time, additional time is required for the performance of data validation. Unless a quick turnaround is required for specific sampling events, a 35-day turnaround time will be requested of the CDM laboratory subcontractor as stated in the analytical SOW. The DESA laboratory will provide 35-day turnaround; however, full data packages will not be provided with these results.

Non-RAS Laboratory Scheduling

Scheduling of the CDM subcontract laboratory will be performed by the FTL or a designee.

6.3 Documentation

This section primarily refers to sample collection, management, shipment, and tracking. Each submittal of samples for analysis will be properly documented to ensure timely, correct, and complete analysis and to support the use of analytical data in potential enforcement actions. The documentation system provides the means to individually identify, track, and monitor each sample from the point of collection through final data reporting.

Documentation of changes to the QAPP made in the field will be performed as stated in the fourth paragraph of Section 1.0, Introduction (Page 1-1). The FCR form will be used (Figure 2-2).

6.3.1 Field Logbook

An important element in the documentation process is the proper maintenance by field personnel of the formal project-specific field logbook. All entries will be maintained according to the requirements for maintaining field logbooks as described in the CDM TSOP 4-1, Field Logbook Content and Control. As stated in the procedure, all logbook entries must be made in ink. No erasures are permitted. Incorrect entries will be crossed out with a single strike mark and initialed. Military time will be used. All pages in the book and all books used during the field work will be numbered sequentially.

At the beginning of each day of field activity, the following information will be recorded: the date; start time; weather; all field personnel present and their affiliations, any upgrade in the level of personal protection being used during that day for certain locations, and the signature of the person making the entry. All pages must be initialed by the individual making the entry. The field logbooks will be stored, following field activities, in the CDM RAC II document control system.

6.3.2 Organic or Inorganic RAS Documentation

Refer to the attached CDM TSOP 1-2 (Appendix E) for the procedures to be used for sample custody. FORMS II Lite sample management software will be used during the field event to produce sample labels, traffic reports and chain-of-custody records. Separate forms are generated for the laboratory and the region. The laboratory copies will be submitted to the laboratory with the samples and the region copies will be submitted to the RSCC with the sample trip report and to CLASS. Figures 6-1 through 6-4 show examples of the laboratory and region copies of the organic and inorganic chain-of-custody reports. As directed by EPA, CDM may also export the site sampling information to the laboratory, RSCC, or CLASS.

6.3.3 CDM Laboratory Subcontractor Chain-of-Custody Forms

Non-RAS samples submitted to the CDM laboratory subcontractor will be documented on Forms II Lite chain of custody forms. These samples will use the sample location number for identification. CDM TSOP 1-2 includes the procedures to be used for the completion of these forms. Figures 6-1 and 6-2 show examples of the laboratory and region copies of organic Forms II Lite chain-of-custody reports. Table 6-2 illustrates the distribution of sample documentation.

6.3.4 Sample Labels

One adhesive sample label stating the sample number is affixed to each container making up the sample. For CLP RAS samples, a strip of adhesive labels with alpha-numeric sequential numbers (Figure 6-6) are provided by the ASC and are assigned to each sample location number. For samples submitted to the DESA Laboratory and the CDM off site subcontractor laboratories, only the sample location number is required. To protect the sample from water damage, each label will be covered with clear, waterproof tape. For samples requiring decontamination, the sample labels must be completely covered with clear Mylar tape before sampling. The sample labels, which bear the identification number, permanently identify each sample collected and link each sample component throughout the analytical process.

The FORMS II Lite program will be implemented at the site, and sample labels will be generated using this program. The CLP RAS samples numbers will be assigned within the program and printed out on the sample label.

6.3.5 Sample Custody and Shipment Documentation

To maintain a record of sample collection transfer between field personnel, shipment, and receipt by the laboratory, the applicable sample chain-of-custody paperwork (Sections 6.3.2 and 6.3.3 and CDM TSOP 1-2) is completed for each shipment (i.e., cooler) of packed sample bottles or delivery of samples to the onsite mobile laboratory. Each time the samples are transferred to another custodian, signatures of the person relinquishing and receiving the samples, as well as the time and date, are entered to document the transfer. The definition of sample custody according to the EPA Office of Enforcement and Compliance Monitoring National Enforcement Investigations Center (NEIC) Policies and Procedures (EPA 1986) states that a sample is under custody if:

- It is in one's possession, or
- It is in one's view after being in one's possession, or
- It is locked up after being in one's possession, or
- It is in a designated secure area.

Under this definition, the team member actually performing the sampling is personally responsible for the care and custody of the samples collected until they are transferred properly. The FTL will review all field activities to confirm that proper custody procedures were followed during the field work.. The applicable sample chain-of-custody paperwork forms are employed as physical evidence of sample custody.

Samples will be shipped from the field directly to each laboratory via FedEx or an equivalent overnight carrier. Samples will be sent from the field within 24 hours of sample collection. All courier receipts and/or paperwork associated with the shipment of samples will serve as a custody record for the samples while they are in transit from the field laboratory. Custody seals should remain intact during this transfer.

When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them and courier personnel relinquishing them will be completed in the appropriate spaces on the chain-of-custody record. This will complete sample transfer.

It will be each laboratory's responsibility to maintain internal logbooks and records that provide a custody record throughout sample preparation and analysis. To track field samples through data handling, CDM will maintain photocopies of all chain-of-custody forms.

Coolers are secured with nylon fiber tape and at least two custody seals (Figure 6-7) are placed across cooler openings. Since custody forms are sealed inside the sample cooler and custody seals remain intact, commercial carriers are not required to sign the chain-of-custody form.

6.3.6 Sample Trip Reports

A sample trip report must be completed for each site per RAS case number and must contain all the information as shown below. All QC blanks, MS/MSD samples, and duplicate samples must be clearly indicated.

- Site number
- Sampling date
- CLP RAS case number
- Site location
- Sample description
- Names, addresses of laboratories receiving samples and sample types going to those laboratories
- Sample dispatch data (e.g., courier airbill number(s))
- Additional comments (sample types, totals, QC blanks)
- Name of preparer and date of report
- Approval signature and date.

This trip report will be sent directly to the RSCC within 10 working days of final sample shipment with a copy to the CDM ASC. For non-RAS data, the ASC will submit the electronic "ANSETS Data Requirement" form to the RSCC by the first day of each month for the previous month's sampling.

6.4 Sample Bottles

The purchasing of sample containers for each site is of the responsibility of the SM. The containers must meet EPA's specifications and therefore will be acquired through an appropriate vendor. The supplier of the bottles must pre-clean and laboratory analyze them according to the Office of Solid Waste and Emergency Response (OSWER) directive 9240.0-05A to ensure that no contamination exists that may affect analytical results.

Each group of cleaned bottles is assigned a unique identifying QC lot number which is permanently affixed to each container. Clean, empty bottles are shipped to users in protective cardboard containers. Upon receipt, the lot numbers will be recorded in the field logbooks. Analytical data demonstrating bottle cleanliness will be kept on site, and will be filed in the CDM RAC II project file when the field work is completed.

6.5 Sample Handling, Packaging and Shipping

Samples will be packaged and shipped promptly after collection. When sent by common carrier, the packaging, labeling, and shipping of hazardous materials are regulated by the DOT under Code of Federal Regulations (CFR) 49, Part 172.

6.5.1 Packaging

Packaging will be performed according to the EPA *CLP Guidance for Field Samplers, Draft-Final* (EPA 2003). Key steps are as follows.

- Overlap the lid and bottle of each sample container with signed custody seals. This is only required for CLP RAS samples.
- Enclose and seal sample containers in a clear plastic bag.

- Place ice in large zip-lock plastic bags and place the bags in a cooler so that ice surrounds, but is not in direct contact with, the sample bottles. Do not place the ice on top of the top layer of vermiculite as this acts as an insulator between the ice and the sample media. Enough bagged ice should be included to maintain the sample media at 4° C until the cooler arrives at the laboratory.
- Pack non-combustible, absorbent vermiculite around bottles to avoid sample breakage during transport. It is permissible to augment the vermiculite with styrofoam pellets or equivalent for packing non-breakable sample containers.
- Using the Forms II Lite software, complete shipping/sample documentation, *including airbill shipment forms, for each shipment of samples.* Seal documentation in a waterproof plastic bag and tape the bag inside the shipping container lid. Include a return address for the cooler.
- Close the container and seal it with nylon fiber strapping tape and at least two custody seals so that the custody seals would be broken if the cooler were opened. Attach an extra mailing label to the cooler to ensure proper shipment.
- If samples are determined to be of high hazard by visual observation or instrument reading, all such sample bottles will be placed in waterproof plastic bags and then placed in a metal can (paint can). Vermiculite will be used to secure the bottles within the metal can, and clips or tape will be used to permanently hold the can lid tightly in place. One sample bottle is packed per can. The metal cans will be labeled as the sample bottle is labeled and then packed as above. High level samples will not be cooled to 4° C.

6.5.2 Marking/Labeling

Attach return address labels to the inside of the cooler in a clearly visible location. For environmental samples:

- No DOT marking or labeling is required for low-level samples.
- The appropriate side of the container must be marked "This End Up" and the arrows placed accordingly.

Marking/labeling of high-level samples will be in compliance with the EPA *CLP Guidance for Field Samplers, Draft-Final* (EPA 2003).

6.5.3 Shipping Papers

No DOT shipping papers (i.e., bill of lading) are required for low-level environmental samples. Bills of lading are required for shipment of high-level samples. These procedures are as per the EPA *CLP Guidance for Field Samplers, Draft-Final* (EPA 2003).

6.5.4 Transportation

All low-level environmental samples collected at the Site may be transported by field personnel in private vehicles and can be shipped by overnight delivery service, but only in "cargo only" aircraft. The procedures for transporting high-level samples are as per the EPA *CLP Guidance for Field Samplers, Draft-Final* (EPA 2003).

6.5.5 Notification of Sample Shipment

To enable CLASS to track the shipment of RAS samples from the field to the laboratory and to ensure timely laboratory receipt of samples, the RAC II team will notify the designated RAS coordinator at CLASS (phone number: (703) 264-9280) following all sample shipments and provide the following information:

- Sampler name and phone number
- CLP Case RAS number
- Site name
- Total number of samples of each matrix and concentration level shipped
- Laboratory(ies) to which samples were shipped
- Courier and airbill number(s) for shipment
- Shipment method (i.e., overnight)
- Date of shipment
- Any irregularities or anticipated problems with the samples, including special handling instructions, or deviations from established sampling procedures
- Suspected hazards associated with the samples or site
- Status of the sampling project (e.g., final shipment, update of future shipping schedule).

If samples are to be shipped on a Friday, CLASS must be contacted by 3:00 pm eastern standard time (EST) on Thursday in order to alert the laboratory of Saturday receipt of samples.

6.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The CDM Quality Procedure (QP) 2.1, "Procuring Measurement and Test Equipment" will be used by the project personnel when purchasing or renting equipment that will collect site data and field measurements. This process includes the completion of Measurement and Test Equipment (M&TE) forms on which specifications related to meeting project DQOs and requirements for calibration are included. Tables 6-3 and 6-4 include information regarding the calibrated instrument range and specifications of field measurement equipment required for the project. Equipment purchasing/renting activities are performed by CDM purchasing staff, who maintain a copy of QP 2.1. Copies of QP 2.1 are also available in each CDM office.

Table 6-4 includes requirements for maintenance as well as calibration of field equipment. The staff will obtain spare replacement parts as required for the various equipment as well as appropriate calibration standards. One "Equipment Calibration Log" as shown in Figure 6-8 will be used for each piece of field measurement equipment and is traceable by serial number. These forms will be completed daily or as specified on Table 6-4. The "Maintenance and Calibration Record" will be used in two ways. It will be completed during the initial calibration or field check of each instrument to provide detailed information regarding the calibration procedure. The FTL or designee will check that these forms have been completed correctly. Secondly, it will be used to document any maintenance performed on an instrument. Section 6.7 discusses equipment maintenance. These forms will be maintained in the project files and referred to by project staff.

6.7 Instrument Calibration and Frequency

Each piece of field equipment used for measuring, monitoring, or analytical purposes is calibrated and maintained periodically by the field staff to assure accuracy within specified limits. General equipment handling and calibration procedures are detailed in the manufacturer's manuals. A copy of these manuals will be on site at all times. Field equipment to be used at the site that require calibration and/or maintenance is listed in Tables 6-3 and 6-4.

If the calibration schedule is not adequately maintained or accuracy as reported in the specifications cannot be attained, the instrument is labeled "HOLD" and is unavailable for use until the specifications are attained. The field team should not accept instruments labeled "HOLD" or instruments that are out of the maintenance requirements as specified in the manufacturer's manual and Table 6-4.

The field team will be required to calibrate/ field check and maintain the field equipment on a daily basis, per the users' manual and Table 6-4. Information related to the field calibration and maintenance will be noted in the field logbook. This information will include, at a minimum, the instrument identification number, date and time of calibration, the calibration standard and its source, the person performing calibration, adjustments made, any problems noted during calibration, and a record of calibration measurements. This information will be tracked on Figure 6-8, "Equipment Calibration Log" and Figure 6-9 "Maintenance and Calibration Record."

It is the analytical laboratory's responsibility to perform calibration and maintenance at the mandated frequencies for their laboratory analytical equipment as required. In addition, pool subcontractors will be required to perform equipment calibration per the contractual statement of work.

6.8 Inspection/Acceptance Requirements for Supplies and Consumables

Upon receipt from the vendor, field equipment will be inspected to make sure that the items are in compliance with the required specifications, that they are in working order and that the correct amount has been received. The form shown on Table 6-5 may be used to track supplies and consumables. The project staff will inspect the equipment in accordance with CDM quality procedures 2.3 and 5.3. The following forms may be used by project staff as necessary.

- Figure 6-10 - "Nonconformance Report" from QP 2.3
- Figure 6-11 - "Item Inspection Report" from QP 5.3

In addition to requirements specified elsewhere in this QAPP, the following criteria will be met when purchasing field equipment.

Sample Bottleware
When purchasing sample containers, the following criteria must be met. The sample containers must meet EPA's specifications and therefore will be acquired through an appropriate vendor. The supplier of the sample containers must pre-clean and laboratory analyze them according to the OSWER Directive 9240.0-05A to ensure that no contamination exists that may affect analytical results. .

Each group of cleaned sample containers is assigned a unique identifying QC lot number, which is permanently affixed to each container. Clean, empty sample containers are shipped to users in protective cardboard containers. Upon receipt, the lot numbers will be recorded in the field logbooks. Analytical data demonstrating sample container cleanliness will be kept on site, and will be filed in the CDM RAC II project file when the field work is completed.

Demonstrated Analyte-free Water
The demonstrated analyte-free blank water will meet the criteria specified in the EPA Region II CERCLA QA Manual, Revision 1 (EPA, 1989) Part II, Section 10-A.2, pages 59-60. The detections must demonstrate that the water quality is analyte-free to levels that fall below the target compound list (TCL) and target analyte list (TAL) CRQL. Certificates of analysis will be maintained for the blank water and are traceable by lot numbers.

Calibration Solutions and On Site Laboratory Standards
The field team leader will check expiration dates for equipment calibration solutions and on site laboratory standards and fresh replacements purchased as necessary.

6.9 Data Acquisition Requirements (Non-Direct Measurement)

No non-direct data measurements will be made during this project.

6.10 Data Management

The ASC is responsible for tracking samples from the point of field collection to submittal for laboratory analysis and the subsequent data validation and data management efforts. The sample handling and custody requirements including field logbook (TSOP 4-1) and generation of sample paperwork, sample labels and custody seals (TSOP 1-2) discussed in Sections 6.3 and 6.5 will be followed. The laboratory QA requirements including laboratory audits and contract compliance screening will be followed according to procedures described below and in Section 6.16. The ASC will receive non-RAS data from the laboratory and track it through the data validation process. RAS data will be validated by EPA who will be responsible for tracking and maintaining custody of the laboratory data packages through the data validation process (Section 6.12). When non-RAS data packages are received from the laboratory, the ASC will initiate a non-RAS Data Package Chain-of-Custody Form. All transfers of the data package from one individual to the next must be recorded on the custody record. The data package itself must remain under lock and key when not undergoing processing. Data validation performed by CDM will be in accordance with the procedures described in Section 6.12 of this plan. Once the data is validated, it will be input into CDM's database.

A project-specific electronic spreadsheet will be developed for sample tracking purposes prior to field activities. The tracking system will be initiated in the field during sample collection and will be updated during the sample analysis and data validation phases. The data will be entered by project staff and then checked by the ASC for accuracy. This tracking system will ensure that no data is lost during the data management process.

The following information is recorded in the tracking system:

- Sample Number
- Area of Concern
- Sample Matrix
- Sample Delivery Group Number
- CLP Case No.
- CLP No.
- Analytical Parameter
- Collection Date
- Shipment Date
- Date Received from Lab
- Date Submitted for Data Validation
- Name of Data Validator
- Date of Data Validation Completion
- Database Entry Date
- Database QC Date
- Comments (i.e., MS/MSD designation, duplicate samples)

Analytical data collected during the field effort will be entered into EQuIS, a relational database management system, and standard commercial software packages. This management system will include both location and environmental data. Historical data and potentially responsible party data can also be entered. The database management system will provide data storage, retrieval, and analytical capabilities. The system will be able to meet a full range of site and media sampling requirements since it will be able to interface with a variety of spreadsheet, word processing, statistical, and graphics software packages.

To facilitate the use of the database, CDM will provide the laboratories with a detailed format specification for the delivery of analytical data in an electronic data deliverable (EDD). Once it is uploaded into the database, validated analytical data will be organized, formatted, and input into the database for use in the data evaluation phase. A 100 percent quality control check will be performed on the data entry of all (location and environmental) data to insure accuracy.

Data tables that compare the results of the various phases of sampling efforts will be prepared and evaluated. In addition, data tables that compare analytical results with both state and federal applicable or relevant and appropriate requirements (ARARs) will be prepared. Analytical data results will interface with graphics packages to illustrate the contaminants detected. As a quality control check, reports, tables, and graphical figures will be compared to the sample tracking system for errors and omissions. CDM will provide EPA with final analytical data on electronic media.

Data management will utilize personal computers (PC), local area networks (LAN), and electronic communications (ex: the World Wide Web) to support the database management system software. CDM will set up PC stations on which the database management system and commercial software will run in compliance with those software licensing requirements. CDM will take reasonable care to protect the data and will perform periodic backups to prevent wholesale loss of project data. Control of the computer hardware and software will be as per CDM QP 4.1.

After the data has been validated, the package is returned to the ASC. The ASC will then have copies made of the Region II chain-of-custody/data transfer log, validated Form Is, data validation assessment and data validation checklist for distribution to the project manager and RAC II document control files. The original data package with all associated forms will be boxed and coded for subsequent archival by the EPA. The data package is then hand delivered to the EPA RSCC. A signed receipt must be obtained from RSCC and filed by the ASC and a copy placed in the project file and RAC II document control files.

Laboratory Audits

Requirements for the performance and reporting of laboratory technical system audits and PE sample audits will be as specified in the RAC II QMP and the governing subcontract SOW for non-RAS analytical services.

Contract Compliance Screening

Laboratory compliance will be tracked by the use of Contract Compliance Screening (CCS) forms and Complete SDG File (CSF) inventory sheets. The CCS and CSF information will be used by CDM to track the contract laboratory performance and deliverables completeness. This is not a data validation step but is the first step in the case review. Problems noted in the CCS will be communicated to the laboratory in writing with copies to the RQAC. Problems noted in the CSF will require that the laboratory provide the missing deliverable or better copies in a timely manner to allow the start of the data validation process.

The CCS and CSF information will be used to track laboratory performance and initiate laboratory audits. Chronic problems identified through the CCS process will trigger consideration for corrective action.

6.11 Data Reduction

Each laboratory will be responsible for preparing the analytical data packages for the various analyses. The analytical laboratories will also be responsible for providing an electronic copy of the analytical data.

The CLP laboratories will provide analytical data packages to the EPA Region II shipping coordinator and to Environmental Services Assistance Team (ESAT), EPA's data validation contractor, for data validation. The EPA DESA laboratory normally provides only the Form I equivalent data report for use by CDM. Any additional data package back-up for the DESA samples must be obtained through a request by the EPA RPM to the DESA laboratory. The CDM non-RAS laboratory subcontractor will be responsible for data reporting in accordance with the requirements of the contractual statement of work for these analytical services.

Data reduction will consist of tabulating the validated sample data and evaluating it for consistency with field documentation. Reports will be prepared by CDM summarizing the results. Data entry will be checked for quality control during the preparation of any report presenting the data. Samples sent to PNNL for analysis will be validated by PNNL.

6.12 Data Validation

Data validation will be performed for RAS data (LDL VOCs) by ESAT data validators and for non-RAS CDM laboratory data (trace metals) by CDM data validators who have experience in validating the parameters of interest.

Metals data validation will be performed using SOP No. HW-2 (or current revision) for inorganics. ESAT data validators will use SOP No. HW-13 (or current version) for LDL VOCs.

Analytical methods are listed on Table 6-1. Items such as instrument tuning criteria, surrogate recovery, internal standard response criteria, initial and continuing calibration response criteria, and laboratory control recovery will be assessed as part of the data validation.

The following requirements apply to CLP data and non-RAS data. The project personnel will review sample and related QC data. At a minimum, QC review will consist of the following steps.

1. Verifying analytical system performance and calibration acceptability
2. Verifying sample results by tracing the final number back to the raw data
3. Verifying that QC data has met project QC frequency and control limits or, if the requirements were not met, verifying that documentation is present explaining why the data were accepted and verify that the data were flagged to signify an out-of-control situation
4. Verifying that sample holding times meet method requirements
5. Verifying that samples were analyzed using the specified methods
6. Verifying that the proper chain-of-custody procedures were documented

6.13 Data Reporting

Analytical results (CLP-generated and non-RAS data) will be in a format consistent with and equivalent to the CLP organic target compound list and inorganic target analyte list multi-media/multi-concentration SOW (document numbers OLC03.2 and ILM05.3, respectively). Unless an alternative is required for a specific analysis and approved by EPA, analyses will be reported in this CLP RAS format.

Upon request, documentation files pertaining to standards and standard preparation must be submitted with the data package. EPA QC reference standards, or any other reference standards or initial calibration verification standards, will be identified as to source and lot number.

A. For each sample delivery group, all sample analysis must be completed and the written report and computer-readable format submitted to the ASC within the specified days (as stated in the applicable SOW) of the last sample receipt for that SDG.

B. The following documentation is required with SDG deliverables (all data packages must follow EPA CLP deliverables format cited in SOW OLC03.2, or most current revision):

    1) Data sheets with tabulated results, including tentatively identified compound (TIC) information where applicable. Data sheets must contain all information required for EPA CLP Form Is.

    2) QA/QC information forms, utilizing EPA CLP forms wherever applicable, including but not limited to:

Organics

a) surrogate recovery information, CLP Form IIs
b) blank spike/laboratory control sample/matrix spike/matrix spike duplicate/matrix duplicate percent recovery and relative percent difference information, CLP Form IIIs
c) method blank summary information, CLP Form IVs
d) instrument performance checks, CLP Form Vs
e) initial calibration data, CLP Form VIs
f) continuing calibration data, CLP Form VIIs
g) internal standard area and retention time data, CLP Form VIIIs
h) any information relating to data quality required by CLP SOWs or specified EPA methodologies

Inorganics

a) initial and continuing calibration verification, CLP-like Form IIAs
b) contract required detection limit (CRDL) standard for AA and inductively coupled plasma (ICP), CLP-like Form IIBs
c) blanks, CLP-like Form IIIs
d) ICP interference check sample, CLP-like Form IVS
e) spike sample recovery, CLP-like Form VAs
f) post digestion spike sample recovery, CLP-like Form VBs
g) duplicates, CLP-like Form VIs
h) laboratory control sample, CLP-like Form VIIs
i) standard addition results, CLP-like Form VIIIs
j) ICP serial dilutions, CLP-like Form IXs
k) instrument detection limits (quarterly), CLP-like Form Xs
l) ICP interelemental correction factors (annually), CLP-like Forms XIA and B
m) ICP linear ranges (quarterly), CLP-like Form XIIs
n) preparation log, CLP-like Form XIIIs
o) analysis run log, CLP-like Form XIVs

3) Written case narrative describing all factors affecting the analysis and all corrective actions taken, including but not limited to:

a) problems with the receipt, preparation and/or analysis of samples and/or QC results
b) the actual method used for preparation and analysis

c) justification for any dilution and reanalysis of any samples or extracts and/or digestates. CDM management must approve these dilutions and reanalysis before they will be accepted as a separate cost unit
d) summary table of laboratory ID versus CDM's sample ID numbers
e) modification made to the methods (the laboratory must immediately inform CDM's ASC of such modifications)
f) any analytical problems or inconsistencies in data and corrective action taken to resolve the problem

4) Raw data to include but not be limited to:

a) Sample ID number that must appear on all raw data.
b) quantitation reports, chromatograph, relevant spectra. run logs, instrument printouts, strip charts and any other information necessary to validate during independent data review the results reported on data sheets.
c) Sample packing lists, chain-of-custody records, and log-in record sheets.
d) The laboratory will be also be required to provide the ASC with a weekly listing, by project, of SDG number, samples in each SDG, and SDG date.
e) The laboratory will also be required to provide a monthly report to the ASC.

The data packages must be submitted unbound, paginated, and sequentially numbered.

The CDM subcontract laboratory is required by the applicable SOW to archive data reports and associated raw data (e.g., gas chromatography/mass spectrometry (GC/MS) tapes) after submittal of the final SDG. Statement 4 (f) above refers to ad hoc requests for the current laboratory QA Management Plan and other documentation as an on-going stipulation of the contract after contract award. However, these documents will be initially requested and evaluated by technical and QA reviewers prior to award as part of the procurement process.

Storage and document control of validated data will be performed by CDM. CDM will maintain a document control system that is linked to the RACMIS, which has been designed for the RAC II program. The document control system assigns a unique number to each document. The system provides a verification database to ensure consistency in such items as work assignment number and project name.

All project documentation will be maintained in the project files by the CDM SM until the project undergoes final closeout procedures. Copies of all deliverables submitted to EPA will be maintained in the RAC II document control files. In accordance with the RAC II contract, documents will be stored by CDM for ten years following the final closeout of the RAC II program.

See Section 6.10 for further details regarding data management.

6.14 Internal QC Checks and Frequency for Laboratory Analysis

This section discusses the general laboratory QC requirements. The CLP laboratories will adhere to the EPA CLP organic target compound list multi-media/multi-concentration SOW, document number OLC03.2, QC requirements.

- Method Blanks. Method blanks contain all the reagents used in the preparation and analysis of samples and are processed through the entire analytical scheme to assess spurious contamination arising from reagents, glassware, and other materials used in the analysis.
- Calibration Check Samples. One of the working calibration standards which is periodically used to check that the original calibration is still valid (e.g., continuing calibration standard).
- Laboratory Duplicates/Replicates. A duplicate aliquot taken from the same sample is carried through the entire preparative and analytical scheme. May also be received as double volume samples from the field. The results are used to estimate the precision of the analytical procedures.
- Spiked Samples. Known amounts of a particular constituent are added to high purity laboratory water or solvent, or to a field sample. The percent recovery of the added amount is used to estimate the accuracy of the analytical procedure. If laboratory water or solvent is spiked, the resulting sample may be called a Laboratory Control Sample. If a field sample is spiked, the resulting sample is called a matrix spike.
- Laboratory Control Samples (LCS). These samples are usually prepared from EPA Environmental Monitoring Systems Laboratory (EMSL) concentrates or National Institute of Standards and Technology (NIST) standard reference materials. The LCS are used to establish that an instrument or procedure is in control. An LCS is normally carried through the entire sample preparation and analysis procedure. These samples provide an indication of whether the lab processes are in control of problems from matrix effects.
- Matrix Spikes. One field sample is divided into two or more aliquots. One aliquot is analyzed as is (without spiking) and one or more aliquots are spiked and analyzed. The percent recovery of the known spike is determined; it gives information on the accuracy of the analysis, matrix interferences, and provides an indication of the suitability of the method for the matrix.

- Control Charts. Control charts provide a means of defining acceptable levels of analytical performance and determining whether those levels are achieved and maintained. They are also used to indicate shifts and trends in laboratory performance.

Table 6-6 cites the minimum frequency of use for the QC checks. For non-RAS samples, laboratory acceptance limits and planned corrective actions will be included in the laboratory SOW.

6.14.1 Action Required If QC Limits Are Exceeded

General

The CDM subcontract laboratory shall immediately notify CDM verbally and in writing within 48 hours, when major problems occur (i.e., missed holding times, catastrophic equipment failure).

Blanks

Failure to obtain analysis blank values less than the required detection limits requires that all samples associated with that analysis blank be re-prepared and re-analyzed for the affected parameters (except for compounds that are permitted by the methods to be present up to five times the detection limit, i.e., acetone, methylene chloride). The affected samples should only be re-analyzed after the contamination source has been identified and corrected (i.e., analytical data associated with a contaminated blank will not be accepted).

Matrix Spike and Matrix Spike Duplicates (Percent Recovery)

If percent recoveries (%R) are out of control limits:

1. Re-analyze the sample and spikes if sufficient quantity is available. Report both sets of analysis. Perform a post-digestion spike unless the sample result exceeds the spike concentration by a factor of four or more.
2. Calculate and report the percent recoveries. Summarize any deficiencies in the case narrative.

Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD) (Relative Percent Difference)

If the MSD or MD relative percent difference (RPD) are out of control limits:

1. Organics - QC requirements are advisory. No actions are required for exceeded limits.
   Inorganics- Re-analyze the sample and duplicate if sufficient quantity is available.
2. If RPD is still out of control or if re-analysis cannot be performed, calculate and report RPD value(s). Report the need for and/or result of re-analysis in the narrative summary. Include a list of associated field samples.

Quality Control Check Sample

If quality control check sample is out of control limits:

1. Re-analyze the prepared quality control check sample and if still "out of control, "re-extraction and re-analysis of associated samples is required.
2. Field sample or laboratory QC sample results associated with "out of control" quality control check sample analyses will be qualified according to the relevant validation protocol shown in section 6.12.

6.14.2 Non-Standard Analysis

When a laboratory will need to perform a non-standard method that has not been previously approved by EPA (such as SW-846 methods) or analyze by a modification to established methods, the laboratory will be required to perform the following protocol to demonstrate their ability to analyze for the non-standard parameters or methods.

A. A method detection limit (MDL) study following the description given in 40 CFR Part 136, Appendix B.

B. A calibration of no less than four standards including the blank. The standards preparation method and calculations, from neat or original standard to working standards, must be provided with the first submission of data for the new analyte.

C. Verification of standard calibration with a second source, if feasible, or at a minimum an independently prepared standard at the mid-range of concentration.

D. Accuracy and precision studies using blank spikes/blank spike duplicates, matrix spike/matrix spike duplicates and matrix spike/duplicates.

E. A run sequence comparable to those normally described in EPA methodologies, i.e., calibration, initial calibration verification, instrument blank, method blank, ten samples (including QC), continuing calibration verification, instrument/method blank, and so on.

F. Analytical results must be reported in CLP RAS format utilizing CLP forms wherever possible.

G. All QC requirements in the method cited for the analysis, whether suggested, recommended, or required must be implemented.

A summation of the MDL study will be included with the data package. The laboratory will supply a detailed example calculation that clearly demonstrates the manner in which the final result was derived. Where applicable, each component of the calculation will be explained (i.e., if the calculation includes a dilution factor, it must be clear where, why, and how each dilution occurred). The laboratory will supply any and all information required to reproduce, during an independent data review, all reported results.

6.15 PARCCS Definition and Evaluation

Once generated data has been reviewed, verified, and/or validated, trained technical CDM personnel will evaluate the finalized sample data packages against the DQIs as discussed in Section 6.1 and defined on Table 6-1. These DQIs include precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS). PARCCS parameters are indicators of data quality. PARCC goals are established for the site characterization to aid in assessing data quality. The following paragraphs define these PARCC parameters in conjunction with this project. The evaluation will serve as a check on whether the total measurement set had met the work assignment scope and objectives described in Section 1.6.

Precision is the agreement between a set of replicate or duplicate measurements without assumption of knowledge of the true value. Precision is assessed by means of duplicate/replicate sample analyses. Precision can usually be expressed as relative RPD or relative standard deviation (RSD). The quantities are defined as follows:

$$RPD = 100 \times 2 \,|X_1 - X_2|\, / \,(X_1 + X_2)$$

where X_1 and X_2 are the reported concentrations for each duplicate or replicate

$$RSD = \frac{S}{X} \times 100$$

where S is the standard deviation of the series of individual measurements and X is the mean of the series of individual measurements.

Accuracy is defined as the nearness of a measurement to its true value. Accuracy measures the average or systematic error of a method. Accuracy DQIs are summarized on Table e6-1. Accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. For organic analyses, two type of recoveries are measured: matrix spike and surrogate spike. For a matrix spike, known amounts of standard compounds identical to the compounds present in the sample of interest are added to the sample. For a surrogate spike, the standards are chemically similar but not identical to the compounds being analyzed in the fraction. The purpose of the surrogate spike is to provide quality control on every sample by constantly monitoring for unusual matrix effects and gross sample processing errors. For inorganic analyses, only matrix spikes are measured in general.

Since accuracy is often determined from spiked samples, laboratories commonly report accuracy in this form. Percent recovery is defined as:

$$\% \text{ Recovery} = \frac{R-U}{S} \times 100$$

where

S = concentration of spike added
U = measured concentration in unspiked aliquot
R = measured concentration in spiked aliquot

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Section 6.1.2 discusses field procedures that contribute to representativeness of the sampled media. The documentation required in this QAPP will enable checking that sampling protocols have been followed and sample identification and integrity have been assured. Field planning meetings, field technical system audits, and oversight by the FTL will provide opportunities to check that field procedures are being correctly implemented.

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data will be comparable with other measurement data for similar samples and sample conditions. Comparability of the data will be maintained by use of consistent and standardized methods and units of measurement. Table 6-1 includes the specific parameters, applicable methods of analysis, and target detection limits. Actual detection limits will depend on the sample matrix (e.g., necessary dilutions) and will be reported as defined for the specific samples.

Completeness is a measure of the amount of valid data obtained from the analytical measurement system and the complete implementation of defined field procedures. Section 6.1.2 provides additional information on this DQO. The completeness objective for this project is 90 percent. Percent of completeness is defined as:

$$\% \text{ Completeness} = \frac{V}{n} \times 100 \quad \text{and} \quad = \frac{V}{C} \times 100$$

where

V= number of measurements judged valid
n = total number of measurements made
C= total number of data planned

Sensitivity relates to the method detection limit necessary for each parameter. The reported detection limits must meet the requirements for the project such as defined by ARARs (i.e., drinking water maximum contaminant levels). Table 6-1 indicates the expected detection limits. It should be noted that sensitivity of individual samples is affected by sample size and matrix and the instrument that is used for the analysis.

The equations used for precision, accuracy, and completeness will be used to quantitatively compare sample data results with the required DQIs. Relative percent difference, relative standard deviation, and percent recoveries of sample data will be compared with these DQIs. Any DQIs deviations and/or data outliers will be discussed with the CDM SM, the ASC, and laboratory management to determine possible causes for such conditions. Significant problems with meeting project DQOs and potential solutions may be discussed with the RQAC or other qualified QAC on an ongoing basis. Discussions, evaluations, and conclusions as a result of the above assessments will be consolidated into the QA section of the measurement report provided to EPA. This section will note any limitations on the use of the data. This section will be reviewed by the RQAC or other qualified QAC during QA review.

6.16 Assessments and Response Actions

CDM is responsible for its own system audits. EPA is provided with a copy of the audit reports. Two types of system audits may be conducted, the technical system audit (field audit) and the internal system audit (office audit).

The field audit is used to verify that a system of quality control measures, procedures, reviews and approvals were established and used as specified in the QAPP (e.g., preserving, shipping, documenting, and analyzing the samples). Field audits are conducted by a qualified auditor under the direction of the CDM RAC II QA Manager. Field audits may be conducted in the field or at a subcontract laboratory. The auditor coordinates with the SM to identify the field activities or analytical procedures that are in progress during the audit and obtains documents governing those activities. The auditor prepares a checklist specific to the activities to be performed and observes them to verify compliance with the QAPP. EPA is informed that a field audit will be conducted before its implementation.

An office audit may be performed during this work assignment. This audit evaluates the use of QC measures and includes: interviewing the SM and project personnel; determining whether work has been conducted according to governing documents; determining whether deliverables identified in the work plan have been prepared; determining whether documents received proper technical and/or QA review; reviewing files for appropriate memos, QC records, or other documentation; and examining the central files to verify filing of deliverables. The RAC II QAM or his designee is responsible for scheduling the audit and the RQAC is responsible for the conductance of internal system audits.

These system audits are conducted following the procedures outlined in the CDM RAC II QMP. CDM's QP 6.2, and Auditor's Handbook, section 2.6 details audit requirements. Whether a project is audited and the frequency of field and office systems audits is the responsibility of the RAC II QA Manager. This maintains independence and objectivity in the audit process. Audit schedules are determined quarterly and are based on the project size, level of effort, period of performance, duration of field work (at least two weeks) and type of work. Other considerations apply, such as, potential problems anticipated or whether the project was previously or recently audited. Performance audits of the subcontract laboratory are determined by the project manager and its schedule is dependent on the purpose of the audit. EPA may also conduct or arrange for system audits.

Performance audits, which involve the submittal of a PE sample to a laboratory, will be the responsibility of EPA for the CLP laboratory and the responsibility of CDM for the subcontractor laboratories. CDM will require that subcontractor laboratories successfully pass applicable PE sample audits that were administered prior to award and throughout the length of the subcontract. These PE sample audits will include those administered by EPA and applicable federal or state agencies or other entities.

6.16.1 Corrective Action

If a nonconformance or deficiency is identified during the work assignment or during a technical or internal systems audit, corrective action will be initiated by the RAC II team and its subcontractors as defined in Section 7 of the CDM RAC II QMP. The corrective action steps are:

- Identify and define the problem;
- Assign responsibility for investigating the problem;
- Determine corrective action to eliminate the problem;
- Assign responsibility for implementation of the corrective action;
- Implement the corrective action;
- Verify that the corrective action has eliminated the problem; and
- Document the problem identified, the corrective action taken, and its effectiveness in eliminating the problem.

According to the RAC II QMP procedures, the auditor will be responsible for filing a audit report along with a Corrective Action Request form, if any nonconformances are noted during the system audit. The audit report will be formally approved by the RAC II QAD and distributed to the audited party, CDM program management, and EPA. The SM must accept overall responsibility for completion of all appropriate corrective actions. The FTL will be responsible for initiating, undertaking, and completing any corrective actions associated with the field activities. Each team member is responsible for adherence to corrective action guidelines.

The RAC II team also will be responsible for reporting all suspected technical nonconformances by initiating a corrective action as described in Section 9 of the RAC II QMP. Any staff member who discovers or suspects a nonconformance, which is an identified or suspected deficiency from an approved document, also is responsible for initiating corrective action. The Quality Assurance Coordinator is responsible for investigating the problem and following up on its resolution.

The SM will ensure that no additional work, which is dependent on the nonconforming activity, is performed until the nonconformance is corrected.

Following completion of corrective actions, the RAC II QAM or her designee will determine whether all nonconformances have been adequately addressed. If nonconformances have not been adequately addressed, the subsequent steps outlined in the CDM RAC II QMP will be taken until the nonconformance has been corrected. An audit completion notice will be completed at this time.

Section 7

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Section Seven

Section 7 References

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Section 8

8

Section Eight

Section 8
Acronyms and Abbreviations

AA	Atomic absorption
ANSETS	Analytical Services Tracking System
ARARs	Applicable or Relevant and Appropriate Requirements
ASC	Analytical Services Coordinator
bgs	below ground surface
°C	degrees Celsius
CCS	Contract Compliance Screening
CCWD	Camden County Water Department
CDM	CDM Federal Programs Corporation
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CERCIS	CERCLA Information System
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CLASS	Contract Laboratory Analytical Support Services
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
CSF	Complete SDG File
1,2-DCA	1,2-dichloroethane
1,1-DCE	1,1-dichloroethene
DESA	Division of Environmental Science and Assessment
DO	Dissolved Oxygen
DOT	US Department of Transportation
DQI	Data Quality Indicators
DQO	Data Quality Objectives
EB	Equipment Blank
EDD	Electronic Data Deliverable
EMSL	Environmental Monitoring Systems Laboratory
EPA	United States Environmental Protection Agency
ESAT	Environmental Service Assistance Team
EST	Eastern Standard Time
FASTAC	Field and Analytical Services Teaming Advisory Committee
FB	Field Blank
FCR	Field Change Request
FG	Field Geologist
FS	Feasibility Study
FTL	Field Team Leader
GC/MS	Gas chromatograph/mass spectrometer
GPS	Global Positioning System

HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
ID	identification
IDW	Investigation-Derived Waste
L	liter
LAN	local area network
LCS	Laboratory control sample
LDL	Low detection limit
MCL	Maximum Contaminant Level
MDL	Method detection limit
mg/L	milligram per liter
mgd	Million gallons per day
ml/min	milliliters per minute
MS	matrix spike
MSD	matrix spike duplicate
M&TE	Measurement and Test Equipment
MW	Monitoring Well
NA	Not available; not applicable
NEIC	National Enforcement Investigations Center
NIST	National Institute of Standards and Technology
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priority List
NTU	nephalometric turbidity units
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Act
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PARCCS	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCE	tetrachloroethene
PE	performance evaluation
PNNL	Pacific Northwest National Laboratory
PRM	Potomac-Raritan-Magothy
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
QP	quality procedure
RA	risk assessment
RAC	Response Action Contract
RACMIS	RAC Management Information System
RAS	Routine Analytical Services
RI/FS	Remedial Investigation/Feasibility Study
RI	Remedial Investigation
RPD	relative percent difference

RPM	Remedial Project Manager
RQAC	Regional Quality Assurance Coordinator
RSCC	Regional Sample Control Center
SCBA	self contained breathing apparatus
SDG	sample delivery group
SM	Site Manager
SOW	Statement of Work
TAL	Target Analyte List
TB	Trip Blank
TCE	Trichloroethene
TCL	Target Compound List
TIC	Tentatively Identified Compound
TSOP	Technical Standard Operating Procedure
USGS	United States Geological Survey
VOA	volatile organic analysis
VOC	Volatile Organic Compound
µg/L	microgram per liter
% R	percent recoveries

Tables

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Table 4-1

Summary of Data Quality Objective (DQO) Process
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Area/Activity		Step 1: Problem Statement	Step 2: Decision Statement	Step 3: Identify Decision Inputs	Step 4: Define Study Boundary	Step 5: Decision Rules	Step 6: Limits on Uncertainty	Step 7: Investigation/ Sample Design
In Situ Remedial Technology Pilot Test Site: MW-36 and MW-37	Sediment Sampling	In situ geological, physical geochemical and microbiological data are needed by PNNL to evaluate planned in situ treatment technologies at the site.	What are the in situ physical, geochemical, and microbial characteristics of subsurface sediments at the in situ remedial technology pilot test site?	PNNL data from physical, geochemical, and microbial sediment samples; CDM geological data	Horizontal boundaries include the locations of the two borings, as shown on Figure 4-1. Vertical boundaries range from ground surface to 300 feet bgs.	PNNL will determine the decision rules for this activity.	PNNL will analyze and validate all sediment data for use in the PNNL treatibility study; PNNL has evaluated limits on uncertainty and incorporated them into company-specific analytical methods.	20 subsurface sediment samples per boring, as shown on Table 4-2 (40 samples total).
	Discrete-Depth Groundwater Sampling	Data is needed to develop a parameter baseline for planned in situ treatment technologies. Data is needed to determine if the proposed treatment technology will be effective. Data is also needed to determine if trace metals analytes will interfere with the planned in situ technologies	What are baseline levels of testing parameters? What analytes may interfere with planned in situ treatment technologies? Is the treatment technology effective?	1. CLP-validated data for LDL VOCs 2. CDM-validated data for trace metals 3. PNNL data for ferrous iron 4. CDM field screening data for ferrous iron and hexavalent chromium	Horizontal boundaries include the locations of the two borings, as shown on Figure 4-1. Vertical boundaries range from ground surface to 300 feet bgs.	PNNL will determine the decision rules for this activity.	Analytical methods and quantitation limits have been specified by PNNL.	20 discrete-depth groundwater samples per boring, as shown on Table 4-2 (36 samples total)
	Monitoring Well Installation				Horizontal boundaries include the locations of the two borings, as shown on Figure 4-1. Vertical boundaries range from ground surface to 300 feet bgs.	PNNL will determine the decision rules for this activity.	Analytical methods and quantitation limits have been specified by PNNL.	2 monitoring wells
	Monitoring Well Sampling				Horizontal boundaries include the locations of the two borings/monitoring wells at the in situ remedial technology pilot test site, as shown on Figure 4-1, and one existing downgradient monitoring well in the downgradient plume attenuation study area. Vertical boundaries include the monitoring well screen interval depths.			2 monitoring well samples
Downgradient Plume Attenuation Study Area: D1 and D2	Sediment Sampling	In situ geological, physical, and geochemical data are needed to evaluate planned in situ treatment technologies at the site.	What are the in situ physical and geochemical characteristics of subsurface sediments at the downgradient plume attenuation area?	PNNL data from physical, geochemical, and microbial sediment samples; CDM geological data	Horizontal boundaries include the locations of the two borings, as shown on Figure 4-1. Vertical boundaries range from ground surface to 300 feet bgs.	PNNL will determine the decision rules for this activity.	PNNL will analyze and validate all sediment data for use in the PNNL treatibility study; PNNL has evaluated limits on uncertainty and incorporated them into company-specific analytical methods.	18 subsurface sediment samples per boring, as shown on Table 4-2 (36 samples total).

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Table 4-1

Summary of Data Quality Objective (DQO) Process
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Area/Activity		Step 1: Problem Statement	Step 2: Decision Statement	Step 3: Identify Decision Inputs	Step 4: Define Study Boundary	Step 5: Decision Rules	Step 6: Limits on Uncertainty	Step 7: Investigation/ Sample Design
Downgradient Plume Attenuation Study Area: D1 and D2	Discrete-Depth Groundwater Sampling	Data is needed to develop a parameter baseline for planned in situ treatment technologies. Data is needed to determine if the proposed treatment technology will be effective. Data is also needed to determine if trace metals analytes will interfere with the planned in situ technologies	What are baseline levels of testing parameters? What analytes may interfere with planned in situ treatment technologies? Is the treatment technology effective?	1. CDM-validated data for trace metals 2. PNNL data for ferrous iron 3. CDM field screening data for ferrous iron and hexavalent chromium	Horizontal boundaries include the locations of the two borings, as shown on Figure 4-1. Vertical boundaries range from ground surface to 300 feet bgs.	PNNL will determine the decision rules for this activity.	Analytical methods have been specified by PNNL.	20 discrete-depth groundwater samples per boring, as shown on Table 4-2 (36 samples total)
	Monitoring Well Sampling				Horizontal boundaries include the location one existing downgradient well to be determined. Vertical boundaries include the monitoring well screen interval depths.			1 monitoring well sample

Notes:
bgs Below ground surface
LDL VOCs Low detection limit volatile organic compounds
PNNL Pacific Northwest National Laboratory

Table 4-2

Summary of Borehole Sampling and Analysis Program
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Borehole	Hydro-stratigraphic Layer [2]	Sediment Samples [3]			Groundwater Samples [4]				
		Geochemical Analyses	Microbial Analyses	Physical Parameters	VOCs [5]	Trace Metals [6]	Ferrous Iron (PNNL)	Ferrous Iron [7] *(Field Screening)*	Hexavalent Chromium [8] *(Field Screening)*
MW-36	A-2a	1	1	1	0	1	1	1	1
	A-2b	1	1	1	0	1	1	1	1
	C-2AI	6	6	6	3	3	3	3	3
	A-3a	5	5	5	3	3	3	3	3
	A-3b	4	4	4	1	1	1	1	1
	A-3c	3	3	3	1	1	1	1	1
MW-37	A-2a	1	1	1	0	1	1	1	1
	A-2b	1	1	1	0	1	1	1	1
	C-2AI	6	6	6	3	3	3	3	3
	A-3a	5	5	5	3	3	3	3	3
	A-3b	4	4	4	1	1	1	1	1
	A-3c	3	3	3	1	1	1	1	1
	Subtotal	40	40	40	16	20	20	20	20
D-1	A-2a	1	0	1	0	1	1	1	1
	A-2b	1	0	1	0	1	1	1	1
	C-2AI	4	0	4	0	2	2	2	2
	A-3a	4	0	4	0	2	2	2	2
	A-3b	4	0	4	0	2	2	2	2
	A-3c	4	0	4	0	2	2	2	2
D-2	A-2a	1	0	1	0	1	1	1	1
	A-2b	1	0	1	0	1	1	1	1
	C-2AI	4	0	4	0	2	2	2	2
	A-3a	4	0	4	0	2	2	2	2
	A-3b	4	0	4	0	2	2	2	2
	A-3c	4	0	4	0	2	2	2	2
	Subtotal	36	0	36	0	20	20	20	20
Totals [9]		76	40	76	16	40	40	40	40

Table 4-2

Summary of Borehole Sampling and Analysis Program
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

1. MW-36 and MW-37 are in the "in situ remedial technology pilot test site" and "D" indicates a borehole in the "down gradient location for plume attenuation studies"

2. Hydrostratigraphic layers are the subsurface water bearing and confining units defined by the USGS during the Remedial Investigation.

3. Each sediment sample will consist of three 6-inch lexan encased segments: one segment will be analyzed for geochemical parameters, one for microbial parameters, and one for physical parameters at PNNL.

4. In the field the pH, electrical conductivity, dissolved oxygen, temperature, and oxidation-reduction potential will be measured during purging.

5. Groundwater samples will be analyzed for VOCs through the CLP program using OLC03.2 "Low Detection Limit VOCs".

6. Groundwater samples will be analyzed using EPA Method 6020 for the following metals: Na, Mg, K, Ca, Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Mo, Ag, Cd, Sn, Sb, Ba, Pb, and U.

7. Ferrous iron will be analyzed in the field using a HACH test kit and in the laboratory at PNNL

8. Hexavalent chromium will be analyzed in the field using a HACH test kit.

9. Totals do not include QA/QC samples such as equipment blanks, trip blanks, and duplicates.

Table 4-3

Field Screening and Analytical Sampling Program Summary
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Area	Task	Matrix	# Samples			Analyses			
			Environmental	Dups	TOTAL	Onsite Field Screening	CLP	Subcontract Laboratory	PNNL
In Situ Remedial Technology Pilot Test Site *(consists of two borings: MW-36, MW-37)*	Subsurface Sediment Sampling	SD	40	0	40	---	---	---	Grain Size Distribution; Bulk Density/Porosity; Geochemical Characteristics; Microbial Characteristics
	Discrete-Depth Groundwater Sampling	GW	20	2	22	Ferrous Iron (filtered); Hexavalent Chromium (filtered)	LDL VOCs*	Trace Metals (filtered)	Ferrous Iron (filtered)
Downgradient Plume Attenuation Study Area *(consists of two borings: D-1, D-2))*	Subsurface Sediment Sampling	SD	36	0	36	---	---	---	Grain Size Distribution; Bulk Density/Porosity; Geochemical Characteristics
	Discrete-Depth Groundwater Sampling	GW	20	2	22	Ferrous Iron (filtered); Hexavalent Chromium (filtered)	---	Trace Metals (filtered)	Ferrous Iron (filtered)
Select Monitoring Wells	Monitoring Well Sampling	GW	3	1	4	Ferrous Iron (filtered); Hexavalent Chromium (filtered)	LDL VOCs	Trace Metals (filtered)	Ferrous Iron (filtered); Bench Scale Test Parameters

Notes:
* Per Table 4-2, only 8 of the 10 groundwater samples from each boring in the in situ remedial technology pilot test site will be analyzed for LDL VOCs

SD Sediment
GW Groundwater
PNNL Pacific Northwest National Laboratory
LDL VOCs Low detection limit volatile organic compounds

Table 4-4

Quality Assurance/Quality Control Samples
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Field Task/ Matrix	Area	Analytical Parameters	Laboratory	Environ-mental Samples	Duplicates	MS/ MSDs[1]	Field Equipment Blanks[2]	Trip Blanks[3]	Water Blanks[4]
Sediment Sampling (SD)	In Situ Remedial Technology Pilot Test Site Borings	Physical parameters	PNNL	40	*PNNL does not require QA/QC samples for these parameters. They will address the QA/QC of the process using statistical techniques.*				
		Geochemical Analysis	PNNL	40					
		Microbial Analysis	PNNL	40					
	Downgradient Plume Attenuation Study Area Borings	Physical parameters	PNNL	36					
		Geochemical Analysis	PNNL	36					
Discrete Depth GW Sampling (GW)	In Situ Remedial Technology Pilot Test Site (Two Borings)	LDL VOCs	CLP	16	2	1	10	10	3
		Trace Metals	non-RAS	20	2	1	10	NA	NA
		Ferrous Iron	PNNL	20	2	1	NA	NA	NA
		Ferrous Iron	CDM Field Analysis	20	2	NA			
		Hexavalent Chromium	CDM Field Analysis	20	2				
	Downgradient Plume Attenuation Study Area (Two Borings)	Trace Metals	non-RAS	20	2	1	10	NA	NA
		Ferrous Iron	PNNL	20	2	1	10	NA	NA
		Ferrous Iron	CDM Field Analysis	20	2	NA			
		Hexavalent Chromium	CDM Field Analysis	20	2				
Monitoring Well Sampling (GW)	In Situ Remedial Technology Pilot Test Site Monitoring Wells (2) and Existing Monitoring Well (1)	LDL VOCs	CLP	3	1	1	2	2	NA
		Trace Metals	PNNL	3	1	1	2	NA	NA
		Ferrous Iron	PNNL	3	1	1	2	NA	NA
		Ferrous Iron	CDM Field Analysis	3	1	NA			
		Hexavalent Chromium	CDM Field Analysis	3	1				

Notes:

1: Matrix Spike/Matrix Spike Duplicate

2: Field blanks are collected at a frequency of 1 per day per sampling event

3: Trip blanks are collected at a frequency of 1 per day per cooler of VOCs

4: Water Blanks are collected at a frequency of 1 per lot number of analyte-free and DI water

NA - Not applicable

GW Groundwater Sample

LDL Low-Detection Limit

MW Monitoring Well

SD Sediment Sample

VOC Volatile Organic Compound

Table 4-5

Laboratory Sample Parameters, Methods, Containers, Preservation, and Holding Times
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Sample Matrix	Analytical Parameter	Analytical Method	Containers		Sample Preservation	Holding Time
Aqueous	LDL VOCs	*OLC03.2 or current version* (a)	3	*40-ml vials with Teflon* septum	*HCl to pH < 2 (c), Cool to* 4oC	10 days preserved
	Trace Metals	EPA SW-846 Method 6020	1	1-L polyethylene bottle	HNO3 to pH < 2	178 days
	Ferrous Iron (PNNL analysis)	Ferrozine (Gibbs 1976) (b)	1	40-ml vials with Teflon septum	HNO3 to pH < 2	NA
Sediment	Grain Size Distribution, Bulk Density, and Porosity	ASTM or other standard method	1	6" long Lexan liner sleeve with end caps	None	NA
	Geochemical Analysis	PNNL-specific method	1	6" long Lexan liner sleeve with end caps	Anoxic Protocol (d)	NA
	Microbial Analysis	PNNL-specific method	1	6" long Lexan liner sleeve with end caps	Aseptic Protocol (d)	NA

Notes:

(a) Aqueous samples collected for LDL VOCs will be analyzed according to Chemical Analytical Services for Low Concentration Samples for Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) and Gas Chromatography/Electron Capture (GC/EC) Techniques Document No. OLC03.2 (or current version)
(b) Gibbs, C.R., 1976, Characterization and Application of Ferrozine iron reagent as a Ferrous Iron Indicator, Analytical Chemistry, 48 (8), 1197-1200
(c) Adjust pH of aqueous VOC samples to <2 by the drop-wise addition of 1;1 HCl to the 40-ml vials prior to filling with sample. Do not acidify samples if effervescence is observed; indicate on sampleand sample paperwork that no acid preservative has been added, and contact the laboratory. If VOC samples are not acidified, then the holding time becomes 5 days from verified time of sample receipt or 7 days from time of sample.
(d) See Appendix B preservation protocols and Appendix C for anoix and aseptic preservation protocols

LDL VOCs Low detection limit volatile organic compounds
PNNL Pacific Northwest National Laboratory

Table 6-1

Data Quality Indicators for Precision, Accuracy, Sensitivity, and Completeness of Analyses Puchack Well Field Superfund Site Pennsauken Township, New Jersey

Matrix	Parameter	EPA Method/ SOW	Precision (a) Maximum RPD	Accuracy (b) % Recovery	Sensitivity (c)	Completeness %
Water	LDL VOCs	OLC03.2	50 (Field Duplicate)	37- 171 (DMCs) (e)	0.5 µg/L except as noted (d)	90
	Trace Metals *(Filtered)*	ICP-MS, (SW-846 6020)	20	75-125 (MS) 90-110 (ICV) 80-120 (CCV)	10 ug/L	90
	Ferrous Iron (to PNNL) *(Filtered)*	Ferrozine (Gibbs 1976) (h)	NA	± 10 %	0.02 mg/L	90
	Ferrous Iron (Field Screening) *(Filtered)*	HACH 8146 (f)	50	NA	0.3 mg/L	90
	Hexavalent Chromium (Field Screening *(Filtered)*	HACH 8023 (f)	50	NA	0.007 mg/L	90
Solids	Grain Size	ASTM or other standard method	20 (Lab Duplicate)	NA	NA	90
	Porosity/Bulk Density	ASTM or other standard method	20 (Lab Duplicate)	NA	NA	90
	Geochemical Analysis	PNNL lab specific procedure	NA (g)	NA (g)	NA (g)	NA (g)
	Microbial Analysis	PNNL lab specific procedure	NA (g)	NA (g)	NA (g)	NA (g)

Notes:

a. *Measured as the relative percent difference of spike recovery between the matrix spike (MS) and matrix spike duplicate (MSD) or laboratory duplicate samples. Precision limits for organic analyses are only advisory. Frequent failures warrant investigation. Matrix spikes are not mandatory for low concentration volatile organics, therefore, the precision is measured from any field duplicates, the initial calibration (30 % RSD) or the continuing calibration results (30 % D).*

b. Measured as the percent recovery of surrogate spikes, matrix spikes or as otherwise specified. These limits are specified in the EPA CLP Statement of Work for Chemical Analytical Services for Low Concentration Samples for Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) and Gas Chromatography/Electron Capture (GCE) Technique, Document No. OLC03.2 (or the current revision) and SW-846.

c. For the non-CLP analyses, the sensitivities listed are those indicated in the method. The actual detection limit achieved will be dependent on several factors such as, sample size, matrix and instrumentation used.

d. 0.5 ug/L is the detection limit for all VOCs except as follows: acetone, 2-butanone, 4-methyl-2-pentanone, and 2-hexanone - 5 ug/L.

e. Each DMC has a different recovery limit.

f. See Appendix D for HACH Test Kit procedures

g. Precision, Accuracy, Sensitivity, and completeness not applicable as per PNNL's Sampling and Analysis Plan.

h. Gibbs, C.R., 1976, Characterization and Application of Ferrozine iron reagent as a Ferrous Iron Indicator, Analytic Chemistry, 48 (8), 1197-1200.

PNNL	Pacific Northwest National Laboratory	LDL VOC	Low Detection Limit Volatile Organic Compound
RPD	Relative Percent Difference	ug/l	micrograms per liter
DMC	Deuterated Monitoring Compound		

Table 6-2

Sample Documentation Distribution
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Type of Paperwork	Copy Identification	Copy Submittal
FORMS II Lite Combination Organic and Inorganic Traffic Reports & Chain-of-Custody Records Region Copy	Single Sheet	RSCC[a] CLASS[b]
FORMS II Lite Combination Organic and Inorganic Traffic Reports & Chain-of-Custody Records Laboratory Copy	Single Sheet	Laboratory
FORMS II Lite Non-CLP Traffic Reports & Chain-of-Custody Records Laboratory Copy	Single Sheet	DESA Laboratory[c]
FORMS II Lite Non-CLP Traffic Reports & Chain-of-Custody Records Laboratory Copy	Single Sheet	Laboratory Subcontractor[d] (for later return to CDM) Laboratory Subcontractor PNNL[e] CDM

[a]RSCC address
Mr. Adly Michael
RSCC, Lockheed
175 May St., Ste. 101
Edison, NJ 08837

[b]CLASS address
Ms. Heather Bauer
EPA CLP
1500 Conference Center Drive
Chantilly, VA 20151
(703) 818-4220

[c]DESA Laboratory
Mr. John Birri, Chief
DESA Laboratory
2890 Woodbridge Avenue, Bldg. 209
Edison, NJ 08837

[d]CDM Laboratory Subcontractor
Fixed laboratory address to be determined

[e]PNNL Laboratory
Fixed laboratory address to be determined

Table 6-3

Field Measurement Equipment
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Instrument (parameter)	Reference	Calibrated Instrument Range
RAE Systems miniRAE 2000 Photoionization Detector with 11.7 eV lamp	Manufacturer's Specifications	0.1 - 2000 ppm
YSI Model 600XL (measures pH, conductivity, dissolved oxygen, and temperature)	Manufacturer's Specifications	pH- 0.1-14 pH conductivity 0-100 mS/cm D.O. - 0-19.9 mg/l temperature - 0-50° Celsius
Orion Quickcheck Model 108 (ORP)	Manufacturer's Specifications	+/- 999 mV
HACH DR-2000 Spectrophotometer	Manufacturer's Specifications	400-900 nm
LaMotte Turbidity Meter, Model 2008	Manufacturer's Specifications	0 - 200 NTUs

Notes:

DO	Dissolved Oxygen
ORP	Oxygen-Reduction Potential
eV	Ionization Potential
mg/L	Milligrams per liter
mS/cm	Millisiemens per centimeter
mV	Millivolts
nm	Nanometers
NTUs	Nephelometric Turbidity Units
ppm	Parts per million
psi	Pounds per square inch
psig	Pounds per square inch gauge
psia	Pounds per square inch atmosphere

Table 6-4

Equipment Calibration
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Equipment Type	Calibration Frequency		Calibration Standard	Initial Calibration Tolerance		Post-run Calibration Tolerance		Calibrated Instrument Range	Field Check Frequency	Field Check Accep-tance Range	Maintenance Frequency	
	Primary	Field		Primary	Field	Primary	Field				Primary	Field
miniRAE 2000 Photoionization Analyzer	S	When the unit fails to meet the field check acceptance range	—Primary— NIST traceable I-C_4H_2 in air. —Field— Commercially available I-C_4H_2 in air.	± 0.5ppm of STD.	± 0.5ppm of STD.	N/A	± 25% of the calibrated value	0.1 - 2000 ppm	Beginning and end of each day	± 30% of the calibrated value	S	As needed
YSI Model 600XL	Calibrate before each shipment	Calibrate before each use	NIST traceable buffers and conductivity solution	pH: ±0.05 Cond.: ±5uS DO: ±0.02ppm Temp.: ±0.3° C	N/A	N/A	N/A	N/A	Daily, before each use	N/A	Performed before each shipment	As needed
Orion Quickcheck Model 108	Calibrate before each shipment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Prior to use	N/A	N/A	As needed
HACH DR-2000 Spectro-photometer	Calibrate before each shipment	Calibrate before each use	Zero Standard	N/A	N/A	N/A	N/A	N/A	Prior to use	N/A	Performed before each shipment	As needed
LaMotte Turbidity Meter, Model 2008	Calibrate before each shipment	Calibrate before each use	Calibration Standard	± 2% of reading or 0.05 NTU whichever is greater	± 2% of reading or 0.05 NTU whichever is greater	N/A	N/A	0 to 19.99 and 0 to 199.9 NTU	Daily, before each use	N/A	Performed before each shipment	As needed

Notes:
Primary - Refers to trained personnel, usually associated with the vendor, to perform required maintenance and calibration.

S = Semi-Annually
Q = Quarterly
FS = Full Scale
ORP = Oxidation Reduction Potential

A = Annually
STD = Standard
gpm = gallons per minute
NTU = Nephelometric Turbidity Units

kcps kilo-counts per second
psi pounds per square inch
psia pounds per square inch atmosphere
psig pounds per square inch gauge

N/A = Not Available

Table 6-5

Supplies and Consumables Tracking Log
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Critical Supplies and Consumable (Type, ID No.)	Date Received	Meets Inspection/ Acceptance Criteria (Y/N, Include Date)	Requires Retesting (Y/N, If Yes, Include Date)	Expiration Date	Comments	Initials/ Date

Table 6-6

Laboratory QC Samples
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Sample	Frequency
Internal Laboratory Duplicate	1/20 (minimum of 1/sample event)
Laboratory Check Sample	1/20 (minimum of 1/lab batch)
Matrix Spike	1/20 (minimum of 1/sample event/per matrix)
Matrix Spike Duplicate	1/20 (minimum of 1/sample event/per matrix)
Method Blank	1/20 (minimum of 1/sample event)
Surrogate Spikes (Organic)	1/sample

Figures

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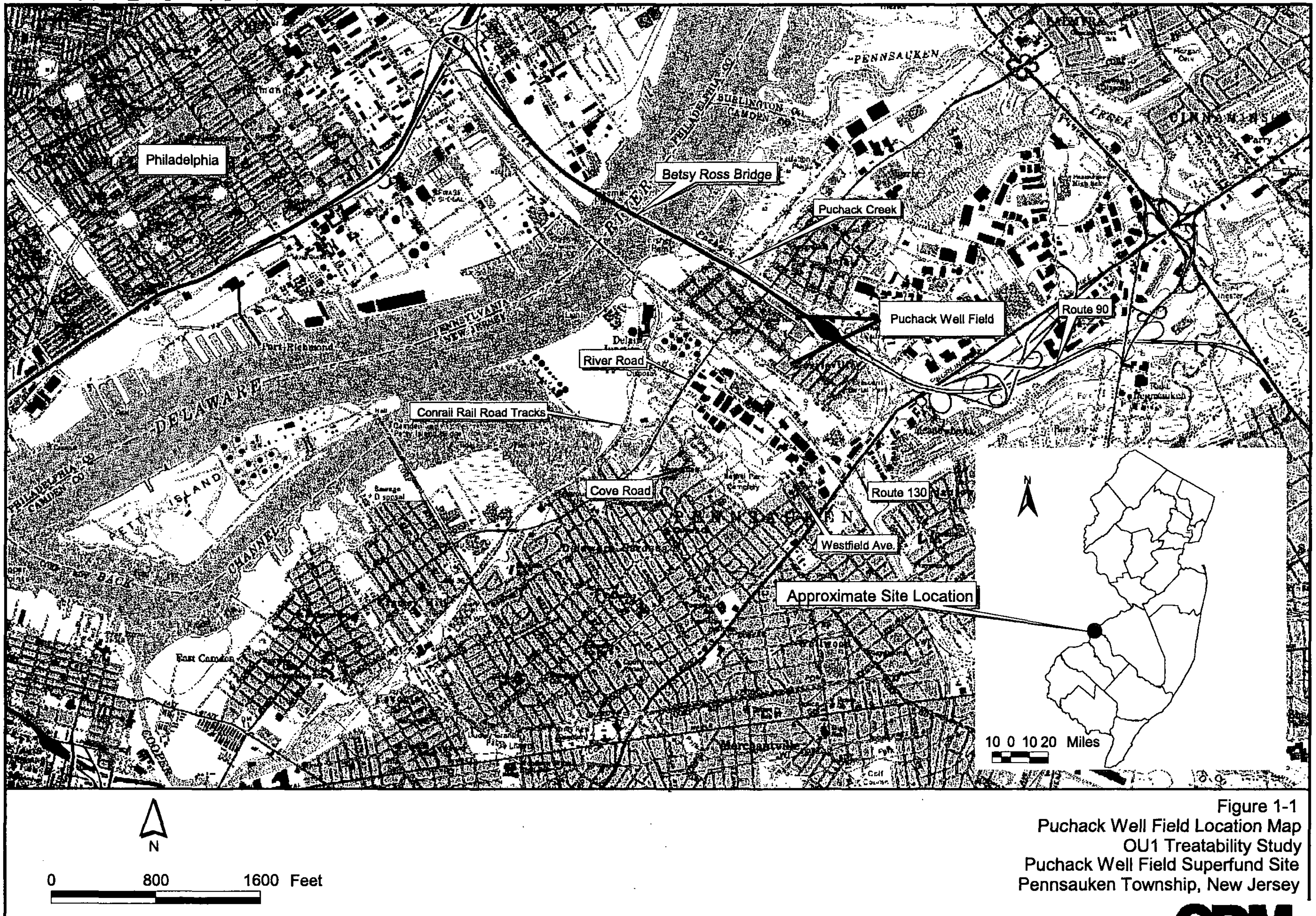

Figure 1-1
Puchack Well Field Location Map
OU1 Treatability Study
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

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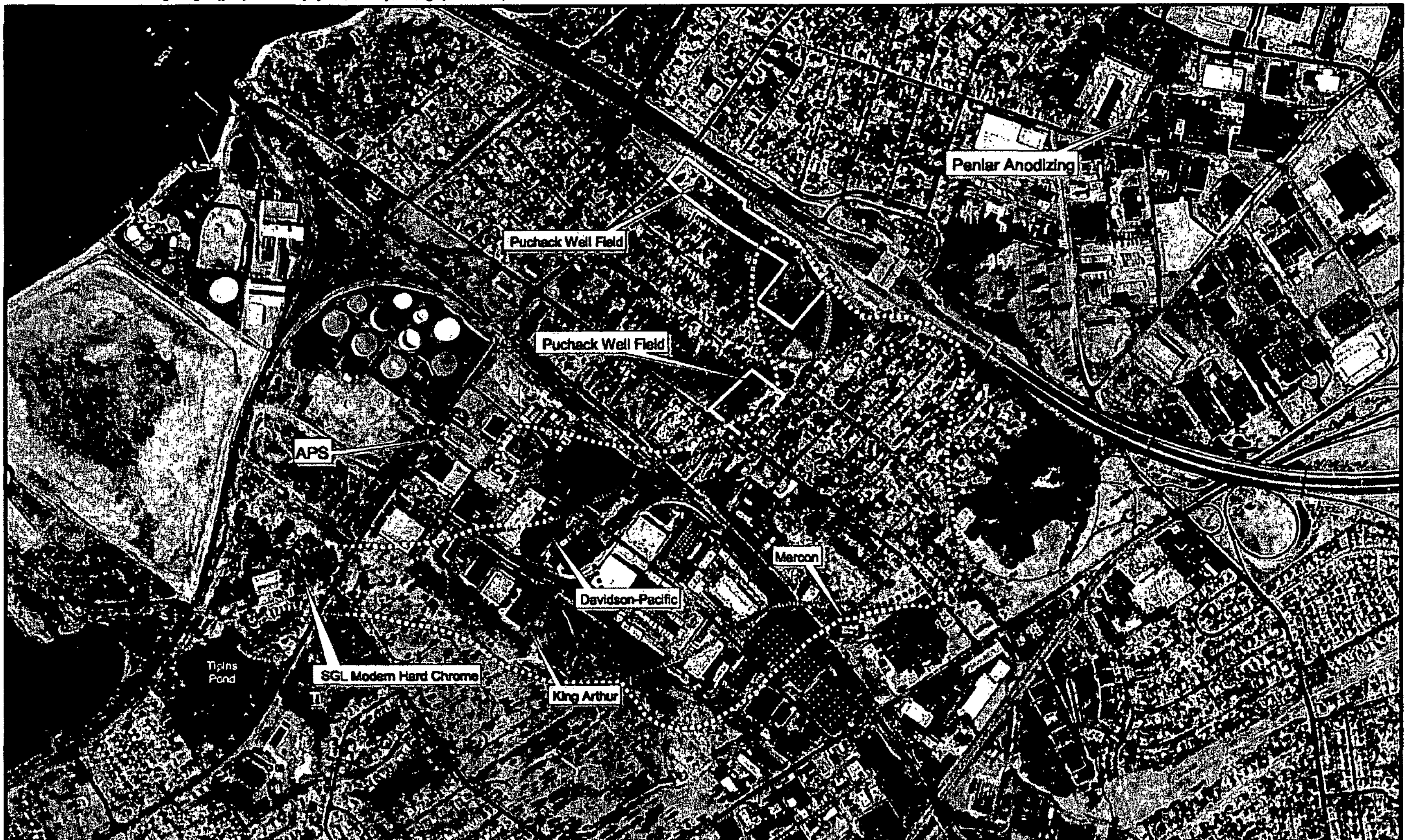

LEGEND

- Approximate Operable Unit (OU1) Boundary
- Chromium > 100 ug/L Middle aquifer, 1999-2001
- Chromium >100 ug/L Intermediate Sand aquifer, 1999-2001
- Chromium >100 ug/L Lower aquifer, 1999-2001

N

0 1000 2000 Feet

Figure 1-2
Puchack Well Field Superfund Site Map
OU1 Treatability Study
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

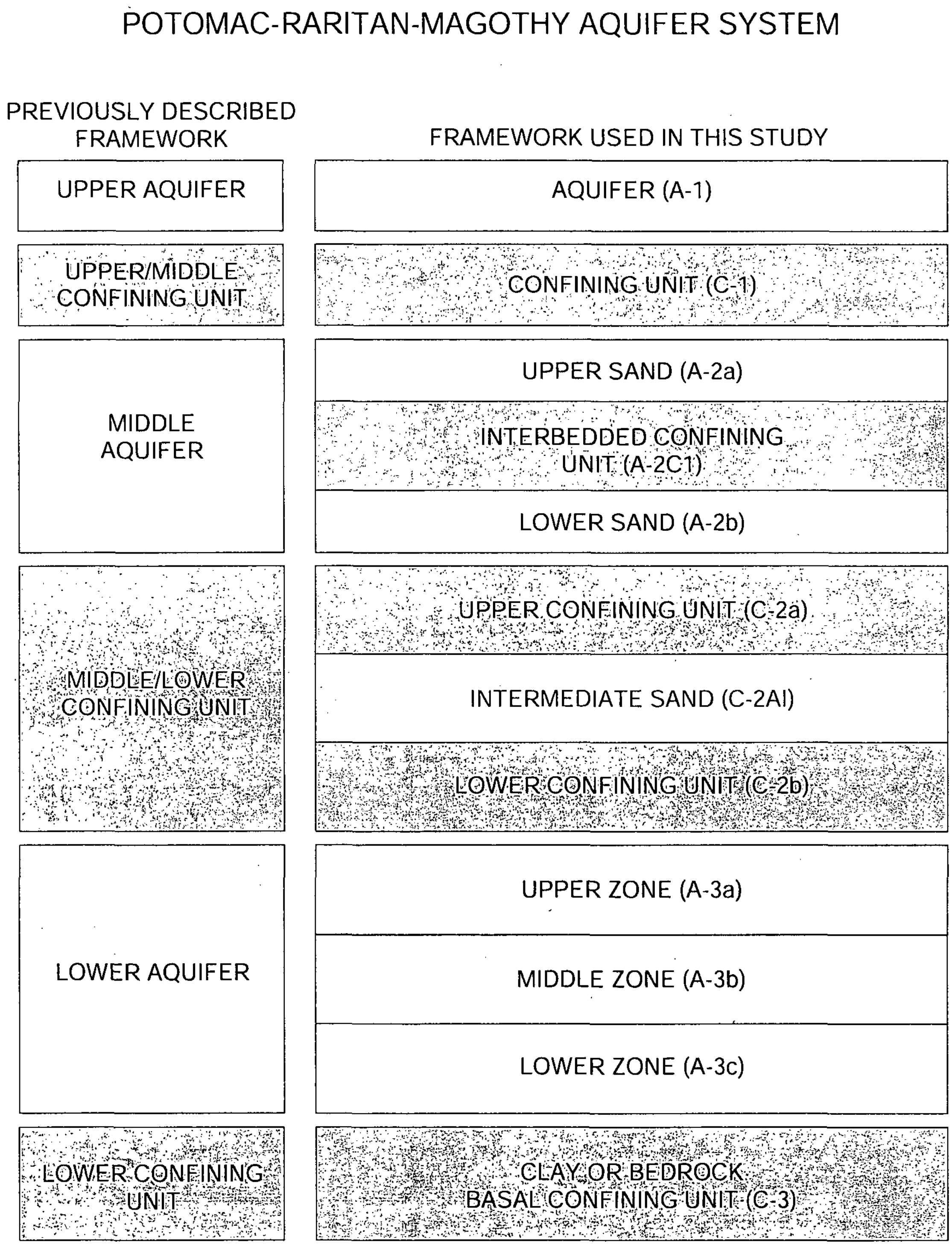

Figure 1-3 Five-layer and subdivided interpretations of the hydrostratigraphic framework of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township, New Jersey. (Figure prepared by the USGS)

301256

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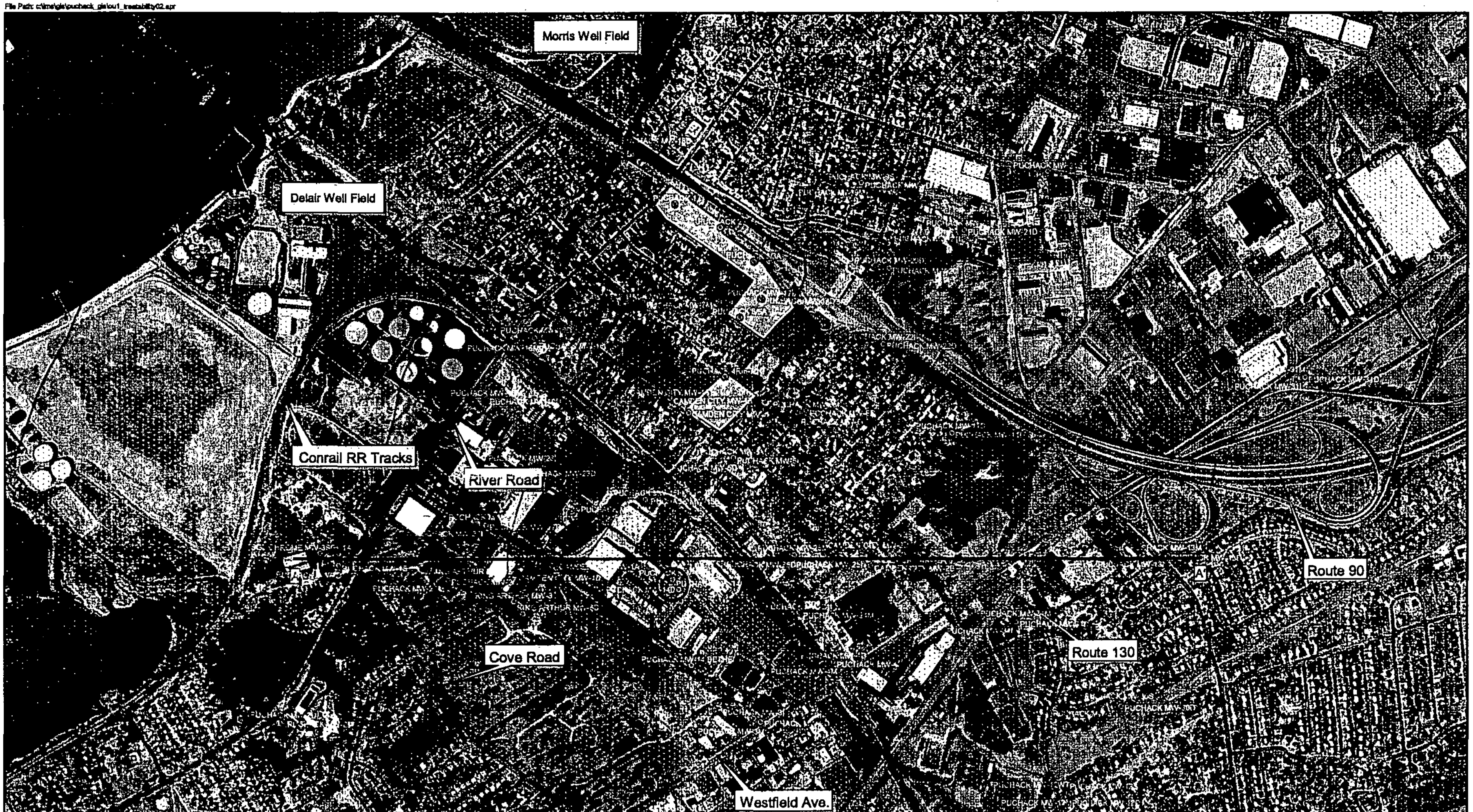


LEGEND

- Monitoring Wells
- Puchack Well Field
- Upper Aquifer Outcrop
- Middle Aquifer Outcrop
- Lower Aquifer Outcrop
- Well Cluster Discussed in Section 1.4
- Cross Section Line A-A', see Figure 1-5

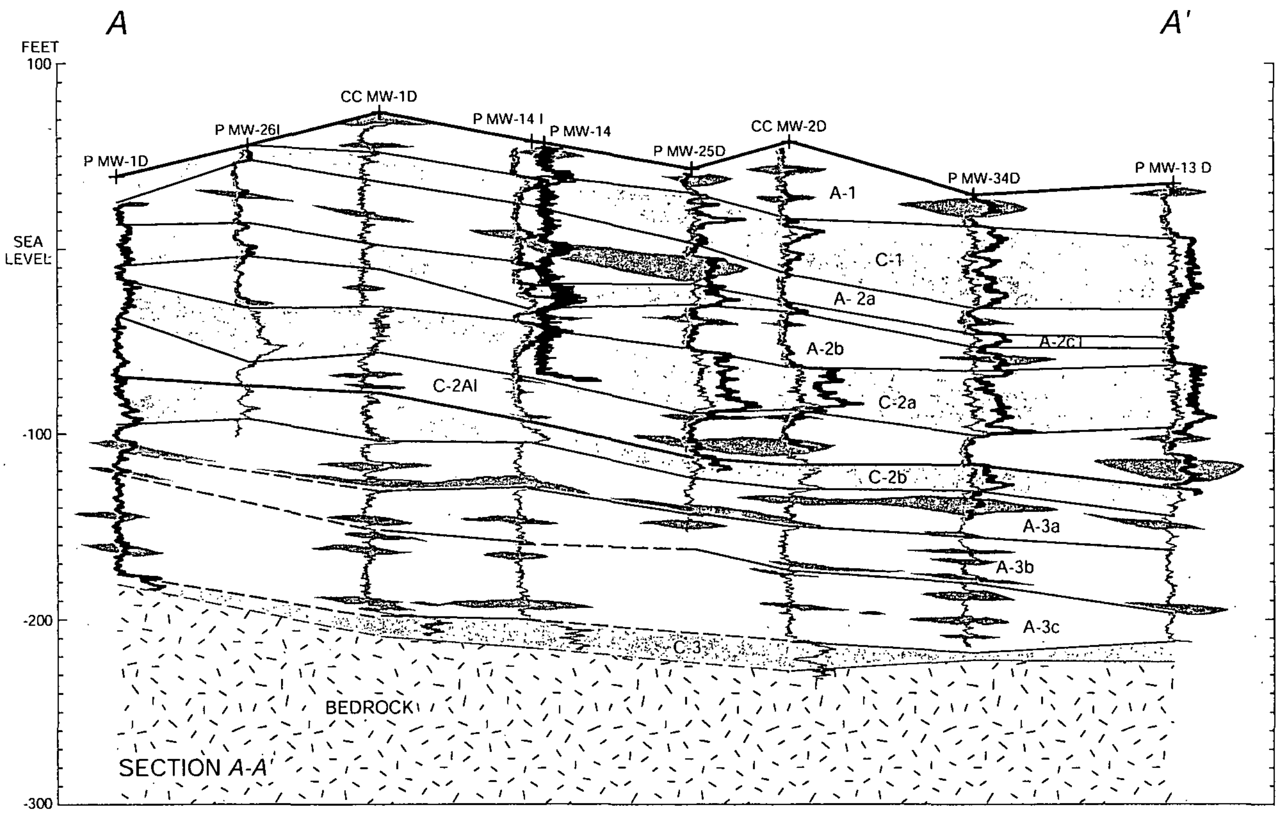
N

0 600 1200 Feet

Figure 1-4
Existing Monitoring Wells, Aquifer Outcrops, and Cross Section Location
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

DRAFT



EXPLANATION

0 200 400 600 800 1,000 2,000 FEET
0 100 200 METERS

Predominantly sands and gravels

Predominantly clays and silts

P MW-1D + Well and well number shown in hydrostratigraphic section

P Puchack

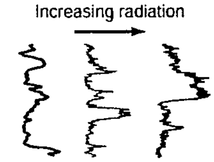
CC Camden City

HYDROSTRATIGRAPHY OF THE POTOMAC-RARITAN-MAGOTHY AQUIFER SYSTEM IN THE PENNSAUKEN TOWNSHIP AND VICINITY

Layer	Unit
A-1	Upper aquifer
C-1	Upper/Middle confining unit
A-2a	Middle aquifer, upper sand
A-2C1	Middle aquifer, interbedded confining unit
A-2b	Middle aquifer, lower sand
C-2a	Middle/Lower confining unit, upper confining unit
C-2AI	Middle/Lower confining unit, intermediate sand
C-2b	Middle/Lower confining unit, lower confining unit
A-3a	Lower aquifer, upper zone
A-3b	Lower aquifer, middle zone
A-3c	Lower aquifer, lower zone
C-3	Basal confining unit

GAMMA LOG

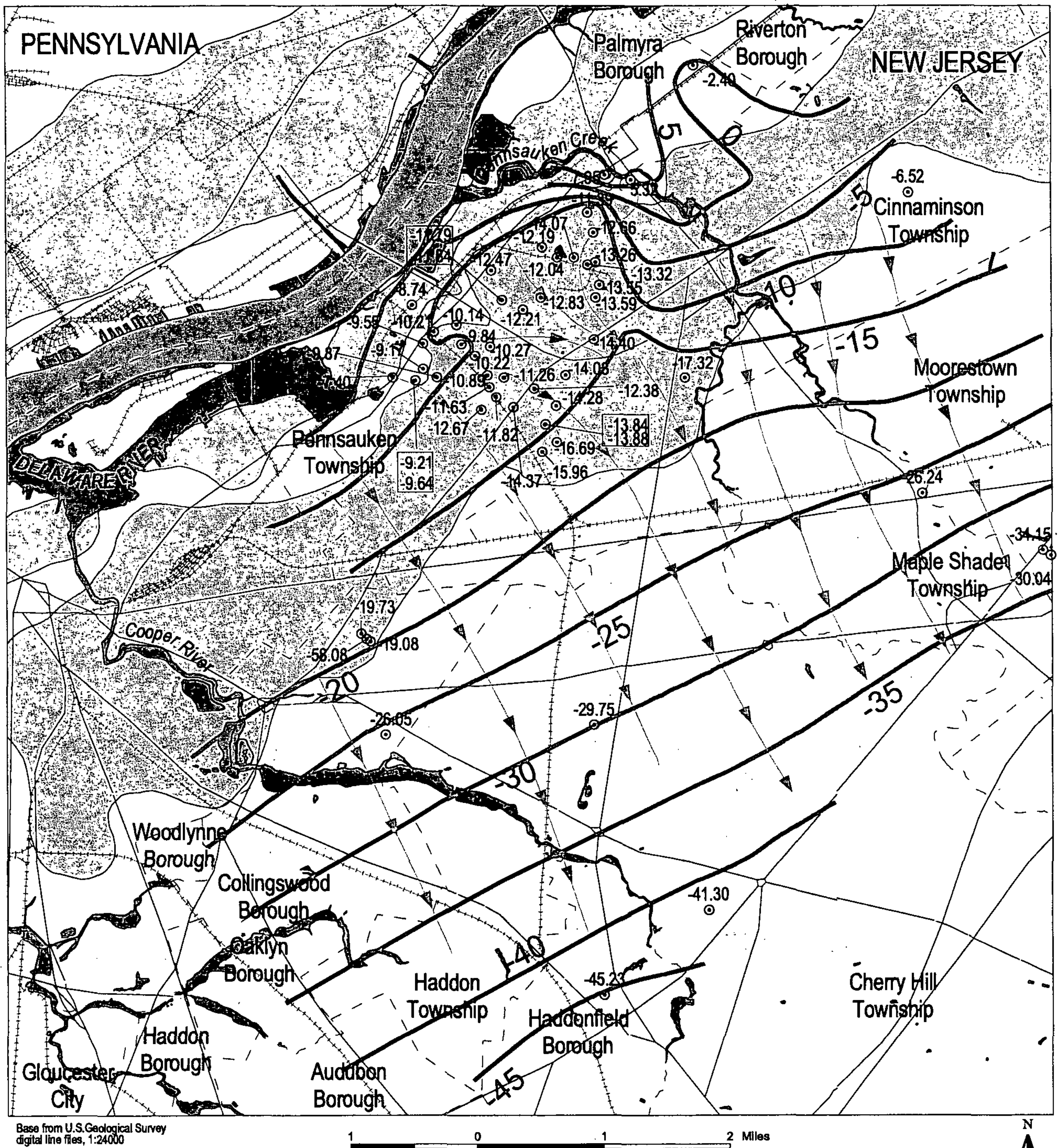
Increasing radiation



Run 1 Run 2 Run 3

Figure 1-5. Estimated lateral extent of minor sand and clay units within the Potomac-Raritan-Magothy aquifer system, section A-A', Puchack Well Field Superfund Site, Pennsauken Township, New Jersey. (Line of section shown on Figure 1-4.) (Figure prepared by the USGS)

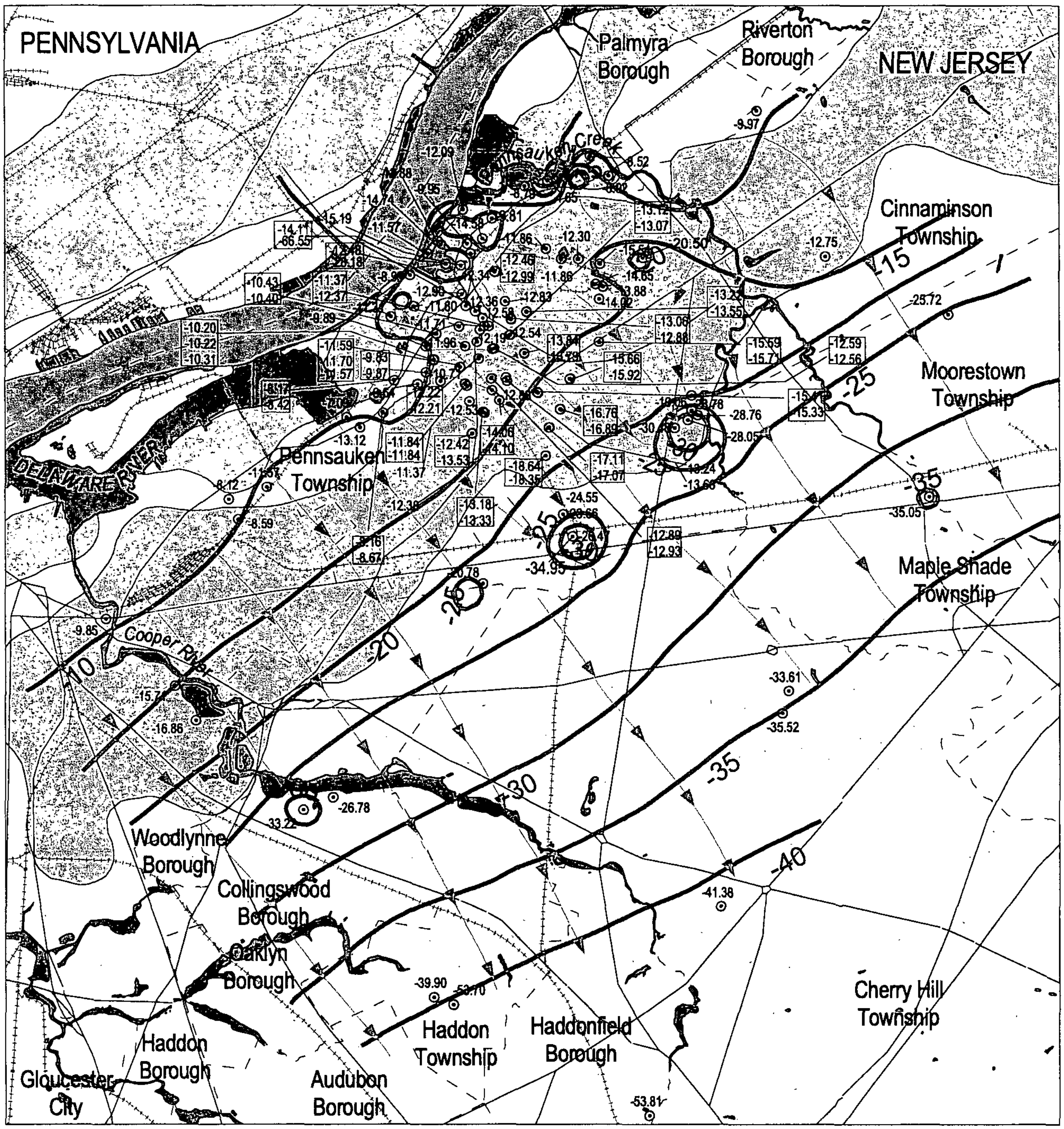
DRAFT



EXPLANATION

-10.27 ⊙	Location of well and water level. Pumping affected water level indicated in blue.		*Outcrop area of the Upper aquifer of the Potomac-Raritan-Magothy aquifer system. Modified from Navoy and Carleton, 1995.*
---▶---	Direction of Flow		
-30 ━━━	WATER LEVEL CONTOUR--Shows altitude of the water level in screened wells. Contour interval 5 feet. Datum is sea level.		Outcrop area of the Middle aquifer of the Potomac-Raritan-Magothy aquifer system. Modifed from Navoy and Carleton, 1995.
– – – –	Township boundaries		
────	Major roads		Outcrop area of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system. *From Navoy and Carleton, 1995*
+++++	Railroads		

Figure 1-6. Potentiometric surface of the Middle aquifer, Potomac-Raritan-Magothy aquifer system, April 2001, Puchack Well Field Superfund Site, Pennsauken Township, New Jersey. (Figure prepared by the USGS)



Base from U.S.Geological Survey digital line files, 1:24000

EXPLANATION

-12.53 ⊙ Location of well and water level. Pumping affected water level indicated in blue.

Direction of Flow

-30 WATER LEVEL CONTOUR–Shows altitude of the water level in screened wells. Contour interval 5 feet. Datum is sea level.

Township boundaries

Major roads

Railroads

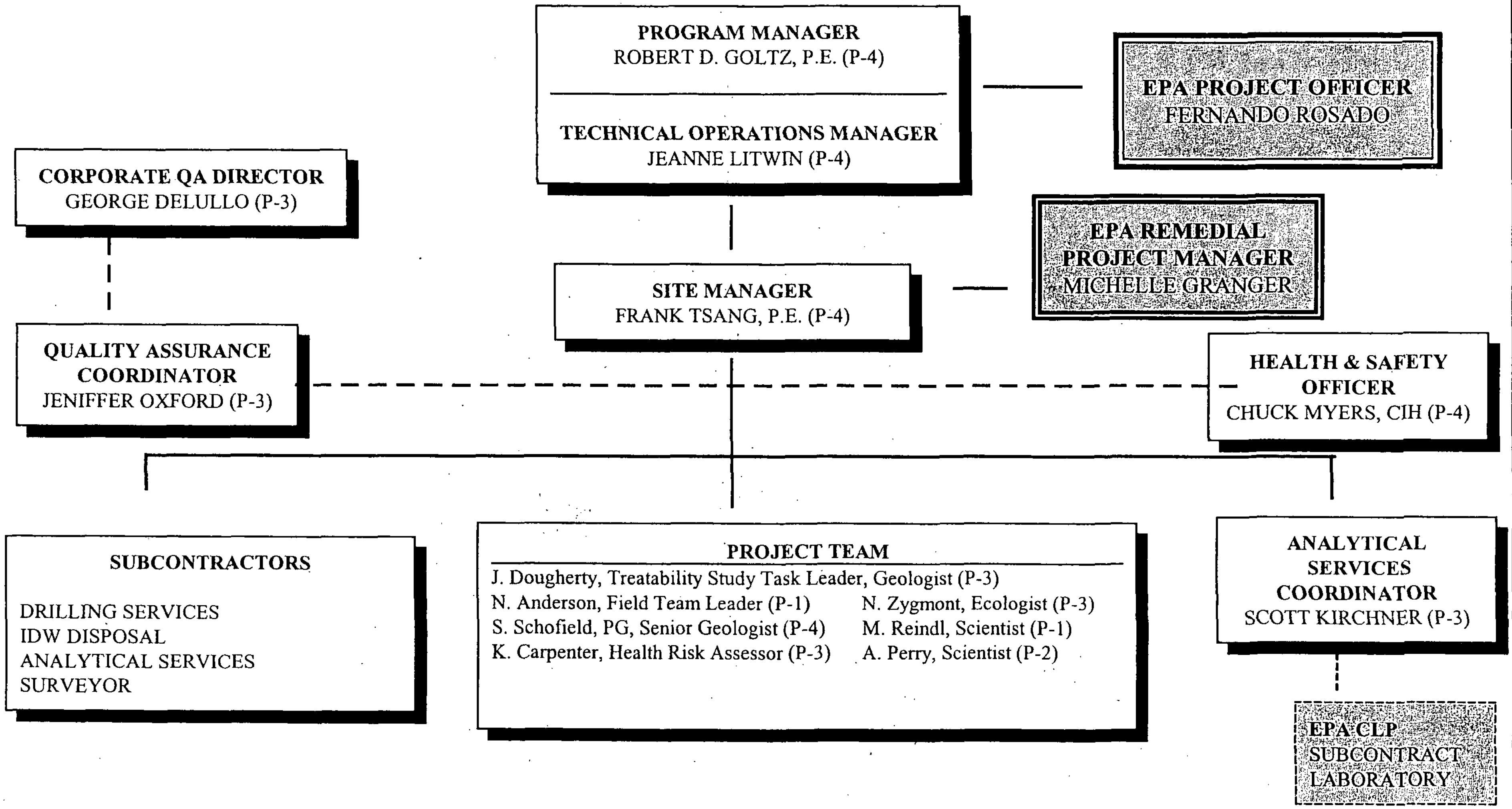
Outcrop area of the Upper aquifer of the Potomac-Raritan-Magothy aquifer system. Modified from Navoy and Carleton, 1995.

Outcrop area of the Middle aquifer of the Potomac-Raritan-Magothy aquifer system. Modifed from Navoy and Carleton, 1995.

Outcrop area of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system. From Navoy and Carleton, 1995

Figure 1-7. Potentiometric surface of the Lower aquifer, including the Intermediate Sand, Potomac-Raritan-Magothy aquifer system, April 2001, Puchack Well Field Superfund Site, Pennsauken Township, New Jersey. (Figure prepared by the USGS)

Figure 2-1
Project Organization
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey



Field Change Request (FCR) Form
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Request No: ____________________ Date: ________________

Fcr Title: ____

Description: ____
____
____

Reason for Deviation: ____
____
____
____

Recommended/modification: ____
____
____
____
____

Signatures: FTL ____________________ ________________
Noel Anderson Date

CDM TS Task Manager ____________________ ________________
John Dougherty Date

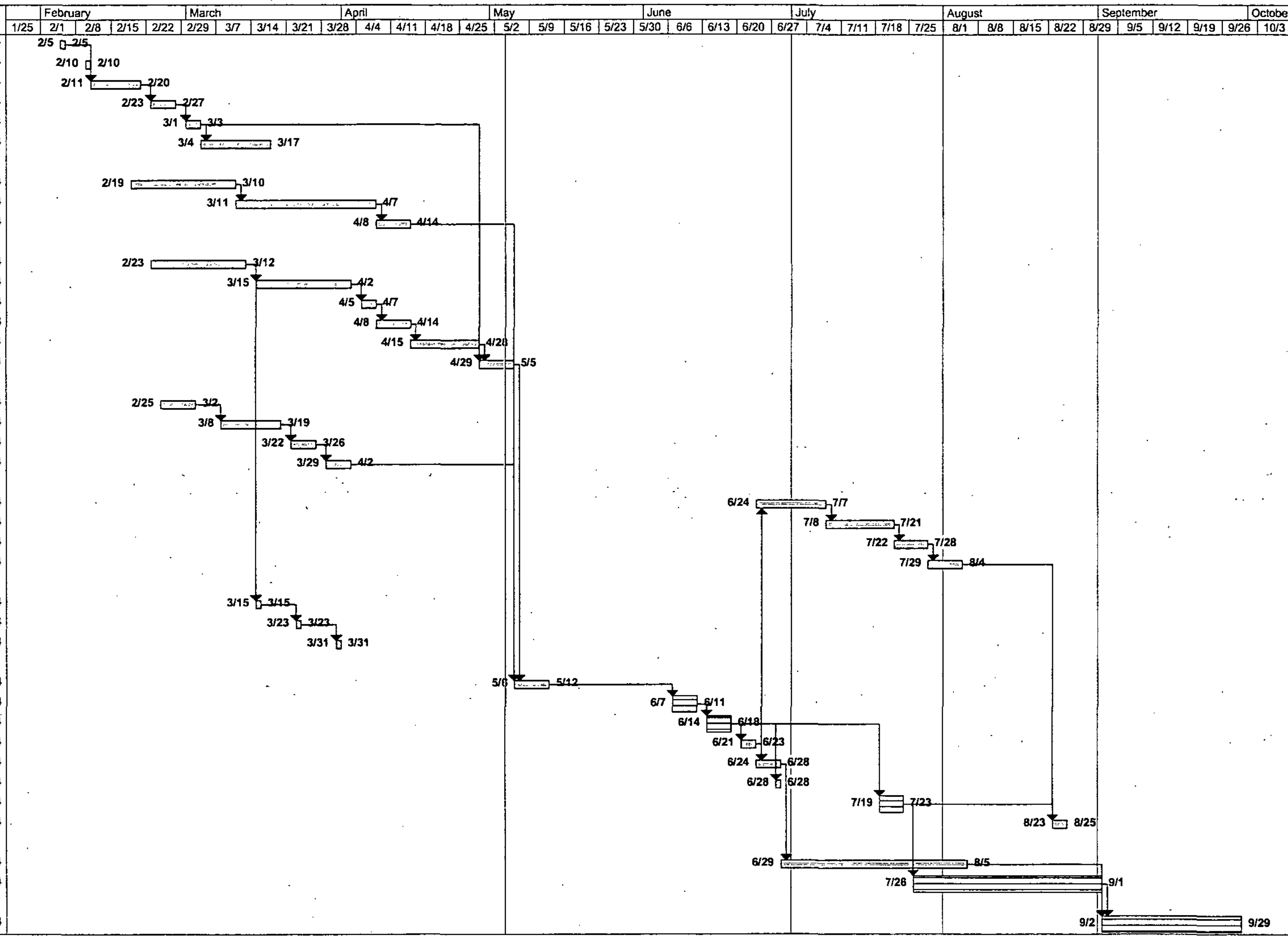
CDM SM ____________________ ________________
Frank Tsang, P.E. Date

Distribution: M. Granger, EPA Remedial Project Manager
F. Tsang, CDM SM
N. Anderson, CDM FTL
J. Oxford, CDM RQAC
Field Team
RAC II Project File

Figure 2-2
Field Change Request Form
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey
CDM

Figure 3-1
Project Schedule
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

ID	Task Name	Duration	Start	Finish
1	Receive SOW	1 day	Thu 2/5/04	Thu 2/5/04
2	Scoping Meeting	1 day	Tue 2/10/04	Tue 2/10/04
3	Prepare WPL	8 days	Wed 2/11/04	Fri 2/20/04
4	EPA review WPL	5 days	Mon 2/23/04	Fri 2/27/04
5	Finalize WPL	3 days	Mon 3/1/04	Wed 3/3/04
6	Funding Approval	10 days	Thu 3/4/04	Wed 3/17/04
7				
8	Prepare QAPP Addendum	15 days	Thu 2/19/04	Wed 3/10/04
9	EPA Review QAPP Addendum	20 days	Thu 3/11/04	Wed 4/7/04
10	Finalize QAPP Addendum	5 days	Thu 4/8/04	Wed 4/14/04
11				
12	Prepare Driller SOW	15 days	Mon 2/23/04	Fri 3/12/04
13	Solicitation	15 days	Mon 3/15/04	Fri 4/2/04
14	Review Driller Proposal	3 days	Mon 4/5/04	Wed 4/7/04
15	Prepare Consent Package	5 days	Thu 4/8/04	Wed 4/14/04
16	EPA Consent	10 days	Thu 4/15/04	Wed 4/28/04
17	Award Driller Subcontract	5 days	Thu 4/29/04	Wed 5/5/04
18				
19	Prepare Lab SOW	5 days	Wed 2/25/04	Tue 3/2/04
20	Solicitation	10 days	Mon 3/8/04	Fri 3/19/04
21	Review Lab Proposal	5 days	Mon 3/22/04	Fri 3/26/04
22	Award Lab Subcontract	5 days	Mon 3/29/04	Fri 4/2/04
23				
24	Prepare IDW SOW	10 days	Thu 6/24/04	Wed 7/7/04
25	Solicitation	10 days	Thu 7/8/04	Wed 7/21/04
26	Review IDW Proposal	5 days	Thu 7/22/04	Wed 7/28/04
27	Award IDW Subcontract	5 days	Thu 7/29/04	Wed 8/4/04
28				
29	Prepare MW Survey SOW	1 day	Mon 3/15/04	Mon 3/15/04
30	Solicitaition	1 day	Tue 3/23/04	Tue 3/23/04
31	Award	1 day	Wed 3/31/04	Wed 3/31/04
32				
33	Mobilization	5 days	Thu 5/6/04	Wed 5/12/04
34	Drilling/MW 1 Installation	5 days	Mon 6/7/04	Fri 6/11/04
35	Drilling/MW 2 Installation	5 days	Mon 6/14/04	Fri 6/18/04
36	Drilling/Sample Collection D1	3 days	Mon 6/21/04	Wed 6/23/04
37	Drilling/Sample Collection D2	3 days	Thu 6/24/04	Mon 6/28/04
38	MW Survey	1 day?	Mon 6/28/04	Mon 6/28/04
39	MW Sampling	5 days	Mon 7/19/04	Fri 7/23/04
40	IDW Disposal	3 days	Mon 8/23/04	Wed 8/25/04
41				
42	Soil Sample Analysis	28 days	Tue 6/29/04	Thu 8/5/04
43	GW Sample Analysis	28 days	Mon 7/26/04	Wed 9/1/04
44				
45	Tech Memo	20 days	Thu 9/2/04	Wed 9/29/04



Date: Tue 5/4/04

Task | Critical Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary

301263

LEGEND

- Existing Monitoring Wells
- OU1 Proposed Treatability Study Monitoring Well and Boring Locations
- Lower Aquifer (including Intermediate Sand) Flow Lines, April 2001
- Lower Aquifer (including Intermediate Sand) Potentiometric Surface, April 2001
- -15 Water Level Elevation, feet below mean sea level

N

0 300 600 Feet

Figure 4-1
Proposed OU1 Treatability Study
Monitoring Well and Boring Locations
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

CDM 125 Maiden Lane, 5th Floor New York, NY 10038	**Boring Name:** **Boring Location:**
Client: U.S. Environmental Protection Agency **Site Location:** Pennsauken Township, New Jersey	**Project Name:** Puchack Well Field **Project Number:** 3223-102
Drilling Contractor: to be determined **Drilling Method:** **Sample Method:** **Date Started:** **Date Completed:** **Logged By:**	**Northing:** **Easting:** **Surface Elevation (ft. above msl):** **Total Depth (ft bgs):** **Initial Depth to Water (ft bgs):** **Field Screening Instrument:**

Depth (ft bgs)	Elevation (ft msl)	Sample Number	Blow Count (per 6-inches)	Sample Interval (ft bgs)	Recovery (feet)	PID Reading (ppm)	Graphic Log	Material Description
0	100							
-1	99							
-2	98							
-3	97							
-4	96							
-5	95							
-6	94							
-7	93							
-8	92							

Note:
ft = fee, est. = estimated
bgs = below ground surface
msl = mean sea level
ppm = parts per million
Initial Depth to Water, during drilling (feet bgs)

Horizontal Datum: NAD83
Horizontal Coordinate System: New Jersey State Plane
Vertical Datum: NGVD??
Units: feet

Figure 5-1
Soil Boring Log
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

CDM 125 Maiden Lane, 5th Floor
New York, NY 10038

Boring Name:
Boring Location:

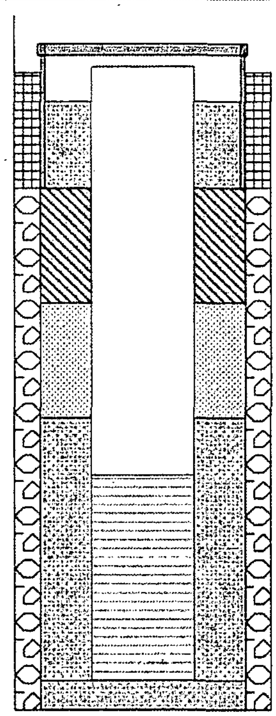
Client: U.S. Environmental Protection Agency
Site Location: Pennsauken Township, New Jersey

Project Name: Puchack Well Field
Project Number: 3223-102

Drilling Contractor: to be determined
Drilling Method:
Sample Method:
Date Started: **Date Completed:**
Logged By:

Northing: **Easting:**
Surface Elevation (ft. above msl):
Total Depth (ft bgs):
Depth to Initial Water (ft bgs):
Field Screening Instrument:

Depth (ft bgs)	Elevation (ft msl)	Sample Number	Blow Count (per 6-inches)	Sample Interval (ft bgs)	Recovery (feet)	PID Reading (ppm)	Graphic Log	Material Description	Well Construction Schematic
1	101								
0	100								
-1	99								
-2	98								
-3	97								
-4	96								
-5	95								
-6	94								
-7	93								
-8	92								
-9	91								
-10	90								
-11	89								



Concrete | Cement/Bentonite Grout | Natural Material | No. 00 Sand
Sand Pack | 4-inch PVC Well Screen, No. 10 slot | 4-inch PVC Well Casing

Note:
ft = feet
bgs = below ground surface
msl = mean sea level
ppm = parts per million

Initial Depth to Water, during drilling (feet bgs)

Figure 5-2
Monitoring Well Construction Log
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

Case No: 30xxx
DAS No:
SDG No:

L

Date Shipped: 4/9/2002
Carrier Name: FedEx
Airbill: 10046
Shipped to: Liberty Analytical
501 Madison Avenue
Cary NC 27513
(919) 379-4080

Chain of Custody Record

Sampler Signature:

Relinquished By	(Date / Time)	Received By	(Date / Time)
1			
2			
3			
4			

For Lab Use Only

Lab Contract No
Unit Price:
Transfer To:
Lab Contract No
Unit Price:

ORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No/ PRESERVATIVE	STATION LOCATION	SAMPLE COLLECT DATE/TIME	INORGANIC SAMPLE No	FOR LAB USE ONLY Sample Condition On Receipt
B0022	Soil/Sediment/ Seth Richardson	L/G	BNA/PEST (21), VOA (21)	(5)	SS-01	S: 4/8/2002 11:00	MB0002	
B0023	Soil/Sediment/ Seth Richardson	L/G	BNA/PEST (21), VOA (21)	(5)	SS-02	S: 4/8/2002 12:00	MB0003	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s):	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number:	
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G		Custody Seal Intact?__	Shipment Iced?__

BNA/PEST = CLP TCL Semivolatiles and Pesticides/PCBs, VOA = CLP TCL Volatiles

TR Number: 2-510506296-040802-0009

LABORATORY COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Contract Laboratory Analytical Services Support, 2000 Edmund Halley Dr., Reston, VA 20191-3436 Phone 703/264-9348 Fax 703/264-9222

F2V5.0.86 Page 1 of 1

Figure 6-1
Forms-II-Lite Organic Traffic Report/Chain of Custody Record, Laboratory Copy
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

EPA USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

Case No:	30xxx
DAS No.	

R

Region:	2	Date Shipped:	4/8/2002
Project Code:	039-RICO-02MP	Carrier Name:	FedEx
Account Code:		Airbill:	10049
CERCLIS ID:	NJ[illegible]08	Shipped to:	Liberty Analytical 501 Madison Avenue Cary NC 27513 (919) 379-4085
Spill ID:	MP		
Site Name/State:	Iceland Coin Laundry and Dry Cleaning S [illegible]		
Project Leader:	Seth Richardson		
Action:	Remedial Investigation		
Sampling Co:	CDM		

Chain of Custody Record

Sampler Signature:

	Relinquished By (Date / Time)	Received By (Date / Time)
1		
2		
3		
4		

ORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE	STATION LOCATION	SAMPLE COLLECT DATE/TIME	INORGANIC SAMPLE No.	QC Type
30002	Soil/Sediment/ Seth Richardson	L/G	BNA/PEST (21), VOA (21)	(5)	SS-01	S: 4/8/2002 11:00	MB0002	--
30003	Soil/Sediment/ Seth Richardson	L/G	BNA/PEST (21), VOA (21)	(5)	SS-02	S: 4/8/2002 12:00	MB0003	--

Shipment for Case Complete? N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s):	Chain of Custody Seal Number:
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Shipment Iced? ________

BNA/PEST = CLP TCL Semivolatiles and Pesticides/PCB, VOA = CLP TCL Volatiles

TR Number: 2-510506296-040802-0009

PR provides preliminary results. Requests for preliminary results will increase analytical costs
Send Copy to: Contract Laboratory Analytical Services Support, 2000 Edmund Halley Dr., Reston, VA. 20191-3436 Phone 703/264-9348 Fax 703/264-9222

F2V5.0.66 Page 1 of 1

Figure 6-2
Forms-II-Lite Organic Traffic Report/Chain of Custody Record, Region Copy
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

EPA USEPA Contract Laboratory Program
Inorganic Traffic Report & Chain of Custody Record

Case No: 30xxx
DAS No:
SDG No:
L

Date Shipped: 4/8/2002
Carrier Name: FedEx
Airbill: 10045
Shipped to: PDP Analytical Services
1680 Lake Front Circle
The Woodlands TX 77380
(281) 363 2233

Chain of Custody Record
Sampler Signature:

Relinquished By	(Date / Time)	Received By	(Date / Time)
1			
2			
3			
4			

For Lab Use Only
Lab Contract No:
Unit Price:
Transfer To:
Lab Contract No:
Unit Price:

INORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE	STATION LOCATION	SAMPLE COLLECT DATE/TIME	ORGANIC SAMPLE No.	FOR LAB USE ONLY Sample Condition On Receipt
MB0202	Soil/Sediment/ Seth Richardson	L/G	TM/CN (21)	(1)	SS-01	S: 4/8/2002 11:00	B0202	
MB0203	Soil/Sediment/ Seth Richardson	L/G	TM/CN (21)	(1)	SS-02	S: 4/8/2002 12:00	B0203	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s):	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number:
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite - C, Grab - G		Custody Seal Intact?__ Shipment Iced?__

TM/CN = CLP TAL Total Metals and Cyanide

TR Number: 2-510506296-040802-0008

LABORATORY COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Contract Laboratory Analytical Services Support, 2000 Edmund Halley Dr., Reston, VA 20191-3436 Phone 703/264-9348 Fax 703/264-9222

F2V5.0 66 Page 1 of 1

Figure 6-3
Forms-II-Lite Inorganic Traffic Report/Chain of Custody Record, Laboratory Copy
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

EPA USEPA Contract Laboratory Program
Inorganic Traffic Report & Chain of Custody Record

Case No: 30xxx
DAS No:
R

Region	2
Project Code:	029-RICO-02MP
Account Code	
CERCLIS ID:	NJD000139169
Spill ID:	MF
Site Name/State:	Iceland Coin Laundry and Dry Cleaning Site
Project Leader:	Seth Richardson
Action:	Remedial Investigation
Sampling Co:	CDM

Date Shipped:	4/8/2002
Carrier Name:	FedEx
Airbill:	10045
Shipped to:	PDP Analytical Services 1680 Lake Front Circle The Woodlands TX 77380 (281) 363-2233

Chain of Custody Record

Sampler Signature:

Relinquished By (Date / Time)	Received By (Date / Time)
1	
2	
3	
4	

INORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE	STATION LOCATION	SAMPLE COLLECT DATE/TIME	ORGANIC SAMPLE No.	QC Type
MB0002	Soil/Sediment/ Seth Richardson	L/G	TM/CN (21)	(1)	SS-01	S: 4/8/2002 11:00	B0002	--
MB0003	Soil/Sediment/ Seth Richardson	L/G	TM/CN (21)	(1)	SS-02	S: 4/8/2002 12:00	B0003	--

Shipment for Case Complete? N	Sample(s) to be used for laboratory QC:	Additional Sampler Signature(s):	Chain of Custody Seal Number:
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Shipment Iced? ________

TM/CN = CLP TAL Total Metals and Cyanide

TR Number: 2-510506296-040802-0008

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Contract Laboratory Analytical Services Support, 2000 Edmund Halley Dr., Reston, VA. 20191-3436 Phone 703/264-9348 Fax 703/264-9222

REGION COPY

F2V5.0 66 Page 1 of 1

Figure 6-4
Forms-II-Lite Inorganic Traffic Report/Chain of Custody Record, Region Copy
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

US EPA REGION 2 LABORATORY

Page ____ of ___ pages

CHAIN OF CUSTODY/ FIELD DATA FORM

SURVEY NAME & LOCALITY ______________________________ PROJECT LEADER ______________

PROGRAM: SF ☐ : SITE ID _____ OPERABLE UNIT _______ PROGRAM RESULTS CODE _________

Permit # ______________ RCRA ☐ NPDES ☐ SDWA ☐ AM ☐ CAA ☐ TSCA ☐ ENFORCEMENT: CRIMINAL ☐ CIVIL ☐

LAB ID/ FIELD ID	# OF CONTAINERS	MATRIX	SPECIAL REQUIREMENTS?	DESCRIPTION & INSTRUCTIONS INCLUDING LOCATION, ESTIMATED CONCENTRATIONS, SPECIAL REPORTING LIMITS, SPECIAL TEST REQUIREMENTS & ALIQUOTING	Preservative (circle)	Collection Time (24hr clock) Begin	Collection Time (24hr clock) End	Collection Date mm/dd/yy
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			
			☐		1 2 3 4 5 6 7 8 9			

COMMENTS:

Preservative
1=Ice
2=H2SO4 pH<2
3=HNO3 pH<2
4=HCl pH<2
5=Na2S2O3
6=NaOH pH>9
7=Ascorbic Acid
8 = FAS
9=ZnAc

Matrix:
A=aqueous
B=aqueous (chlorinated)
C=soil
D=sediment
E=sludge
F=multiphasic
G=solvent
H=biota
I=oil
J=other

Survey Complete? Y ☐ N ☐

	Person Assuming Responsibility for Sample(s):	Time	Date
Relinquished By:	Received By:		
Relinquished By:	Received By:		
Relinquished By:	Received By:		

Figure 6-5
EPA Region 2 Laboratory Chain of Custody/Field Data Form
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

CDM

Organic Labels	Inorganic Labels
B03RL - BNA	MB03F2 - Total Metals
B03RL - BNA	MB03F2 - Total Metals
B03RL - PEST/PCB	MB03F2 - Cyanide
B03RL - PEST/PCB	MB03F2 - Cyanide
B03RL - VOA	MB03F2
B03RL - VOA	MB03F2
B03RL	MB03F2
B03RL	
B03RL	
B03RL	

Figure 6-6
RAS Adhesive Labels
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey
CDM

CUSTODY SEAL

Person Collecting Sample ______________________ Sample No.__________
(signature)

Date Collected ______________________ Time Collected__________

Figure 6-7
Custody Seal
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey
CDM

Equipment Calibration Log
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Instrument (Name/Model No./Serial No.):______________________________

Manufacturer:______________________________

Calibration Date	Initial Setting	Standard/ Gas Used (Concentration)	Lot Control No. Expiration Date	Adjustments Made	Final Reading	Comments Pass/Fail	Signature

Figure 6-8
Equipment Calibration Log
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey
CDM

Maintenance and Calibration Record
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Date:____________ Time:____________ (hours)

Employee Name:____________________ Equipment Description:____________________

Contract/Project:____________________ Equipment ID No.:____________________

Activity:____________________ Equipment Serial No.:____________________

MAINTENANCE

Maintenance Performed:____

____

____

Comments:____

____

Signature:____________________ Date:____________________

CALIBRATION/FIELD CHECK

Calibration Standard:____________________ Concentration of Standard:____________________

Lot No. of Standard:____________________ Expiration Date of Standard:____________________

Pre-Calibration Reading:____________________ Post-Calibration Reading:____________________

Pre-Field Check Reading:____________________ Post-Field Check Reading:____________________

Adjustment(s):____

____

Calibration: ☐ Passed ☐ Failed

Comments:____

____

Signature:____________________ Date:____________________

Figure 6-9
Maintenance and Calibration Record
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey
CDM

CDM

Figure 6-10: NONCONFORMANCE REPORT

Item Name/ID #:________________________ Vendor:________________________

Project Name/#: Puchack Well Field Site/3223-102 Purchase Order #: ______________

Description of nonconformance: ____

____

____

Have nonconforming items been marked or segregated to prevent inadvertent use? Yes / No If no, explain: ________

____

Name:____________________ Signature:____________________ Date:__________

For newly purchased items forward this form to the appropriate buyer.

For other items:
- M&TE, forward this form to the Health & Safety Manager.
- GFE, forward this form to the Area Manager.
- Project supplies or materials, forward this form to the Project Manager.

DISPOSITION

Buyer

❑ Reject.......................... Return authorization #:______________ Buyer:______________

❑ Retain.......................... Reason: ____

Identify procurement follow-up action:____

____

Health & Safety Manager/Area Manager/Project Manager

❑ Discard.......................... Authorized by:____________________ Date: ____________

❑ Use-as-is..................... Authorized by:____________________ Date: ____________

❑ Rework/ ❑ Repair....... Authorized by:____________________ Date: ____________

Performed by: ____________________ Date: ____________

Inspected by: ____________________ Date: ____________

Justification for disposition: ____

____

____

Item Inspection Report
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Contract/Project:____________________________ DCN:________________________

Inspector:____________________________________ Inspection Date:________________

Item Inspected:____

____

Controlling Documents/Specifications/Procedures:__________________________________

____

____

____

Specific Sections Applicable to Inspection:____

____

Inspection Results (*pass/fail, hold point status, explaination, etc.*):_______________________

____

____

____

Comments, Reccommendations, NCRs issued:____

____

____

____

Follow-Up Required?____

Inspector:____________________________________ Date:________________________

Signature

____

Distribution:

Project Manager:_____________________________

cc: _____________________________

____

Figure 6-11
Item Inspection Report
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey
CDM

United States Environmental Protection Agency

ANSETS Data Requirement
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Date: ____________________ Sampling Start Date: ____________________
Sampling End Date: ____________________

Project Numbers				
Project Number:		Regional Account Number:	DAS Number:	Assoc. CLP Case No:
Site Information				
Site Name:			City:	State:
CERCLIS ID:	Operable Unit:		Action:	Funding Lead:
Responsible EPA Project Individual:			Sampling Organization:	

Analytical Services Information	
If field analytical services are used during this project write "field *analysis" in the Laboratory Name Column. If fixed laboratory* is used write the name of the laboratory in the Laboratory Name Column. Please specify in this box all field analytical techniques used.	COST:

Laboratory Name (include location if multiple lab locations)	No. Samples	Matrix	Analysis	Requested Turnaround (Days)

Completed by:	Organization:	Date:

Figure 6-12
ANSETS Data Requirement Form
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey
CDM

ver 1.0

Appendix A

Appendix A

Project-Specific Groundwater Sampling Procedure Low-Stress (Low-Flow) Purging and Sampling

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUNDWATER SAMPLING PROCEDURE
LOW STRESS (LOW-FLOW) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II preferred method for collecting groundwater samples from monitoring wells at the Puchack Well Field Site. The procedure minimizes stress on the formation and minimizes disturbance of sediment in the well. The procedure applies to monitoring wells that have well casing with an inner diameter of 2.0 inch or greater. It is appropriate for groundwater samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with any EPA program.

This procedure does not address the collection of non-aqueous phase liquid (NAPL) samples and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The goal of the Low Stress Purging and Sampling procedure is to collect samples that are representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that allows a maximum drawdown of 0.3 foot.

Sampling at such a low flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing a filtered sample from the same well. Second, it minimizes aeration of the groundwater during sample collection, which improves the sample quality for VOC analysis. Third, in most cases it significantly reduces the volume of groundwater purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of a key indicator parameter to stabilize; c) cascading of water and formation of air bubbles in the tubing; and d) cross-contamination.

For wells with insufficient yield (i.e., low recharge rate of the well), care should be taken to avoid loss of pressure in the tubing line, cascading through the sand pack, or pumping the well dry. Purging should be interrupted before the water level in the well drops below the top of the pump. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

If a key indicator parameter fails to stabilize after 4 hours, one of two options should be considered: a) continue purging in an attempt to achieve stabilization; or b) discontinue purging, collect samples, and document attempts to reach stabilization in the log book. The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

For cascading and air bubbles in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 inch ID) to ensure that the tubing remains filled with liquid during sampling.

An item that should be checked on a daily basis, is the water within the cooling chamber of the submersible pump. This chamber should always be filled with demonstrated analyte-free water and any leakage from this chamber should be immediately brought to the attention of the person(s) responsible for equipment maintenance so that the appropriate seals can be replaced. Operating the pump with insufficient water in this cooling chamber could result in the pump overheating and/or pump failure. The analyte-free water should be replaced on a daily basis in order to facilitate the mechanical operation of the pump.

IV. EQUIPMENT

- **Approved site-specific Quality Assurance Project Plan (QAPP).** Generally, the target depth corresponds to just above the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake.
- Well construction data, location map, field data from last sampling event.
- Polyethylene sheeting.
- Photo Ionization Detector (PID).
- Adjustable rate, positive displacement groundwater sampling pump constructed of stainless steel.
- Interface probe or equivalent device for determining the presence or absence of NAPL.

- Teflon-lined polyethylene tubing to collect samples for organic and inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.
- Electronic water level measuring device, 0.01 foot accuracy.
- Flow measurement supplies (e.g., graduated cylinder and stop watch).
- Power source (generator).
- Monitoring instruments for indicator parameters. Redox potential (Eh) and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Temperature, pH and specific conductance may be monitored with an in-line monitor. A nephalometer is used to measure turbidity.
- Decontamination supplies (see Section VII, below).
- Logbook (see Section VIII, below).
- Sample bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags or labels, chain of custody.
- Other supplies as specified in the EPA approved field sampling plan/QAPP.

V. SAMPLING PROCEDURES

<u>Pre-Sampling Activities</u>

1. Start at the well known or believed to have the least contaminated groundwater and proceed systematically to the well with the most contaminated groundwater. Check well for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID or FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field log book.

6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one.

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled before any purging begins. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment which has accumulated at the bottom of the well. Record the observations in the log book.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth, specified on Table 5-1,for that well. The pump intake must be kept at least two feet above the bottom of the well to prevent disturbance and resuspension of any sediment or DNAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well with a rate that varies from 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every three to five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every three to five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

$\pm$0.1 for pH
$\pm$3% for specific conductance (conductivity)
$\pm$10 mv for redox potential
$\pm$10% for DO and turbidity

Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

If pH adjustment is necessary for sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 mls). Groundwater purged from the well prior to sampling can be used for this purpose.

13. Collect Samples: Collect samples at flow rates of between 100 and 250 ml/min or such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. Samples should be collected at the same flow rate at which the indicator parameters stabilized. VOC samples must be collected first, at the lower rate, and directly into pre-preserved sample containers. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for re-sampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance was consulted when preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at frequency of one per sample cooler.

- Field duplicate.
- Equipment blank (not necessary if equipment is dedicated to the well).
- Trip blank (VOCs only)

Groundwater samples should be collected systematically beginning at wells known or believed to have the lowest level of contamination and proceeding in order to wells known or believed to have the highest level of contamination.

VII. DECONTAMINATION

Sampling equipment must be decontaminated thoroughly each day before use (daily decon) and after each well is sampled (between-well decon). As noted above, wells should be sampled in order from the least contaminated to the most contaminated. Pumps should not be removed from the well between purging and sampling operations. All non-disposable equipment, including the pump (support cable and electrical wires which are in contact with the sample) will be decontaminated as described below.

17. Prior to Sampling Event Decon

Please Note: Steps D through K should only be performed once (for each pump that is to be used) before the commencement of a particular sampling event by a person qualified to disassemble pumps.

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

D) Disassemble pump.

E) Wash pump parts (inlet screen, shaft suction interconnector, motor lead assembly, stator house): Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water for five minutes.

G) Rinse the pump parts with demonstrated analyte-free water.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water for five minutes.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Thoroughly rinse impeller assembly with demonstrated analyte-free water.

18. Daily and Between-Well Decon

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

D) Final Rinse: Operate pump in a deep basin of analyte-free water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.
- Other logbook entries as required in the EPA approved field sampling plan/QAPP.

IX. REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

EPA, 1998, EPA Region II, Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, March 16.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

Appendix B

Appendix B

Appendix B

Project-Specific Sampling Procedure for Anoxic Subsurface Sediment Samples

PROJECT-SPECIFIC OPERATING PROCEDURE
PUCHACK WELL FIELD SUPERFUND SITE
PENNSAUKEN TOWNSHIP, NEW JERSEY

Project SOP No.: 1
Revision: 0
Date: 03/09/2004

SOP Title: Anoxic Sediment Sample Handling System

QA Review: Nancy Rzepnant 3/8/04

Approved : C. Tsang 3/9/04
Project Manager Signature/Date

RATIONALE

To assess the applicability of an in situ treatment technology proposed for use at the Puchack Well Field Superfund Site by Pacific Northwest Laboratories certain geochemical analyses need to be performed on aquifer sediment samples. To perform the required geochemical analyses effectively, the in-situ condition of the aquifer sediment samples must be preserved by preventing oxidation, or other chemical reactions, due to exposure to the atmosphere. To do this, an anoxic sediment sample handling system will be used at each sampling location. First, aquifer sediment samples will be retrieved from a borehole in unconsolidated deposits completed using a drilling rig and split barrel sampler. Then, at ground surface, the sampler will be placed as quickly as possible into a glove bag with an anoxic atmosphere created using an inert gas. Inside the chamber, the sample will be processed and sealed in an air tight container. After collection, the samples will be maintained and shipped for analysis to the laboratory under anoxic conditions.

PREPARATORY ACTIVITIES

The field team will review and discuss, in detail, the Health and Safety Plan (HSP), material safety data sheets (MSDS), and appropriate, approved Quality Assurance Project Plan (QAPP) sections (sample locations, sample labeling, etc). The field team must pay particular attention to the safe handling of the inert gas. Discuss the inert gas handling and equipment requirements (e.g. tubing, regulators, strapping) with the gas vendor to make sure all required items are identified on the procurement request. The field team leader will visit each proposed work location with the gas vendor to ensure that the gas can be delivered safely to each location. Prior to the field activities, the necessary equipment will assembled and the procedure tested, using air, to check that all components are on hand and that field personnel are familiar with the procedure. Equipment manufacturers' and vendor operating manuals or literature will be reviewed to confirm that the proper equipment operation and material handling procedures are used in the field. All monitoring and protective equipment will be thoroughly checked prior to field activities. Finally, before processing samples, the field team will set up the anoxic sediment handling system in the field and practice with dummy samples to ensure that all components and procedures are working properly.

FIELD EQUIPMENT

A subcontractor will supply a drill rig and split barrel core sampler to retrieve sediment samples from depth in the unconsolidated deposits at the site.

The following equipment will be required and supplied by CDM Federal Programs Corporation (CDM):

- 2x4 lumber, eight to ten feet long
- Air monitoring equipment and calibration span gas
- Blank log sheets
- Box truck, 10 or 15 foot length
- Bricks, two
- Buckets, white, 5-gallon, plastic
- Cable ties
- Camera and film
- Chain-of-custody form
- Clear tape
- Coolers
- Copper vent tube (for vent from cryogenic liquid to atmosphere)
- Decontamination equipment
- Duct tape
- Fan
- Field work table, two, 6+ feet long, 2+ feet wide
- Field logbook
- First aid kit
- Fittings for tubing
- Floor for glove bag (to anchor bag, protect glove bag floor from damage)
- Framework to support bag
- Frit or equal (for bubbling gas into water)
- Glove bag (I2R Inc. Model SS30-20 or equal)
- Ice

- Inert gas (nitrogen or argon) with two regulators
- Lexan® cylinder end caps
- Lexan cylinders, sized to fit in core barrel, cut in 6-inch lengths (supplied by driller)
- Measuring tape
- Oxygen sensors, three (to monitor for oxygen deficient atmosphere)
- Paper towels
- Personnel protective equipment, per HASP
- Pipe wrenches, 2, sufficient size to be used on the PVC sample shipping tube.
- Plastic baggies, 1 gallon size, self closing
- Polyethylene sheeting
- Post hole digger
- PVC sample shipping tube, water tight, for holding Lexan cylinders
- Shelter, portable, temporary; one for glove bag, one for water and shipping tubes
- Shovel
- Small pry bar (for opening sampler)
- Spay bottle (for deoxygenated, sterile water)
- Support for sampler (to prevent rolling)
- Surgical gloves
- Teflon tape
- Tool box
- Trowel
- Tubing (to connect gas source to glove bag and water boxes)
- Utility knife
- Vermiculite
- Water, deionized, sterile, in 20 liter containers (for use in shipping samples)

Figure 1 is a schematic of the sample handling system setup.

FIELD PROCEDURES

Setup

1. The anoxic sample handling system will be set up at a close but safe distance from the drilling location to minimize the time required to get the sampler into an anoxic environment. The location selected should be at least one boom height away from the rig to minimize the chances

of being hit by anything falling from the rig.

2. The anoxic sample handling system will consist of a glove bag set up on a table under folding, portable shelter which is open on the sides (Figure 1).
3. Arrange for delivery of the inert gas to the site before the drill rig sets up at the work location. If possible, have the box truck parked in the location where it will stay during work at that location and have the delivery truck back up the to the box truck. The gas containers will be transferred form the back of the delivery vehicle directly into the back of the box truck. This transfer must be done on a hard, level, paved surface such as a parking lot, as close to the work location as practical (if not right at the work location). Great care must be taken in handling and securing the gas container in the box truck due to their weight. After each container is secured, move the truck, if necessary, very slowly (maximum of 5 miles per hour (mph)) to the work location. Do not drive the truck on public roads with gas containers in the truck.
4. Park the truck with the back of the truck facing the portable shelter where the glove bag is installed. The truck will remain parked in this location until the work at this borehole is completed or the gas container(s) needs to be replaced.
5. Place an oxygen sensor on the floor of the truck near the inert gas source to check for an oxygen deficient atmosphere. Set it up in alarm mode and leave it on during the day. Recharge the instrument overnight.
6. Hook up a copper tubing vent line to the gas container, if using a cryogenic liquid, to allow the container to vent to the atmosphere. Direct the tubing up and along the wall of the truck to the front, into the cab, through a window and up on to the roof. Direct the tubing up to the roof, bend it over to prevent moisture from entering and secure. Close the window and lock the doors to the cab. This will minimize the chance of someone coming into contact with the vented gas and will help ensure that it is safely dispersed.
7. Attach two regulators to the gas supply: one to control flow to the glove bag and one to control flow to deoxygenate the water that will be used to ship the samples under anoxic conditions.
8. Set up the shelter adjacent to the drilling rig.
9. Set up the work table under this shelter.
10. Set up the glove bag on the table. Use bricks to hold the glove bag down until ready for use.
11. Set up a fan adjacent to the open end of the glove bag. This fan will be used when the bag is opened to ensure adequate dilution and dispersion of gas coming out of the bag as equipment is placed into the bag.
12. Place an oxygen sensor on the table near the glove bag to check for an oxygen deficient atmosphere. Set it up in alarm mode and leave it on during all day. Recharge the instrument overnight.

13. Connect one end of the tubing to the regulator and the other end to the glove bag. Put a valve close to the connection to the glove bag to allow flow to bag to be controlled at the work table. Connect tubing to the gas discharge side of the glove bag. Put a valve close to the connection to the glove bag to allow flow to bag to be controlled at the work table. Run the discharge line about 50 feet away from, and downwind of, the work area and away from residences of other structures. Secure the end of the tubing to a 2x4 piece of lumber, dig a 2- to 3-foot hole in the ground with a post hole digger and place the other end of the 2x4 in the hole so that it stands up thereby elevating the discharge end of the hose above ground surface. This will help ensure safe dilution and dispersion of the gas as it is discharged to the atmosphere.
14. Set up a second shelter and place the sample shipping tubes and 20-liter boxes of water under this shelter.
15. Connect tubing to the other regulator, attach a frit to the end and place in a 20-liter box of sterile, deionized water. Set up several boxes of water in the same manner to ensure a sufficient supply of water. Place the boxes of water in an area away from the work area where the inert gas bubbling out of the containers will not pose a hazard to workers.
16. Open a PVC sample shipping tube, remove both caps from the tube. Put Teflon tape on the threads of one cap and seal the cap on the tube. Use pipe wrenches to fasten the cap tightly.
17. Set up the sample shipping tube with the closed bottom of the tube in a rack, support, or 5-gallon plastic bucket which will allow the tube to stand vertically and also allow ice to be placed around the bottom of it to help keep samples cold prior to shipping.
18. When ready to begin sample collection place the following equipment into the glove bag:
    a. Floor for glove bag (to anchor bag, protect floor from damage)
    b. Support for sampler (to prevent rolling)
    c. Framework to support bag (constructed from PVC pipe)
    d. Surgical gloves (to wear over glove bag gloves to improve dexterity)
    e. Oxygen sensor (multiRAE or equal)
    f. Lexan tube end caps
    g. Tape to seal end caps
    h. Medium and large point "sharpie" marker to label Lexan tubes
    i. Small pry bar (for opening sampler)
    j. Trowel
    k. Spay bottle of deoxygenated, sterile water
    l. Paper towels
19. Driller decontaminates the split barrel sampler and Lexan liners (pre-cut into 6-inch lengths by driller) per the drilling subcontract and allow to air dry on plastic sheeting

20. Fill a sample shipping tube with deionized, sterile, deoxygenated water. While filling the tube tilt the tube to one side to minimize the agitation of the water. Overfill the tube, place water in the cap, and replace the cap on the cylinder to limit contact of the water with the atmosphere.
21. Record all appropriate data in the appropriate field logbook in accordance with CDM Technical Standard Operating Procedure (TSOP) 4-1, "Field Logbook Content and Control"

Sample Collection

1. Using rotosonic drilling techniques the driller advances casing to target depth and removes slough from borehole.
2. Two CDM personnel (CDM 1 and CDM 2) will handle the sample and package it once the driller retrieves it from the borehole and carries it to the work location.
3. Close glove bag equipment entrance and start flow of inert gas sufficient to inflate glove bag to the consistency of a soft pillow. The objective is to create and maintain a positive pressure of gas in the glove bag.
4. Assemble the framework inside the glove bag if necessary to support the bag.
5. CDM 1 turns on fan to blow fresh air across open end of glove bag.
6. Wearing clean gloves, the driller assembles the split barrel sampler with Lexan segments inserted in the sampler.
7. Driller collects the sample and retrieves the split barrel sampler from the borehole and loosens fittings at the top and bottom sampler so they can be removed by hand in the glove bag.
8. Driller carries sampler to the glove bag.
9. CDM 1 shuts off or reduces the flow of inert gas into the bag to minimize discharge of gas into the breathing zone when the bag is opened to insert the sampler.
10. Driller hands sampler to CDM 2.
11. CDM 1 opens the glove bag.
12. CDM 2 places sampler in glove bag on support.
13. CDM 1 closes the glove bag and seals the opening.
14. CDM 1 restarts or increases flow of inert gas into glove bag to maintain positive pressure.
15. CDM 1 places their hands in the glove bag and dons surgical gloves in preparation for handling the sample.
16. CDM 2 updates log book and completes sampling paperwork.
17. CDM 2 logs the depth interval of the sample, calculate the depth interval of each Lexan segment, and records a description of the sample.
18. CDM 1 prepares the geochemical sample for shipment as follows

   a. Open sampler by removing shoe and rod connector and prying off top half of split barrel with pry bar.
   b. Select a Lexan segment. (Note that samples for physical analysis must be full, samples for geochemical analysis do not need to be full.)
   c. Cap both ends with vinyl caps
   d. Use duct tape to secure caps on either end of sample
   e. Use paper towel to wipe off part of Lexan tube (use spray bottle to moisten towel if necessary) and place an arrow on the tube indicting which end of the tube is up (which end is closer to ground surface).
   f. Replace Lexan segment in sampler

19. CDM 1 prepares the physical parameter sample for shipment as follows
   a. Select Lexan segment that is full. If not full use trowel to fill tube with sediment.
   b. Cap both ends with vinyl caps.
   c. Use duct tape to secure caps on either end of sample
   d. Use paper towel to wipe off part of Lexan tube (use spray bottle to moisten towel if necessary) and place an arrow on the tube indicting which end of the tube is up (which end is closer to ground surface).
   e. Replace Lexan segment in sampler

20. CDM 1 labels the geochemical sample for shipment as follows
   a. Use paper towel to wipe off the Lexan tube (use spray bottle to moisten towel if necessary).
   b. Write the following on the Lexan tube:
      i. Date and time sample collected
      ii. Sample identifier as defined in the QAPP
      iii. Depth interval of the sample
      iv. Sampler's initials
      v. "Geochem"
      vi. Make sure the up arrow is clear on the tube.
   c. Place the Lexan tube in a self closing bag and close the bag

21. CDM 1 labels the physical parameter sample for shipment as follows
   a. Use paper towel to wipe off the Lexan tube (use spray bottle to moisten towel if necessary).
   b. Write the following on the Lexan tube:
      i. Date and time sample collected
      ii. Sample identifier as defined in the QAPP

iii. Depth interval of the sample
iv. Sampler's initials
v. "Phys"
vi. Make sure the up arrow is clear on the tube.

c. Place the Lexan tube in a self closing bag and close the bag

22. CDM 2 notes the sample information on a chain-of-custody form. Use separate chains-of-custody for the geochemical and physical analyses. Maintain one anoxic and aseptic for each shipping tube or container. Once a shipping container is filled, close out the chain-of-custody and start of new chain-of-custody. Samples for geochemical and physical analysis will be labeled and chained with out using Forms2Lite.
23. Samples may now be removed from the glove bag and prepared for shipment to the laboratory.
24. Remove the surgical gloves used in the bag from the glove bag gloves.
25. Turn off the flow of inert gas to the glove bag.
26. Purge inert gas from the bag by flattening it to drain gas from the bag.
27. Open the glove bag, remove samples.
28. As quickly as possible, take the bag with the geochemical sample to the shipping tube filled with deoxygenated water, remove the sample from the bag, and place the sample in the shipping tube. Allow the water to overflow the tube, top off the tube if necessary, replace the cap on the shipping tube to limit contact with the atmosphere. See sample shipping below.
29. Place the sampled for physical analysis ("Phys") in a cooler, this sample does not need to maintained in an anoxic environment or on ice. Take care to open the self closing bag, purge it of inert gas, and then reseal the bag.
30. Remove the split barrel sampler and components from the glove bag and return to the driller for decontamination and reuse.
31. Remove any used PPE and trash from the glove bag.
32. Prepare for the next sample and repeat this process as required. Replace the glove bag if necessary.
33. At the end of each day store all equipment and supplies in the box truck. Close and lock all doors on the box truck to secure the equipment, supplies, and inert gas.

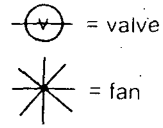
Sample Shipping

1. After collection, the geochemical samples will be maintained and shipped for analysis to the laboratory under anoxic conditions. The physical parameter samples will be stored in a regular cooler and don't need to be shipped on ice.

2. To maintain and ship the geochemical samples under anoxic conditions use the following procedure:
   a. As quickly as possible, take the bag with the geochemical sample to the shipping tube filled with deoxygenated water, remove the sample from the bag, and place the sample in the shipping tube. Allow the water to overflow the tube, top off the tube if necessary, replace the cap on the shipping tube to limit contact with the atmosphere.
   b. Once the tube is full of samples, overfill the tube with deoxygenated water. Put Teflon tape on the threads of the cap, place water in the cap, seal the cap on the tube. Take care to try to eliminate head space in the tube. Use pipe wrenches to fasten the cap tightly.
   c. Remove the tube from the rack or support and check for leaks.
   d. Turn the shipping tube over to the field sampling coordinator (FSC) for shipment to the laboratory. Maintain the tube on ice during preparation for shipment and during shipment.
   e. Close out the chain-of-custody for the shipping tube and turn it over to the FSC.
   f. Replace the full tube with a new tube in the rack and fill the sample shipping tube with deionized, sterile, deoxygenated water. While filling the tube tilt the tube to one side to minimize the agitation of the water. Overfill the tube, place water in the cap, and replace the cap on the cylinder to limit contact of the water with the atmosphere.
   g. The FSC will complete paperwork, pack and ship samples as described in CDM TSOP 1-2 "Sample Custody" and TSOP 2-5 "Packaging and Shipping of Environmental Samples".

LEGEND

W = sterile, dionized water in 20 liter boxes
V = vent
R = Regulator
I = oxygen monitor
D = gas discharge line, elevated using 2x4
G = shipping tube, geochemical analysis samples
M = shipping tube, microbial analysis samples
C = supporting container with ice
Note: schematic is not to scale
Water boxes, sample shipping tubes, and
field screening table will be under a second shelter, omitted for clarity



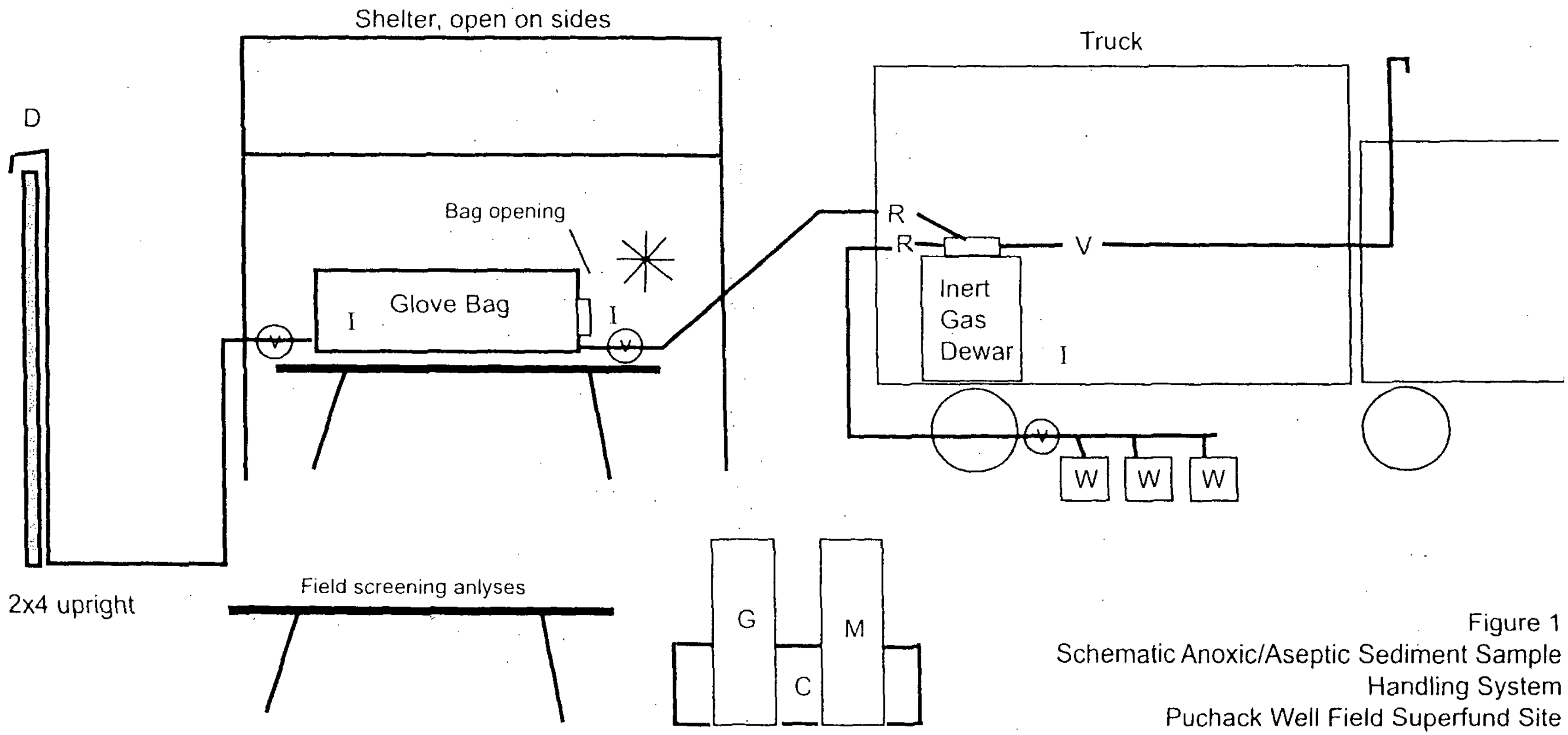


Figure 1
Schematic Anoxic/Aseptic Sediment Sample
Handling System
Puchack Well Field Superfund Site
Pennsuaken Township, New Jersey

301299

Appendix C

Appendix C

Project-Specific Sampling Procedure for Anoxic and Aseptic Subsurface Sediment Samples

PROJECT-SPECIFIC OPERATING PROCEDURE
PUCHACK WELL FIELD SUPERFUND SITE
PENNSAUKEN TOWNSHIP, NEW JERSEY

Project SOP No.: 2
Revision: 0
Date: 03/09/2004

SOP Title: **Anoxic and Aseptic Sediment Sample Handling System**

QA Review: Nancy Suzmont 3/8/04

Approved : C. [signature] 3/9/04
Project Manager Signature/Date

RATIONALE

To assess the applicability of an in situ treatment technology proposed for use at the Puchack Well Field Superfund Site by Pacific Northwest Laboratories certain geochemical and microbial analyses need to be performed on aquifer sediment samples. To perform the required geochemical and microbial analyses effectively, the in-situ condition of the aquifer sediment samples must be preserved by preventing oxidation, or other chemical reactions, due to exposure to the atmosphere and microbial contamination. To do this, an anoxic and aseptic sediment sample handling system will be used at each sampling location. First, aquifer sediment samples will be retrieved from a borehole in unconsolidated deposits completed using a drilling rig and a sterilized split barrel sampler. Then, at ground surface, the sampler will be placed as quickly as possible into a glove bag with an anoxic atmosphere created using an inert gas. Inside the chamber, the sample will be processed using aseptic procedures and sealed in an air tight container. After collection, the samples will be maintained and shipped for analysis to the laboratory under anoxic and aseptic conditions.

PREPARATORY ACTIVITIES

The field team will review and discuss, in detail, the Health and Safety Plan (HSP), material safety data sheets (MSDS), and appropriate, approved Quality Assurance Project Plan (QAPP) sections (sample locations, sample labeling, etc). The field team must pay particular attention to the safe handling of the inert gas. Discuss the inert gas handling and equipment requirements (e.g. tubing, regulators, strapping) with the gas vendor to make sure all required items are identified on the procurement request. The field team leader will visit each proposed work location with the gas vendor to ensure that the gas can be delivered safely to each location. Prior to the field activities, the necessary equipment will assembled and the procedure tested, using air, to check that all components are on hand and that field personnel are familiar with the procedure. Equipment manufacturers' and vendor operating manuals or literature will be reviewed to confirm that the proper equipment operation and material handling procedures are used in the field. All monitoring and protective equipment will be thoroughly checked prior to field activities. Finally, before processing samples, the field team will set up the anoxic sediment handling system in the field and practice with dummy samples to ensure that all components and procedures are working properly.

FIELD EQUIPMENT

A subcontractor will supply a drill rig and split barrel core sampler to retrieve sediment samples from depth in the unconsolidated deposits at the site.

The following equipment will be required and supplied by CDM Federal Programs Corporation (CDM):

- 2x4 lumber, eight to ten feet long
- Air monitoring equipment and calibration span gas
- Blank log sheets
- Box truck, 10 or 15 foot length
- Bricks, two
- Buckets, white, 5-gallon, plastic
- Cable ties
- Camera and film
- Chain-of-custody form
- Clear tape
- Coolers
- Copper vent tube (for vent from cryogenic liquid to atmosphere)
- Decontamination equipment
- Duct tape
- Ethanol (denatured)
- Fan
- Field work table, two, 6+ feet long, 2+ feet wide
- Field logbook
- First aid kit
- Fittings for tubing
- Floor for glove bag (to anchor bag, protect glove bag floor from damage)
- Foil, aluminum, sterile
- Framework to support bag
- Frit or equal (for bubbling gas into water)

- Glove bag (I2R Inc. Model SS30-20 or equal)
- Ice
- Inert gas (nitrogen or argon) with two regulators
- Lexan® cylinder end caps
- Lexan cylinders, sized to fit in core barrel, cut in 6-inch lengths (supplied by driller)
- Measuring tape
- Oxygen sensors, three (to monitor for oxygen deficient atmosphere)
- Paper towels
- Personnel protective equipment, per HASP
- Pipe wrenches, 2, sufficient size to be used on the PVC sample shipping tube.
- Plastic baggies, 1 gallon size, self closing
- Polyethylene sheeting
- Post hole digger
- PVC sample shipping tube, water tight, for holding Lexan cylinders
- Shelter, portable, temporary; one for glove bag, one for water and shipping tubes
- Shovel
- Small pry bar (for opening sampler)
- Spay bottle (for deoxygenated, sterile water)
- Stainless steel sprayer for ethanol
- Sterile gloves
- Support for sampler (to prevent rolling)
- Surgical gloves
- Teflon tape
- Tool box
- Trowel
- Tub, steel, decon
- Tubing (to connect gas source to glove bag and water boxes)
- Utility knife
- Vermiculite
- Water, deionized, sterile, in 20 liter containers (for use in shipping samples)

Figure 1 is a schematic of the sample handling system setup.

FIELD PROCEDURES

Setup

1. The anoxic and aseptic sample handling system will be set up at a close but safe distance from the drilling location to minimize the time required to get the sampler into an anoxic and aseptic environment. The location selected should be at least one boom height away from the rig to minimize the chances of being hit by anything falling from the rig.
2. The anoxic and aseptic sample handling system will consist of a glove bag set up on a table under folding, portable shelter which is open on the sides (Figure 1).
3. Arrange for delivery of the inert gas to the site before the drill rig sets up at the work location. If possible, have the box truck parked in the location where it will stay during work at that location and have the delivery truck back up the to the box truck. The gas containers will be transferred form the back of the delivery vehicle directly into the back of the box truck. This transfer must be done on a hard, level, paved surface such as a parking lot, as close to the work location as practical (if not right at the work location). Great care must be taken in handling and securing the gas container in the box truck due to their weight. After each container is secured, move the truck, if necessary, very slowly (maximum of 5 miles per hour (mph)) to the work location. Do not drive the truck on public roads with gas containers in the truck.
4. Park the truck with the back of the truck facing the portable shelter where the glove bag is installed. The truck will remain parked in this location until the work at this borehole is completed or the gas container(s) needs to be replaced.
5. Place an oxygen sensor on the floor of the truck near the inert gas source to check for an oxygen deficient atmosphere. Set it up in alarm mode and leave it on all day. Recharge the instrument overnight.
6. Hook up a copper tubing vent line to the gas container, if using a cryogenic liquid, to allow the container to vent to the atmosphere. Direct the tubing up and along the wall of the truck to the front, into the cab, through a window and up on to the roof. Direct the tubing up to the roof, bend it over to prevent moisture from entering and secure. Close the window and lock the doors to the cab. This will minimize the chance of someone coming into contact with the vented gas and will help ensure that it is safely dispersed.
7. Attach two regulators to the gas supply: one to control flow to the glove bag and one to control flow to deoxygenate the water that will be used to ship the samples under anoxic and aseptic conditions.
8. Set up the shelter adjacent to the drilling rig.
9. Set up the work table under this shelter.
10. Set up the glove bag on the table. Use bricks to hold the glove bag down until ready for use.

11. Set up a fan adjacent to the open end of the glove bag. This fan will be used when the bag is opened to ensure adequate dilution and dispersion of gas coming out of the bag as equipment is placed into the bag.
12. Place an oxygen sensor on the table near the glove bag to check for an oxygen deficient atmosphere. Set it up in alarm mode and leave it on during all day. Recharge the instrument overnight.
13. Connect one end of the tubing to the regulator and the other end to the glove bag. Put a valve close to the connection to the glove bag to allow flow to bag to be controlled at the work table. Connect tubing to the gas discharge side of the glove bag. Put a valve close to the connection to the glove bag to allow flow to bag to be controlled at the work table. Run the discharge line about 50 feet away from, and downwind of, the work area and away from residences of other structures. Secure the end of the tubing to a 2x4 piece of lumber, dig a 2- to 3-foot hole in the ground with a post hole digger and place the other end of the 2x4 in the hole so that it stands up thereby elevating the discharge end of the hose above ground surface. This will help ensure safe dilution and dispersion of the gas as it is discharged to the atmosphere.
14. Set up a second shelter and place the sample shipping tubes and 20-liter boxes of water under this shelter.
15. Set up a table under this second shelter, cover with 3 layers of polyethylene sheeting, and sterilize by spraying ethanol on it and allowing it to air dry. Use this table to place objects after spraying with ethanol while allowing them to air dry. Spray all objects with ethanol over a steel tube to catch excess ethanol. Allow this excess liquid to evaporate.
    a. Don sterile gloves and wrap sterilized end caps in sterile foil
16. Connect tubing to the other regulator, attach a frit to the end and spray the bottom three feet of tubing and the frit with ethanol, allow to air dry, then place in a 20-liter box of sterile, deionized water. Set up several boxes of water in the same manner to ensure a sufficient supply of water. Place the boxes of water in an area away from the work area where the inert gas bubbling out of the containers will not pose a hazard to workers.
17. Open two PVC sample shipping tube, remove both caps from the tube. For each tube, put Teflon tape on the threads of one cap and seal the cap on the tube. Use pipe wrenches to fasten the caps tightly.
18. Prepare the tube for microbial sample shipment by spraying ethanol one the inside and outside of the tube, drain, and allow to air dry. Then don sterile gloves and set up the sample shipping tube with the closed bottom of the tube in a rack, support, or 5-gallon plastic bucket which will allow the tube to stand vertically and also allow ice to be placed around the bottom of it to help keep samples cold prior to shipping.

19. Prepare the tube for geochemical analyses by simply setting it up with the closed bottom of the tube in a rack, support, or 5-gallon plastic bucket which will allow the tube to stand vertically and also allow ice to be placed around the bottom of it to help keep samples cold prior to shipping.
20. When ready to begin sample collection place the following equipment into the glove bag:
    a. Floor for glove bag (to anchor bag, protect floor from damage)
    b. Support for sampler (to prevent rolling)
    c. Cover the floor and support with sterile foil
    d. Framework to support bag (constructed from PVC pipe), sterilized with ethanol.
    e. Sterile gloves (to wear over glove bag gloves to improve dexterity)
    f. Oxygen sensor (multiRAE or equal)
    g. Lexan tube end caps, sterilized with ethanol and wrapped in sterile foil
    h. Tape to seal end caps
    i. Medium and large point "sharpie" marker to label Lexan tubes
    j. Small pry bar (for opening sampler), sterilized with ethanol
    k. Trowel, sterilized with ethanol
    l. Spay bottle of deoxygenated, sterile water, sterilized with ethanol
    m. Paper towels
21. Driller decontaminates and sterilizes (with ethanol) the split barrel sampler and Lexan liners (pre-cut into 6-inch lengths by driller) per the drilling subcontract and allow to air dry on plastic sheeting.
22. Prepare two shipping tubes, one for microbial analyses and one for geochemical analyses. The tube for microbial analyses must be sterilized by spraying inside and out with ethanol and allowing it to air dry. Mark this tube with an "M" near the top and mark the other tube with a "G" near the top. Don sterile gloves to handle the microbial shipping tube. Fill each shipping tube with deionized, sterile, deoxygenated water. First fill the tube for microbial analyses, then fill the tube for geochemical analyses. While filling the tubes tilt them tube to one side to minimize the agitation of the water. Overfill each tube, place water in the cap, and replace the cap on the cylinder to limit contact of the water with the atmosphere.
23. Record all appropriate data in the appropriate field logbook in accordance with CDM Technical Standard Operating Procedure (TSOP) 4-1, "Field Logbook Content and Control"

Sample Collection

1. Using rotosonic drilling techniques the driller advances casing to target depth and removes slough from borehole.
2. Two CDM personnel (CDM 1 and CDM 2) will handle the sample and package it once the driller retrieves it from the borehole and carries it to the work location.
3. Close glove bag equipment entrance and start flow of inert gas sufficient to inflate glove bag to the consistency of a soft pillow. The objective is to create and maintain a positive pressure of gas in the glove bag.
4. Assemble the framework inside the glove bag if necessary to support the bag.
5. CDM 1 turns on fan to blow fresh air across open end of glove bag.
6. Wearing clean, sterile gloves, the driller assembles the split barrel sampler with Lexan segments inserted in the sampler.
7. Driller collects the sample and retrieves the split barrel sampler from the borehole and loosens fittings at the top and bottom sampler so they can be removed by hand in the glove bag.
8. Driller carries sampler to the glove bag.
9. CDM 1 shuts off or reduces the flow of inert gas into the bag to minimize discharge of gas into the breathing zone when the bag is opened to insert the sampler.
10. CDM 2 dons sterile gloves.
11. Driller hands sampler to CDM 2.
12. CDM 1 opens the glove bag.
13. CDM 2 places sampler in glove bag on support.
14. CDM 1 closes the glove bag and seals the opening.
15. CDM 1 restarts or increases flow of inert gas into glove bag to maintain positive pressure.
16. CDM 1 places their hands in the glove bag and dons sterile surgical gloves in preparation for handling the sample.
17. CDM 2 updates log book and completes sampling paperwork.
18. CDM 2 logs the depth interval of the sample, calculate the depth interval of each Lexan segment, and records a description of the sample.
19. CDM 1 prepares the geochemical sample for shipment as follows
    a. Open sampler by removing shoe and rod connector and prying off top half of split barrel with pry bar.
    b. Select a Lexan segment. (Note that samples for physical analysis must be full, samples for geochemical analysis do not need to be full.)
    c. Cap both ends with vinyl caps
    d. Use duct tape to secure caps on either end of sample

   e. Use paper towel to wipe off part of Lexan tube (use spray bottle to moisten towel if necessary) and place an arrow on the tube indicting which end of the tube is up (which end is closer to ground surface).
   f. Replace Lexan segment in sampler
20. CDM 1 prepares the microbial sample for shipment as follows
   a. Select a Lexan segment. (Note that samples for physical analysis must be full, samples for microbial analysis do not need to be full.)
   b. Cap both ends with vinyl caps
   c. Use duct tape to secure caps on either end of sample
   d. Use paper towel to wipe off part of Lexan tube (use spray bottle to moisten towel if necessary) and place an arrow on the tube indicting which end of the tube is up (which end is closer to ground surface).
   e. Replace Lexan segment in sampler
21. CDM 1 prepares the physical parameter sample for shipment as follows
   a. Select Lexan segment that is full. If not full use trowel to fill tube with sediment.
   b. Cap both ends with vinyl caps.
   c. Use duct tape to secure caps on either end of sample
   d. Use paper towel to wipe off part of Lexan tube (use spray bottle to moisten towel if necessary) and place an arrow on the tube indicting which end of the tube is up (which end is closer to ground surface).
   e. Replace Lexan segment in sampler
22. CDM 1 labels the geochemical sample for shipment as follows
   a. Use paper towel to wipe off the Lexan tube (use spray bottle to moisten towel if necessary).
   b. Write the following on the Lexan tube:
      i. Date and time sample collected
      ii. Sample identifier as defined in the QAPP
      iii. Depth interval of the sample
      iv. Sampler's initials
      v. "Geochem"
      vi. Make sure the up arrow is clear on the tube.
   c. Place the Lexan tube in a self closing bag and close the bag
23. CDM 1 labels the microbial sample for shipment as follows
   a. Use paper towel to wipe off the Lexan tube (use spray bottle to moisten towel if necessary).

b. Write the following on the Lexan tube:
   i. Date and time sample collected
   ii. Sample identifier as defined in the QAPP
   iii. Depth interval of the sample
   iv. Sampler's initials
   v. "Microb"
   vi. Make sure the up arrow is clear on the tube.
c. Place the Lexan tube in a self closing bag and close the bag

24. CDM 1 labels the physical parameter sample for shipment as follows
    a. Use paper towel to wipe off the Lexan tube (use spray bottle to moisten towel if necessary).
    b. Write the following on the Lexan tube:
       i. Date and time sample collected
       ii. Sample identifier as defined in the QAPP
       iii. Depth interval of the sample
       iv. Sampler's initials
       v. "Phys"
       vi. Make sure the up arrow is clear on the tube.
    c. Place the Lexan tube in a self closing bag and close the bag
25. CDM 2 notes the sample information on a chain-of-custody form. Use separate chains-of-custody for the geochemical, microbial, and physical analyses. Maintain one chain-of-custody for each shipping tube or container. Once a shipping container is filled, close out the chain-of-custody and start of new chain-of-custody. Samples for geochemical and physical analysis will be labeled and chained with out using Forms2Lite.
26. Samples may now be removed from the glove bag and prepared for shipment to the laboratory.
27. Remove the sterile surgical gloves used in the bag from the glove bag gloves.
28. Turn off the flow of inert gas to the glove bag.
29. Purge inert gas from the bag by flattening it to drain gas from the bag.
30. Open the glove bag, remove samples.
31. As quickly as possible, take the bags with the geochemical and microbial samples to the shipping tube filled with deoxygenated water, remove the sample from the bag, and place each sample in the appropriate shipping tube. Allow the water to overflow the tube, top off the tube if necessary, replace the cap on the shipping tube to limit contact with the atmosphere. See sample shipping below.

32. Place the sampled for physical analysis ("Phys") in a cooler, this sample does not need to maintained in an anoxic or aseptic environment or on ice. Take care to open the self closing bag, purge it of inert gas, and then reseal the bag.
33. Remove the split barrel sampler and components from the glove bag and return to the driller for decontamination and reuse.
34. Remove any used PPE and trash from the glove bag.
35. Prepare for the next sample and repeat this process as required. Replace the glove bag if necessary.
36. At the end of each day store all equipment and supplies in the box truck. Close and lock all doors on the box truck to secure the equipment, supplies, and inert gas.

Sample Shipping

1. After collection, the geochemical samples will be maintained and shipped for analysis to the laboratory under anoxic conditions. The microbial samples will be maintained and shipped for analysis to the laboratory under anoxic and aseptic conditions. The physical parameter samples will be stored in a regular cooler and don't need to be shipped on ice.
2. To maintain and ship the geochemical samples under anoxic conditions use the following procedure:
   a. As quickly as possible, take the bag with the geochemical sample to the shipping tube filled with deoxygenated water, remove the sample from the bag, and place the sample in the shipping tube. Allow the water to overflow the tube, top off the tube if necessary, replace the cap on the shipping tube to limit contact with the atmosphere.
   b. Once the tube is full of samples, overfill the tube with deoxygenated water. Put Teflon tape on the threads of the cap, place water in the cap, seal the cap on the tube. Take care to try to eliminate head space in the tube. Use pipe wrenches to fasten the cap tightly.
   c. Remove the tube from the rack or support and check for leaks.
   d. Turn the shipping tube over to the field sampling coordinator (FSC) for shipment to the laboratory. Maintain the tube on ice during preparation for shipment and during shipment.
   e. Close out the chain-of-custody for the shipping tube and turn it over to the FSC.
   f. Replace the full tube with a new tube in the rack and fill the sample shipping tube with deionized, sterile, deoxygenated water. While filling the tube tilt the tube to one side to minimize the agitation of the water. Overfill the tube, place water in the cap, and replace the cap on the cylinder to limit contact of the water with the atmosphere.

g. The FSC will complete paperwork, pack and ship samples as described in CDM TSOP 1-2 "Sample Custody" and TSOP 2-5 "Packaging and Shipping of Environmental Samples".

3. To maintain and ship the microbial samples under anoxic and aseptic conditions use the following procedure:

a. As quickly as possible, take the bag with the microbial sample to the sterilized shipping tube filled with deoxygenated water, remove the sample from the bag, and place the sample in the shipping tube. Allow the water to overflow the tube, top off the tube if necessary, replace the cap on the shipping tube to limit contact with the atmosphere.

b. Once the tube is full of samples, overfill the tube with deoxygenated water. Put Teflon tape on the threads of the cap, place water in the cap, seal the cap on the tube. Take care to try to eliminate head space in the tube. Use pipe wrenches to fasten the cap tightly.

c. Remove the tube from the rack or support and check for leaks.

d. Turn the shipping tube over to the field sampling coordinator (FSC) for shipment to the laboratory. Maintain the tube on ice during preparation for shipment and during shipment.

e. Close out the chain-of-custody for the shipping tube and turn it over to the FSC.

f. Spray a new tube with ethanol, allow it to air dry and place it in the rack and fill the sample shipping tube with deionized, sterile, deoxygenated water. While filling the tube tilt the tube to one side to minimize the agitation of the water. Overfill the tube, place water in the cap, and replace the cap on the cylinder to limit contact of the water with the atmosphere.

g. The FSC will complete paperwork, pack and ship samples as described in CDM Federal TSOP 1-2 "Sample Custody" and TSOP 2-5 "Packaging and Shipping of Environmental Samples".

LEGEND

W = sterile, dionized water in 20 liter boxes
V = vent
R = Regulator
I = oxygen monitor
D = gas discharge line, elevated using 2x4
G = shipping tube, geochemical analysis samples
M = shipping tube, microbial analysis samples
C = supporting container with ice
Note: schematic is not to scale
Water boxes, sample shipping tubes, and
field screening table will be under a second shelter, omitted for clarity

(v) = valve

(✳) = fan

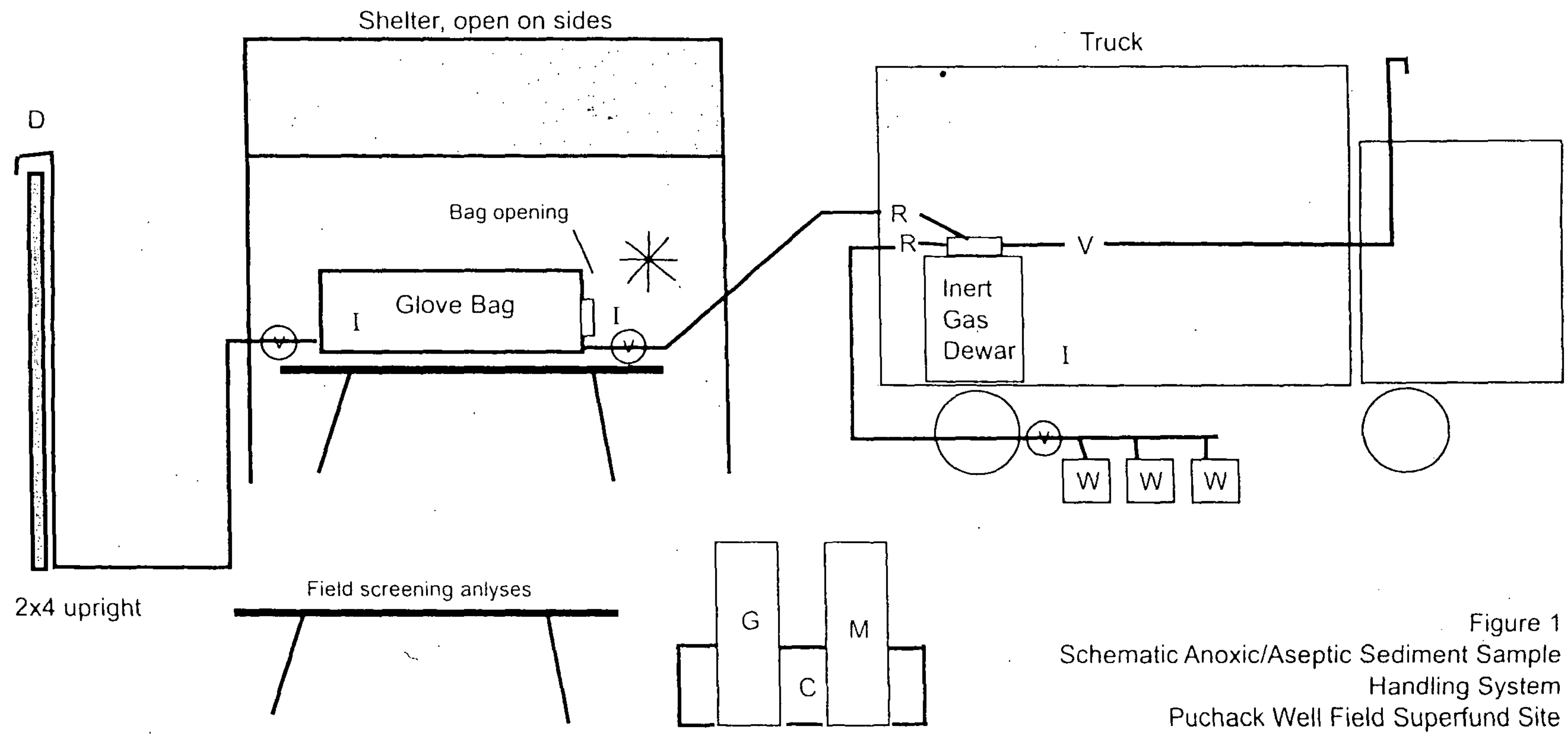


Figure 1
Schematic Anoxic/Aseptic Sediment Sample
Handling System
Puchack Well Field Superfund Site
Pennsuaken Township, New Jersey

301313

Appendix D

Appendix D

Appendix D

Hach Test Kit Procecures for Hexavalent Chromium and Ferrous Iron

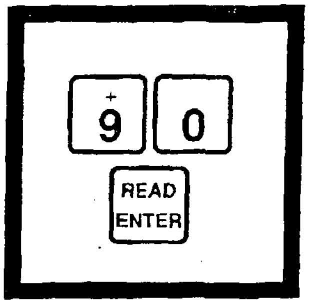
Hach Test Kit Method 8023

Method 8023

CHROMIUM, HEXAVALENT (0 to 0.60 mg/L Cr^{6+}) For water and wastewater

1, 5-Diphenylcarbohydrazide Method* (Powder Pillows or AccuVac Ampuls), USEPA accepted for reporting wastewater analysis**

USING POWDER PILLOWS



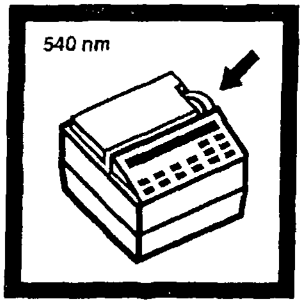
1. Enter the stored program number for hexavalent chromium (Cr^{6+}).

Press: **9 0 READ/ENTER**

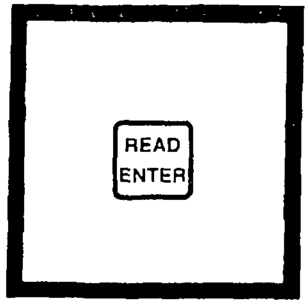
The display will show:
DIAL nm TO 540

Note: DR/2000s with software versions 3.0 and greater will display "P" and the program number.

Note: Instruments with software versions 3.0 and greater will not display "DIAL nm TO" message if the wavelength is already set correctly. The display will show the message in Step 3. Proceed with Step 4.

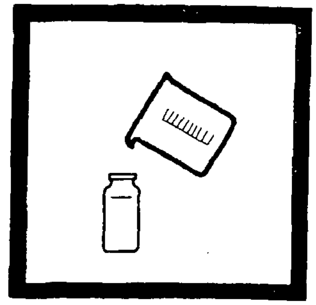


2. Rotate the wavelength dial until the small display shows:
540 nm



3. Press: **READ/ENTER**

The display will show:
mg/l Cr^{6+}



4. Fill a sample cell with 25 mL of sample.

Note: For proof of accuracy, use a 0.25 mg/L hexavalent chromium standard solution (preparation given in the Accuracy Check*) in place of the sample.*

*Adapted from *Standard Methods for the Examination of Water and Wastewater*

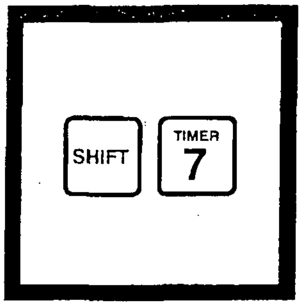
**Procedure is equivalent to USGS method I-1230-85 for wastewater

301317

5. Add the contents of one ChromaVer 3 Reagent Powder Pillow to the sample cell (the prepared sample). Swirl to mix.

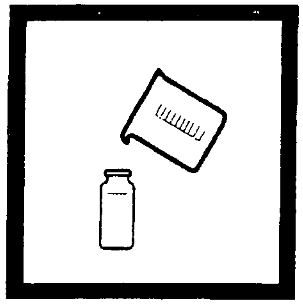
Note: A purple color will form if hexavalent chromium is present.

Note: At high chromium levels a precipitate will form. Dilute sample according to Sample Dilution Techniques *(Section 1).*



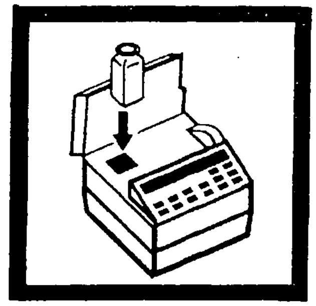
6. Press: **SHIFT TIMER**

A 5–minute reaction period will begin.



7. Fill another sample cell with 25 mL of sample (the blank).

Note: For turbid samples, treat the blank with the contents of one Acid Reagent Powder Pillow. This will ensure any turbidity dissolved by the acid in the ChromaVer 3 Chromium Reagent also will be dissolved in the blank.

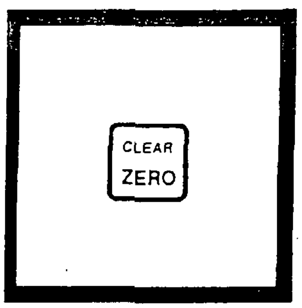


8. When the timer beeps, the display will show:

mg/l Cr^{6+}

Place the blank into the cell holder. Close the light shield.

Note: The Pour–Thru Cell can be used with this procedure.



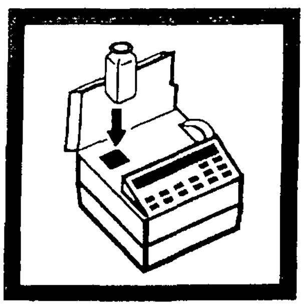
9. Press: **ZERO**

The display will show:

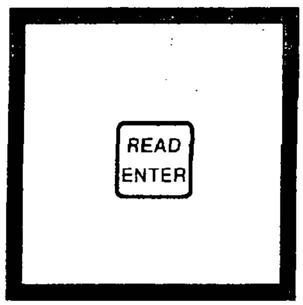
WAIT

then:

0.00 mg/l Cr^{6+}



10. Place the prepared sample into the cell holder. Close the light shield.



11. Press: **READ/ENTER**

The display will show

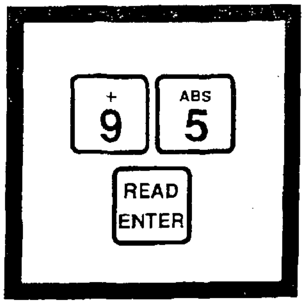
WAIT

then the results in mg/L hexavalent chromium will be displayed.

Note: The results can be expressed as mg/L chromate (CrO_4^{2-}) or mg/L sodium chromate (Na_2CrO_4) by multiplying the mg/L hexavalent chromium by 2.23 or 3.12, respectively.

Note: In the constant–on mode, pressing READ/ENTER is not required. WAIT will not appear. When the display stabilizes, read the result.

USING ACCUVAC AMPULS



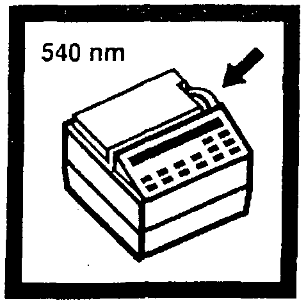
1. Enter the stored program number for hexavalent chromium.

Press: **9 5 READ/ENTER**

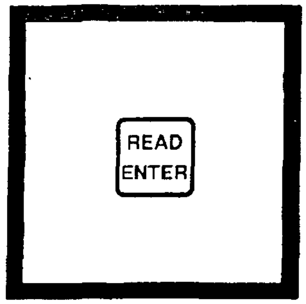
The display will show:
DIAL nm TO 540

Note: DR/2000s with software version 3.0 and greater will display "P" and the program number.

Note: Instruments with software version 3.0 and greater will not display "DIAL nm TO" message if the wavelength is already set correctly. The display will show the message in Step 3. Proceed with Step 4.

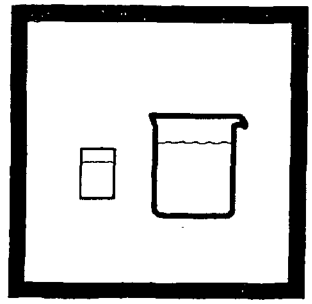


2. Rotate the wavelength dial until the small display shows:
540 nm



3. Press: **READ/ENTER**

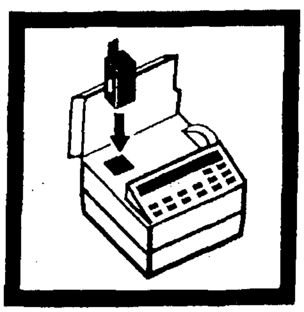
The display will show:
mg/l Cr^{6+} AV



4. Fill the zeroing vial with at least 10 mL of sample (the blank). Collect at least 40 mL of sample in a 50–mL beaker.

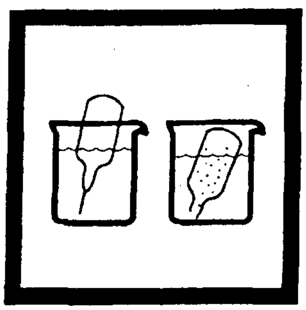
Note: For turbid samples, treat 25 mL of the blank with the contents of one Acid Reagent Powder Pillow. This will ensure any turbidity dissolved by the acid in the ChromaVer 3 Chromium Reagent also will be dissolved in the blank.

Note: For proof of accuracy, use a 0.25 mg/L hexavalent chromium standard solution (preparation given in the Accuracy Check*) in place of the sample*



5. Place the AccuVac Vial Adapter into the cell holder.

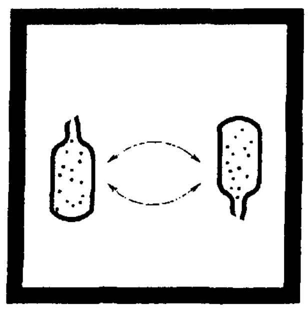
Note: Place the grip tab at the rear of the cell holder.



6. Fill a ChromaVer 3 Reagent AccuVac Ampul (the prepared sample) with sample.

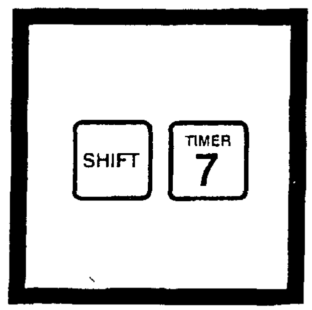
Note: Keep the tip immersed while the ampul fills completely.

Note: ChromaVer 3 should be white to tan in color. Replace if it is brown or green.



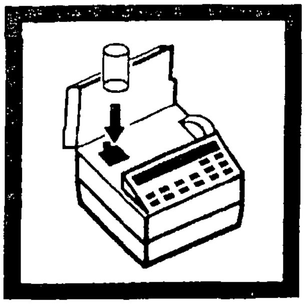
7. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

Note: A purple color will form if hexavalent chromium is present.



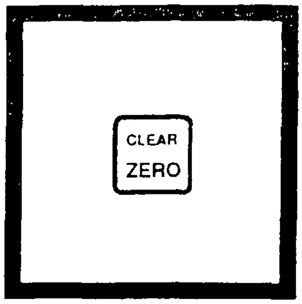
8. Press: **SHIFT TIMER**

A 5–minute reaction period will begin.



9. When the timer beeps the display will show:
mg/l Cr^{6+} AV

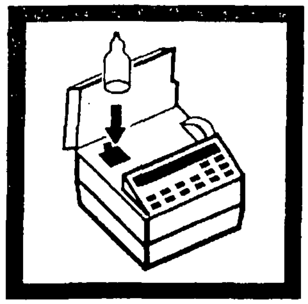
Place the blank into the cell holder. Close the light shield.



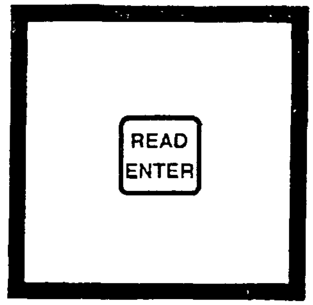
10. Press: **ZERO**

The display will show:
WAIT

then:
0.00 mg/l Cr^{6+} AV



11. Place the prepared sample into the cell holder. Close the light shield.



12. Press: **READ/ENTER**

The display will show:
WAIT

then the result in mg/L hexavalent chromium will be displayed.

Note: The results can be expressed as mg/L chromate (CrO_4^{2-}) or mg/L sodium chromate (Na_2CrO_4) by multiplying the mg/L hexavalent chromium (Cr^{6+}) by 2.23 or 3.12, respectively.

Note: In the constant-on mode, pressing READ/ENTER is not required. WAIT will not appear. When the display stabilizes, read the result.

SAMPLING AND STORAGE

Collect samples in a cleaned glass or plastic container. Store at 4 °C (39 °F) up to 24 hours. Samples must be analyzed within 24 hours.

ACCURACY CHECK

Standard Additions Method

a) Snap the neck off a Chromium Voluette Ampule Standard, 12.5 mg/L Cr^{6+}.

b) Use the TenSette pipet to add 0.1 mL, 0.2 mL and 0.3 mL of standard, respectively to three 25–mL samples. Mix each thoroughly.

c) Analyze each sample as described above. The Chromium concentration should increase 0.05 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see *Standard Additions* in *Section I* for more information.

Standard Solution Method

Prepare a 0.25–mg/L Cr^{6+} by pipetting 5.00 mL of hexavalent chromium standard solution, 50.0 mg/L Cr^{6+}, into a 1000–mL volumetric flask and diluting to the mark with demineralized water. Prepare this solution daily. Perform the chromium procedure as described above. The mg/L Cr^{6+} reading should be 0.25 mg/L Cr^{6+}.

PRECISION

In a single laboratory, using a standard solution of 0.4 mg/L Cr^{6+} and two representative lots of reagent with the DR/2000, a single operator obtained a standard deviation of ±0.003 mg/L Cr^{6+}.

In a single laboratory, using a standard solution of 0.4 mg/L Cr^{6+} and two representative lots of AccuVac ampuls with the DR/2000, a single operator obtained a standard deviation of ±0.001 mg/L Cr^{6+}.

INTERFERENCES

The following do not interfere in the test up to the following concentration:

Mercurous & Mercuric Ions	Interferes Slightly
Iron	1 mg/L
Vanadium	1 mg/L

Vanadium interference can be overcome by waiting ten minutes before reading.

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment *(see pH interfernce in Section I)*.

SUMMARY OF METHOD

Hexavalent chromium is determined by the 1,5–diphenylcarbohydrazide method using a single dry powder formulation called ChromaVer 3 Chromium Reagent. This reagent contains an acidic buffer combined with 1,5–diphenylcarbohydrazide, which reacts to give a purple color when hexavalent chromium is present.

REQUIRED REAGENTS AND APPARATUS (Using Powder Pillows)

Description	Quantity Required Per Test	Unit	Cat. No.
ChromaVer 3 Chromium Reagent Powder Pillows	1 pillow	100/pkg	12066–99
Clippers, for opening pillows	1	each	968–00

REQUIRED REAGENTS AND APPARATUS (Using AccuVac Ampuls)

Description	Quantity Required Per Test	Unit	Cat. No.
ChromaVer 3 AccuVac ampuls	1 ampul	25/pkg	25050–25
Adapter, AccuVac Vial	1	each	43784–00
Beaker, 50 mL	1	each	500–41
Sample Cell, 25 x 54 mm, 10 mL, with cap	1	each	21228–00

OPTIONAL REAGENTS

Description	Unit	Cat. No.
Acid Reagent Powder Pillows	50/pkg	2126–66
Chromium, Hexavalent, Standard Solution, 50 mg/L Cr^{6+}	100 mL	810–42
Chromium, Hexavalent, Solution, Voluette ampule, 12.5 mg/L Cr^{6+}, 10 mL	16/pkg	14256–10
Nitric Acid, ACS	500 mL	152–49
Nitric Acid Solution, 1:1	500 mL	2540–49
Sodium Hydroxide Solution, 5.0 N	59 mL* SCDB	2450–26
Water, demineralized	4 L	272–56

OPTIONAL APPARATUS

Description	Unit	Cat. No.
AccuVac Snapper Kit	each	24052–00
Ampule Breaker Kit	each	21968–00
Flask, volumetric, Class A, 25 mL	each	14574–40
Flask, volumetric, Class A, 1000 mL	each	14574–53
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391–33
pH Meter, EC10, portable	each	50050–00
Pipet, serological, 2 mL	each	532–36
Pipet, TenSette, 0.1 to 1.0 mL	each	19700–01
Pipet Tips, for 19700–01 TenSette Pipet	50/pkg	21856–96
Pipet, volumetric, 5.00 mL, Class A	each	14515–37
Pipet Filler, safety bulb	each	14651–00
Pour–Thru Cell Assembly Kit	each	45215–00
Sample cell, with 25–mL mark, matched pair	each pair	20950–00

For additional ordering information, see final section.
In the U.S.A. call 800–227–4224 to place an order.

*Contact Hach for larger sizes.

301321

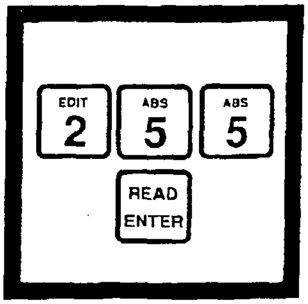
Hach Test Kit Method 8146

IRON, FERROUS (0 to 3.00 mg/L)

For water, wastewater and seawater

1,10 Phenanthroline Method* (Powder Pillows or AccuVac Ampuls)

USING POWDER PILLOWS



1. Enter the stored program number for ferrous iron, (Fe^{2+})– powder pillows.

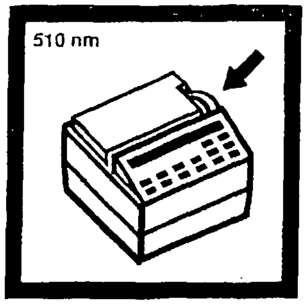
Press: **2 5 5 READ/ENTER**

The display will show:
DIAL nm TO 510

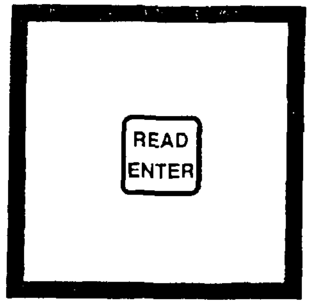
Note: DR/2000s with software versions 3.0 and greater will display "P" and the program number.

Note: Instruments with software versions 3.0 and greater will not display "DIAL nm TO" message if the wavelength is already set correctly. The display will show the message in Step 3. Proceed with Step 4.

Note: Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric iron, which is not determined.

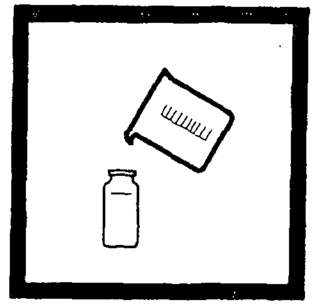


2. Rotate the wavelength dial until the small display shows:
510 nm



3. Press: **READ/ENTER**

The display will show:
mg/l Fe^{2+}



4. Fill a sample cell with 25 mL of sample.

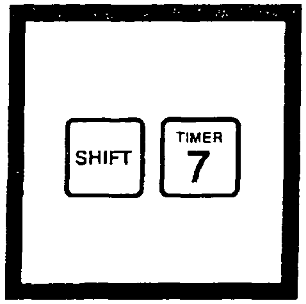
Note: For proof of accuracy, use a 1.0 mg/L ferrous iron standard solution (preparation given in the Accuracy Check*) in place of the sample.*

*Adapted from *Standard Methods for the Examination of Water and Wastewater*

5. Add the contents of one Ferrous Iron Reagent Powder Pillow to the sample cell (the prepared sample). Swirl to mix.

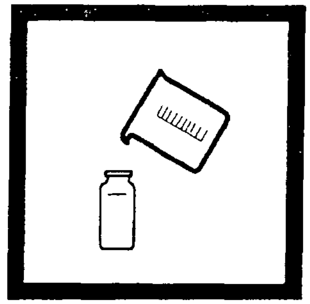
Note: An orange color will form if ferrous iron is present.

Note: Undissolved powder does not affect accuracy.



6. Press: **SHIFT TIMER**

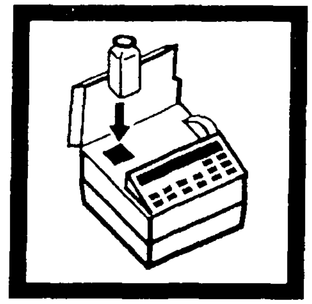
A 3–minute reaction period will begin.



7. When the timer beeps, the display will show:

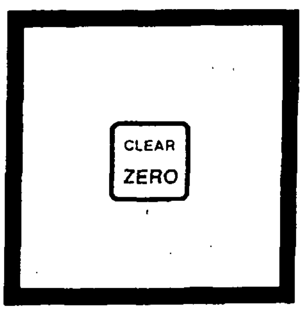
mg/l Fe^{2+}

Fill a second sample cell (the blank) with 25 mL of sample.



8. Place the blank into the cell holder. Close the light shield.

Note: The Pour-Thru Cell can be used with this procedure.



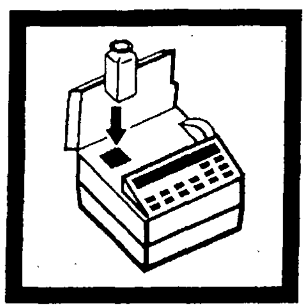
9. Press: **ZERO**

The display will show:

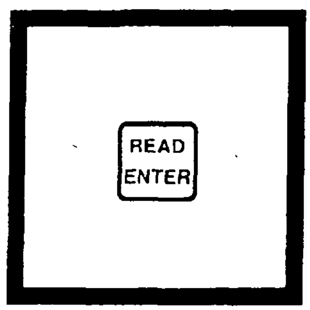
WAIT

then:

0.00 mg/l Fe^{2+}



10. Place the prepared sample into the cell holder. Close the light shield.



11. Press: **READ/ENTER**

The display will show:

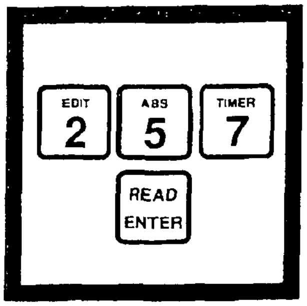
WAIT

then the result in mg/L Fe^{2+} will be displayed.

Note: In the constant–on mode, pressing READ/ENTER is not required. WAIT will not appear. When the display stabilizes, read the result.

301324

USING ACCUVAC AMPULS



1. Enter the stored program number for ferrous iron (Fe^{2+})–AccuVac ampuls.

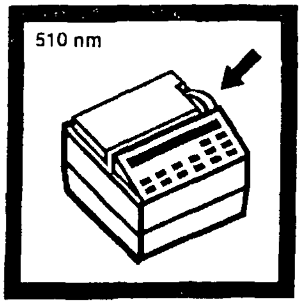
Press: **2 5 7 READ/ENTER**

The display will show:
DIAL nm TO 510

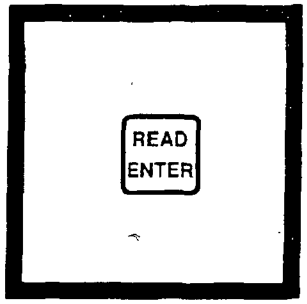
Note: DR/2000s with software versions 3.0 and greater will display "P" and the program number.

Note: Instruments with software versions 3.0 and greater will not display "DIAL nm TO" message if the wavelength is already set correctly. The display will show the message in Step 3. Proceed with Step 4.

Note: Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric iron, which is not determined.

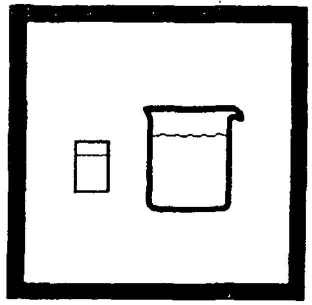


2. Rotate the wavelength dial until the small display shows:
510 nm



3. Press: **READ/ENTER**

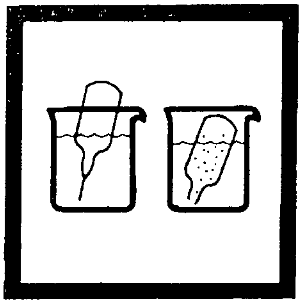
The display will show:
mg/l Fe^{2+} AV



4. Fill a zeroing vial (the blank) with at least 10 mL of sample. Collect at least 40 mL of sample in a 50–mL beaker.

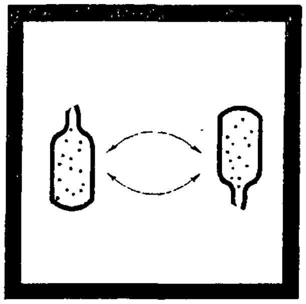
Note: For proof of accuracy, a 1.0 mg/L ferrous iron standard solution (preparation given in the Accuracy Check*) can be used in place of the sample.*

301325



5. Fill a Ferrous Iron AccuVac Ampul with sample.

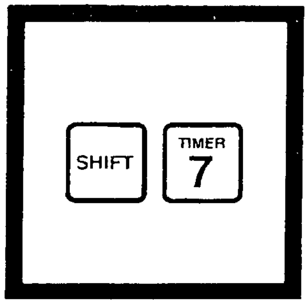
Note: Keep the tip immersed while the ampul fills completely.



6. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

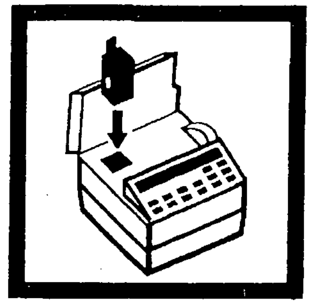
Note: An orange color will form if ferrous iron is present.

Note: Undissolved powder does not affect accuracy.



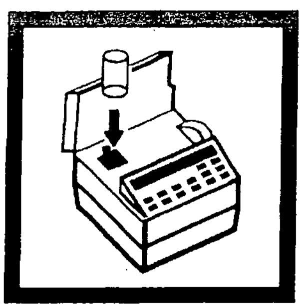
7. Press: **SHIFT TIMER**

A 3-minute reaction period will begin.



8. Place the AccuVac Vial Adapter into the cell holder.

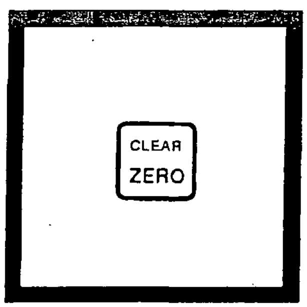
Note: Place the grip tab at the rear of the cell holder.



9. When the timer beeps, the display will show:

mg/l Fe^{2+} AV

Place the blank into the cell holder. Close the light shield.



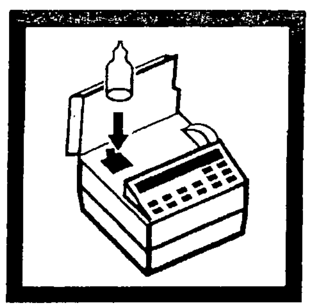
10. Press: **ZERO**

The display will show:

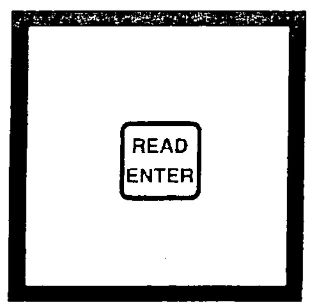
WAIT

then:

0.00 mg/l Fe^{2+} AV



11. Place the AccuVac ampul into the cell holder. Close the light shield.



12. Press: **READ/ENTER**

The display will show:

WAIT

then the result in mg/L Fe^{2+} will be displayed.

Note: In the constant-on mode, pressing READ/ENTER is not required. WAIT will not appear. When the display stabilizes, read the result.

ACCURACY CHECK

Standard Solution Method

Prepare a ferrous iron stock solution (100 mg/L Fe) by dissolving 0.7022 grams of ferrous ammonium sulfate, hexahydrate, in demineralized water. Dilute to 1 liter. Prepare immediately before use. Dilute 1.00 mL of this solution to 100 mL with demineralized water to make a 1.0 mg/L standard solution. Prepare this immediately before use.

PRECISION

In a single laboratory, using an iron standard solution of 1.000 mg/L Fe^{2+} and two representative lots of reagent with the DR/2000, a single operator obtained a standard deviation of ±0.006 mg/L Fe^{2+}.

In a single laboratory using a standard solution of 1.000 mg/L Fe^{2+} and two representative lots of AccuVac ampuls with the DR/2000, a single operator obtained a standard deviation of ±0.009 mg/L Fe^{2+}.

SUMMARY OF METHOD

The 1,10 phenanthroline indicator in Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not react. The ferric iron (Fe^{3+}) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test.

Description	Quantity Required Per Test	Units	Cat. No.
REQUIRED REAGENTS (Using Powder Pillows)			
Ferrous Iron Reagent Powder Pillows	1 pillow	100/pkg	1037–69
REQUIRED REAGENTS (Using AccuVac Ampuls)			
Ferrous Iron Reagent AccuVac Ampuls	1 ampul	25/pkg	25140–25
REQUIRED APPARATUS (Using Powder Pillows)			
Clippers, for opening powder pillows	1	each	968–00
REQUIRED APPARATUS (Using AccuVac Ampuls)			
Adapter, AccuVac Vial	1	each	43784–00
Beaker, 50 mL	1	each	500–41
Sample Cell, 10 mL, with cap	1	each	21228–00
OPTIONAL REAGENTS			
Ferrous Ammonium Sulfate, hexahydrate, ACS		113 g	11256–14
Water, demineralized		4 L	272–56
OPTIONAL APPARATUS			
AccuVac Snapper Kit		each	24052–00
Clippers, shears, 7–1/4"		each	23694–00
Flask, volumetric, 100 mL, Class B		each	547–42
Flask, volumetric, 1000 mL, Class B		each	547–53
Pipet, volumetric, 1 mL		each	515–35
Pipet Filler, safety bulb		each	14651–00
Pour–Thru Cell Assembly Kit		each	45215–00

For additional ordering information, see final section.
In the U.S.A. call 800–227–4224 to place an order.

Appendix E

Appendix E

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APPENDIX E

CDM TECHNICAL STANDARD OPERATING PROCEDURES

1-2 Sample Custody*
1-4 Subsurface Soil Sampling*
1-6 Water Level Measurement
1-10 Field Measurement of Organic Vapors
2-1 Packaging and Shipping of Environmental Samples*
2-2 Guide to Handling Investigation-Derived Waste
3-5 Lithologic Logging
4-1 Field Logbook Content and Control*
4-2 Photographic Documentation of Field Activities
4-3 Well Development and Purging*
4-4 Design and Installation of Monitoring Wells in Aquifers*
4-5 Field Equipment Decontamination at Non-Radioactive Sites*
5-1 Control of Measurement and Test Equipment*

* Includes RAC II Contract-Specific Clarification

TSOP 1-2

SAMPLE CUSTODY

CONTRACT-SPECIFIC CLARIFICATION

SOP Title: SAMPLE CUSTODY

SOP No.: 1 - 2
Revision: 3
Date: July 12, 2002

QA Review: Nancy Zygmont 7/12/02

Approved and Issued: [signature] 7/12/02
Program Manager Signature/Date

Contract No.: RAC II   Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II - Specific

Clarification (attach additional sheets if necessary; state section and page numbers when applicable).

1.0 OBJECTIVE, add (1 of 9):

For the RAC II contract, the sample custody paperwork will also be supplied to the U.S Environmental Protection Agency (EPA) Region II Regional Sample Contract Laboratory Program (CLP) Coordinator and the Contract Laboratory Analytical Service Support (CLASS) contact. This will include the hand written combination traffic reports & chain of custody Records and the combination forms generated using the EPA Field Operations Records Management System II Lite (FORMS II Lite™) software.

Beginning in October 2002, all samples sent through the CLP system will be required to be recorded on the FORMS II Lite™ generated combination Traffic Reports & Chain of Custody Records.

4.0 REQUIRED SUPPLIES, replace (on page 2 of 9):

- Chain-of-Custody Records (applicable CDM Federal forms)

with

- Chain-of-Custody Records

Add (to page 2 of 9):

If using the FORMS II Lite™ software the following additional equipment will be required.

- FORMS II Lite™ Software
- Computer
- Printer

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1-2
Revision: 3
Date: July 12, 2002

SOP Title: SAMPLE CUSTODY

5.0 PROCEDURES

5.1 Chain-of-Custody

Field Custody, on page 3 of 9 under item 2, replace:

"Complete sample label or tags for each sample, using waterproof ink.", with, "Complete sample labels for each sample using indelible ink or pre-printed labels."

Add, before 5.2 Sample Labels and Tags (on page 6 of 9):

Procedure for Completing EPA Contract Laboratory Program (CLP) Routine Analytical Services (RAS) Combination Forms

A combination Organic or Inorganic Traffic Report (TR)/Chain-of-Custody (COC) Record is a four-page carbonless form (Figures C1 and C2) The information that must be entered in the combination forms is detailed in the *Contract Laboratory Program (CLP) Guidance for Field Samplers* (EPA/540/R-00/003). A copy of this guidance is to be on site. Field quality control blanks and matrix spike samples will be noted on the combinations forms.

Each sample will be assigned an identification number that will be affixed in the field to each container for CLP analysis For routine analytical services (RAS) samples, a strip of adhesive labels is provided for each organic and inorganic sample bottled filled at a given sampling point. This unique number, which is recorded on the combination form, is used by EPA to identify the sample. Notations will be made if the sample is to be used as the matrix spike/matrix spike duplicate (organics), matrix spike/duplicate (inorganics), a field (rinsate) blank or trip blank

The following is a list of items required for the combination forms:

- Site spill number
- Region number, sampling entity, sampler name and signature
- Type of activity
- Date shipped, courier and air bill number
- Analytical laboratory name, address and contact
- Case number
- CLP sample number
- Sample description (media type)

- Sample concentration (low, medium, high)
- Sample type (composite, grab)
- Preservative used
- Turn-around time (for organic analysis only)
- RAS analytical fraction(s)
- Date and time of sample collection
- Sampler's initials
- Corresponding CLP inorganic CLP sample number, if applicable
- Field QC sample information (information regarding trip or field blanks but not reference to duplicate samples)
- Whether shipment for case is complete
- Sample designated for matrix spike laboratory QC purposes

After completing the day's sampling, the bottom two copies of each completed combination form are placed in a zip-lock bag taped to the inside cooler lid and shipped with the samples to the laboratory. The top copy is submitted to the Regional Sample Control Center (RSCC) and the second copy is submitted to CLASS along with the sampling trip report. A copy of each combination form is made and retained for the CDM Federal RAC II files.

Procedure for Generating EPA's FORMS II Lite™ Combination Forms

FORMS II Lite™ is used to automate printing of sample documentation in the field; reduce the time spent completing sample collection and transfer documentation; and facilitate electronic capture of data prior to and during field sampling activities. FORMS II Lite™ can be populated with the general site information, laboratory information, CLP case number, sample locations, CLP sample numbers, analysis, preservatives, etc prior to the sampling event Sample labels can then be generated from FORMS II Lite™.

The procedures for generating the FORMS II Lite™ combination forms are similar to preparing the CLP RAS combination forms detailed in the previous section. The difference is the information will be entered into the FORMS II Lite™ software and the combination forms will be printed out at site instead of filling in the combination forms in by hand.

Detailed procedures for using the FORMS II Lite™ software are provided in the FORMS II Lite™ User's Guide supplied with the software.

After completing the day's sampling, the date, time and field QC sample information are entered into the FORMS II Lite™ software. Samples are assigned to the traffic reports, shipping information is entered and the traffic reports are printed. The software generates a Region and a Laboratory copy of the TR/COC Record. The Laboratory copies of the TR/COC Records are signed and placed in a zip-lock bag taped to the inside cooler lid and shipped with the samples to the laboratory. The Region copies of the TR/COC Records are submitted to the RSCC and to CLASS along with the sampling trip report. Examples of TR/COC Records that FORMS II Lite™ generates for the Laboratory copies (Figures C3 and C4) and the Region copies (Figures C5 and C6) are attached to this Contract-Specific Clarification. A copy of the sampling trip report is made and retained for the CDM Federal RAC II files.

<u>Procedure for Completing EPA's Division of Environmental Sciences (DESA) Laboratory Chain-of-Custody Record/Field Data Form</u>

A US EPA Region 2 Laboratory Chain-of-Custody/Field Data Form (Figure C7; a 2 page, carbonless form) is required with each submittal of samples to the DESA laboratory. This combined form requires the following information:

- Site name and location
- Project leader
- Site identification
- Operable unit
- Sample identification
- Number of containers
- Sample matrix
- Special requirements (check-off and describe under comments)
- Sample location, analysis requested, estimated concentration, special requirements information
- Preservative used
- Collection time
- Collection date
- Comments – for example, field QC sample information (trip blank, field blank, sample designated for matrix spike analysis – do not note duplicate samples), type of sample (grab or composite), and air bill number of shipment
- Person assuming the responsibility for the sample (the sampler) and time and date (assign the time of collection of the first sample)
- Person/entity who relinquishes custody, person/entity who receives custody, time, and date

ie DESA laboratory allows the use of alternate COC records

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1-2
Revision: 3
SOP Title: SAMPLE CUSTODY
Date: July 12, 2002

5.2 Sample Labels and Tags, (on page 6 of 9)

It should be noted that sample tags are no longer required for Region II CLP samples. Therefore, Figure 2 on page 7 of 9 is not applicable.

7.0 REFERENCES, add:

U.S. Environmental Protection Agency (EPA). 1989. *Region II CERCLA Quality Assurance Manual.* Revision 1. EPA Monitoring Management Branch of the Environmental Services Division. October 1989.

SAMPLE CUSTODY

SOP 1-2
Revision: 3
Date October 12, 2001

Prepared: David O. Johnson

Technical Review: Jackie Mosher

QA Review: Doug Updike

Approved: [signature] 10/12/01
Signature/Date

Issued: Rose Mary Justin 10/12/01
Signature/Date

1.0 OBJECTIVE

Due to the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Federal Programs Corporation (CDM Federal) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

Note: Sample custody documentation requirements vary with the specific EPA region or client. This SOP is intended to present basic sample custody requirements, along with common options. Specific sample custody requirements should be presented in the project-specific quality assurance (QA) project plan or project-specific modification or clarification form (See Section U-1).

2.0 BACKGROUND

2.1 Definitions

Sample – A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody – A sample is under custody if:

1. It is in your possession.
2. It is in your view, after being in your possession.
3. It was in your possession and you locked it up.
4. It is in a designated secure area.

Chain-of-Custody Record – A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another.

Custody Seal - A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label – A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag – A sample tag is attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

3.0 RESPONSIBILITIES

Sampler – The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Field Team Leader (FTL) – The FTL is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork and decides if additional samples are required.

Field Sample Custodian – The field sample custodian, when designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses. A field sample custodian is typically designated only for large and complex field efforts.

4.0 REQUIRED SUPPLIES

- Chain-of-custody records (applicable client or CDM Federal forms)
- Custody seals
- Sample labels or tags
- Clear tape

5.0 PROCEDURES

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations prior to the actual fieldwork. As few people as possible should handle samples.

2. Complete sample labels or tags for each sample, using waterproof ink.

Transfer of Custody and Shipment

1. Complete a chain-of-custody record for all samples (see Figure 1 for an example of a chain-of-custody record. Similar forms may be used when requested by the client). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the sample custodian in the appropriate laboratory.

   - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the chain-of-custody record.

   - In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.

   - If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

NOTE: If a field sample custodian has been designated, he/she may initiate the chain-of-custody record, sign and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher (refer to Figure 1).

2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied with a separate chain-of-custody record.

3. Include a chain-of-custody record identifying its content in all shipments (refer to Figure 1). The original record will accompany the shipment, and the copies will be retained by the FTL and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the FTL as part of the permanent documentation.

Figure 1
EXAMPLE CDM Federal Chain-of-Custody Record

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123
Fax: (212) 785-6114

CHAIN OF CUSTODY RECORD

PROJECT ID.	FIELD TEAM LEADER	LABORATORY AND ADDRESS	DATE SHIPPED
PROJECT NAME/LOCATION		LAB CONTRACT:	AIRBILL NO.

MEDIA TYPE
1. Surface Water
2. Groundwater
3. Leachate
4. Field QC
5. Soil/Sediment
6. Oil
7. Waste
8. Other ______

PRESERVATIVES
1. HCl, pH <2
2. HNO3, pH <2
3. NaOH, pH >12
4. H2SO4, pH <2
5. Zinc Acetate, pH >9
6. Ice Only
7. Not Preserved
8. Other ______

SAMPLE TYPE
G = Grab
C = Composite

ANALYSES (List no. of containers submitted)

SAMPLE LOCATION NO.	LABORATORY SAMPLE NUMBER	PRESER-VATIVES ADDED	MEDIA TYPE	SAMPLE TYPE	19__ DATE	TIME SAMPLED									REMARKS (Note if MS/MSD)
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															

SAMPLER SIGNATURES:

RELINQUISHED BY:	DATE/TIME	RECEIVED BY:	DATE/TIME	RELINQUISHED BY:	DATE/TIME	RECEIVED BY:	DATE/TIME
(PRINT)		(PRINT)		(PRINT)		(PRINT)	
(SIGN)		(SIGN)		(SIGN)		(SIGN)	
RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME	RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME
(SIGN)		(SIGN)		(SIGN)		(SIGN)	

COMMENTS:

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers. 1/98

NOTE: If requested by the client, different chain-of-custody records may be used. Copies of the template for this record may be obtained from the Fairfax Graphics Department.

Procedure for Completing CDM Federal Example Chain-of-Custody Record (Refer to Figure 1.)

The following procedure is to be used to fill out the CDM Federal chain-of-custody record. The record is provided herein as an example chain-of-custody record. If another type of custody record (i.e., provided by the EPA contract laboratory program or a subcontract laboratory) is used to track the custody of samples, the custody record should be filled out in its entirety.

1. Record project number.
2. Record FTL for the project (if a field sample custodian has been designated, also record this name in the "Remarks" box).
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier's airbill number.
6. Record sample location number.
7. Record sample number.
8. Note preservatives type and reference number.
9. Note media type (matrix) and reference number.
10. Note sample type.
11. Enter date of sample collection.
12. Enter time of sample collection in military time.
13. When required by the client, enter the names or initials of the samplers next to the sample location number of the sample they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter MS/MSD (matrix spike/matrix spike duplicate) if sample is for laboratory quality control or other remarks (e.g. sample depth).
16. Sign the chain-of-custody record(s) in the space provided. All samplers must sign each record.
17. If sample tags are used, record the sample tag number in the "Remarks" column.
18. Record date shipped.
19. The originator checks information entered in Items 1 through 16 and then signs the top left "Relinquished by" box, prints his/her name, and enters the current date and time (military).

20. Send the top two copies (usually white and yellow) with the samples to the laboratory; retain the third copy (usually pink) for the project files. Retain additional copies for the project file or distribute as required to the appropriate sample coordinators.

21. The laboratory sample custodian receiving the sample shipment checks the sample label information against the chain-of-custody record. Sample condition is checked and anything unusual is noted under "Remarks" on the chain-of-custody record. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the copy. The white copy is returned to CDM Federal.

5.2 Sample Labels and Tags

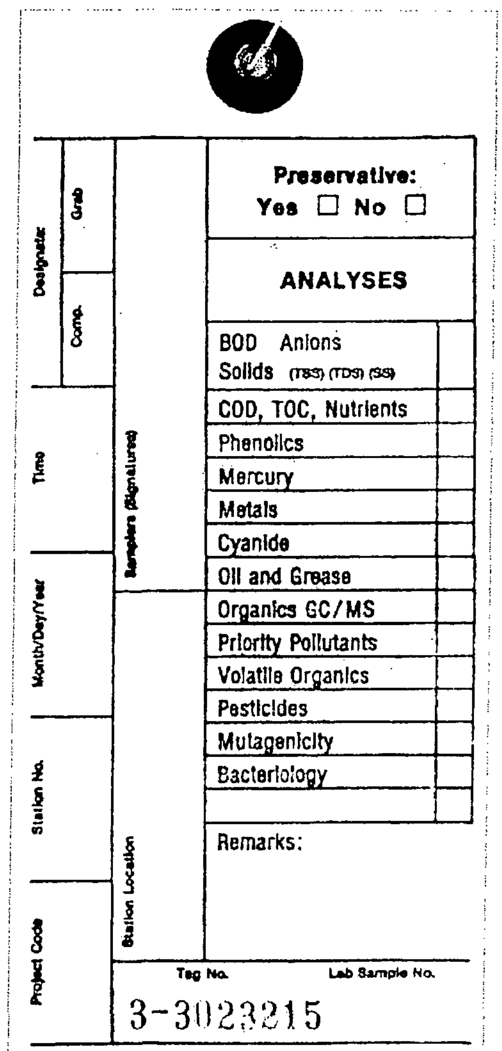
Unless the client directs otherwise, sample labels or tags will be used for all samples collected or accepted for CDM Federal projects.

1. Complete one label or tag with the information required by the client for each sample container collected. A typical label or tag would be completed as follows (see Figure 2 for example of sample tag; labels are completed with the equivalent information):
   - Record the project code (i.e., project or task number).
   - Enter the station number (sample number) if applicable.
   - Record the date to indicate the month, day, and year of sample collection.
   - Enter the time (military) of sample collection.
   - Place a check to indicate composite or grab sample.
   - Record the station (sample) location.
   - Sign in the space provided.
   - Place a check next to "yes" or "no" to indicate if a preservative was added.
   - Place a check under "Analyses" next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. Note: Do not write in the box for "laboratory sample number."
   - Place or write additional relevant information under "Remarks".

2. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.

3. Securely attach sample tags to the sample bottle. On 80 oz. amber bottles, the tag string may be looped through the ring style handle and tied. On all other containers, it is recommended that the string be looped around the neck of the bottle, then twisted and re-looped around the neck until the slack in the string is removed.

Figure 2
EXAMPLE Sample Tag



NOTE: Equivalent sample labels or tags may be used.

5.3 Custody Seals

Custody seals must be placed on the shipping containers (e.g., picnic cooler) prior to shipment. The seal should be signed and dated by a field team member.

Custody seals may also be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction.

5.4 Sample Shipping

The CDM Federal standard operating procedure listed below defines the requirements for packaging and shipping environmental samples.

- CDM Federal SOP 2-1, Packaging and Shipping of Environmental Samples

6.0 RESTRICTIONS/LIMITATIONS

Check with the EPA region or client for specific guidelines. If no specific guidelines are identified, this procedure should be followed.

For EPA Contract Laboratory Program (CLP) sampling events, combined chain-of-custody/traffic report forms or other EPA-specific records may be used. Refer to regional guidelines for completing these forms.

The EPA FORMS II Lite™ software may be used to customize sample labels and custody records when directed by the client or the CDM Federal project manager.

7.0 REFERENCES

U.S. Environmental Protection Agency, *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5, EPA/600/R-98/018, February 1998, Section B3.

U.S. Environmental Protection Agency, *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R, Revised March 1992, p.85.

U.S. Environmental Protection Agency, *Contract Laboratory Program (CLP), Guidance for Field Samplers*, EPA-540-R-00-003, Draft Final, June 2001, Section 3.2.

U.S. Environmental Protection Agency, *FORMS II Lite™ User's Guide*, March 2001

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996, Section 3.3.

U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plan*, EM 200-1-3, February 2001, Appendix F.

TSOP 1-4

SUBSURFACE SOIL SAMPLING

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1-4
Revision: 4
Date: February 15, 2002

SOP Title: SUBSURFACE SOIL SAMPLING

QA Review: [signature]

Approved and Issued: [signature]
Program Manager Signature/Date

Contract No.: RAC II   Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II - Specific

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

2.1 Definitions, add (on page 1 of 21):

Homogenization - The process of mixing individual grab samples in order to minimize the bias in sample representativeness introduced by the natural stratification of constituents within the sample. Homogenization of soil is accomplished by thoroughly mixing the collected soil with a stainless steel spoon or spatula in the following manner. The soil should be scraped from the stainless steel container sides, corners, and bottom, then rolled into the middle and initially mixed. The soil is then quartered and moved to the four quarters of the container. Each quarter of the sample should be mixed individually, then rolled to the center of the stainless steel container sample mixed again.

For the definition of Liner add:

Only stainless steel or Teflon® liners are to be used when sampling soil.

5.2.2.1, EN CORE™ SAMPLER COLLECTION FOR LOW LEVEL ANALYSIS (≥1 μg/kg)

EN CORE™ Sampling Equipment Requirement

Page 6, second bullet - A 60ml Teflon® sealed vial is used to collect the sample for percent moisture analysis (filled to capacity with no headspace) instead of a dry weight cup.

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 1 - 4
Revision: 4
Date: February 15, 2002

SOP Title: SUBSURFACE SOIL SAMPLING

EN CORE™ Sampling Steps for Low Level Analysis

Page 6, item 8 - All samples must be shipped to the laboratory within 24 hours from the time of collection.

5.2.2.2 ACID PRESERVATION SAMPLING FOR LOW LEVEL ANALYSES (≥1 μg/kg)

This section (pages 7-10) is not applicable since samples are not preserved in the field. The laboratory will preserve the samples

5.2.2.3 EN CORE™ SAMPLER COLLECTION FOR HIGH LEVEL ANALYSIS (≥200 μg/kg)

EN CORE™ Sampling Equipment Requirement

Page 10, first bullet - Use the 5 gram sampler option.

Page 10, second bullet - A 60ml Teflon® sealed vial is used to collect the sample for percent moisture analysis (filled to capacity with no headspace) instead of a dry weight cup.

EN CORE™ Sampling Steps for High Level Analysis

tem 8 (page 10) - All samples must be shipped to the laboratory within 24 hours from the time of collection.

.2.2.4 METHANOL PRESERVATION SAMPLING FOR LOW LEVEL ANALYSES

his section (pages 11-12) is not applicable since samples are not preserved in the field. The laboratory will eserve the samples.

0 References

S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services vision, *Region II CERCLA Quality Assurance Manual*, Final Copy, Revision 1, October 1989.

SUBSURFACE SOIL SAMPLING

Prepared: Del Baird

Technical Review: Brian Jenks

QA Review: Matt Brookshire

Approved: Signature/Date

Issued: Signature/Date

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples from the unconsolidated zone. Techniques include use of hand augers, Shelby tubes, continuous core samplers, and split-spoon samplers.

2.0 BACKGROUND

2.1 Definitions

Unconsolidated Zone - The layer of soil above bedrock that exists in a relatively loose state.

Hand Auger - A stainless steel cylinder (bucket) approximately 3 to 4 inches in diameter and 1 foot in length, open at both ends with the bottom edge designed to twist into the soil and cut out a soil core. The bucket collects the soil sample. The auger has a T-shaped handle (for hand operation) attached to the top of the bucket by extendable stainless steel rod(s).

Shelby Tube - A cylindrical sampling device, generally made of steel, which is driven into the subsurface soil through the hollow-stem auger. The tube, once retrieved, may be capped and the undisturbed soil sample extruded in the laboratory prior to analysis.

Split-Spoon - A cylindrical sampling device, generally made of carbon steel, which fits into a hollow stem auger. The spoon is hinged lengthwise, which allows the sample to be retrieved by opening ("splitting") the spoon.

Subsurface Soil - The soil which exists deeper than approximately 1 foot (30 centimeters) from the surface but above bedrock or any other consolidated material.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Liner - A cylindrical sampling device, generally made of brass, stainless steel, or Teflon® that is placed inside a split-spoon or hand auger bucket to collect undisturbed samples.

Composite Sample - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, then a single average sample is taken from the mixture.

Auger Flight - A steel section length attached to an auger to extend the auger as coring depth increases.

2.2 Discussion

Shallow subsurface soil samples (to depths between 6 inches and 10 feet) may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those collected by split-spoon or Shelby tube samplers since the soil sample is disturbed in the augering process. Split-spoon and Shelby tube liners may be used to prevent loss of volatile organic compounds (VOCs). The size and construction material of sampling devices should be selected based on project and analytical objectives and defined in site-specific plans.

2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping of Environmental Samples
- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites

3.0 RESPONSIBILITIES

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and the required equipment, and for ensuring that subsurface soil samples are collected in accordance with this procedure and any other SOPs pertaining to specific media sampling.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with this SOP and other relevant procedures.

4.0 REQUIRED EQUIPMENT

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Clear, waterproof tape
- Appropriate sample containers

- Insulated cooler(s) and waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon®-lined spatulas and pans, trays, or bowls
- Plastic sheeting

Additional equipment is discussed in Section 5.2.2 VOC Field Sampling/Preservation Methods.

4.2 Manual (Hand) Augering

- T-handle
- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers

4.3 Split-Spoon and Shelby Tube Sampling

- Drill rig equipped with a 140-lb drop hammer and sufficient hollow-stem augers to drill to the depths required by the site-specific plans.
- Sufficient numbers of split-spoon or Shelby tube samplers so that at least one is always decontaminated and available for sampling. Three split-spoon or Shelby tube samplers are generally the minimum necessary. (Shelby tubes are usually used only once.)
- Split-spoon liners (as appropriate).
- Wrench(es), hammer.

5.0 PROCEDURES

5.1 Preparation

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc..

3. Processes for verifying depth of sampling must be specified in the site-specific plans.

4. Clear away vegetation and debris from the surface at the boring location.

5. Prepare an area next to the sample collection location for laying out cuttings by placing plastic sheeting on the ground to cover the immediate area surrounding the borehole.

6. Set up a decontamination line, if decontamination is required in accordance with CDM Federal SOP 4-5.

5.2 Collection

The following general steps must be followed when collecting all subsurface soil samples:

1. VOC samples or samples degraded by aeration shall be collected first and with the least disturbance possible. These samples shall be collected as grab samples.

2. Sampling information shall be recorded in the field logbook and on any associated forms. Describe lithology, according to CDM Federal SOP 3-5, in the field logbook or on the lithologic log form.

3. Specific sampling devices to be used shall be identified in the site-specific plans and recorded in the field logbook.

4. Care must be taken to prevent cross-contamination and misidentification of samples.

5. Processes for verifying depth of sampling must be specified in the site-specific plans.

6. Sample bottles for VOC analysis should be filled completely to minimize headspace.

5.2.1 Manual (Hand) Augering

The following steps must be followed when collecting hand-augered samples:

1. Auger to the depth required for sampling. Place cuttings on plastic sheeting or as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout the augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.

3. Cease augering when the top of the specified sampling depth has been reached. If required, remove the auger from the hole and decontaminate the auger or use a fresh auger. Then obtain the sample.

4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration)

immediately and place in sample container. Sample bottles should be filled completely to minimize headspace.

5. Label the sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

6. Remaining sample should be homogenized for other analyses prior to placing samples in the appropriate containers. Label containers as required.

7. Wipe containers with a clean Kimwipe or paper towel to remove residual soil from the exterior of the container(s).

8. Place the containers in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice.

9. Proceed with further sampling, as required by the site-specific plans.

10. When all sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before leaving the site.

12. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.2 Field Sampling/Preservation Methods

The following four sections contain SW 846 Methods for sampling and field preservation. These methods include ENCORE ™ Sampler Method for low-level detection limits, ENCORE ™ Sampler Method for high-level limits/screening, acid preservation, and methanol preservation. These methods may be used if required by the EPA Region, client, or governing sample plan. These methods are very detailed and contain equipment requirements at the beginning of each section.

Note: Some variations from these methods may be required depending on the contracted analytical laboratory, such as sample volume.

5.2.2.1 EN CORE™ SAMPLER COLLECTION FOR LOW LEVEL ANALYSES (≥1 UG/KG)

EN CORE™ Sampling Equipment Requirements

The following equipment is required for low level analysis:

- Three 5g samplers

NOTE: The sample volume requirements specified are general requirements. Actual sample volume and/or container sizes, may vary depending on client or laboratory requirements.

- One dry weight cup
- One T-handle
- Paper towels

EN CORE™ Sampling Steps for Low Level Analysis

1. Remove sampler and cap from package and attach T-handle to sampler body.
2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full.
3. Extract sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.
4. Push cap on with a twisting motion to secure.
5. Fill out sample label and attach to sampler.
6. Repeat procedure for the other two samplers.
7. Collect dry weight sample (60 ml).
8. Store samplers at 4 degrees (°) Celsius.

Ship sample containers with plenty of ice to the laboratory within 40 hours of collection.

NOTE: Verify state requirements for extraction/holding times.

5.2.2.2 ACID PRESERVATION SAMPLING FOR LOW LEVEL ANALYSES (≥1 UG/KG)

Acid Preservation Sampling Equipment Requirements

The following equipment and supplies are required if field preservation is required:

- One 40mL VOA vial with acid preservation (for field testing of soil pH). Two pre-weighed 40mL VOA vials with acid preservative and stir bar (for lab analysis).
- Two pre-weighed 40mL VOA vials with water and stir bar (in case sample effervesces).
- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (for screening sample and/or high level analysis).
- One dry weight cup.
- One 2oz jar with acid preservative (in case additional acid is needed due to high soil pH).
- One scoop capable to deliver about 1g of solid sodium bisulfate.
- pH paper.
- Weighing balance that weighs to 0.01g (with an accuracy $\pm$0.1g).
- Set of balance weights used in daily balance calibration.
- Gloves for working with pre-weighed sample vials.
- Paper towels.
- Sodium bisulfate acid ($NaHS0_4$) acid.
- A cutoff plastic syringe or other coring device to deliver 5g or 25g of soil.

Testing Effervescing Capacity of Soils

Soils must be tested with acid to determine the amount of effervescing that will occur when preserved with acid. Effervescing will drive off VOCs as well as create a very high pressure in a sealed vial which could explode. The following steps will provide information on the effervescing capacity of the soil.

1. Place approximately 5g of soil into a vial that contains acid preservative and no stir bar.

2. Do not cap this vial as it may EXPLODE upon interaction with the soil.

3. Observe the sample for gas evolution (due to carbonates in the soil).

4. If vigorous or sustained gas evolution occurs, then acid preservation is not acceptable to preserve the sample.
   - In this case the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.

5. If a small amount or no gas evolution occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering test detailed below.

- In this case the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

Testing Buffering Capacity of Soils

The soils must be tested to determine the quantity of acid that is required to reach a less than 2 pH reading. The following steps will assist in determining this quantity.

1. If acid preservation is acceptable for sampling soils, then the sample vial that was used in the effervescing testing can be used here for the buffering testing.

2. Cap the vial that contains approximately 5g of soil, acid preservative, and no stir bar from Step 1 in the effervescing testing.

3. Shake the vial gently to attempt to make a homogenous solution.

4. When done, open the vial and check the pH of the acid solution with pH paper.

   - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40mL VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.

   - If the pH paper reads above 2, then additional acid needs to be added to the sample vial.

5. Use the jar with the solid sodium bisulfate acid and add another 1g of acid to the sample.

6. Cap the vial and shake thoroughly again.

7. When done, open the vial and check the pH of the acid solution with a new piece of pH paper.

   - If the pH paper reads below 2 then the sampling can be done in the two pre-weighed 40mL VOA vials with the acid preservative and stir bar and one extra gram of acid.

   - Make a note of the extra gram of acid needed so the same amount of acid can be added to the vials the lab will analyze.

   - If the pH paper reads above 2, then add another gram of acid and repeat this procedure one more time.

Now that the soil chemistry has been determined, the actual sampling can occur. The procedure stated below assumes the correct vials are used based on the guidance discussed.

Sample Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.
2. Quickly collect a 5g sample using a cut off plastic syringe or other coring device designed to deliver 5g of soil from a freshly exposed surface of soil.
3. Carefully wipe exterior of sample collection device with a clean paper towel.
4. Quickly transfer to the appropriate VOA vial, extruding with caution so that the solution does not splash out of the vial.
5. Add more acid if necessary (this is based on the buffering testing discussed in the previous section).
6. Use the paper toweling and quickly remove any soil off the vial threads.
7. Cap vial and weigh the jar to the nearest 0.01g.
8. Record exact weight on sample label.
9. Repeat sampling procedure for the duplicate VOA vial.
10. Weigh the vial containing methanol preservative to the nearest 0.01g. If the weight of the vial with methanol varies by more than 0.01g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation below.
11. Take the empty jar or the jar that contains the methanol preservative.
12. Quickly collect a 25g or 5g sample using a cut off plastic syringe or other coring device designed to deliver 25g or 5g of soil from a freshly exposed surface of soil. The 25g or 5g size is dependent on who is doing the sampling and who is doing the laboratory analysis.
13. Carefully wipe the exterior of the collection device with a clean paper towel.
14. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar received is dependent on who is doing the laboratory analysis.
15. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

16. Use the paper toweling and remove any soil off of the vial threads and cap the jar.

17. Weigh the jar with the soil in it to the nearest 0.01g and record the weight on the sample label.

18. Collect dry weight sample-fill container.

19. Store samples at 4° Celsius.

20. Ship sample containers with plenty of ice in accordance with Department of Transportation (DOT) regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

5.2.2.3 EN CORE™ SAMPLER COLLECTION FOR HIGH LEVEL ANALYSES (≥200 UG/KG)

EN CORE™ Sampling Equipment Requirements

The following equipment is required for high-level analysis:

- One 25g sampler or one 5g sampler (The sampler size used will be dependent on who is doing the sampling and who is doing the laboratory analysis).
- One dry weight cup.
- One T-handle.
- Paper towels.

EN CORE™ Sampling Steps for High Level Analysis

1. Remove sample and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full.

3. Use paper toweling to quickly wipe the sampler head so that the cap can be tightly attached.

4. Push cap on with a twisting motion to attach cap.

5. Fill out a sample label and attach to sampler.

6. Collect dry weight sample.

7. Store samplers at 4° Celsius.

8. Ship sample containers with plenty of ice to the laboratory within 40 hours of collection.

NOTE: Verify state requirements for extraction/holding times.

5.2.2.4 METHANOL PRESERVATION SAMPLING FOR HIGH LEVEL ANALYSES (≥200 UG/KG)

Methanol Preservation Sampling Equipment Requirements

- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (laboratory grade).
- One dry weight cup.
- Weighing balance that accurately weighs to 0.01g (with accuracy of ±0.1g).
- Set of balance weights used in daily balance calibration.
- Latex gloves.
- Paper towel.
- Cutoff plastic syringe or other coring device to deliver 5g or 25g of soil.

Sampling Preservation Steps

1. Wear gloves during all handling of pre-weighed vials.

2. Weigh the vial containing methanol preservative to the nearest 0.01g. If the weight of the vial with methanol varies by more than 0.01g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.

3. Take the empty jar or the jar that contains the methanol preservative.

4. Quickly collect a 25g or 5g sample using a cut off plastic syringe or other coring device designed to deliver 25g or 5g of soil from a freshly exposed surface of soil. The 25g or 5g size used is dependent on who is doing the sampling and who is doing the laboratory analysis.

5. Carefully wipe the exterior of the collection device with a clean paper towel.

6. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on who is doing the laboratory analysis.

7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

8. Using the paper toweling, remove any soil off of the vial threads and cap the jar.

9. Weigh the jar with the soil in it to the nearest 0.01g and record the weight on the sample label.

10. Collect dry weight sample-fill container.

11. Store samples at 4° Celsius.

12. Ship sample containers with plenty of ice in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis

The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Label each sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

2. Use a decontaminated stainless steel or Teflon®-lined trowel or spoon to obtain sufficient sample from the required interval and subsampling points, if necessary, to fill the specified sample containers.

3. Empty the contents of each fill of the sampling device directly into a clean stainless steel or Teflon®-lined tray or bowl.

4. Homogenize the sample by mixing with a spoon, spatula, or trowel.

5. Use the spoon, spatula, or trowel to distribute the uniform mixture into the labeled sample containers. Fill organic sample containers first, then inorganics.

6. Secure the appropriate cap on each container immediately after filling it.

7. Wipe the sample containers with a clean Kimwipe or paper towel.

8. Place sample containers in individual zip-top plastic bags and seal the bags.

9. Pack all samples as required. Include properly completed documentation, and affix custody seals to the cooler lid.

10. Decontaminate sampling equipment according to CDM Federal SOP 4-5.

5.2.4 Manual (Hand) Augering Using a Tube Sampler With Liner

The following steps must be followed when collecting hand-augered samples using a tube sampler with liner:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.
2. Throughout augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.
3. Cease augering when the top of the specified sampling depth has been reached. Remove the auger from the hole and decontaminate.
4. Prepare a decontaminated tube sampler by installing a decontaminated liner in the auger tube.
5. Obtain the sample and retrieve the auger. Remove the liner from the tube and immediately cover ends with Teflon® tape and cap the ends of the tube. Seal the caps with waterproof tape.
6. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner. Indicate boring/well number and depth on outside of liner.
7. Wipe sealed liners with a clean Kimwipe or paper towel.
8. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.
9. Proceed with further sampling, as required by the site-specific plans.
10. When sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
11. Decontaminate all equipment according to CDM Federal SOP 4-5.
12. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.
13. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.5 Split-Spoon Sampling

The following steps must be followed when collecting split-spoon samples:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location prior to drilling, per CDM Federal SOP 4-5 or the site-specific decontamination procedures.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s) to the drill rig.
4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.
5. Slightly raise the auger flight(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods.
7. Install a decontaminated split spoon on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
8. Mark the center rod in 6-inch increments from the top of the auger flight(s).
9. Drive the spoon using the hammer. Use a full 30-inch drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the spoon or tube through each 6-inch increment.
10. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little (<1 inch) or no progress is made for 50 blows of the hammer.
11. Pull the spoon or tube free by using upswings of the hammer to loosen the sampler. Pull out the center rod and spoon or tube.
12. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.
13. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.
14. With the drive shoe and head assembly off, open (split) the spoon, being careful not to disturb the sample.

15. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape.

16. If VOC analyses are to be conducted on the soil sample, place that sample in its sample container immediately after opening the spoon, filling the sample bottle completely. Seal the container immediately, then describe it in the field logbook and/or associated forms. Record the sample identification number, depth from which the sample was taken, and the analyses to be performed on the samples in the field logbook and on the appropriate forms.

17. Remaining sample should be homogenized prior to placing samples in appropriate containers. Label containers as required.

18. Wipe containers with a clean Kimwipe or paper towel.

19. Place containers in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

20. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.

21. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

22. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans. Backfill bore hole as specified in project-specific plans.

23. Decontaminate split spoons and other small sampling equipment according to CDM Federal SOP 4-5 before proceeding to other sampling locations.

24. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

25. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.6 Split-Spoon Sampling Using Liners

The following steps must be followed when collecting samples with lined split spoons:

1. Remove any pavement and sub base material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location prior to drilling.

3. Attach the hollow-stem auger with the cutting head and center rod(s).

4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.

5. Slightly raise the auger flight(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.

6. Remove the plug and center rods.

7. Install decontaminated liners in the split-spoon barrel.

8. Install a decontaminated split spoon on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.

9. Mark the center rod in 6-inch increments from the top of the auger flight(s).

10. Drive the spoon using the hammer. Use a full 30-inch drop as specified by ASTM Method D-1586. Record the number of blows required to drive the spoon or tube through each 6-inch increment.

11. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little (<1 inch) or no progress is made after 50 blows of the hammer.

12. Pull the spoon or tube free by using upswings of the hammer to loosen the sampler. Pull out the center rod and spoon or tube.

13. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.

14. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.

15. With the drive shoe and head assembly off, open (split) the spoon and remove the liners without disturbing the sample.

16. Immediately install Teflon® tape over the ends of the liners, cap the liners, and seal the caps over the ends of the liner with waterproof tape. Label the samples as required by the site-specific plans. Mark the top and bottom of each sample on the outside of each liner. Indicate boring/well number and depth on outside of liner.

17. Wipe sealed liners with a clean Kimwipe or paper towel.

18. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

19. In the field logbook and on the boring log, describe sample lithology by observing cuttings and the bottom end of the sample in the liner.

20. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.

21. When sampling is complete, remove the drilling rig to the heavy equipment decontamination site.

22. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

23. Decontaminate split spoons and other small sampling equipment before proceeding to other sampling locations as required by the CDM Federal SOP 4-5.

24. Complete the field logbook entry, and other forms, being sure to record all relevant information before leaving the site.

25. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.7 Shelby Tube Sampling

The following steps must be followed when collecting samples using the Shelby tube:

1. Remove any pavement and sub base material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location prior to drilling.

3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).

4. Begin drilling and proceed to the first designated sample depth, adding auger flight(s) as necessary.

5. Slightly raise the auger flight(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.

6. Remove the plug and center rods.

7. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby tube assembly to the center rods.

8. Lower the Shelby tube and center rods into the hollow-stem augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.

9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube should be pushed with a steady force. Note the pressure used to push the Shelby tube in the field logbook.

10. When the Shelby tube has been advanced its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, twist to break off the sample, and pull the apparatus out of the hole with the rig winch.

11. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.

12. Since the typical intent of Shelby tube sampling is for engineering purposes and an undisturbed sample is required, the tube ends should be sealed immediately. Sealing is accomplished by filling any void space in the tube with beeswax, then placing caps on the ends of the tube and taping caps into place. The top and bottom ends of the tube should be marked and the tube transported to the laboratory in an upright position. Indicate boring/well number and depth on outside of liner.

13. Wipe sealed tubes with a clean Kimwipe or paper towel.

14. Place sealed tubes in zip-top plastic bags and seal bags. Pack samples in a chilled cooler.

15. Continue to advance the borehole to the next sampling point. Collect samples as outlined above

16. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

17. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

18. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client or governing sample plan.

6.0 RESTRICTIONS/LIMITATIONS

Basket or spring retainers may be needed for split-spoon sampling in loose, sandy soils.

Shelby tubes may not retain the sample in loose, sandy soils.

7.0 REFERENCES

American Society for Testing and Materials, *Penetration Test And Split Barrel Sampling Of Soils*, Standard Method D-1586-84, 1984.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements For Field Methods*, DOE/HWP-69/R1, July 1990.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures For Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Update III, June 1997). Method 5035: Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

TSOP 1-6

WATER LEVEL MEASUREMENT

WATER LEVEL MEASUREMENT

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Approved: Signature/Date 12/18/02

Issued: Signature/Date 12/18/02

1.0 OBJECTIVE

Water-level measurements are fundamental to groundwater and solute transport studies and are conducted during groundwater sampling events to calculate purging requirements. This standard operating procedure (SOP) defines the techniques and requirements for taking groundwater level measurements.

2.0 BACKGROUND

2.1 Definitions

Water Level Indicator - A portable device for measuring the depth from a fixed point at the ground surface or above the ground surface to the groundwater inside a well, borehole or other underground opening.

Measurement Point - An easily located and clearly defined mark at the top of a well or borehole from which all water level measurements from that particular well are made. The measurement point should be as permanent as possible to provide consistency in measurements.

Electrical Tape - A graduated plastic tape onto which a water-sensitive electrode is connected that will electronically signal the presence of water (circuit closure).

Immiscible Fluids - Two or more fluid substances that will not mix and, therefore, will exist together in a layered form. The fluid with the highest density will exist as the bottom layer, the fluid with the lowest density will exist as the top layer, and any other fluid layers will be distributed relative to their respective densities.

Discharge - The removal/release of water from the zone of saturation.

Recharge - The addition of water to the zone of saturation.

Static Water Level - The level of water in a well, borehole or other underground opening that is not influenced by discharge or recharge.

Well Riser - A steel, stainless steel, or polyvinyl chloride (PVC) pipe that extends into a borehole and is connected to the well screen or sealed at the bedrock surface in open-hole wells. The well riser is normally enclosed by an outer steel protective casing.

Protective Casing - A steel cylinder or square protective sleeve extending approximately 3 to 5 feet into the ground, surrounding the well riser, and extending above the ground surface approximately 2 to 3 feet. The protective casing protects the well riser.

2.2 Discussion

Major uses of static water level data are to determine the direction of groundwater flow, to identify areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relations. Specific uses for water level data may include:

1. Determine the change in water level due to distribution or rate of regional groundwater withdrawal.

2. Show the relationship of groundwater to surface water.

3. Estimate the amount, source, and area of recharge and discharge.

4. Determine rate and direction of groundwater movement.

Water levels should be measured in each well prior to purging, sampling, or other disturbance of the water table.

2.3 Associated Procedures

- CDM Federal (CDM) SOP 4-1, Field Logbook Content and Control
- CDM SOP 4-5, Field Equipment Decontamination at Non-radioactive Sites

3.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that measurements are conducted in accordance with this procedure and any other SOP pertaining to site activities related to obtaining groundwater level measurements.

Field Team Leader - The Field Team Leader is responsible for ensuring that field personnel take water level measurements in accordance with this and other relevant procedures.

4.0 REQUIRED EQUIPMENT

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens
- Permanent felt-tip marker (e.g., Sharpie)
- Decontamination equipment and supplies, including rinse bottles and de-ionized water
- Personal protective clothing and equipment
- Tap water and large beaker or bucket
- Water level meters

4.2 Measuring Devices

The equipment required to obtain water level measurements is dependent on the type of procedure chosen. Measurements may be made with a number of different devices and procedures. Measurements are taken relevant to a permanent measurement point on the well riser.

When a choice exists, electrical tapes are preferred over other devices such as steel tape due to the electrical tape's simplicity and ability to make measurements in a short period of time. Many types of electrical instruments have been devised for measuring water levels; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Examples of electrical tapes that are frequently used include the Slope Indicator Co.® and Solinst® electronic water level indicators. These instruments are powered by batteries that should be checked prior to mobilization to the field.

Electrical tapes are coiled on a hand-cranked reel unit that contains batteries and a signaling device that indicates when the circuit is closed (i.e., when the probe reaches the water). Electrodes are generally contained in a weighted probe that keeps the tape taut in addition to providing some shielding of the electrodes against false indications as the probe is being lowered into the hole. The electrical tapes are marked with 0.01-foot increments. Caution should be exercised when using electrical tapes when the water contains elevated amounts of dissolved solids. Under these conditions, the signaling device will remain activated after the probe is removed from the water. When the water being measured contains very low amounts of dissolved solids, it is possible for the probe to extend several inches below the water level prior to activating the signaling device. Both of these conditions are related to the conductivity of the water and in some cases may be compensated for by the sensitivity control, if the device has this option.

Steel surveying tapes in lengths of 100, 200, and 300 feet (as appropriate for site geology) are coiled on a hand-cranked reel. They are weighted at the free end to ensure straight-line measurements are made. The lower few feet of tape are chalked by pulling the tape across a piece of carpenter's chalk. After the tape is lowered to the water level and retrieved, the wet chalk mark identifies the portion of the tape that was submerged. This distance is subtracted from the measurement taken at the top of the well (the measurement point). This method of obtaining water level measurements is not recommended for use in monitoring wells where the introduction of chalk into the well may affect the integrity of groundwater samples. The tape used should be capable of being read to 0.01-foot increments. Steel surveying tapes may be used when conditions prohibit the use of other devices. If a steel surveying tape is used, the following items of caution should be noted:

- The steel tape has tremendous tensile strength but will snap very easily when kinked.
- The steel tape has more surface area than round cables and may stick to the sides of casing or boreholes.
- Deep water levels may be difficult to measure because the chalk will become wet due to the condensation inside wells.

5.0 PROCEDURES

5.1 Preparation

The following steps must be taken when preparing to take a water level measurement:

- Assign a designated field logbook to record all field events and measurements according to CDM SOP 4-1. Document any and all deviations from SOPs and site-specific plans in the logbook and include rationale for the changes.
- Standing upwind from the well, open the groundwater well. Monitor the well with a photo ionization detector (PID), flame ionization detector (FID), or equivalent vapor analyzer as soon as the cap is opened, as dictated by the site-specific health and safety plan.

For comparability, water level measurements should always be referenced to the same vertical (elevation) datum marker, such as a U. S. Geological Survey (USGS) vertical and horizontal control point monument. Elevation datum obtained from the measurement of static water levels should be referenced to Mean Sea Level unless otherwise specified in the site-specific plans.

The measurement point must be as permanent as possible, clearly defined, marked, and easily located. Frequently, the top of the PVC riser is designated as the measurement point. However, since the top of the riser is seldom smooth and horizontal, one particular point on the riser pipe should be designated and clearly marked. This can be accomplished by marking a point on the top of the riser pipe with a permanent marker. To avoid spilling liquids into the well, paints or other liquid marking materials should not be used. The protective outer casing can also be used as the measurement point if required. However, due to frost heave or other outside influences, which may change the casing elevation, this is less desirable than the well riser pipe.

5.2 Water Level Measurement Using Electronic Water Level Indicators

The following steps must be followed when taking water level measurements using electrical tapes:

1. Before lowering the probe into the well, the circuitry should be checked by dipping the probe in tap water and checking to ensure that the signaling device responds to probe submergence. The probe should then be lowered slowly into the well until contact with the water surface is indicated. The electrical tape reading is made at the measuring point. Take a second check reading before completely withdrawing the tape from the well to verify the measurement.

2. Independent electrical tape measurements of static water levels using the tape should agree within ±0.01 foot for depths of less than about 200 feet. At greater depths, independent measurements may not be this close. For a depth of about 500 feet, the maximum difference of independent measurement using the same tape should be within ±0.1 foot.

3. Decontaminate the electrical tape according to CDM SOP 4-5 before proceeding to the next well to minimize cross contamination.

It may be necessary to check the electrical tape length with a graduated steel tape after the line has been used for a long period of time (at least annually) or after it has been pulled hard in attempting to free the line. Some electrical tapes, especially the single line wire, are subject to permanent stretch. Because the probe is larger in diameter than the wire, the probe can become lodged in a well that may contain pumps or other groundwater measuring equipment.

5.3 Water Level Measurement Using Graduated Steel Tape

The following steps must be followed when taking water level measurement using a graduated steel tape:

1. Chalk the lower few feet of the tape by pulling the tape across a piece of blue carpenter's chalk.

2. Lower the graduated steel tape and weight from the measuring point at the top of the well into the water slowly to prevent splashing until a short length (less than chalked distance) of the tape

is submerged. Read the tape at the measurement point. Submergence of the weight and tape may temporarily cause a water level rise in wells or piezometers having very small diameters. This effect can be significant if the well exists in materials of very low hydraulic conductivity. Under dry surface conditions it may be desirable to pull the tape from the well by hand, being careful not to allow the tape to become kinked, and to read the water mark before rewinding the tape onto the reel. In this way, the water mark on the chalked part of the tape is rapidly brought to the surface before the wetted part of the tape dries. In cold regions, rapid withdrawal of the tape from the well is necessary before the wet part freezes and becomes difficult to read. Read the water mark on the tape. The difference between the measurement point and the water mark readings is the depth to the water.

3. To ensure accurate readings, two measurements should be taken and recorded in the logbook. If two measurements of static water level do not agree within about 0.01 foot (generally regarded as the practical limit of precision), continue to measure until the reason for the lack of agreement is determined or until the results are shown to be reliable based upon three measurements within 0.01 foot. Where water is dripping into the hole or is covering the well, it may be impossible to get a good watermark on the chalked tape.

4. Decontaminate, according to CDM SOP 4-5, the portion of steel tape that was placed into the well before proceeding to another well to minimize cross contamination.

5.4 Other Water Level Measurement Methods

Although the two methods cited above (especially the electronic water level indicator) predominate in the environmental sector, there are a number of other methods available which may be well suited for a particular purpose. Please note: caution must always be exercised to prevent inappropriate or contaminated materials from entering an environmental well.

5.4.1 Ultrasonic Method

The ultrasonic method electronically measures the amount of time it takes a sound wave to reach and reflect off the water surface and return to the ground surface. These instruments contain electronic microprocessors, capable of performing this measurement many times each second. The actual depth to water, as calculated by the microprocessor, is an average of many individual and separate readings.

5.4.2 Pressure Gauge Method

This method, also called the Air-Line Submergence Method, uses a pressure gauge and is the preferred method for pumping wells. An air line constructed of semi-rigid tubing is inserted into the well below the water table. The tube end is connected to an air tank or compressor and pressure gauge. Filtered air is then forced through the tube and the resultant pressure is read in pounds per square inch (psi). This reading is converted to feet of water in the column and subtracted from the total tube length to give depth to water. Readings are then converted to groundwater elevation. Results are plotted on a field logging form. Calibration records and the exact procedures used must be maintained.

5.4.3 Popper Method

A popper is a metal cylinder, 2 to 3 inches in length and approximately 1 inch in diameter with a concave bottom. The popper is attached to a measuring tape and lowered into the well to within several inches of the water level. The popper is then dropped until a "popping" sound is heard, noting the tape reading at this point. This action is repeated several times and depth to water is determined in this manner.

5.4.4 Acoustic Probe Method

The acoustic probe is an electronic device containing two electrodes and a battery-powered transducer. The probe is attached to a tape. The probe is dropped into the well until a sound is detected, indicating the electrodes in the probe have contacted the water surface. This method is similar to the electrical probe method discussed in Section 5.2.

5.4.5 Continuous Recording Method

The measurement of groundwater elevations within pumping or monitoring wells can be accomplished by the use of a mechanical or digital-analog computerized continuous recording system and should be performed according to specifications given by the manufacturer of each unit. In general, when using either the mechanical or digital system, the pressure or electrical transducer is lowered into the well until it intersects the water surface. The actual depth to water is then measured by one of the methods described above and used to calibrate the continuous recorder.

The necessary adjustments and preparations are then completed according to the specifications given for each type of continuous recorder. Proper maintenance of continuous recording devices during water level monitoring should be performed such that continuous, permanent records are developed for the specified period of time. Records shall be stored on mechanical graph paper or on a microprocessor. Frequent calibrations of equipment shall also be made during monitoring periods of long duration in accordance with the manufacturers specifications.

6.0 RESTRICTIONS/LIMITATIONS

6.1 Groundwater and Miscible Fluids

Where water is rapidly dripping or flowing into a well, either from the top of the well or from fractures, obtaining an accurate reading may not be possible.

The effect of the water flowing into the well may interfere with an electronic water level measuring device resulting in a false water level measurement. Also, the "splashing" of the water surface makes obtaining consistent results by the wetted-tape method impossible. If water levels must be recorded in wells completed in aquifers that are recharging or discharging, the electronic water level indicator is the preferred measuring device, but should be used with the awareness of possible false measurements. To minimize the effects of "splashing", a 1-inch pipe (decontaminated for environmental wells) may be lowered into the pumping well to minimize the effect of disturbance and protect the probe from potential damage due to down-hole equipment (i.e., submersible pumps).

6.2 Immiscible Fluids

For wells containing immiscible contaminants, the field personnel will need to use special procedures for the measurement of fluid levels. The procedure to follow will depend on whether layers are light immiscibles that form lenses floating on the top of the water table, or dense immiscibles that sink through the aquifer and form lenses over less permeable layers.

In the case of light immiscibles, measurements of immiscible fluid and water levels cannot be accomplished by using normal techniques. For example, a chalked steel tape measurement will only indicate the depth to the immiscible fluid (not the depth to water), and a conventional electrical tape often will not respond to nonconducting immiscible fluids.

Techniques have been specially developed to measure fluid levels in wells containing immiscible fluids, particularly petroleum products. One method is similar to the chalked steel tape method. The difference is the use of a special paste or gel rather than ordinary carpenters chalk, which, when applied to the end of the steel tape and submerged in the well, will show the top of the oil as a wet line and the top of the water as a distinct color change. Another method is similar to the electrical tape method.
The difference is that an interface probe is used that can detect the presence of conducting and nonconducting fluids. Thus, if a well is contaminated with low density, nonconducting immiscible fluids such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction; however, when the probe is lowered deeper to contact water, it will detect electrical conduction. Normally, a variation in an audible signal indicates the difference between phases.

Both of these methods have disadvantages. These methods are less effective with heavier and less refined petroleum products because the product tends to stick to the tape or probe, giving a greater product thickness measurement than it should. Paste or gel cannot be used when sampling groundwater for the same constituents present in the paste or gel product.

Note that water levels obtained in this situation are not suitable without further interpretation for determining hydraulic gradients. To use those data for determining hydraulic gradients, the differences in density between the light immiscible and water have to be accounted for.

Measuring fluid levels in wells screened in lenses of dense immiscible fluids resting on a low permeability formation is somewhat easier, provided the immiscible fluid is nonconducting. The top of the dense layer can be identified by simply using an electrical sounder. As an electrical sounder passes from groundwater into the immiscible phase, the detection unit will deactivate because the fluid will no longer conduct electricity. A better method would be to use an interface probe as described above. The variation in the audible signal associated with the detection of differing phase liquids will also allow the user to obtain a groundwater depth and dense immiscible thickness measurement.

7.0 REFERENCES

Camp Dresser & McKee Inc., et al. *Sampling and Analysis Procedures Geophysical Survey Procedures*, May 1991.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods. EPA/540/P-87/001*, December 1987.

Westinghouse Savannah River Company, *Standard Operating Procedures Manual*, 3Q5, Chapter 13, Revision 1, Hydrogeologic Data Collection Procedures and Specifications, October 1992.

TSOP 1-10

FIELD MEASUREMENT OF ORGANIC VAPORS

FIELD MEASUREMENT OF ORGANIC VAPORS

Prepared: Tammy Phillips

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Approved: [signature] 6/20/01
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Issued: [signature] 6/20/01
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1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to define the techniques and the requirements for the measurement of organic vapors in the field.

2.0 BACKGROUND

2.1 Definitions

Flame Ionization Detector - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the flame ionization of organic vapors.

Photoionization Detector - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the photoionization of organic vapors.

2.2 Discussion

The measurement of organic vapors is a required step during numerous field activities. The primary purpose of such measurements is health and safety monitoring to determine if the breathing zone in a work area is acceptable or if personal protective equipment such as a respirator or a supplied air device is necessary for field personnel. In addition to health and safety monitoring, organic vapor measurement also is used in conjunction with sampling activities, including subsurface soil sampling and groundwater sampling, where measurements are useful for establishing approximate contaminant levels or ranges.

The two types of instruments most commonly used to measure organic vapors are photoionization detectors (PIDs) and flame ionization detectors (FIDs). Both instruments first ionize the gaseous compound and then measure the response, which is proportional to the concentration. The PID ionizes the gas using an ultraviolet lamp. The photons emitted by the ultraviolet lamp are absorbed by the gas molecules, producing a positively charged ion and an electron. The ionization potential (in electron volts) of the organic compounds to be measured must be less than energy carried by the photons; therefore, the ionization potential of the known or suspected compounds should be checked against the energy of the ultraviolet lamp to verify that the energy provided by the lamp is greater. The FID ionizes the gas by burning in a hydrogen/air flame. The FID allows measurement of a wide variety of compounds but in general its sensitivity is not as high as the PID.

2.3 Associated Procedures

- CDM Federal SOP 1-4, Subsurface Soil Sampling
- CDM Federal SOP 1-5, Groundwater Sampling Using Bailers
- CDM Federal SOP 1-6, Water Level Measurement
- CDM Federal SOP 3-1, Geoprobe Soil Sampling Survey
- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-3, Well Development and Purging

3.0 RESPONSIBILITIES

Site Manager - The site manager is responsible for ensuring that field activities are conducted in accordance with the procedure and any other SOPs pertaining to the specific activity.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that field personnel conduct field activities in accordance with this and other relevant procedures.

4.0 REQUIRED EQUIPMENT

- Site-specific plans
- Field logbook
- Waterproof black ink pen
- Personal protective clothing and equipment
- Photoionization detector or flame ionization detector
- 16-ounce or "mason" type glass jar
- Hydrogen Canister (if using FID for a period of more than one day)

5.0 PROCEDURES

5.1 Direct Reading Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.

2. Calibrate the instrument following the applicable manufacturer's manual

3. Make sure the instrument is reading zero and all function and range switches are set appropriately.

4. Insert the end of the probe directly into the atmosphere to be measured (e.g., breathing zone, monitoring well casing, split spoon, etc.) and read the organic vapor concentration in parts per million (ppm) from the instrument display. Record the highest instrument response.

5. Immediately document the reading in the field logbook or on the appropriate field form.

5.2 Headspace Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.

2. Calibrate the instrument following the appropriate manufacturer's manual.

3. Make sure the instrument is reading zero and all function and range switches are set appropriately.

4. Fill a clean glass jar approximately half-full of the sample to be measured. Quickly cover the top of the jar with one or two sheets of clean aluminum foil and apply cap to seal the jar.

5. Allow headspace to develop for approximately 10 minutes. It is generally preferable to shake the sealed jar for 10 to 15 seconds at the beginning and end of headspace development. NOTE: When the ambient temperature is below 32°F (0°C), the headspace development and subsequent measurement should occur within a heated vehicle or building.

6. Remove the jar cap and quickly puncture the foil and insert the instrument probe to a point approximately one-half of the headspace depth.

7. Read the organic vapor concentration in ppm from the instrument display. Record the highest instrument response.

8. Immediately record the reading in the field logbook or on the appropriate field form.

6.0 RESTRICTIONS/LIMITATIONS

The two methods outlined above are the most commonly used for field measurement of organic vapors, but these do not apply to all circumstances. Consult project- or program-specific procedures and guidelines for deviations. Both the PID and FID provide quantitative measurement of organic vapors, but generally neither instrument is compound-specific. The typical reading range of the PID is 0 to 2,000 ppm, and the typical reading range of the FID is 0 to 1,000 ppm. The FID will measure methane while the PID will not. Note: The presence of methane will cause erratic PID measurements. In methane rich environments, toxic organic vapors should be monitored with a FID. If desired, a charcoal filter can be placed temporarily on the FID inlet probe, which will trap all organic vapors except methane. The filtered (methane only) reading can be subtracted from unfiltered (total organic vapors) to provide an estimate of non-methane organic vapors. The reading accuracy of both instruments can be affected by ambient temperature, barometric pressure, humidity, lithology, etc.

7.0 REFERENCES

Martin Marietta Energy Systems, Inc., *Environmental Surveillance Procedures Quality Control Program*, ESH/Sub/87-21706/1, 1988.

TSOP 2-1

PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

CONTRACT-SPECIFIC CLARIFICATION

SOP No. 2-1
Revision 3
Date: August 6, 2001

SOP Title: PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

QA Review: Nancy Zygmont

Approved and Issued: [signature] 8/20/01
Program Manager Signature/Date

Contract No.: RAC II   Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II - Specific

Clarification (attach additional sheets if necessary, state section and page numbers when applicable)

1.4 REQUIRED EQUIPMENT

Add to the list of equipment.

- Paint can-type metal cans with lids, clean (optional)

1.5 PROCEDURES

Under Step 2, add

Clean to the description of the cooler used to transport samples

Under Step 4, add.

- If bubble wrap or other wrapping material will be placed around the labeled containers, write the sample number and analysis on the outside of the wrap, and then place wrapped container in a plastic zip-top bag and close the bag

If samples are determined to be of medium or high hazard by visual observation or instrument reading, or if the sample is known to contain dioxin, all such sample bottles will be placed in waterproof plastic bags and then placed in a metal can (paint can) Vermiculite will be used to secure the bottles within the metal can, and clips or tape will be used to permanently hold the can lid tightly in place One bottle is packed per can The metal cans will be labeled as the sample bottle is labeled High level samples will not be cooled to 4^0 centigrade

Note A labeled cooler temperature blank must be added to each cooler

CONTRACT-SPECIFIC MODIFICATION

SOP No 2-1
Revision 3
Date August 6, 2001

SOP Title PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

Under Step 4, remove the sentence

Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent

Under Step 5, add

While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record or CLP traffic report form The chain-of-custody record or CLP traffic report form with the cooler should reflect only those samples within the cooler Samples recorded on the chain-of-custody record or CLP traffic report form cannot be packed across coolers

Under Step 7, add

Include shipping paperwork for cooler return in the bag taped on the inner side of the cooler lid

Under Step 8, add

At least two custody seals must be attached to each cooler at diagonally opposing corners

Under Step 9, add.

The outside of the cooler must be marked "Environmental Samples" if the samples are designated "Low-level"

Bills of Lading (DOT shipping papers) are required only for shipment of medium- or high-level samples ipment of medium- or high-level samples are as per the *Contract Laboratory Program (CLP) Guidance for Field Samplers* (June 2001)

REFERENCES

Remove

Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program*, EPA/540/P-006, December 1990

Environmental Protection Agency, *Contract Laboratory Program (CLP) Guidance for Field Samplers*, (Draft Final), EPA-540-R-00-003, June 2001

PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

Prepared: Krista Lippoldt   Technical Review: Brian Jenks

QA Review: David O. Johnson   Approved: Signature/Date

Issued: Signature/Date

1.0 PACKAGING AND SHIPPING OF ALL SAMPLES – This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

Section 2.0 – Packaging and Shipping of Samples Preserved with Hexane
Section 3.0 – Packaging and Shipping of Samples Preserved with Sodium Hydroxide
Section 4.0 – Packaging and Shipping of Samples Preserved with Hydrochloric Acid
Section 5.0 – Packaging and Shipping of Samples Preserved with Nitric Acid
Section 6.0 – Packaging and Shipping of Samples Preserved with Sulfuric Acid
Section 7.0 – Packaging and Shipping of Limited Quantity Radioactive Samples

1.1 OBJECTIVE

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples.

1.2 BACKGROUND

1.2.1 Definitions

Environmental Sample - An environmental sample is any sample that has less than reportable quantities for any hazardous constituents according to Department of Transportation (DOT) regulations promulgated in 49 CFR - Part 172.

Custody Seal – A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the sample shipping container (i.e. cooler) before offsite shipment. Custody seals are used as a protective mechanism to ensure that sample integrity is not compromised during transportation from the field to the analytical laboratory.

Secondary Containment – A secondary containment is the container that the sample is shipped in (i.e., plastic overpackaging if liquid sample is collected in glass).

Exempted Quantity – Exempted quantity is the amount of hazardous material that does not fall under DOT/IATA/ICAO regulations. This exemption is very difficult to meet; most shipments will be made under limited quantity.

Limited Quantity – Limited quantity is the maximum amount of a hazardous material for which there is a specific labeling or packaging exception.

Performance Testing – Performance testing is the required testing of outer packaging. These tests include the drop and stacking test.

Qualified Shipper – A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis.

1.2.3 Associated Procedure

- CDM Federal SOP 1-2, Sample Custody

1.3 RESPONSIBILITIES

Field Team Leader (FTL) - The field team leader is responsible for ensuring that packaging and sampling procedures are conducted in accordance with this SOP. The field team leader is also responsible for ensuring that CDM Federal properly coordinates laboratory analysis of samples.

1.4 REQUIRED EQUIPMENT

- Coolers with return address of CDM Federal office
- Heavy-duty plastic garbage bags
- Plastic Ziploc®-type bags, small and large
- Clear tape
- Fiber tape – nylon reinforced strapping tape
- Duct tape
- Vermiculite (or equivalent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or CLP custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.5 PROCEDURES

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "Environmental Sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with the appropriate health and safety coordinator or the health and safety manager should be observed.

2. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape. Line the cooler with a large heavy-duty plastic garbage bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. Note: Trip blanks must be included in coolers containing VOA samples.

5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of more packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Due to the strength properties of a glass container, there is much less chance for breakage when the container is packed vertically rather than horizontally.

6. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° centigrade. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.

7. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.

8. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the hinges of the cooler on opposite sides. The custody seals should be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

9. The shipping container lid must be marked "THIS END UP" and arrow labels that indicate the proper upward position of the container should be affixed to the cooler. A label containing the name and address of the shipper (CDM Federal) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

1.6 RESTRICTIONS/LIMITATIONS

The holding times for the samples packed for shipment must not be exceeded. It is recommended that samples be packed in time to be shipped nightly for overnight delivery. Use caution when shipping samples for weekend delivery; make arrangements with the laboratory before sending samples.

2.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH HEXANE

2.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

2.2 BACKGROUND

2.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

2.2.2 Transportation

This section was prepared for the shipment of hexane-preserved samples.

2.2.3 Containers

- 40 ml glass VOA vials (up to 1L per outer package)

2.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to ensure that each shipment contains no more than the maximum of 24 VOA vials for a total liquid volume of 1 liter and that the shipment is packaged according to IATA/ICAO packaging instruction Y305 for limited quantities of hexane.

REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap
- Ice
- Chain-of-custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

2.5 PACKAGING

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials

- Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- Wrap each container (40 ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

HEXANES MIXTURE
UN1208
LTD. QTY.

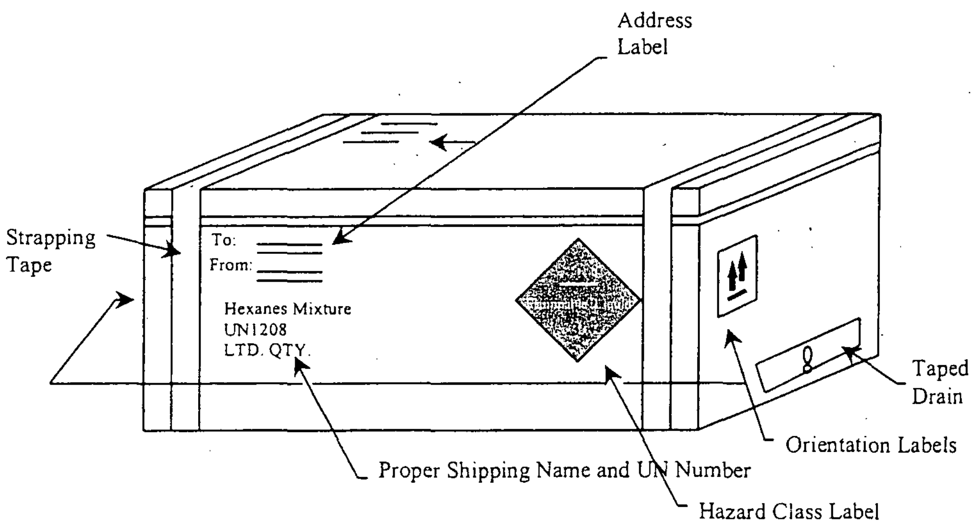
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

Figure 1 Example of Cooler Label/Marking Locations



3.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH SODIUM HYDROXIDE

3.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

3.2 BACKGROUND

3.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

3.2.2 Transportation

This section was prepared for the shipment of sodium hydroxide (NaOH) preserved samples.

3.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted Quantities of Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Chain-of-custody form

- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

3.5 PACKAGING

Samples containing NaOH as a preservative that exceed the exempted concentration of 0.08 percent (2 ml of a 30 percent per liter) will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.

- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

SODIUM HYDROXIDE SOLUTION
UN1824
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: Samples meeting the exemption concentration of 0.08 percent NaOH by weight will be shipped as non-regulated or non-hazardous.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

4.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH HYDROCHLORIC ACID

4.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

4.2 BACKGROUND

4.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

4.2.2 Transportation

This section was prepared for the shipment of hydrochloric acid (HCl) preserved samples.

4.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted quantities of preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HCl	2N	<2	0.04%	.2	.5	1		

5 drops = 1 ml

4.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

4.4 REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape

- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap
- Ice
- Custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

4.5 PACKAGING

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)
- Wrap each container (40 ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.

- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

HYDROCHLORIC ACID SOLUTION
UN1789
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: Samples meeting the exemption concentration of 0.04 percent HCl by weight will be shipped as non-regulated or non-hazardous.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.

- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

5.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH NITRIC ACID

5.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

5.2 BACKGROUND

5.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

5.2.2 Transportation

This section was prepared for the shipment of nitric acid (HNO_3) preserved samples.

5.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted quantities of preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HNO_3	6N	<2	0.15%		2	4	5	8

5 drops = 1 ml

5.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

5.4 REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

5.5 PACKAGING

Samples containing HNO_3 as a preservative that exceed the exempted concentration of 0.15% HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

NITRIC ACID SOLUTION (with less then 20%)
UN2031
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: Samples meeting the exemption concentration of 0.15 percent HNO_3 by weight will be shipped as non-regulated or non-hazardous.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

6.0 PACKAGING AND SHIPPING OF SAMPLES PRESERVED WITH SULFURIC ACID

6.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

6.2 BACKGROUND

6.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

6.2.2 Transportation

This section was prepared for the shipment of sulfuric acid (H_2SO_4) preserved samples.

6.2.3 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Exempted quantities of preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
H_2SO_4	37N	<2	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.3 RESPONSIBILITY

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

6.4 REQUIRED EQUIPMENT

- Outer packaging (for limited quantities) insulated cooler that has passed the performance test.
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (or equivalent)*
- Bubble wrap
- Ice
- Custody seals
- Chain-of-custody form
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

6.5 PACKAGING

Samples containing H_2SO_4 as a preservative that exceed the exempted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection

- Sample location
- Sample identification number
- Collector's initials
- Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble wrapped container into a 2.7 mil Ziploc®-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

SULFURIC ACID SOLUTION
UN2796
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

NOTE: Samples meeting the exemption concentration of 0.35 percent H_2SO_4 by weight will be shipped as non-regulated or non-hazardous.

NOTE: No marking or labeling can be obscured by strapping or duct tape.

NOTE: The inner packaging of dangerous goods may be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

7.0 PACKAGING AND SHIPPING OF LIMITED QUANTITY RADIOACTIVE SAMPLES

7.1 OBJECTIVE

This section provides guidance for the shipment of soil and water environmental samples regulated under the DOT Hazardous Materials Regulations and the IATA/ICAO Dangerous Goods Regulations for shipment by air and applies only to domestic shipments.

7.2 BACKGROUND

7.2.1 Definitions

Section 1.2.1 defines the terms relevant to this section.

7.2.2 Transportation

This section was prepared for the shipment of environmental samples containing radioactive materials in limited quantities.

7.2.3 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

7.3 DESCRIPTION/RESPONSIBILITIES

- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, "Limited Quantities of Radioactive Materials."
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.
- If the shipment is from a Department of Energy (DOE) facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring prior to shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM Federal will use the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm^2 (alpha) and 1000 dpm/100 cm^2 (beta/gamma). It should be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive".
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910".

7.4 REQUIRED EQUIPMENT

- Cooler or other acceptable outer packaging
- Garbage bags
- Clear tape
- Duct tape
- Strapping tape (optional)
- Ziploc®-type bags, small and large
- Vermiculite (for water samples) or equivalent*
- Bubble wrap (optional)
- Ice (if necessary)
- Custody seals
- Chain-of-custody form
- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Exempted quantities label
- Consignor/consignee labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

7.5 PACKAGING

The following steps are to be followed when packaging limited quantity samples shipments.

- The cooler is to be surveyed by a qualified radiation control technician to ensure the exterior surfaces do not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.

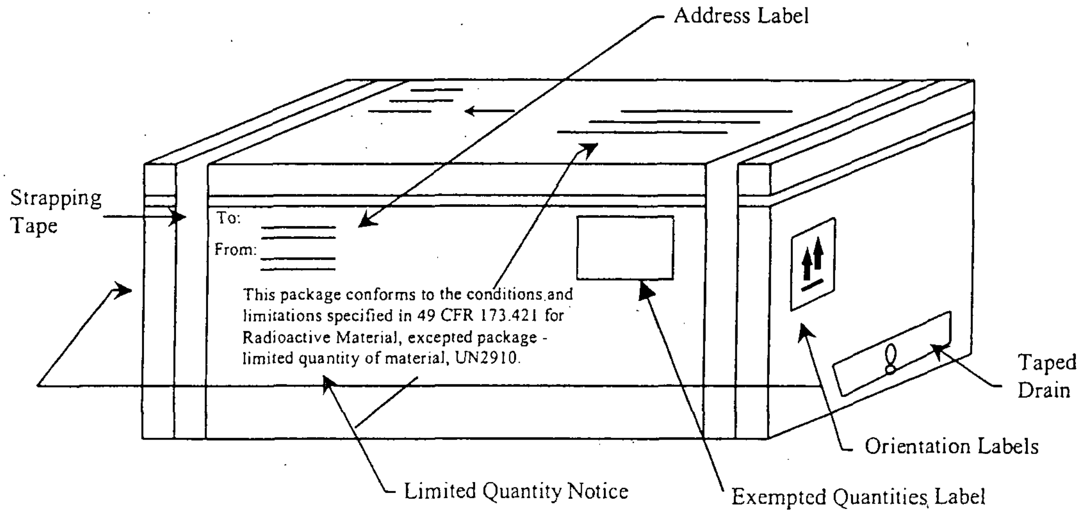
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- Place a label marked "Radioactive" on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a Ziploc®-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of the cooler labeling/marking is shown in Figure 2.

  NOTE: No marking or labeling can be obscured by strapping or duct tape.

- Complete the Shipment Quality Assurance Checklist (Appendix B).

  NOTE: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U.
  NOTE: A declaration of dangerous goods is not required.

Figure 2 Radioactive Material - Limited Quantity Cooler Marking Example



8.0 REFERENCES

U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program*, EPA/540/P-90/006, December 1990.

U.S. Environmental Protection Agency, Region IV, *Standard Operating Procedures and Quality Assurance Manual*, February 1991.

APPENDIX A

Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited Quantity

Sample Packaging

Yes	No	N/A	
❑	❑	❑	The VOA vials are wrapped in bubble wrap and placed inside a Ziploc®-type bag.
❑	❑	❑	The VOA vials are placed into a polyethylene bottle, filled with vermiculite, and tightly sealed.
❑	❑	❑	The drain plug is taped inside and outside to ensure control of interior contents.
❑	❑	❑	The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C.
❑	❑	❑	The cooler exceeds the 66-pound limit for limited quantity shipment.
❑	❑	❑	The garbage bag has been sealed with tape (or tied) to prevent movement during shipment.
❑	❑	❑	The chain-of-custody has been secured to the interior of the cooler lid.
❑	❑	❑	The cooler lid and sides have been taped to ensure a seal.
❑	❑	❑	The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape.

Air Waybill Completion

Yes	No	N/A	
❑	❑	❑	Section 1 has the shipper's name, company and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached.
❑	❑	❑	Section 2 has the recipient's name and company along with a telephone number where they can be reached.
❑	❑	❑	Section 3 has the **Bill Sender** box checked.
❑	❑	❑	Section 4 has the **Standard Overnight** box checked.
❑	❑	❑	Section 5 has the **Deliver Weekday** box checked.
❑	❑	❑	Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6?
❑	❑	❑	Under the **Transport Details** box, the **Cargo Aircraft Only** box is obliterated, leaving only the **Passenger and Cargo Aircraft** box.
❑	❑	❑	Under the **Shipment Type**, the **Radioactive** box is obliterated, leaving only the **Non-Radioactive** box.
❑	❑	❑	Under the **Nature and Quantity of Dangerous Goods** box, the **Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions and Authorization** have been filled out for the type of chemical being sent.
❑	❑	❑	The **Name, Place & Date, Signature, and Emergency Telephone number** appears at the bottom of the FedEx Airbill.
❑	❑	❑	The statement "In accordance with IATA/ICAO" appears in the **Additional Handling Information** box.

Proper Shipping Name	Class or Division	UN or ID No.	Packing Group	Sub Risk	Quantity	Packing Instruction	Authorization
Hydrochloric Acid Solution	8	UN1789	II		1 plastic box × 0.5 L	Y809	LTD QTY
Nitric Acid Solution (with less than 20%)	8	UN2031	II		1 plastic box × 0.5 L	Y807	LTD QTY
Sodium Hydroxide Solution	8	UN1824	II		1 plastic box × 0.5 L	Y809	LTD QTY
Sulfuric Acid Solution	8	UN2796	II		1 plastic box × 0.5 L	Y809	LTD QTY
Hexanes	3	UN1208	II		1 plastic box × 1 L	Y305	LTD QTY

Sample Cooler Labeling

Yes	No	N/A	
❑	❑	❑	The proper shipping name, UN number, and LTD. QTY. appears on the shipping container.
❑	❑	❑	The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape.
❑	❑	❑	The name and address of the shipper and receiver appear on the top and side of the shipping container.
❑	❑	❑	The air waybill is attached to the top of the shipping container.
❑	❑	❑	**Up Arrows** have been attached to opposite sides of the shipping container.
❑	❑	❑	Packaging tape does not obscure markings or labeling.

APPENDIX B
SHIPMENT QUALITY ASSURANCE CHECKLIST

Date: ____________ Shipper: ____________________________ Destination: ________________________

Item(s) Description: ____

Radionuclide(s): ____

Radiological Survey Results: surface __________________mrem/hr 1 meter _______________________

Instrument Used: Mfgr: __________________________________ Model: ___________________________

S/N: ____ Cal Date: ____________________________________

LIMITED QUANTITY OR INSTRUMENT AND ARTICLE

Yes	No	
___	___	1. Strong tight package (package that will not leak material during conditions normally incidental to transportation).
___	___	2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr.
___	___	3. Removable surface contamination less than 20 dpm/100 cm^2 (alpha) and 1000 dpm/100 cm^2 (beta/gamma).
___	___	4. Outside inner package bears the marking "Radioactive".
___	___	5. Package contains less than 15 grams of ^{235}U (check yes if ^{235}U not present).
___	___	6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."
___	___	7. Activity less than that specified in 49 CFR 173.425. Permissible package limit: Package Quantity:
___	___	8. On all air shipments, the statement, Radioactive Material, excepted package-limited quantity of material shall be noted on the air waybill.

Qualified Shipper: ____________________________ Signature: ________________________________

TSOP 2-2

GUIDE TO HANDLING OF INVESTIGATION-DERIVED WASTE

GUIDE TO HANDLING INVESTIGATION-DERIVED WASTE

Prepared: Tim Eggert
Technical Review: Mike Profit

QA Review: Krista Lippoldt
Approved: [signature] 6/20/01 Signature/Date

Issued: [signature] 6/20/01 Signature/Date

1.0 OBJECTIVE

This standard operating procedure (SOP) presents guidance for the management of investigation-derived waste (IDW). The primary objectives for managing IDW during field activities include:

- Leaving the site in no worse condition than existed prior to field activities
- Remove wastes which pose an immediate threat to human health or the environment
- Proper handling of onsite wastes that do not require off site disposal or extended above-ground containerization
- Complying with federal, state, and facility applicable or relevant and appropriate requirements (ARARs)
- Careful planning and coordination of IDW management options
- Minimizing the quantity of IDW

2.0 BACKGROUND

2.1 Definitions

Hazardous Waste – Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-Derived Wastes (IDWs) - Discarded materials resulting from field activities such as sampling, surveying, drilling, excavations, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment. Wastes may be solid, liquid, or gaseous, or multiphase materials that may be classified as hazardous or non-hazardous.

Mixed-Waste - Any material that has been classified as hazardous and radioactive.

Radioactive Wastes – Discarded materials that are contaminated with radioactive constituents with specific activities in concentrations greater than the latest regulatory criteria (i.e., 10 CFR 20).

Treatment, Storage, and Disposal Facility (TSDF) - Permitted facilities which accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the U.S. Environmental Protection Agency (EPA) and appropriate state agencies.

2.2 Discussion

Field investigation activities result in the generation of waste materials that may be characterized as a hazardous or radioactive waste. IDWs may include drilling muds, cuttings, and purge water from test pit and well installation; purge water, soil, and other materials from collection of samples; residues from testing of treatment technologies and pump and treat systems; personal protective equipment (PPE); solutions (aqueous or otherwise) used to decontaminate non-disposable protective clothing and equipment; and other wastes or supplies used in sampling and testing potentially hazardous or radiologically contaminated material.

NOTE: The client's representatives may not be aware of all potential contaminants. The management of IDW must comply with regulatory requirements that are applicable.

3.0 RESPONSIBILITIES

Site Manager - The site manager is responsible for ensuring that all IDW procedures are conducted in accordance with this SOP. The site manager is also responsible for ensuring that handling of IDW is in accordance with site-specific requirements.

Project Manager - The project manager is responsible for identifying site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements.

Field Crew Members - Field crew members are responsible for implementing this SOP and communicating any unusual or unplanned condition to the project manager's attention.

4.0 REQUIRED EQUIPMENT

Equipment required for IDW containment will vary according to site-specific/client requirements. Management decisions concerning the necessary equipment required should consider: containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be on site and inspected before commencing work.

4.1 IDW Containment Devices

The appropriate containment device (drums, tanks, etc.) will depend on site- or client-specific requirements and the ultimate disposition of the IDW. Typical IDW containment devices can include:

- Plastic sheeting (polyethylene) with a minimum thickness of 20 millimeters
- Department of Transportation (DOT) approved steel containers
- Bulk storage tanks comprised of polyethylene or steel

Containment of IDW should be segregated by waste type (i.e., solid or liquid, corrosive or flammable, etc.) and source location. Volume of the appropriate containment device should be site-specific.

4.2 IDW Container Labeling

A "Waste Container" or "IDW Container" label or indelible marking should be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported off site are:

- Labels and markings that contain the following information: project name; generation date; location of waste origin; container identification number; sample number (if applicable); contents (drill cuttings, purge water, PPE, etc.).
- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.
- Containers that are five-gallons or less may only require one label or set of markings.
- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.
- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the drum color.
- Labels will be secured in a manner to ensure the label remains affixed to the container.

Labeling or marking requirements for IDW expected to be transported off site must be in accordance with the requirements of 49 CFR 172.

4.3 IDW Container Movement

Staging areas for IDW containers should be predetermined and in accordance with site-specific and/or client requirements. Arrangements should be made prior to field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation off site onto a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage

Containerized IDW should be staged pending chemical analysis or further onsite treatment. Staging areas and bulk storage procedures are to be determined according to site-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided as appropriate.

5.0 PROCEDURES

The three general options for managing IDW are (1) collection and onsite disposal; (2) collection for off site disposal; and (3) collection and interim management. Attachment 1 summarizes media-specific information on generation processes and management options. The option selected should take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW on site
- Compliance with regulatory requirements
- IDW minimization and consistency with the IDW remedy and the site remedy

In all cases the client should approve the plans for IDW. Formal plans for the management of IDW must be prepared as part of a work plan or separate document.

5.1 Onsite Disposal

5.1.1 Soil/Sludge/Sediment

The options for handling soil/sludge/sediment IDW are as follows:

1. Return to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas).

2. Spread around boring, pit, or source within the area of contamination (AOC) as long as returning the media to these areas will not increase site risks (e.g., direct contact with surficial contamination).

3. Consolidate in a pit within the AOC as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas).

4. Send to onsite TSDF - may require analytical analysis prior to treatment/disposal.

NOTE: These options may require client and/or regulatory approval.

5.1.2 Aqueous Liquids

The options for handling aqueous liquid IDW are as follows:

1. Discharge to surface water, only when IDW is not contaminated.

2. Discharge to ground surface close to the well, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background up-gradient wells is not a community concern nor associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well.

3. Discharge to sanitary sewer.

4. Send to onsite TSDF - may require analysis prior to treatment/disposal.

NOTE: These options may require analytical results to obtain client and/or regulatory approval.

5.1.3 Disposable PPE

The options for handling disposable PPE are as follows:

1. Double-bag contents in non-transparent trash bags and place in onsite industrial dumpster, only if PPE is not contaminated.

2. Containerize, label, and send to onsite TSDF - may require analysis prior to treatment/ disposal.

5.2 Off Site Disposal

Before sending to an offsite TSDF, analysis may be required. Also, manifests are required. Arrangements must be made with the client responsible for the site; it is CDM Federal's policy not to sign manifests. The TSDF and transporter must be permitted for the respective wastes.

5.2.1 Soil/Sludge/Sediment

When the final site remedy requires off site treatment and disposal, the IDW may be stored (e.g., drummed, covered in a waste pile) or returned to its source until final disposal. The management option selected should take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.2 Aqueous Liquids

When the final site remedy requires off site treatment and disposal, the IDW may be stored (e.g., mobile tanks or drums) until final disposal. The management option selected should take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.3 Disposable PPE

When the final site remedy requires off site treatment disposal, the IDW may be containerized and stored. The management option selected should take into account potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.3 Interim Measures

All interim measures must be approved by the client and regulatory agencies.

1. Storing IDW on site until the final action may be practical in the following situations:

   A. Returning wastes (especially sludges and soils) to their onsite source area would require re-excavation for disposal in the final remediation alternative.

   B. Interim storage in containers may be necessary to provide adequate protection to human health and the environment.

   C. Off site disposal options may trigger land disposal regulations under the Resource Conservation and Recovery Act (RCRA). Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.

   D. Interim storage may be necessary to provide time for sampling and analysis.

2. Segregate and containerize all waste for future treatment and/or disposal.

   A. Containment options for soil/sludge/sediment may include drums or covered waste piles in AOC.

   B. Containment options for aqueous liquids may include mobile tanks or drums.

   C. Containment options for PPE may include drums or roll-off boxes.

6.0 RESTRICTIONS/LIMITATIONS

SITE MANAGERS SHOULD DETERMINE THE MOST APPROPRIATE DISPOSAL OPTION FOR AQUEOUS LIQUIDS ON A SITE-SPECIFIC BASIS. Parameters to consider, especially when determining the level of protection, include the volume of IDW, the contaminants present in the groundwater, the presence of contaminants in the soil at the site, whether the groundwater or surface water is a drinking water supply, and whether the groundwater plume is contained or moving. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components.

Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be managed on a site-specific basis. **UNDER NO CIRCUMSTANCES SHOULD THESE TYPES OF MATERIALS BE BROUGHT BACK TO THE OFFICE OR WAREHOUSE.**

7.0 REFERENCES

Environmental Resource Center, *Hazardous Waste Management Compliance Handbook*, Van Nostrand Reinhold, 1992.

Institute of Hazardous Materials Management, *Handbook on Hazardous Materials Management*, 4th Ed., 1992.

U. S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996 and 1997 revisions.

U. S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1, 1987.

U. S. Environmental Protection Agency, *Management of Investigation-Derived Wastes During Site Inspections*, EPA/540/G-91/009, May 1991.

U. S. Environmental Protection Agency, *Low-Level Mixed Waste: A RCRA Perspective for NRC Licensees*, EPA/530-SW-90-057, August 1990.

U. S. Environmental Protection Agency, *Guide to Management of Investigation-Derived Wastes*, 9345.3-03FS, January 1992.

ATTACHMENT 1
IDW MANAGEMENT OPTIONS

TYPE OF IDW	GENERATION PROCESSES	MANAGEMENT OPTIONS
Soil	• Well/Test pit installations • Borehole drilling • Soil sampling	**Onsite Disposal** • Return to boring, pit, or source immediately after generation • Spread around boring, pit, or source within the AOC • Consolidate in a pit (within the AOC) • Send to onsite TSDF **Off site Disposal** • Client to send to off site TSDF **Interim Management** • Store for future treatment and/or disposal
Sludge/Sediment	• Sludge pit/sediment sampling	**Onsite Disposal** • Return to boring, pit, or source immediately after generation • Send to onsite TSDF **Off site Disposal** • Client to send to off site TSDF **Interim Management** • Store for future treatment and/or disposal
Aqueous liquids (groundwater, surface water, drilling fluids, wastewaters)	• Well installation/development • Well purging during sampling • Groundwater discharge during pump tests • Surface water sampling • Waste water sampling	**Onsite Disposal** • Pour onto ground close to well (non-hazardous waste) • Discharge to sewer • Send to onsite TSDF **Off site Disposal** • Client to send to off site commercial treatment unit • Client to send to publicly owned treatment works (POTW) **Interim Management** • Store for future treatment and/or disposal
Decontamination fluids	• Decontamination of PPE and equipment	**Onsite Disposal** • Send to onsite TSDF • Evaporate (for small amounts of low contamination organic fluids) • Discharge to ground surface **Off site Disposal** • Client to send to off site TSDF • Discharge to sewer **Interim Management** • Store for future treatment and/or disposal

ATTACHMENT 1
IDW MANAGEMENT OPTIONS

TYPE OF IDW	GENERATION PROCESSES	MANAGEMENT OPTIONS
Disposable PPE and Sampling Equipment	• Sampling procedures or other onsite activities	**Onsite Disposal** • Place in onsite industrial dumpster • Send to onsite TSDF **Off site Disposal** • Client to send to off site TSDF **Interim Management** • Store for future treatment and/or disposal

Adapted from U.S. Environmental Protection Agency, Guide to Management of Investigation-Derived Wastes, 9345-03FS, January 1992.

TSOP 3-5

LITHOLOGIC LOGGING

LITHOLOGIC LOGGING

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Issued: Rose Mary J. Gustin 6/20/01
Signature/Date

1.0 OBJECTIVE

This standard operating procedure (SOP) governs lithologic logging of core, cuttings, split spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by CDM Federal Programs Corporation (CDM Federal). The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used by all investigators in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

2.0 BACKGROUND

2.1 Definitions

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the lithologic logger in what to look for when following the sequences. An example lithologic log is given in Attachment A.

Name of Sediment or Rock - In naming unconsolidated sediments, the logger should use field equipment and reference charts to help identify the grain-size distribution and should name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger should examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

Texture - In examining unconsolidated sediments, the texture shall refer to the grain-size distribution, particle angularity, sorting, and packing. The logger should provide estimates of the grain sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles should be examined for angularity by comparing with Attachment B and the sorting should be determined by percentage estimation. The logger should note that the Unified Soil Classification System (USCS) uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliate structure (slaty, phyllitic, schistose, or gneissic) or non-foliate structure (granular).

Color - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color should be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names should be listed, and an overall best color name should be given.

Sedimentary Structures - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures, and the logger is referred to Compton's Manual of Field Geology (1962) book for more details. Among the more common structures are bedding, cross-bedding, laminations, and burrows. These structures should only be included in the description if found in the samples.

Degree of Consolidation - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and should be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and should be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials should be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) should be done and results recorded under the description. If the logger believes he/she can identify the cementing material then it should be included in the description.

Moisture Content - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and should be described as dry, moist, or wet. Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks should be noted.

Presence of Fractures, Cavities, and Secondary Mineralization - The rock types that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they should be noted and a description as to the density of fractures should be given. Cavities or vugs may be present, and the density of voids as well as a size estimation should be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill should be added.

Evidence of Contamination - The logger should examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations should be noted in the field book as should any readings from the photo ionization or flame ionization detector (PID/FID). PID/FID hits should be recorded on the Lithologic Log form also.

Description of Contacts - The logger should note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts should be noted as to whether they are erosional, gradational, or sharp, and the depth below the surface should be noted.

Composition - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock should be stated and an estimation of their percentage should be noted. The classification charts listed in Attachments D and F provide a description of common compositions.

Degree of Vitrification - This term is applicable to volcanic rocks and refers to the degree of welding in pyroclastic materials. Describe these rocks as poorly welded, moderately welded, or strongly welded.

2.2 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks; grain-size percentage estimation; particle shape; grain-size charts; and lithologic symbols. In order to make lithologic descriptions produced by CDM Federal staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

2.3 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

3.0 RESPONSIBILITIES

Geologist - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the field team leader (FTL).

Field Team Leader - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

4.0 REQUIRED EQUIPMENT

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log form
- Clipboard
- Dilute (10 percent) HCl
- Plastic sheeting
- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts

5.0 PROCEDURES

5.1 Office

- Obtain field logbook and Lithologic Log forms.
- Coordinate schedules/actions with FTL.
- Obtain necessary field equipment (i.e., hand lens, 10 percent HCl).
- Obtain CDM Federal reference field charts.
- Review field support documents (i.e., sampling plan, health and safety plan).
- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps.

5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log forms. Lithologic loggers will follow the general procedures for keeping a field logbook (SOP 4-1). When using a bound field logbook, record the same data required on the Lithologic Log form. Data from the field logbook must be transcribed to the Lithologic Log form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log form, it should be done within one day of the original data recording. All blanks in the Lithologic Log form must be filled out. If an item is not applicable, an "NA" should be entered.

The Lithologic Log form should be filled out according to the following instructions:

The top part of the form contains general information. The project name and number must be filled in to identify the site. The date that drilling was started and completed, and the well number within the site should be stated. The name of the person logging the well is recorded as is the total depth drilled. Weather condition descriptions should correlate with what is written in the logbook. The last item to be completed is the name and company of the driller and the type of drill rig and bits used.

The bottom part of the form shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and should be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column should contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes should be recorded as to why the section was not recovered. The X should be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a solid horizontal line. Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits should be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs should ask the FTL whether it is required information. The description column is the most important part of the lithologic log form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging should determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger should fill in appropriate information into the logbook when there is a rig shutdown, rig problems, failures to recover cores, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This should be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference. General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions should be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

This SOP includes protocols for describing igneous, metamorphic, sedimentary rocks, and unconsolidated materials. Common abbreviations are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology* and *American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log form or in the field logbook.

- The Munsell soil color chart may be used for descriptions of color.

- The Dictionary of Geological Terms (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions should include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category should be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All lithologic descriptions shall be segregated from interpretive comments by recording them in the field book.

Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation should be described if observed. Exact measurement of apparent bed thicknesses should be made when logging core and should supplement terminology such as "thin" or "thick." Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible. In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the Unified Soil Classification System (USCS) or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they should do so with permission from the FTL. It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed.

However, the abbreviation and its meaning should be recorded on the lithologic log the first time it is used and should be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

5.2.1 Protocols for Lithologic Description

This section describes the protocols for completing a lithologic description. The logger should use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core, it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the "big" picture. For instance, in a 20-foot-thick zone, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 below ground surface (bgs) = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in "seeing" the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

Description of Unconsolidated Material

Unconsolidated material comprises a significant portion of the sections of interest at CDM Federal sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and should use the same description format. The scientist may use the USCS classification if consistent with project objectives. More detailed soil descriptions should only be made in addition to descriptions outlined in Section 3.3.3.

Descriptions of unconsolidated sediments should follow the following sequence:

- Name of sediment (sand, silt, clay, etc.)
- Texture
- Composition of larger-grained sediments
- Color
- Structure
- Degree of consolidation and cementation
- Moisture content
- Evidence of bioturbation
- Description of contacts

In naming unconsolidated material (refer to Naming of Unconsolidated Materials, Attachment I), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written: ____________________(dominant grain) with ________________(subordinate grain). For example, a sediment with 90 percent sand and 10 percent silt would be named a sand with silt. If a sediment contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage should be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

Description of Sedimentary Rocks

Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E, Classification of Sedimentary Rocks.

Descriptors for sedimentary rocks should be given in the lithologic log in the following sequence:

- Name of rock
- Texture
- Color
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Moisture content
- Bioturbation
- Description of contacts

Description of Igneous and Metamorphic Rocks

Igneous rocks, volcanic and plutonic, and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments E and F provide a classification system for these materials.

Igneous and metamorphic rock descriptions should follow the general format:

- Name of rock
- Texture
- Color
- Degree of induration for volcaniclastics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization
- Moisture content
- Weathering

6.0 RESTRICTIONS/LIMITATIONS

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 REFERENCES

American Geological Society, *American Geological Society Data Sheets for Geology in the Field*, Laboratory, and Office, 3rd Ed, 1989.

American Geological Society, *Dictionary of Geologic Terms*, Anchor Press, Garden City, New York, 1960.

Compton, R.R., *Manual of Field Geology*, John Wiley & Sons Inc., New York, New York, 1962.

Munsell Color Chart, Soil Test Inc., Evanston, Illinois, 1975.

U.S. Department of Agriculture Soil Conservation Service, *Soil Taxonomy*, U.S. Government Printing Office, Washington, D.C., 1972.

Woodward, L.A., *Laboratory Manual Physical Geology*, University of New Mexico Printing, Albuquerque, New Mexico, 1988.

8.0 ATTACHMENTS

Note: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - CDM Federal Programs Corporation Lithologic Log

Attachment B - Grain-Size Scale; Graph determining size of sedimentary particles, particle degree of roundness charts

Attachment C - Comparison Chart for Estimating Percentage Composition

Attachment D - Classification of Igneous Rocks

Attachment E - Classification of Sedimentary Rocks

Attachment F - Classification of Metamorphic Rocks

Attachment G - Lithologic Symbol Chart

Attachment H - Abbreviations

Attachment I - Naming of Unconsolidated Materials

Attachment J - Sorting Chart

Attachment K - Example of United Soil Classification System (USCS)

ATTACHMENT A

CDM FEDERAL PROGRAMS CORPORATION
LITHOLOGIC LOG

Boring No. ____________		Sheet ____ of ____
Project:	Project No.:	Date Started:
Well No.:	Rig:	Date Ended:
Logged by:	Total Depth:	Driller:
Weather:		Bits:

DEPTH	LITHOLOGY	SAMPLE INTERVAL	% RECOVERY	PID/ FID	BLOW COUNTS	DESCRIPTION

PROPORTIONS		COHESIONLESS		COHESIVE CONSISTENCY	
			Blows	Blows	
trace	0 to 10%	loose	0 to 10	0-4	soft
little	10 to 20%	med dens	10 to 30	4-8	med stiff
some	20 to 35%	dense	30 to 50	8-15	stiff
and	35 to 50%	very dense	50+	15-30	very stiff
				30+	hard

ATTACHMENT B

AGI DATA SHEET 29.1

Grain-size Scales

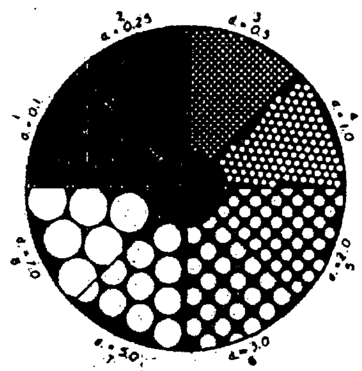
By Roy L. Ingram, University of North Carolina

GRAIN-SIZE SCALE USED BY AMERICAN GEOLOGISTS
Modified Wentworth Scale — after Lane, et al., 1947, Trans. American Geophysical Union, v. 28, p. 936-938

phi	mm	mm	inches	U.S. Standard Sieve Series	GRADE NAME		
-12	4096		161.3				
					very large		
-11	2048		80.6				
					large		
-10	1024		40.3			Boulders	
					medium		
-9	512		20.2				
					small		
-8	256		10.1				
					large		
-7	128		5.0			Cobbles	GRAVEL
					small		
-6	64		2.52	63 mm			
					very coarse		
-5	32		1.26	31.5 mm			
					coarse		
-4	16		0.63	16 mm		Pebbles	
					medium		
-3	8		0.32	8 mm			
					fine		
-2	4		0.16	No. 5			
					very fine		
-1	2		0.08	No. 10			
					very coarse		
0	1		0.04	No. 18			
					coarse		
+1	1/2	0.500		No. 35			
					medium	Sand	SAND
+2	1/4	0.250		No. 60			
					fine		
+3	1/8	0.125		No. 120			
					very fine		
+4	1/16	0.062		No. 230			
					coarse		
+5	1/32	0.031					
					medium		
+6	1/64	0.016				Silt	
					fine		
+7	1/128	0.008					
					very fine		
+8	1/256	0.004					MUD
					coarse		
+9	1/512	0.002					
					medium		
+10	1/1024	0.001				Clay size	
					fine		
+11	1/2048	0.0005					
					very fine		
+12	1/4096	0.00025					

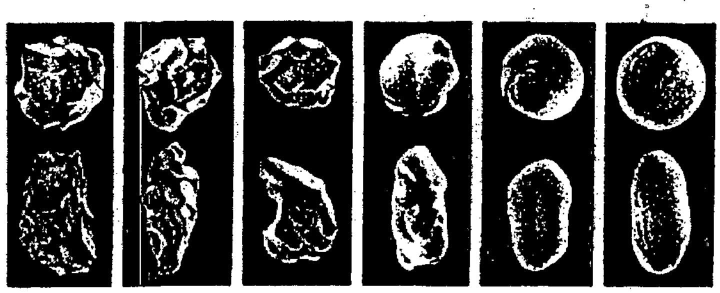
AGI DATA SHEET 28.2

LIGHT PARTICLES



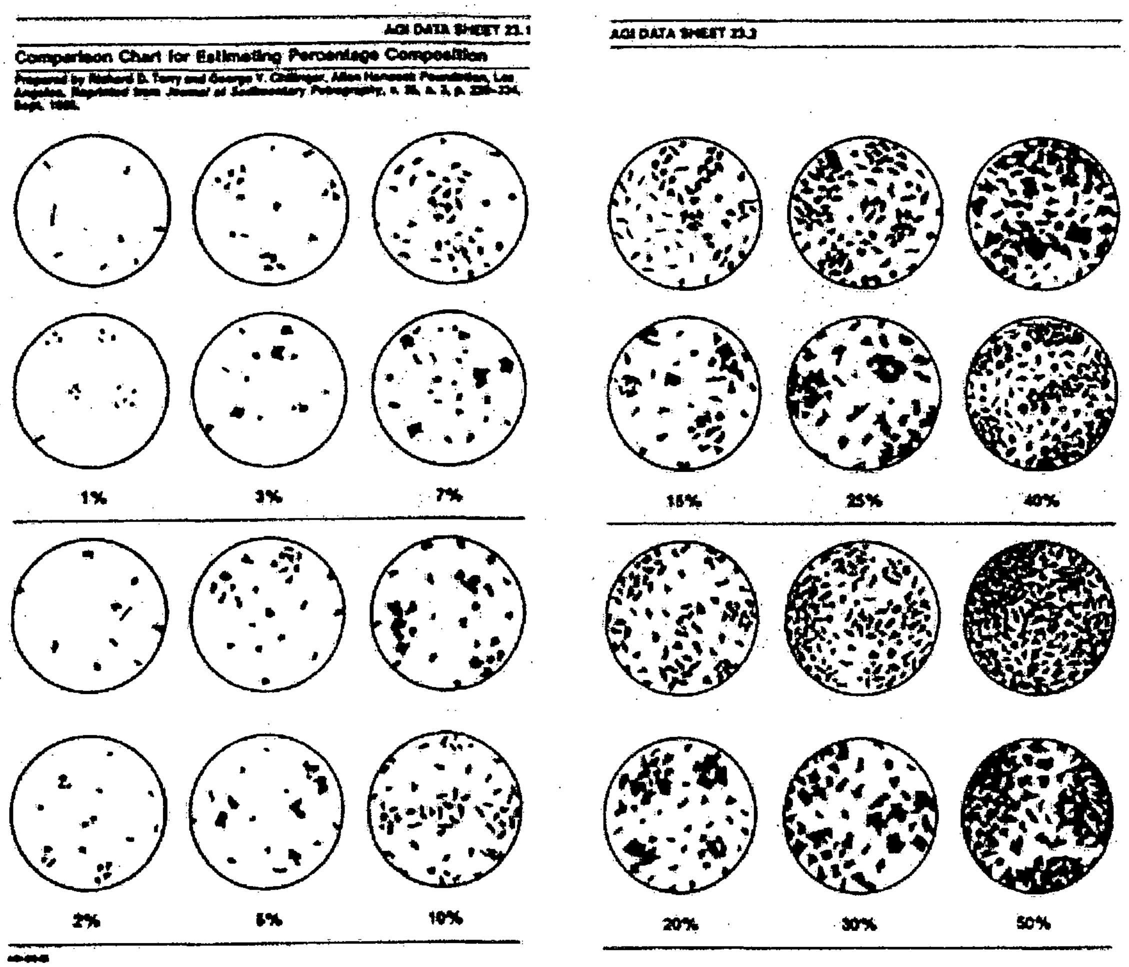
References: (1) George V. Chilingar, 1956, Sorted classification of sedimentary particles and ... AAPG Bull., v. 40, no. 7, p. 1714. (2) M.S. Shvetsov, 1948, Petrography of sedimentary rocks, 2nd ed., 387 p. Gosgeolizdat, Moscow-Leningrad

American Geological Institute, Data Sheets, Third Edition, 1989.



Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT C



American Geological Institute, Data Sheets, Third Edition, 1989.

ATTACHMENT D

CLASSIFICATION OF IGNEOUS ROCKS					
MINERAL COMPOSITION					
		Quartz >10% Abundant feldspar Mafic minerals minor	Quartz <10% Abundant feldspar Mafic minerals moderate	Feldspar abundant Mafic Minerals 40-70%; Quartz minor or absent	Mafic minerals >70%
Color Index		Light Color	Intermediate color	Dark	Dark
Chemistry		SiO_2 70%	SiO_2 60%	SiO_2 50%	SiO_2 40%
TEXTURE	Phaneritic (visible with naked eye)	Granite (Gr)	Diorite (Dr)	Gabbro (Gb)	Peridotite (Pr) (mostly olivine)
TEXTURE	Aphanitic (microscopic)	Rhyolite (Ry) (quartz phenocrysts)	Andesite (An) (feldspar or mafic phenocrysts; no quartz)	Basalt (Ba)	Komatiite (Km) (very rare)
TEXTURE	Aphanitic (microscopic)	Felsite (Fl) (no phenocrysts)			
TEXTURE	Glassy	Obsidian (ob) Pumice (Pu)		Rare	
TEXTURE	Glassy-Fragmental (Pyroclastic)	Tuff <4mm (Tf) Breccia >4mm (Br)		Rare	

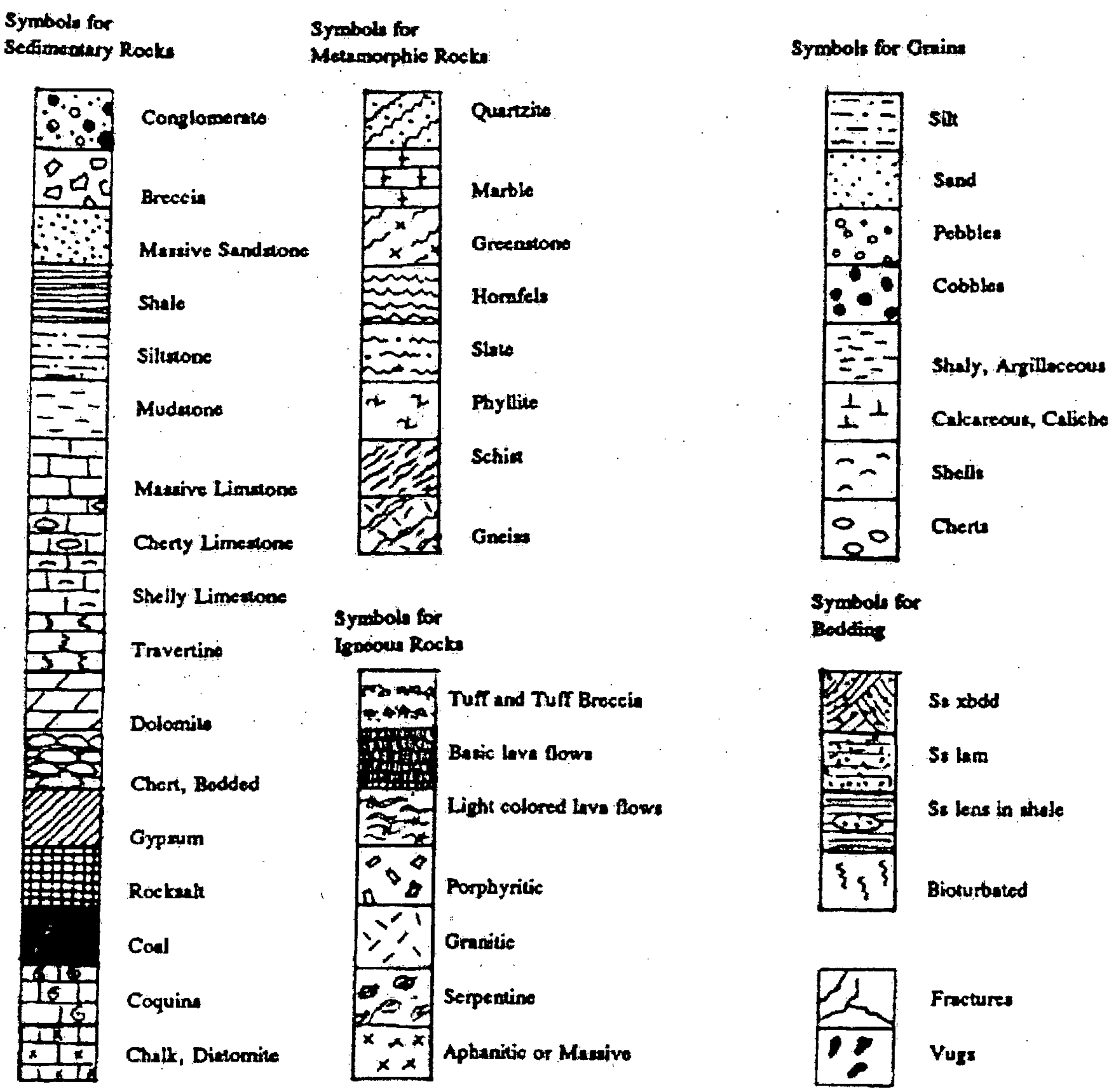
ATTACHMENT E

CLASSIFICATION OF SEDIMENTARY ROCKS		
	COMPOSITION AND/OR GRAIN SIZE	NAME OF ROCK
DETRITAL	Gravel greater than 2 mm	CONGLOMERATE (Cg)
		BRECCIA (Br)
	Sand 2 mm to 1/16 mm	SANDSTONE (Sa) QUARTZ (Qrz) GRAYWACKE (Gw) ARKOSE (Ak)
	Mud less than 1/16 mm	SHALE (Shl)
		SILTSTONE (Sls)
		MUDSTONE (Ms)
CHEMICAL	Limy mud or oolites	LIMESTONE (La)
		TRAVERTINE (Tvr)
		DOLOMITE (Dl)
	Silica	CHERT (Ch)
	Calcium Sulphate plus Water	GYPSUM (Gy)
	Halite	ROCKSALT (Na)
BIOGENIC	Plant remains	COAL (Cl)
	Shell fragments, shells, fragments; some limy mud usually present	COQUINA (Cq)
		CHALK (Chk)
	Shells of diatoms (marine or freshwater algae)	DIATOMITE (Dm)

ATTACHMENT F

CLASSIFICATION OF METAMORPHIC ROCKS			
STRUCTURE	TEXTURE	CHIEF MINERALS	NAME
Nonfoliate	granular; breaks across grains	quartz	Quartzite (Qzt)
	granular; grains clearly visible	calcite	Marble (Mbl)
	granular; grains altered and indistinct	plagioclase, chlorite, epidote hornblende	Greenstone (Grs)
	very fine-grained	indistinguishable; mostly submicroscopic micas and clays	Hornfels (Hnf)
Foliate	slaty	submicroscopic mica, quartz	Slate (Slt)
	phyllitic	microscopic mica, quartz	Phyllite (Pyl)
	schistose	microscopic mica, quartz, amphibole	Blueschist
		chlorite, mica plagioclase	chlorite schist (CL-Sch)
		muscovite, quartz	Muscovite (Ms) Schist (Sch)
		garnet, muscovite	Garnet (G) Muscovite (Ms) Schist (Sch)
		hornblende, plagioclase	Amphibolite (Amp)
		staurolite, garnet, muscovite	Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)
	gneissose	plagioclase, hornblende	Amphibolite (Amp) Gneiss (Gns)
		feldspar, quartz	Granitie (Gr) Gneiss (Gns)
		eye-shaped feldspar, mica	Augen (Au) Gneiss (Gns)

ATTACHMENT G



Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT H

COMMON ABBREVIATIONS		
Abundant - abnt	Diameter – dia	Laminated – lam
Amount – amt	Different – diff	Maximum – max
Approximate – approx	Disseminated – dissem	Pebble – pbl
Arenaceous – aren	Elevation – elev	Phenocryst – phen
Argillaceous – arg	Equivalent – equiv	Porphyritic – proph
Average – ave	foliated – fol	Probable – prob
Bedded – bdd	Formation frm	Quartz – qrz
Bedding – bdg	Fracture – frac	Regular – reg
Calcareous – calc	Fragmental – frag	Rocks – rx
Cemented – cmt	Granular – Gran	Rounded – rnd
Cobble – cbl	Gypsiferous – Gyp	Saturated – sat
Contact – ctc	Horizontal – hriz	Secondary – sec
Cross-bedded - xbdd	Igneous – ign	Siliceous – sil
Cross-bedding – xbdg	Inclusion – incl	Structure – struc
Cross-laminated – xlam	Interbedded – intbdd	Unconformity – uncnf
Crystal – xl	Irregular – ireg	Variegated – vrgt
Crystalline – xln	Joint – jnt	Vein – vn
Grain Size	Contacts	Sorting
grain – gn	gradational – grad	poor – pr
fine – f	erosional – er	moderate – mod
very fine – vf	abrupt – ab	well – well
medium – med		
coarse – crs	Fabric	
large – lg	grain supported - gs	
very large – vlg	matrix supported – ms	
small – sm	imbricate - im	

Adapted from, Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT I

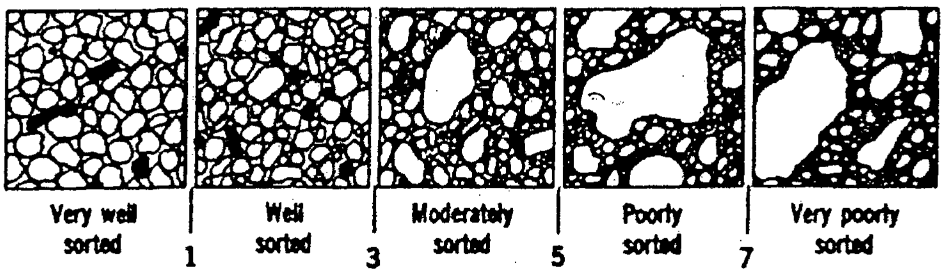
Naming of Unconsolidated Materials

Main Particle	Gravel	Sand	silk	Clay
> 15 % gravel	Gravel	Gravelly Sand	Gravelly Silt	Gravelly Clay
> 15 % sand	Sandy Gravel	Sand	Sandy Silt	Sandy clay
> 15 % silt	Silty Gravel	Silty Sand	Silt	Silty Clay
> 15 % clay	Clayey Gravel	Clayey Sand	Clayey Silt	Clay
5-15 % gravel	Not Applicable	Sand with Gravel	Silt with Gravel	Clay with Gravel
5-15 % sand	Gravel with sand	Not applicable	Silt with Sand	Clay with sand
5-15 % silt	Gravel with silt	Sand with silt	Not applicable	Clay with silt
5-15 % clay	Gravel with clay	Sand with clay	Silt with clay	Not applicable
> 15% gravel plus 15% sand	Sandy Gravel	Gravelly Sand	Gravelly Sandy Silt	Gravelly Sandy Clay
> 15% gravel plus 15% silt	Silty Gravel	Gravelly Silty Sand	Gravelly Silt	Gravelly Silty Clay
> 15% gravel plus 15% clay	Clayey Gravel	Gravelly Clayey Sand	Gravelly Sandy Silt	Gravelly Clay
> 15% sand plus 15% silt	Silty Sand Gravel	Silty Sand	Sandy Silt	Sandy Silty Clay
> 15% sand plus 15% clay	Sandy Clayey Gravel	Clayey Sand	Sandy Clayey Silt	Sandy Clay
> 15% silt plus 15% clay	Silty Clayey Gravel	Silty Clayey Sand	Clayey Silt	Silty Clay
NOTE: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt.				

Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT J

Sorting Chart



Compton, R.R., Manual of Field Geology, 1962.

ATTACHMENT K

Example of Unified Soil Classification System (USCS)

Unified Soil Classification System (USCS)

	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL: COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND: COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10 
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40 
FINE	.43 - .08	.02 - .003	No. 40 - No. 200 
FINES: SILTS	< .08	< .003	< No. 200 
CLAYS	< .08	< .003	< No. 200

ATTACHMENT K

Example of Unified Soil Classification System (USCS)
(Continued)

CLAY

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF) TORVANE	Unconfined Compressive Strength q Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4" by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

SAND

SOILTYPE	SPT, N Blows/ft	Relative Density,%	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

TSOP 4-1

FIELD LOGBOOK CONTENT AND CONTROL

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4-1
Revision: 2
SOP Title: FIELD LOGBOOK CONTENT AND CONTROL
Date: December 10, 2001

QA Review: [signature] 12-10-01
Approved and Issued: [signature] 12/10/01
Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II
Reason for and Clarification: Make SOP USEPA Region II - Specific.

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

5.0 PROCEDURES

5.2 Operation

Other specific information that will be recorded in the project logbook includes:

- Schedule for the day;
- Sample container and demonstrated analyte-free water shipment log numbers (as received in the field);
- Equipment used (record ID number, where available)
- Equipment decontamination procedures;
- Descriptions of any photographs taken and photolog entries as specified in the CDM Federal SOP No 4-2,
- Problems encountered, and
- Notes of conversations with project coordinators.

CONTRACT-SPECIFIC MODIFICATION

SOP No.: 4-1
Revision: 1
Date: December 10, 2001

SOP Title: **FIELD LOGBOOK CONTENT AND CONTROL**

For each sample collected and shipped the following information will be recorded (at a minimum) in the field logbook.

- Names of field personnel;
- CDM Federal assigned sample number/location (use at least two permanent landmarks for reference points);
- Date sampled;
- Date shipped ;
- Sample location number;
- Corresponding CLP RAS or DESA sample number;
- Media type;
- Type of analysis to be performed,
- Sample volume and containers;
- Any unusual discoloration or evidence of contamination;
- Field parameter measurements (sure as turbidity, temperature, pH, conductivity, dissolved oxygen, and Eh readings of aqueous media),
- Calculations;
- Preservatives added to the sample;
- Courier airbill number and means of delivery to the laboratory; and
- General observations.

5.3 **Post-Operation,** add (on page 4 of 5):

The field logbooks will be stored, following field activities, in the CDM Federal RAC II document control system

FIELD LOGBOOK CONTENT AND CONTROL

Prepared: Del Baird
Technical Review: Larry Davidson
QA Review: David O. Johnson
Approved: [signature] Signature/Date
Issued: [signature] 6/20/01 Signature/Date

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to set CDM Federal criteria for content entry and form of field logbooks. Field logbooks are an essential tool to document field activities for historical and legal purposes.

2.0 BACKGROUND

2.1 Definitions

Biota - The flora and fauna of a region.

Magnetic Declination Corrections - Compass adjustments to correct for the angle between magnetic north and geographical meridians.

2.2 Discussion

Information recorded in field logbooks includes field team names, observations, data, calculations, date/time, weather, and description of the data collection activity, methods, instruments, and results. Additionally, the logbook may contain deviations from plans and descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 RESPONSIBILITIES

Field Team Leader (FTL) - The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure.

Site Personnel - All CDM Federal employees who make entries in field logbooks during onsite activities are required to read this procedure prior to engaging in this activity. The FTL will assign field logbooks to site personnel who will be responsible for their care and maintenance. Site personnel will return field logbooks to the records file at the end of the assignment.

4.0 REQUIRED EQUIPMENT

- Site-specific plans
- Field notebook
- Indelible black or blue ink pen
- Ruler or similar scale

5.0 PROCEDURES

5.1 Preparation

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the logbook. Prior to use in the field, each logbook will be marked with a specific document control number issued by the document control administrator, if required by the contract quality implementation plan (QIP). Not all contracts require document control numbers. The following information shall be recorded on the cover of the logbook:

- Field logbook document control number.
- Activity (if the logbook is to be activity-specific) and location.
- Name of CDM Federal contact and phone number(s).
- Start date.
- In specific cases, special logbooks may be required (e.g., waterproof paper for storm water monitoring).

The first few (approximately five) pages of the logbook will be reserved for a table of contents (TOC). Mark the first page with the heading and enter the following:

TABLE OF CONTENTS

Date/Description	Page
(Start Date)/Reserved for TOC	1-5

The remaining pages of the table of contents will be designated as such with "TOC" written on the top center of each page.

5.2 Operation

The following is a list of requirements that must be followed when using a logbook:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information need not be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the logbook by inserting the following:

  Above notes authored by:
  - (Sign name)
  - (Print name)
  - (Date)

- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
  - Date and time
  - Name of individual making entry
  - Names of field team and other persons on site
  - Description of activity being conducted including station or location (i.e., well, boring, sampling location number) if appropriate
  - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
  - Level of personal protection to be used
  - Serial numbers of instruments
  - Required calibration information
  - Serial/tracking numbers on documentation (e.g., carrier air bills)

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Maps, sketches, figures, or data that will not fit on a logbook page should be referenced and attached to the logbook to prevent separation.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.

5.3 Post-Operation

To guard against loss of data due to damage or disappearance of logbooks, completed pages shall be periodically photocopied (weekly, at a minimum) and forwarded to the field or project office. Other field records shall be photocopied and submitted regularly and as promptly as possible to the office. When possible, electronic media such as disks and tapes should be copied and forwarded to the project office.

At the conclusion of each activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated, and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed logbook shall be submitted to the records file.

6.0 RESTRICTIONS/LIMITATIONS

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM Federal personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these notebooks should be factual, clear, precise, and non-subjective. Field logbooks, and entries within, are not to be utilized for personal use.

7.0 REFERENCES

Sandia National Laboratories, *Procedure for Preparing, Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures*, QA-02-03, Albuquerque Environmental Program Department 3220, Albuquerque, New Mexico, 1991.

Sandia National Laboratories, Division 7723, *Field Operation Procedure for Field Logbook Content and Control, Environmental Restoration Department*, Albuquerque, New Mexico, 1992.

TSOP 4-2

PHOTOGRAPHIC DOCUMENTATION OF FIELD ACTIVITIES

PHOTOGRAPHIC DOCUMENTATION OF FIELD ACTIVITIES

Prepared: David O. Johnson
Technical Review: Jackie Mosher
QA Review: Doug Updike
Approved: [signature] 10/12/01
Signature/Date
Issued: Rose Mary Gustin 10/12/01
Signature/Date

1.0 OBJECTIVE

The purpose of this standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include still and digital photography and videotape recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This document shall provide guidelines designed for use by a professional or amateur photographer. This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

2.0 BACKGROUND

2.1 Definitions

Photographer – A photographer is the camera operator (professional or amateur) of still photography, including digital photography, or videotape recording whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Identifier Component – Identifier components are visual components used within a photograph such as visual slates, reference markers, and pointers.

Standard Reference Marker – A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Slates – Slates are blank white index cards or paper used to present information pertaining to the subject/ procedure being photographed. Letters and numbers on the slate will be bold and written with black, indelible marking pens.

Arrows and Pointers – Arrows and pointers are markers/pointers used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds – Contrasting backgrounds are backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Data Recording Camera Back – A data recording camera back is a camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film.

2.2 Discussion

Photographs and videotape recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the "visual media" that, for the purpose of this document, shall encompass still photographs, digital photographs, and videotape recordings (or video footage). The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

2.3 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

3.0 RESPONSIBILITIES

Field Team Leader (FTL) – The FTL is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer – The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP.

4.0 REQUIRED EQUIPMENT

The following is a general list of equipment that may be used:

- 35mm camera or disposable single use camera (35mm or panoramic use)
- Digital camera
- Video camera
- Logbook
- Indelible black or blue ink pen
- Standard reference markers
- Slates
- Arrows or pointers

- Contrasting backgrounds
- Medium speed, or multi purpose fine-grain, color, 35 mm, negative film or slide film (project dependent)
- Data recording camera back (if available)
- Storage medium for digital camera

5.0 PROCEDURES

5.1 Documentation

A commercially available, bound logbook will be used to log and document photographic activities. Review the CDM Federal SOP 4-1 (Field Logbook Content and Control) and prepare all supplies needed for logbook entries.

Note: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log and documentation section.

5.1.1 Field - Health and Safety Considerations

There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Federal Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation prior to commencing field activities. The site health and safety plan must be read prior to entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., low overhead hazard, edge of excavation).

5.2 OPERATION

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from closeup to wide-angle. Many shots will be repetitive in nature or format especially closeup site feature photographs. Consideration should therefore be given to designing a system or technique that will provide a reliable repetition of performance.

- All still film photographs should be made using a medium speed, or multi purpose fine-grain, color negative film in the 35 mm format unless otherwise directed by the FTL.
- It is suggested that Kodak brand "Ektapress Gold Deluxe" film or equivalent be used as the standard film for the still photography requirements of the field activities. This film is stable at room temperature after exposure and will better survive the time lag between exposure and processing. It is suggested that film speed ASA 100 should be used for outdoor photographs in bright sunlight, ASA 200 film should be used in cloudy conditions, and ASA 400 film should be used indoors or for very low-light outdoor photographs.
- No preference of videotape brand or digital storage medium is specified and is left to the discretion of the photographer.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. If the ambient lighting conditions are inadequate, the photographer should be prepared to augment the light (perhaps with reflectors or electronic flash) to maintain the desired visual effect.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

5.2.2 General Guidelines for Still Photography

Slate Information

When directed by the FTL, each new roll of film or digital storage medium shall contain upon the first usable frame (for film) a slate with consecutively assigned control numbers (a consecutive, unique number that is assigned by the photographer as in sample numbers).

Caption Information

All still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. The caption should contain the following information (digital photographs should have a caption added after the photographs are downloaded):

- Film roll control number (if required) and photograph sequence number
- Date and time
- Description of activity/item shown
- Direction (if applicable)
- Photographer

When directed by the FTL, a standard reference marker should be used in all documentary visual media. While the standard reference marker will predominantly be used in closeup feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day.

Closeup and Feature Photography

When directed by the FTL, closeup photographs should include a standard reference marker of appropriate size as an indication of the feature size and contain a slate marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. When directed by the FTL, include a standard reference color strip (color chart such as Munsell Soil Color Chart or that available from Eastman Kodak Co.) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aid to the viewer for formal lithologic observations and interpretations.

Site Photography

Site photography, in general, will consist predominantly of medium and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the film/tape control number shall be entered in the photographic logbook along with the frame number and all other information pertinent to the scene.

Panoramic

In situations where a wide-angle lens does not provide sufficient subject detail, a single-use disposable panoramic camera is recommended. If this type of camera is not available, a panoramic series of two or three photos would be appropriate. Panoramas can provide greater detail while covering a wide subject, such as an overall shot of a site.

To shoot a panoramic series using a standard 35mm or digital camera, the following procedure is recommended.

- Use a stable surface or tripod to support the camera.
- Allow a 20 to 30 percent overlap while maintaining a uniform horizon.
- Complete 2 to 3 photos per series.

5.2.3 General Photographic Documentation Using Video Cameras

As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or "show" videotape recording. The following guidelines are set for documentary videotape recordings only and should be implemented at the discretion of the FTL.

Documentary videotape recordings of field activities may include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking closeup shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

It is recommended that a standard reference marker and caption/slate be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original videotape recordings will not be edited. This will maintain the integrity of the information contained on the videotape. If editing is desired, a working copy of the original videotape recording can be made.

5.2.4 Photographic Documentation

Photographic activities must be documented in a photographic logbook or in a section of the field logbook. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in CDM Federal SOP 4-1, the following information should be maintained in the appropriate logbook:

- Photographer name.
- If required, an entry shall be made for each new roll/tape control number assigned.
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used).
- Date and time (military time).
- Location.
- A description of the activity/item photographed.
- If needed, a description of the general setup, including approximate distance between the camera and the subject, may be recorded in the logbook.
- Record as much other information as possible to assist in the identification of the photographic document.

5.3 Post Operation

All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer shall also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape to the project management representative.

5.3.1 Documentation

At the end of each day's photographic session, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in CDM Federal SOP 4-1.

5.3.2 Archive Procedures

1. Photographs and the associated set of negatives, digital media, and original unedited documentary videotape recordings will be submitted to the project files and handled according to contract records requirements. The FTL will ensure their proper distribution.

2. Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 RESTRICTIONS/LIMITATIONS

This document is designed to provide a set of guidelines for the field amateur or professional photographer to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The FTL is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the FTL.

NOTE: Some sites do not permit photographic documentation. Check with the site contact for any restrictions.

7.0 REFERENCES

U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3*, February 2001, Appendix F.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Athens, Georgia, May 1996.

U.S. Environmental Protection Agency, National Enforcement Investigations Center, *Multi-Media Investigation Manual*, EPA-330/9-89-003-R, Revised March 1992, p. 85.

TSOP 4-3

WELL DEVELOPMENT AND PURGING

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4-3
Revision: 2
SOP Title: WELL DEVELOPMENT AND PURGING Date: December 10, 2001

QA Review: [signature] 12/10/01

Approved and Issued: [signature] 12/10/01
Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for Clarification: Make SOP USEPA Region II - Specific.

5.0 PROCEDURES

5.1 Well Development

Under Step 7, (page 2 of 4), add;
Development will be considered complete when a visually sediment-free discharge is achieved and the pH, temperature and specific conductivity remain consistent within a +/- ten percent range.

5.2 Volumetric Method of Well Purging

Under Step 7, (page 3 of 4), add:
Any water removed during evacuation should not be reintroduced into the well as it can no longer be considered a representative portion of the aquifer.

5.3 Indicator Parameter Method of Well Purging

Under step 8, (page 4 of 4), add:
Any water removed during evacuation should not be reintroduced into the well as it can no longer be considered a representative portion of the aquifer.

7.0 REFERENCES, add (on page 4 of 4)

U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual*, Final Copy, Revision 1, October 1989.

WELL DEVELOPMENT AND PURGING

Prepared: Del Baird
Technical Review: Peggy Bloisa
QA Review: David O. Johnson
Approved: Signature/Date
Issued: Signature/Date

1.0 OBJECTIVE

The purpose of this standard operating procedure (SOP) is to define the procedural requirements for well development and purging.

2.0 BACKGROUND

Monitoring wells are developed to remove skin (i.e., near-well-bore formation damage) and to settle and remove fines from the filter pack. Wells should not be developed for 24 hours after completion when a cement bentonite grout is used to seal the annular space; however, wells may be developed before grouting if conditions warrant. Wells are purged immediately before groundwater sampling to remove stagnant water and to sample representative groundwater conditions. Wells should be sampled within 3 hours of purging (optimum) to 24 hours after purging (maximum, for low recharge conditions).

2.1 Associated Procedures

- CDM Federal SOP 1-6, Water Level Measurement
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-radioactive Sites

3.0 RESPONSIBILITIES

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that development and purging are carried out in accordance with this procedure.

Field Team Leader - The field team leader is responsible for complying with this procedure.

4.0 REQUIRED EQUIPMENT

- Pump, pump tubing, or bailer and rope or wire line
- Power source (e.g., generator), if required
- Water-level meter or weighted surveyor's tape
- Temperature, conductivity, pH, and turbidity meters

- Personal protective equipment as specified in the site-specific health and safety plan
- Decontamination supplies, as required, according to CDM Federal SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites
- Disposal drums, if required
- Photoionization detector (PID) or equivalent as specified in site-specific health and safety plan

5.0 PROCEDURES

5.1 Well Development

The following steps must be followed when developing wells:

1. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
2. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.
3. Monitor wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
4. Determine the depth to static water level and depth to bottom of the casing.
5. Prepare the necessary equipment for developing the well. There are a number of techniques that can be used to develop a well. Some of the more common methods are bailing, overpumping, backwashing, mechanical surging, surge and pump, and high-velocity jetting. All of these procedures are acceptable; however, final approval of the development method rests with the appropriateness of a specific method to the site and the client.
6. For screened intervals longer than 10 feet, develop the well in 2- or 3-foot intervals from bottom to top. This will ensure proper packing of the filter pack.
7. Continue well development until produced water is clear and free of suspended solids, as determined by a turbidity meter or when pH, conductivity, and temperature have stabilized. Record pertinent data in the field logbook and on appropriate well development forms. Remove the pump assembly or bailers from the well, decontaminate (if required), and clean up the area. Lock the well cover before leaving. Dispose of development water as required by the site-specific plans.

5.2 Volumetric Method of Well Purging

The following steps should be followed when purging a well by the volumetric method:

1. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
2. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.
3. Monitor wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

4. Determine the depth to static water level and depth to bottom of well casing according to CDM Federal SOP 1-6 Water Level Measurement. Calculate the volume of water within the well bore using the following formula (or equivalent):

$$7.4805 \left[\frac{D^2\pi}{(4)} \right] dH = \text{volume (in gallons)},$$

where

D = casing diameter in feet. (NOTE: This equation is used for grouted wells with short screens. For wells with long screens and/or ungrouted wells, the D = borehole diameter in feet).

dH = the distance from well bottom to static water level in feet

$\pi = 3.1416$

NOTE: Record all data and calculations in the field logbook.

5. Prepare the pump and tubing, or bailer, and lower it into the casing.
6. Remove the number of well volumes specified in the site-specific plans. Generally, three to five well volumes will be required. Conductivity, pH, and temperature should be measured and recorded, if required by site-specific plans. In low recharge aquifers, the well commonly will be pumped or bailed to dryness before three well volumes of water are removed. If this is the case, there is no need to continue with purging operations. Record pertinent data in the field logbook.
7. Remove the pump assembly or bailer from the well, decontaminate it (if required), and clean up the site. Lock the well cover before leaving. Dispose of development water as required by the site-specific plan.

5.3 Indicator Parameter Method of Well Purging

1. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
2. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.
3. Monitor wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
4. Determine the depth to static water level and depth to bottom. Set up surface probe(s), (e.g., pH, conductivity) at the discharge orifice or dedicated probe port of the pump assembly or within the flow-through chamber. Allow probe(s) to equilibrate according to manufacturer's specifications. Record the equilibrated readings in the field logbook.
5. Assemble the pump and tubing, or bailer, and lower into the casing.
6. Begin pumping or bailing the well. Record indicator parameter readings for every purge volume. Maintain a record of the approximate volumes of water produced.
7. Continue pumping or bailing until indicator parameter readings remain stable within +10 percent for three consecutive recording intervals, or in accordance with site-specific plans. Purging should continue until the discharge stream is clear or turbidity becomes asymptotic-low or meets project requirements. In a low recharge aquifer, the well may pump or bail to

dryness before indicator parameters stabilize. In this case, there is no need to continue purging. Record pertinent data in the field logbook.

8. Remove the pump assembly or bailer from the well, decontaminate (if required), and clean up the site. Lock the well cover before leaving. Dispose of development water as required by the site-specific plans.

6.0 RESTRICTIONS/LIMITATIONS

Where flammable, free, or emulsified product is expected, or known to exist on, or in groundwater, use intrinsically safe electrical devices only and place portable power sources (e.g., generators) 50 feet or further from the wellhead and disposal drums.

7.0 REFERENCES

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements For Field Methods*, DOE/HWP-69/R2, September 1996.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures For Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, OSWER Directive 9355.6-14, December 1987.

TSOP 4-4

DESIGN AND INSTALLATION OF MONITORING WELLS IN AQUIFERS

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4-4
Revision: 2
Date: December 10, 2001

SOP Title: DESIGN & INSTALLATION OF MONITORING WELLS IN AQUIFERS

QA Review: [signature] 12/10/01

Approved and Issued: [signature] 12/10/01
Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II - Specific.

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

4.0 REQUIRED EQUIPMENT AND MATERIALS

4.2 Required Construction Materials

Under Well Screen (page 3 of 13), add:
Monitoring well screens should be 5 to 10 feet in length to avoid dilution of the contaminated groundwater with water from less contaminated zones in this aquifer.

7.0 **REFERENCES**, add (on page 13 of 13)

U.S. Environmental Protection Agency, Monitoring Management Branch of the Environmental Services Division, *Region II CERCLA Quality Assurance Manual,* Final Copy, Revision 1, October 1989.

DESIGN AND INSTALLATION OF MONITORING WELLS IN AQUIFERS	SOP: 4-4 Revision: 4 Date: June 20, 2001 Page 1 of 13

Prepared: Del Baird	Technical Review: Peggy Bloisa
QA Review: David O. Johnson	Approved: [signature] 6/20/01 Signature/Date
Issued: [signature] 6/20/01 Signature/Date	

1.0 OBJECTIVE

The purpose of this standard operating procedure (SOP) is to provide guidelines for the installation of groundwater monitoring wells. These guidelines will help to produce consistency of approach in the design and installation of monitoring wells. Individual installations will probably vary in some respects as they may encounter differing hydrogeologic conditions.

2.0 BACKGROUND

2.1 Definitions

Monitoring Well Installation - The act of installing well casing, screen, filter pack, bentonite seal, grout, and other specified materials in a borehole to make a complete monitoring well.

2.2 Discussion

This SOP is intended to cover the installation of monitoring wells for use in conducting a variety of environmental investigations. It is intended to be a general guideline listing the types of materials and methods to be considered when a well is installed. Materials are not specified in detail since it is likely there will be wide variability required to meet the needs of individual site conditions.

2.3 Associated Procedures

- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-2, Photographic Documentation of Field Activities
- CDM Federal SOP 4-3, Well Development and Purging
- CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites

3.0 RESPONSIBILITIES

Site Manager - Translates client's requirements into technical direction of project. Sets technical criteria; reviews and approves technical progress, and ensures that all participating personnel have proper training. Note: Other titles such as project manager may be used.

Field Team Leader (FTL) - Supervises field operations. Assures that all necessary equipment including safety equipment is available and functioning properly before project operations begin. Assures that all necessary personnel are mobilized on time. Maintains daily log of activities each work day.

Field Geologist - Collects and maintains data and completes Monitoring Well Construction Forms. Coordinates and consults with site manager on decisions relative to unexpected encounters during well installation and deviation from this SOP. Directs overall activities of drill and support subcontractors.

Drilling Subcontractor - Provides necessary personnel, equipment, and services to meet terms of the contract.

4.0 REQUIRED EQUIPMENT AND MATERIALS

4.1 Required Equipment

- Field logbook
- Monitoring Well Construction Forms
- Measuring tape

4.2 Required Construction Materials

General - The materials that are used in the construction of a monitoring well and that come in contact with the groundwater should not measurably alter the chemical quality of a groundwater sample. The well casing and well screen should be steam cleaned (if appropriate for the selected material) prior to well installation or certified clean from the manufacturer and delivered to the site in protective wrapping. Samples of the cleaning water, drilling fluids, filter pack, annular seal, and mixed grout should be retained to be analyzed if contamination from well installation is suspected. These samples will serve as quality control checks until the completion of at least one round of groundwater quality sampling and analysis.

Water – Water, which may be used in the well completion process, should be obtained from a source that does not contain constituents that could compromise the integrity of the well installation. A certificate of analysis should be provided with the water, or a sample of the water should be analyzed and documented as contaminant-free.

Primary Filter Pack - The primary filter pack (sand or gravel pack) consists of a granular material of selected grain size and gradation that is installed in the annulus between the casing string and the borehole wall. A sand/filter pack of equivalent/appropriate type and size may be installed along the screened interval using a tremie pipe from the total depth of the well to the designated distance above the top of the screened interval.

Well Screen - The well screen should be new and composed of materials most suited for the environment being monitored. The casing string should be plugged at the bottom. The plug should be of the same material as the bottom section of casing and should be securely attached, making a positive seal. This assembly must have the capability to withstand well installation and development stresses without becoming dislodged or damaged. The length of the well screen slotted area should be appropriate for the interval to be monitored including some allowance for changes in depth of the water table. Prior to installation, the casing string and associated equipment should be cleaned with steam or high-pressure water. Well screens to be used should be composed of stainless steel or polyvinyl chloride (PVC), as appropriate. Fluoropolymer materials may be substituted if necessary due to the potential for incompatible chemical reactions between contaminants and the stainless steel screen, or if stainless steel constituents are possible site contaminants. The minimum internal diameter of the well screen should be chosen based on the particular application. Well screens should be flush threaded per American Society for Testing and Materials (ASTM) standards. Glued or solvent-welded joints may not be used since glues and solvents may alter the chemistry of the water samples.

Slot Size - The slot size of the well screen should be determined relative to the grain-size analysis of the stratum to be monitored and the gradation of the filter pack material. In granular non-cohesive strata that falls in easily around the screen, filter packs may not be necessary. In these cases of natural development, the slot size of the well screen is to be determined using the grain size of the materials in the surrounding strata. The slot size and arrangement should retain at least 90 percent of the filter pack.

Casing - The well casing will be composed of PVC, stainless steel, or some other appropriate material and will extend from the screen to the surface. The type of casing and wall thickness should be adequate to withstand the forces of installation. Several different casing sizes may be required depending on the subsurface geologic conditions. The diameter of the casing for filter packed wells should be selected so that a minimum annular space of 2 inches is maintained between the casing and the borehole wall. The diameter of the casings in multi-cased wells should be selected so that a minimum annular space of 2 inches is maintained between casing strings and between the outer casing and the borehole (e.g., a 2-inch-diameter well screen will require first setting a 6-inch-diameter casing in a 10-inch-diameter boring). Under difficult drilling conditions (collapsing soils, rock or cobbles), it may be necessary to advance temporary casing. Under these conditions, a smaller space may be maintained. The ends of each casing section should be flush-threaded.

Protective Casing - Protective casings may be made of galvanized steel (or rarely stainless steel). The protective casing should have a lid capable of being secured by a locking device. The inside dimensions of the protective casing should be at a minimum 4 inches larger than the diameter of the casing to facilitate the installation and operation of sampling equipment. Protective casing should extend approximately 2 feet into the ground to anchor it securely.

Annular Sealants - The materials used to seal the annulus may be prepared as a slurry or used un-mixed in a dry pellet, granular, or chip form. Sealants should be selected for compatibility with local geologic, hydrogeologic, climatic, and human-induced conditions anticipated to occur during the life of the well.

Bentonite - Bentonite should be powdered, granular, pelletized, or chipped sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities that adversely impact water quality in the well. The diameter of pellets or chips selected for monitoring well construction should be less than one-fifth the width of the annular space into which they are placed to reduce the potential for bridging. Pellets are typically used for placing annular seals, and powdered bentonite is used for mixing in grout slurry.

Cement - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement should be one of the five Portland cement types that are specified in ASTM C 150. Quick-setting cements containing additives are not allowable for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of the groundwater.

Grout - The grout backfill that is placed above the bentonite annular seal should be a liquid slurry consisting of water, bentonite grout of Volclay or equivalent quality, and Portland cement. Bentonite-based grouts are typically used when a more flexible grout is desired (i.e., freeze-thaw). Cement-based grout provides a more rigid installation. A typical bentonite grout mixture is 1 to 1.25 pounds bentonite to 2 pounds of Type I Portland Cement per gallon of water. Cement-based grout is typically 6 to 7 gallons of water per 94 pound bag of Type I Portland Cement and 2.7 percent bentonite.

Transition Sand - A layer of fine to very fine sand may be placed on top of the primary filter pack before emplacement of the bentonite seal. It should be of sufficient thickness to prevent bentonite from penetrating to the vicinity of the well screen during placement of the bentonite seal.

Annular Seal Equipment (Tremie Pipe) - A tremie pipe is used to inject the annular seals and filter pack. Tremie pipes are typically constructed of PVC or galvanized steel. Associated equipment may include a trough or mixing box and "mud pump" to place the material.

Primary Filter Pack - Screened and washed sand that is placed between the well screen and the borehole wall the full length of the screen.

5.0 PROCEDURES

5.1 Drilling Methods

The actual methods of drilling at a site will vary depending on site conditions. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL. Typical drilling methods include air rotary, mud/fluid rotary, and hollow stem auger. Drilling with mud, foam, or water is not desirable, but the driller shall have the capability to use this method if hole conditions warrant it. Installation of wells drilled by mud, foam, water, or air rotary shall be reamed to the appropriate borehole diameter. Installation of wells with protective casing shall be done by either penetrating the outer casing into the ground by hammer blows or by drilling a borehole. The outer casing should be set and secured by grouting or other means specified in the site-specific plans. The inner well borehole can then be drilled through the center of the outside casing. The monitoring wells shall be drilled vertical or at an angle if specified in the site-specific plans. The wells shall be drilled to a depth specified in the site-specific plans and may vary based on actual lithologic conditions. The depth to completion should be approved by the FTL prior to monitoring well construction. Drillers must prevent grease, oil, and other fluids from the drill rig from coming in contact with the ground around the area of well installation.

5.2 Monitoring Well Installation

5.2.1 Stable Borehole

A stable borehole must be constructed prior to attempting to install the monitoring well casing and assembly. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow-in, or both. Boreholes that are not straight or are partially obstructed should be corrected prior to attempting the installations described herein.

Although all monitoring wells will not be completed exactly alike, there are common elements among them. The Monitoring Well Construction Form (Figure 1 or equivalent) must be completed by the end of the activity with data obtained through the installation process. The well construction field form should be reviewed prior to initiation of drilling activities to assure that the required data are collected at appropriate times during drilling and installation.

Some monitoring wells may require collection of continuous core, which will be maintained from surface to total depth. Samples may be collected by the wire line coring method (or split-spoon sampler). A description of soil/lithologic materials and drilling observations needs to be recorded in a boring logbook (CDM Federal SOP 3-5).

The retrieved samples will be visually screened for indications of water saturation to identify any perched zone and associated impervious layer. If there is sufficient groundwater in a perched zone, a monitoring well may be completed in that zone. Operations will resume if the suspected saturated interval is determined not to be perched water or to be of insufficient thickness to warrant well construction.

For wells not completed in perched zones, the drilling method should ensure isolation of the perched water from the advancing hole, which can be accomplished by outer, protective casing. This method, however, may require short core sections to maintain a close interval between the drive casing and the core depth (that is, until the perched water zone has been completely penetrated). During completion of the well through the perched water zones, the cement grout should stay well above the retracting drive casing shoe.

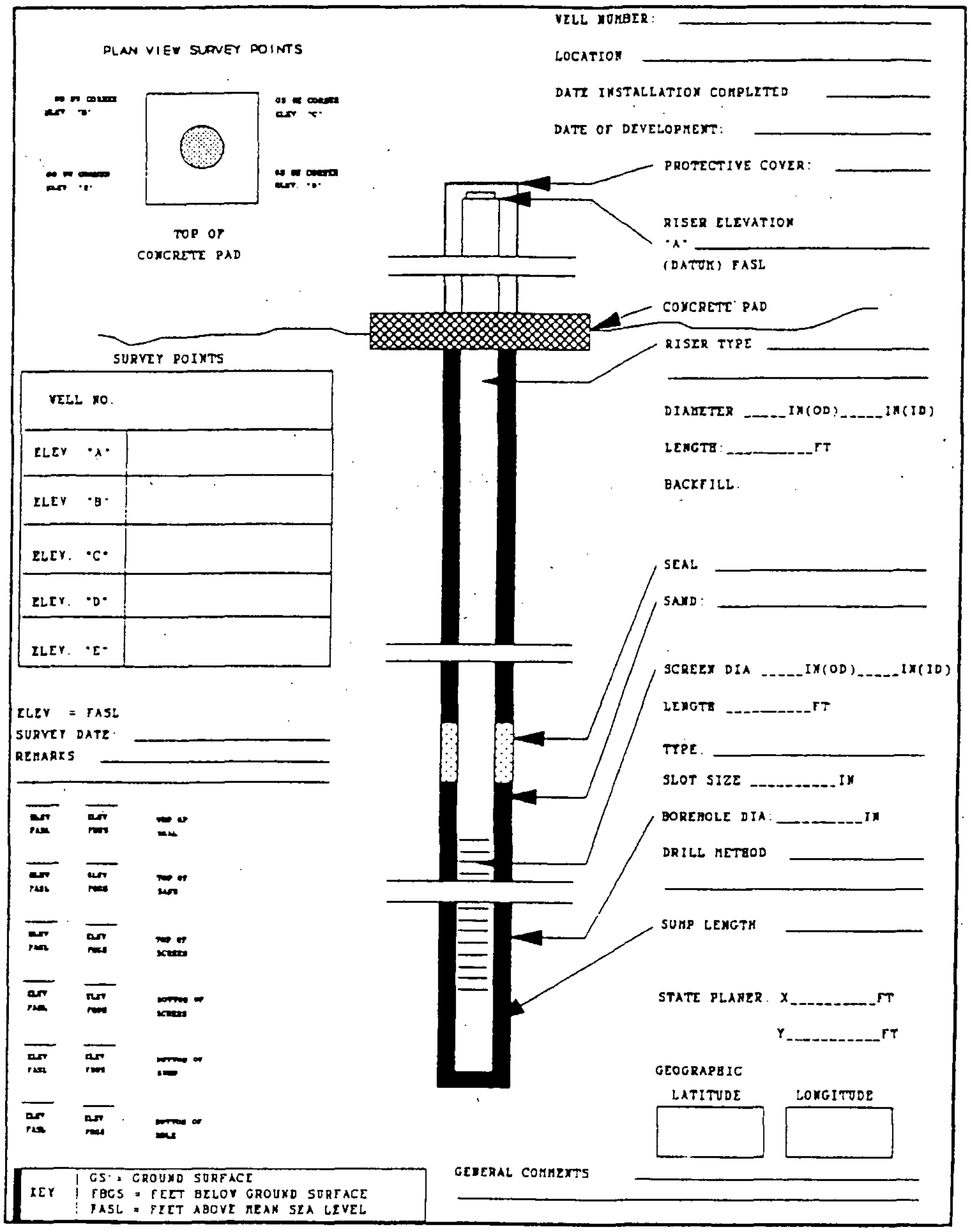
5.2.2 Well Casing Assembly

The well screen, casing, and bottom plug should be either certified clean from the manufacturer or decontaminated according to CDM Federal SOP 4-5.

Personnel should take precautions to assure that grease, oil, or other contaminants that may alter water samples do not contact any portion of the well casing assembly. As a precaution, personnel should wear a pair of clean gloves while handling the assembly.

Normally, couplings are tightened by hand; however, steam or high pressure cleaned strap wrenches may also be utilized. Use pipe wrenches with care as they may scar and weaken the pipe. Precautions should be taken to prevent damage to the threaded joints during installation.

Figure 1 - Monitoring Well Construction Form



5.2.3 Setting the Well Screen and Casing Assembly in Fluid Filled Holes

When the well screen and casing assembly is lowered to the predetermined level and held in position, the assembly may require a ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by continuously filling the casing assembly with contaminant-free water. If fluid ballasts are used, the quantity introduced must be recorded in the field logbook. Alternatively, the casing assembly may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of casing are added to the column. Care must be taken to secure the casing assembly so that personnel safety is assured during the installation. For wells greater than 100 feet, the assembly should be installed straight using centralizers at selected intervals.

Difficulty in maintaining a straight installation may be encountered when the weight of the well screen and casing assembly is significantly less than the buoyant force of the fluid in the borehole. The casing should extend to grade or approximately 2 feet above grade, depending on the intended surface completion, and be capped or covered temporarily to deter entrance of foreign materials during completion operations.

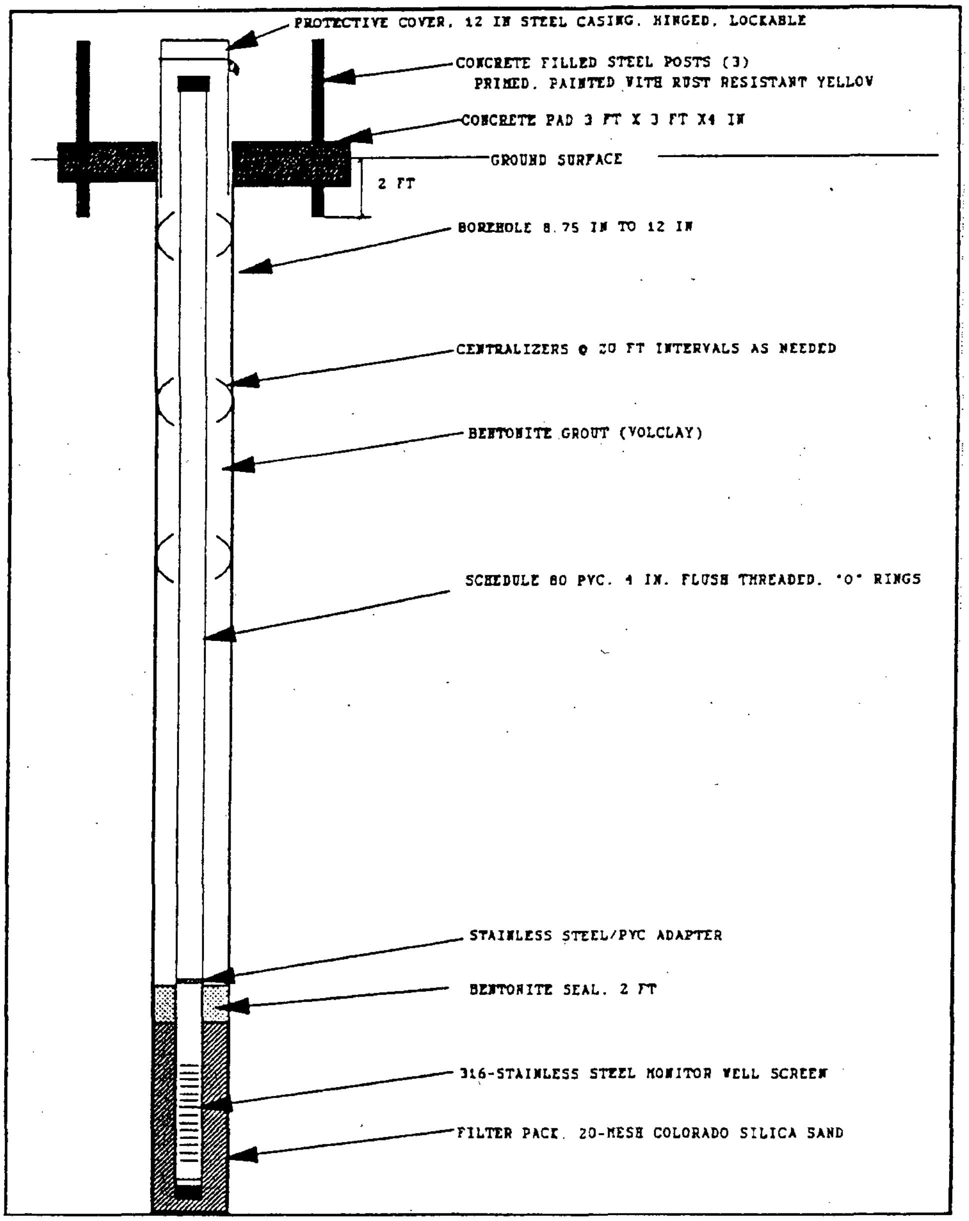
A typical monitoring well is illustrated in Figure 2, (Typical Construction Detail of Monitor Well). Modification of the construction and dimensions on this diagram may be needed depending on site-specific conditions. The monitoring wells will be completed with material as approved by the FTL. The casing should be flush-threaded, using Schedule 40 PVC or other suitable monitoring well casing. No adhesives, cements, or lubricants shall be used during casing make-up or during other drilling and well completion operations.

5.2.4 Installation of the Primary Filter Pack

Placement of the casing assembly is followed by placing the primary filter pack sand/filter pack (consisting of silica sand sized according to the average grain size of the screened formation) into the bottom of the borehole by using a tremie pipe. The remaining primary filter pack is then placed in increments as the tremie is gradually raised. The sand pack will be emplaced by the "washdown" gravity method and the depth to the top of the sand pack shall be determined and recorded frequently during the operation to ensure proper placement. The tremie pipe or a weighted line inserted through the tremie pipe can be used to measure the top of the primary filter pack as work progresses. As primary filter pack material is poured into the tremie pipe, water from a source of known chemistry may be added to help move the filter pack. The quantity of water introduced must be recorded. If bridging of the primary filter pack occurs, the bridged material should be broken mechanically prior to proceeding with the addition of more filter pack material. The depth, volume, and gradation of the primary filter pack will be recorded on the well construction diagram.

Figure 2 - Typical Construction Detail of Monitor Well

(Not to Scale - Shown as an Example Only)



If used, temporary casing or auger sections will be withdrawn in increments. Care should be taken to minimize lifting the casing with the withdrawal of the temporary casing/augers. To limit borehole collapse, the temporary casing or hollow stem auger is usually withdrawn until the lowermost point on the temporary casing or hollow stem auger is at least 2 feet, but no more than 5 feet, above the filter pack for unconsolidated materials; or at least 5 feet, but no more than 10 feet, for consolidated materials. Ascertain the depth of the sand with an acceptable measuring device or with tremie pipe and verify the thickness of the sand pack. The primary filter pack is typically placed a minimum of 2 feet above the top of the well screen to account for settlement of the filter pack.

5.2.5 Installation of the Bentonite Seal

A minimum 2-foot-thick bentonite seal should be emplaced on top of the filter pack or transition sand (if used) by using a tremie pipe, if required. If the tremie pipe becomes plugged, requiring an increase in pressure to clear it, not less than 20 feet of tremie pipe shall be pulled up to avoid jetting into the sand pack. If the seal is installed above the water level, water shall be added to allow proper hydration of the annular seal (approximately 1 gallon for each linear foot of annular seal). The volume and depth of the bentonite seal material should be measured and recorded on the well construction diagram.

5.2.6 Grouting the Annular Space

Because grouting procedures vary with the type of well design, the following procedures apply to both single- and multi-cased monitoring wells.

A sufficient volume of grout should be premixed on site, according to procedure stipulated by the manufacturer, to compensate for unexpected losses and checked against the known volume of annular space to ensure that bridging does not occur during emplacement. The use of alternate grout materials, including grout containing Portland cement, may be necessary to control zones of high grout loss. The mixing (and placing) of grout should be performed with recorded weights and volumes of materials, according to procedures stipulated by the manufacturer. Lumpy grout should not be used in an effort to prevent bridging within the tremie and the well; however, lost circulation materials may be added to the grout if excessive grout loss occurs. Bentonite-based grout of Volclay or equivalent type should be mixed to the manufacturer's specifications then pumped into place using minimum pump pressure. All additives to grouts should be evaluated for their effects on subsequent water samples.

Depending upon the well design, grouting may be accomplished using a pressure grouting technique or by gravity feed through a tremie pipe. With either method, grout is introduced in one continuous operation until grout flows out at the ground surface without evidence of drill cuttings or fluid. The grout backfill should be injected under pressure using a tremie pipe to reduce the possibility of leaving voids in the annular seal and to displace any liquids and drill cuttings that may remain in the annulus.

Grouting should begin directly above the bentonite seal. Grout should be injected using a tremie pipe. The trimie pipe should be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Pump pressure shall be kept to a minimum. Approximately 5 to 10 feet of tremie pipe should remain submerged during group emplacement. If possible, steel tape soundings should be made to ensure the level of the tremie material is in agreement with the calculated volume and that the desired placement of annular materials is achieved. A staged grouting procedure may be considered if the couplings of the selected casing cannot withstand the shear or if there is collapse stress exerted by the full column of grout as it sets. If used, the temporary casing or hollow stem auger should be removed in increments (immediately following each lift of grout installation) well in advance of the time when the grout begins to set. The initial grout mixture must be allowed to cure for approximately 12 hours then refilled to the surface.

The well casing should not be developed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and casing. The amount of time required (generally 24 to 48 hours) will vary with grout content and climate conditions and should be documented on the well completion diagram along with the volume and depth of grout used to backfill the annular space.

5.3 Well Protection

Well protection refers specifically to installations made at or above the ground surface to deter unauthorized entry to the monitoring well and to prevent surface water from entering the annulus.

The protective casing should extend from below the frost line (at least 2 feet below grade) to slightly above the well casing top. The protective casing should be sealed and immobilized in concrete that has been placed around the outside of the protective casing above the set grout backfill. The casing should be positioned and stabilized in a position concentric with the casing. Clearance (usually 6 inches) should be maintained between the lid of the protective casing and the top of the casing to accommodate sampling equipment. A 1/4-inch-diameter weep hole should be drilled in the protective casing at the ground surface to permit water to drain out of the annular space. This hole will also prevent water freezing between the well protector and the well casing.

All materials used should be documented on the well construction diagram. The monitoring well identification number should be clearly visible on the inside and outside of the lid of the protective casing and the outside of the protective casing.

A 3-feet x 3-feet x 6-inch-thick concrete pad, sloped to provide water drainage away from the well, may be placed around the installation. Pad size may vary according to site conditions or client specifications. Three 2-1/2-inch-diameter concrete-filled steel posts set at least 24 inches below the surface in concrete should be equally spaced around the well to protect against damage by vehicular traffic for above ground well completions. The protective casing and steel posts may be primed and painted with rust-resistant yellow paint.

A flush-mounted, traffic-rated utility base or vault is typically used for the surface completion of monitoring wells installed in high use paved areas. The well box cover should be finished slightly above pavement surface to prevent water entry.

5.4 Post Operation

5.4.1 Field

At the conclusion of the monitoring well installation activities, all equipment must be decontaminated (according to CDM Federal SOP 4-5) prior to moving the equipment to a different work location. All water used in the decontamination of drilling equipment will be contained in an appropriate container, if required in the site-specific plans.

5.4.2 Documentation

The Groundwater Monitoring Well Construction Form (Figure 1 or equivalent) should be completed by the CDM Federal FTL or designee at the conclusion of the field activity.

Copies of all field notes, the daily logs, and any completed Groundwater Monitoring Well Construction Forms shall be given to the site manager. These records shall be maintained in the project and document control files. At a minimum, all materials used for construction should be documented by entering identifying numbers (lot numbers, manufacturer's identification, etc.) in the field logbook. Samples of well materials (including grout, sand, etc.) may be archived if specified in the project plans.

6.0 RESTRICTIONS AND LIMITATIONS

None.

7.0 REFERENCES

American Society for Testing and Materials, Designation: D 5092-90, *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers*, ASTM Committee D-18-.21.05. October 1990.

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Sandia National Laboratories, *Statement of Work, Drilling Specifications, Request for Proposal*, Environmental Restoration Program, Albuquerque, New Mexico.

Sandia National Laboratories, *Activity Specific ES&H Standard Operating Procedure Geotechnical Activities Associated with Drilling*, SP 471725, Albuquerque, New Mexico.

Sandia National Laboratories, *Field Operating Procedure for Design and Installation of Groundwater Monitoring Wells in Aquifers*, Draft 92-07, Albuquerque, New Mexico.

U.S. Department of Energy, DOE/HWP-100/R1, Standard Operating Procedures for Site Characteristics. Standard Operating Procedure 2, *Monitoring Well Installation*, September 1996.

TSOP 4-5

FIELD EQUIPMENT DECONTAMINATION AT NON-RADIOACTIVE SITES

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4-5
Revision: 4
Date: March 7, 2003

SOP Title: FIELD EQUIPMENT DECONTAMINATION AT NON-RADIOACTIVE SITES

QA Review: E-Signed by Jeniffer Oxford VERIFY authenticity with Approve

Approved and Issued: E-Signed by Jeanne Litwin VERIFY authenticity with ApproveIt

Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for Clarification: Make SOP USEPA Region II – Specific

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

4.0 REQUIRED EQUIPMENT, add (to page 2 of 9):

- Respirator Sanitizer

Replace reference to ASTM Type II water with demonstrated analyte-free water.

5.0 PROCEDURES

5.1 Heavy Equipment Decontamination, add:

All drilling equipment that comes in contact with the soil must be steam cleaned before use and between boreholes. This includes drill rods, bits and augers, dredges or any other large piece of equipment.

5.2 Downhole Equipment Decontamination, add (on page 4 of 9):

All drilling equipment that comes in contact with the soil must be steam cleaned before use and between boreholes. This includes drill rods, bits, dredges or any other large piece of equipment.

Well casings must be steam cleaned prior to installation to ensure that all oils, greases, and waxes have been removed. Because of the softness of casings and screens made of fluorocarbon resins, these materials should be detergent washed, not steam cleaned prior to installation. They should be rested on clean polyethylene sheeting to keep the possibility of contamination to a minimum.

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 4-5
Revision: 4
Date: March7, 2003

SOP Title: FIELD EQUIPMENT DECONTAMINATION AT NON-RADIOACTIVE SITES

5.3 Sampling Equipment Decontamination, replace (beginning on page 5 of 9) with:

Sampling equipment includes such items as split spoons that directly sample media. Follow these steps when decontaminating this equipment.

1. Set up a decontamination line on plastic sheeting. The decontamination line should progress from "dirty" to "clean" and have an area located upwind for drying decontaminated equipments At a minimum, clean plastic sheeting must be used to cover the ground, tables, or the surfaces on which decontaminated equipment is to be placed for drying.

2. Before washing, disassemble any items that might trap contaminants internally. Do not reassemble these items until decontamination and air drying are complete. Wash items thoroughly in a bucket of low phosphate detergent and potable water. Use a stiff-bristle brush to dislodge any gross contamination (soil or debris).

3. Rinse the items in tap water. Tap water may be used from any municipal water treatment system. The Use of an untreated potable water supply is not an acceptable substitute. Rinse water should be placed as needed, generally when cloudy.

4. Rinse the item with 10% nitric acid prepared from ultra pure grade (for stainless steel, glass, plastic, and Teflon®) or 1% nitric acid prepared from ultrapure grade (for carbon steel implements, such as split spoons). This rinse is required when sampling for inorganics.

5. Rinse item in de-ionized water.

6. Rinse item in acetone. All solvents must be pesticide grade or better. The solvent rinse is only required when sampling for organics.

   If required by the field plan, when sampling for polar organic compounds such as pesticides, polychlorinated biphenyls (PCBs), and fuels, rinse the item with hexane or approved alternatives, followed by a second methanol rinse.

7. Rinse item in demonstrated analyte-free water. The amount of water must be at least five times that of the solvent used in step 6 or 7.

   A sample of demonstrated analyte-free water will be collected and submitted for chemical analysis. Analytical results will be kept on-site. Determination of analyte-free water will be according to the *Region II CERCLA Quality Assurance Manual* (October 1989 revision, page 59).

8. Allow the item to air dry completely.

9. After drying, wrap in aluminum foil, shiny side out, for transport.

10. After decontamination activities are complete, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. (Refer to site-specific plans for labeling and waste management requirements).

5.4 Pump Decontamination

Substitute (on Page 7 of 9) references to ASTM Type II water with demonstrated analyte-free water.

5.5 Instrument Probe Decontamination

Substitute (on page 7 of 9) references to ASTM Type II water with de-ionized water.

Add subsection on:

PERSONAL PROTECTION EQUIPMENT DECONTAMINATION

This decontamination procedure applies to personal protective equipment that is not disposable, such as respirators or overboots.

1. Rinse item in non-residual detergent (Alconox).

2. Apply respirator sanitizer. This step only applies to respirator decontamination.

3. Rinse item in potable water.

4. Allow the item to air dry.

6.0 RESTRICTIONS/LIMITATIONS, add (on page 8 of 9):

While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result from the interaction of the gloves with the organic solvents.

FIELD EQUIPMENT DECONTAMINATION AT NONRADIOACTIVE SITES	SOP: 4-5 Revision: 5 Date: December 11, 2002 Page 1 of 9

Prepared: Steven Fundingsland	Technical Review: Laura Splichal
QA Review: ~~Matt~~ Brookshire	Approved: 12/18/02 Signature/Date
Issued: 12/18/02 Signature/Date	

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to describe the procedures required for decontamination of field equipment.

2.0 BACKGROUND

2.1 Definitions

Clean - Free of visible contamination and when decontamination has been completed in accordance with this SOP.

Cross-Contamination - The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or non-contaminated samples or areas.

Decontamination - The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

2.2 Discussion

Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off-site.

3.0 RESPONSIBILITIES

Field Team Leader - The Field Team Leader (FTL) ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this procedure. The FTL may also be required to collect and document rinsate samples to provide quantitative verification that these procedures have been correctly implemented.

4.0 REQUIRED EQUIPMENT

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Laboratory-grade detergent, low phosphate (Alconox™, Liquinox ™ or similar)
- Nalgene or Teflon Sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting
- Disposable wipes, rags or paper towels
- Potable water and/or de-ionized water of American Society for Testing and Materials (ASTM) Type II or better, as defined by ASTM Standard Specification for Reagent Water, Standard D 1193-77 (re-approved 1983)*
- Gloves, safety glasses, and other protective clothing as specified in the site-specific health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source (e.g. 10% and/or 1% nitric acid (HNO3), acetone, methanol, isopropanol, hexane)
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums or tanks (as required)
- Pallets for drums or tanks holding decontamination water (as required)

* Potable water may be required to be tested for contaminants before use. Check field plan for requirements. ASTM Type II water will include a certificate of quality.

5.0 PROCEDURES

All reusable equipment (non-dedicated) used to collect, handle, or measure samples will be decontaminated before coming into contact with any sample. Decontamination of equipment will occur either at a central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally-located decontamination station will include an appropriately sized bermed and lined area on which equipment decontamination will occur and shall be equipped with a collection system and storage vessels. In certain circumstances, berming is not required when small quantities of water are being generated and for some short duration field activities (i.e., pre-remedial sampling). Equipment should be transported to the decontamination station in a manner to prevent cross-contamination of equipment and/or area. Precautions taken may include enclosing augers in plastic wrap while being transported on a flatbed truck.

The decontamination area will be constructed so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) or within the berms of the decontamination area which then drains into a collection system. Water from the collection system will be transferred into 55-gallon drums or portable tanks for storage. Typically, decontamination water will be staged until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined. The exact procedure for decontamination waste disposal should be discussed in the field plan. Also, decontamination fluids, such as solvents, may need to be segregated from other investigation-derived wastes.

All items that will come into contact with potentially contaminated media will be decontaminated before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, they will be covered either with clean plastic or aluminum foil depending on the size of the item. All decontamination procedures for the equipment being used are as follows:

General Guidelines

- Potable and de-ionized water should be free of all contaminants of concern. Following the field plan, analytical data from the water source may be required. If required, either existing analytical data from the water source supplier (i.e., municipality, bottled water company, de-ionized water producer) may be obtained or chemical testing may be performed on the selected source.
- Soap will be a low phosphate detergent.
- Sampling equipment that has come into contact with oil and grease will be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or client requirements regarding solvent use will be stated in the field plan.
- All solvents will be pesticide grade or better and traceable to a source. The corresponding lot numbers will be recorded in the appropriate logbook.
- Decontaminated equipment will be allowed to air dry before being used.
- Documentation for all cleaning will be recorded in the appropriate logbook.
- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment will be used as specified in the site-specific health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment includes drilling rigs and backhoes. Follow these steps when decontaminating this equipment:

1. Establish a decontamination area with berms that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be utilized; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads should be upwind of the area under investigation.

2. With the rig in place, spray areas (rear of rig or backhoe) exposed to contaminated soils using a hot water high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.

3. Use brushes, low phosphate detergent and potable water to remove dirt whenever necessary.

4. Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.

5. Record equipment type, date, time, and method of decontamination in the appropriate logbook.

6. After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the field plan. Liquids and solids must be drummed separately.

5.2 Downhole Equipment Decontamination

Downhole equipment decontamination includes hollow-stem augers, drill pipes, casings, screens, etc. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area, if possible. This area should be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.

2. Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination pads should be upwind of any areas under investigation.

3. Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports.

4. Using low phosphate detergent and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.

5. If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.

6. Using the manual-pump sprayer, rinse the equipment thoroughly with de-ionized water (ASTM Type II or better).

7. Remove the equipment from the decontamination area and place in a clean area upwind to air dry.

8. Record equipment type, date, time, and method of decontamination in the appropriate logbook.

9. After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.3 Sampling Equipment Decontamination

Sampling equipment includes split spoons, spatulas, and bowls used for sample homogenization that directly contact sample media. Follow these steps when decontaminating this equipment:

1. Set up a decontamination line on plastic sheeting. The decontamination line should progress from "dirty" to "clean" and have an area located upwind for drying decontaminated equipment. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or the surfaces on which decontaminated equipment is to be placed for drying.

2. Before washing, disassemble any items that might trap contaminants internally. Do not reassemble these items until decontamination and air-drying are complete. Wash items thoroughly in a bucket of low phosphate detergent and potable water. Use a stiff-bristle brush to dislodge any gross contamination (soil or debris).

3. Rinse the item in potable water. Rinse water should be replaced as needed, generally when cloudy.

4. Using a hand sprayer, wash bottles, or manual-pump sprayer, rinse the item with de-ionized water (ASTM Type II or better).

5. If sampling for metal analytes, rinse the item with 10% nitric acid (for stainless steel, glass, plastic, and Teflon), or 1% nitric acid (for items made of low-carbon steel) followed by a de-ionized water (ASTM Type II or better) rinse.

   NOTE: Care should be taken not to get nitric acid on skin or clothing. This step should not be used unless required by sampling needs as dictated in the field plan.

   CAUTION: Do not allow nitric acid to contact methanol or hexane. Contain nitric acid waste separate from organic solvents.

6. If sampling for organic analytes, rinse the item with methanol or approved organic solvent.

7. If required by the field plan, when sampling for polar organic compounds such as pesticides, polychlorinated biphenyls (PCBs), and fuels, rinse the item with hexane or approved alternatives, followed by a second methanol rinse.

8. Thoroughly rinse the item with de-ionized water (ASTM Type II or better).

9. Allow the item to air dry completely.

10. After drying, reassemble parts as required and wrap the item in clean plastic wrap or in aluminum foil, shiny side out.

11. Record equipment type, date, time, and method of decontamination in the appropriate logbook.

12. After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. (Refer to site-specific plans for labeling and waste management requirements).

5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum follow these steps when decontaminating pumps:

1. Set up the decontamination area and separate "clean" storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up three 55-gallon drums and one or more containers of ASTM Type II water (or as specified in the field plan). One drum shall contain dilute (non-foaming) soapy water, the second drum shall contain potable water, and the third drum shall be empty to receive waste water.

2. The pump should be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first drum. Place the discharge outlet in the wastewater drum above the level of the wastewater. Pump soapy water through the pump assembly until it discharges to the waste drum. Scrub the outside of the pump and other wetted parts with a metal brush.

3. Move the pump assembly to the potable water drum while leaving discharge outlet in the waste drum. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.

4. Move the pump intake to the ASTM Type II water can. Pump the ASTM Type II water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes will be required.

5. Decontaminate the discharge outlet by hand following the steps outlined in Section 5.3.

6. Remove the decontaminated pump assembly to the "clean" area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices should be covered with aluminum foil to prevent the entry of airborne contaminants and particles.

7. Record the equipment type, serial number, date, time, and method of decontamination in the appropriate logbook.

5.5 Instrument Probe Decontamination

Instrument probes used for field measurements such as pH meters, conductivity meters, etc. will be decontaminated between samples and after use with ASTM Type II, or better, water.

5.6 Waste Disposal

Refer to site-specific plans for waste disposal requirements. The following are guidelines for disposing of wastes:

1. All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste.

2. Small quantities of decontamination solutions may be allowed to evaporate to dryness.

3. If large quantities of used decontamination solutions will be generated, each type of waste should be separated in separate containers. This may permit the disposal of wash water and rinse water onsite or in a sanitary sewage treatment plant rather than as a hazardous waste. If an industrial wastewater treatment plant is available onsite, the disposal of acid solutions and solvent-water solutions may be permitted.

4. Unless otherwise required, plastic sheeting and disposable protective clothing may be treated as solid, non-hazardous waste.

5. Waste liquids should be sampled, analyzed for contaminants of concern in accordance with disposal regulations, and disposed of accordingly.

6.0 RESTRICTIONS/LIMITATIONS

Nitric acid and polar solvent rinses are necessary only when sampling for metals or organics respectively. These steps should not be used, unless required, because of the potential for acid burns and ignitability hazards.

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with your EPA region, state, and client for approved decontamination solvents.

7.0 REFERENCES

Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures For Site Characterization*, DOE/HWP-100/R1, September 1996.

Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements For Field Methods*, DOE/HWP-69/R2, September 1996.

American Society for Testing and Materials, *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites*, ASTM D5088-90, June 29, 1990.

U.S. Environmental Protection Agency, Region II, "*CERCLA*" *Quality Assurance Manual*, Revision 1, 1989.

U.S. Environmental Protection Agency, Region IV, *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual*, 1986.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1, 1987.

TSOP 5-1

CONTROL OF MEASUREMENT AND TEST EQUIPMENT

CONTRACT-SPECIFIC CLARIFICATION

SOP No.: 5 - 1
Revision: 5
SOP Title: CONTROL OF MEASUREMENT AND TEST EQUIPMENT Date: March 26, 2003

QA Review: ______________________________

Approved and Issued: ______________________________
Program Manager Signature/Date

Contract No.: RAC II Client: USEPA, Region II

Reason for and Clarification: Make SOP USEPA Region II – Specific

Clarification (attach additional sheets if necessary; state section and page numbers when applicable):

2.0 BACKGROUND

2.2 **Discussion**, add (to page 1 of 7):

As the RAC II contract does not use any company-owned or government furnished equipment, only procedures discussed for leased and rented measurement and test equipment apply.

CONTROL OF MEASUREMENT AND TEST EQUIPMENT

Prepared: Dave Johnson

Technical Review: Laura Splichal

QA Review: Krista Lippoldt

Approved: 12/18/02
Signature/Date

Issued: 12/18/02
Signature/Date

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE). Contractual obligations may require more specific or stringent requirements that must also be implemented.

2.0 BACKGROUND

2.1 Definitions

Traceability - The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Discussion

M&TE is typically either government furnished (GF), or rented or leased from an outside vendor. It is essential that measurements and tests resulting from the use of this equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be utilized in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures (MPs) and in accordance with any other related project-specific requirements.

2.3 Associated Procedures

- CDM Federal (CDM) Technical Standard Operating Procedure 4-1
- CDM Quality Procedures (QPs) 2.1 and 2.3
- Manufacturer's operating and maintenance and calibration procedures

3.0 RESPONSIBILITIES

All staff with responsibility for the direct control and/or use of M&TE are responsible for being knowledgeable of, understanding and implementing the requirements contained herein as well as any other related project-specific requirements.

4.0 REQUIREMENTS

- Determine and implement M&TE related project-specific requirements
- The MPs must be followed when using M&TE
- Obtain the MPs if they are missing or incomplete
- Attach or include the MPs with the M&TE
- Prepare and record maintenance and calibration (M&C) in an Equipment Log (EL) or a Field Log (FL) as appropriate (Figure 1)
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform M&C using the appropriate procedure and calibration standards
- Identify and take action on non-conforming M&TE

5.0 PROCEDURES

5.1 Determine if Other Related Project-Specific Requirements Apply

For All M&TE Use

1. The Equipment Coordinator (EC), the other person responsible (OPR) for the item and the User - Contact the Project Manager (or appropriate Contract staff in the Project Manager's absence) to determine if M&TE related project-specific requirements apply. If M&TE related project-specific requirements apply, obtain a copy of them and review and implement as appropriate.

5.2 Obtain the Operating and Maintenance and Calibration Documents

For GF M&TE that is to be procured:

1. Requisitioner - Specify that the MPs be included.

For GF M&TE that is acquired as a result of a property transfer:

1. Receiver - Inspect the M&TE to determine whether MPs are included with the item. If the MPs are missing or incomplete, order the appropriate documentation from the manufacturer.

For M&TE that is to be rented or leased from an outside vendor:

1. Requisitioner - Specify that the MPs, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, ask Procurement to request it from the vendor.

5.3 Prepare and Record Maintenance and Calibration Records

For all M&TE:

1. EC, OPR and User – Record all M&C events in a FL unless other project specific requirements apply.

For GF M&TE only (does not apply to rented or leased M&TE):
If an EL is a project specific requirement, perform the following:

1. Receiver - Notify the EC or OPR for the overall property control of the equipment, of the receipt of an item of M&TE.

2. EC or OPR - Prepare a sequentially page-numbered EL for the item using the M&C form (or equivalent) from the CDM Federal Property Control Manual and included here for reference as Figure 1.

3. EC, OPR and User – Record all M&C events in an EL.

5.4 Label M&TE Requiring Calibration

For GF M&TE only (does not apply to rented or leased M&TE):
If calibration labeling is a project specific requirement, perform the following:

1. EC or OPR - Read the MPs to determine the frequency of calibration required.

2. EC or OPR - If an M&TE item requires calibration before use, affix a label to the item stating "Calibrate Before Use".

3. EC or OPR - If an M&TE item requires calibration at other scheduled intervals, e.g. monthly, annually, etc., affix a label listing the date of the last calibration, the date the item is next due for a calibration, the initials of the person who performed the calibration, and a space for the initials of the person who will perform the next calibration.

Figure 1

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

MAINTENANCE AND CALIBRATION

Date: ____________ Time: ________ AM/PM

Employee Name: ________________________ Equipment Description: ________________________

Contract/Project: ________________________ Equipment ID No.: ________________________

Activity: ________________________ Equipment Serial No.: ________________________

MAINTENANCE

Maintenance Performed: ____

____

____

Comments: ____

____

____

Signature: ______________________________ Date: ______________

CALIBRATION/FIELD CHECK

Calibration Standard: ____________________ Concentration of Standard: ____________________

Lot Number of Calibration Standard: ____________ Expiration date of Calibration Standard: ____________

Pre-Calibration Reading: ____________________ Post-Calibration Reading: ____________________

Additional Readings: ____________________ Additional Readings: ____________________

Additional Readings: ____________________ Additional Readings: ____________________

Pre-Field Check Reading: ____________________ Post-Field Check Reading: ____________________

Adjustment(s): ____

____

____

Calibration: ☐ Passed ☐ Failed

Comments: ____

____

____

Signature: ______________________________ Date: ______________

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5.5 Operating, Maintaining or Calibrating an M&TE Item

For all M&TE:

1. EC, OPR and User - Operate, maintain and calibrate M&TE in accordance with the MPs. Record M&C actions in the EL or FL.

5.6 Shipment

For GF M&TE:

1. Shipper - Inspect the item to ensure that the MPs are attached to the shipping case, or included, and that a copy of the most recent EL entry page (if required) is included with the shipment. If the MPs and/or the current EL page (if required) is missing or incomplete, do not ship the item. Immediately contact the EC or OPR and request a replacement.

For M&TE that is rented or leased from an outside vendor:

1. Shipper - Inspect the item to ensure that the MPs and latest calibration and standards certification records are included prior to shipment. If any documentation is missing or incomplete, do not ship the item. Immediately contact Procurement and request that they obtain the documentation from the vendor.

5.7 Records Maintenance

For GF M&TE:

1. EC or OPR - Create a file upon the initial receipt of an item of M&TE or calibration standard. Organize the files by contract origin and by M&TE item and calibration standard. Store all files in a cabinet, file drawer, or other appropriate storage media, at the pertinent warehouse or office location.

2. EC or OPR - Maintain all original documents in the equipment file except for the packing slip and FL.

3. Receiver - Forward the original packing slip to Procurement and a photocopy to the EC or OPR.

4. EC or OPR - File the photocopy of the packing slip in the M&TE file.

5. EC, OPR and User - Record all M&C in an EL or FL (as appropriate.) File the completed ELs in the M&TE records. Forward completed FLs to the Project Manager for inclusion in the project files.

For M&TE rented or leased from an outside vendor:

1. Receiver - Forward the packing slip to Procurement.
2. User - Forward the completed FL to the Project Manager for inclusion in the project files.
3. User - Retain the most current M&C record and calibration standards certifications with the M&TE item and forward previous versions to the Project Manager for inclusion in the project files.

5.8 Traceability of Calibration Standards

For all items of M&TE:

1. EC, OPR and User – When ordering calibration standards request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.
2. EC, OPR and User - Require certifications for standards that clearly state the traceability.
3. EC, OPR and User - Note standards that are perishable and consume or dispose of them on or before the expiration date.

5.9 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:

1. EC, OPR and User - immediately discontinue use and segregate the item from other equipment. Notify the appropriate Project Manager and take appropriate action in accordance with the CDM Quality Procedure for non-conforming items (QP 2.3).
2. EC, OPR and User - review the current and previous M&C records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate Project Manager(s) of the results of the review.

6.0 RESTRICTIONS/LIMITATIONS

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the HDQ Health and Safety Manager and/or HDQ Quality Assurance Director. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 REFERENCES

- CDM Federal Programs Corporation Property Control Manual, March 2002

Appendix F

Appendix F

301505

Appendix F

Mobilization/Demobilization Checklist

Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ____________________ Date Required: ____________________

Requestor: ____________________ Date Returned: ____________________

Job No.: ____________________ Charge No.: ____________________

Date of Request: ____________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
CONSUMABLES/SAMPLING SUPPLIES			
Acid, hydrochloric - Optima - 250 ml			
Acid, nitric - Optima - 500 ml			
Acid, nitric - reagent grade 2.5L (10%)			
Acid, sulfuric - Optima 250 ml			
Base, Sodium Hydroxide - pellets			
Solvent, Acetone - Pesticide Grade			
Solvent, Hexane - Pesticide Grade			
Solvent, Hexane - Optima Grade 1 liter			
Solvent, Methanol - Pesticide Grade			
Alconox			
Bags, garbage			
Bags, ZipLock - large			
Bags, ZipLock - small			
Bailer, Teflon-precleaned, 1 foot x 1 inch dia.			
Bailer, Teflon - weighted, 3 feet x 0 75 inch OD			
Bailer, Teflon - 3 feet x 1 5 inch OD			
Bailer, Mini 1 foot x 1/2 inch dia Hazco lot L010025			
Batteries - C cell			
Batteries - D cell			
Batteries - 9 volt			
Bolts, 9/16 well cap bolts and washers (in envelope)			
Book, log / Rite in the Rain Environmental			
Boot Covers (yellow)			
Bottle, glass vial, 40-ml			
Bottle, glass vial 40-ml HCl PRESERVED			
Bottle, amber, 250-ml			
Bottle, amber, 1-liter			
Bottle, amber, 1-liter (wide mouth)			
Bottle, poly 125-mL (Temp Blank)			
Bottle, poly 250-mL			
Bottle, poly 500 mL (16 oz. wide mouth)			
Bottle, poly 1-liter (wide mouth)			
Bottle, poly 1-liter			
Bottle, poly 2-liter			
Bottle, short glass jar, 2-ounce (60 ml) w/septa			
Bottle, short glass jar, 4-ounce (125 ml)			
Bottle, short glass jar, 4-ounce (125 ml) Welded Septa			
Bottle, short glass jar, 4-ounce, amber			
Bottle, short glass jar, 8-ounce (250 ml)			
Bottle, short glass jar, 9-ounce, amber			
Bottle, glass jar, 8-ounce amber (250 ml)			

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Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ______________________ Date Required: ______________________

Requestor: ______________________ Date Returned: ______________________

Job No.: ______________________ Charge No.: ______________________

Date of Request: ______________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
Bottle, short glass jar, 16-ounce			
Bottles, Spray			
Bottles, Squirt			
Bug Spray			
Calibration Gas - Benzene			
Calibration Gas - Isobutylene			
Calibration Gas - Methane 50% LFL			
Calibration Gas - Pentane 50% or 70% Span			
Calibration Gas - Multi RAE			
Calibration Standards, Horiba Auto Calibration			
Calibration Standard, ORP for YSI meter			
Calibration Standards, pH 4.0, 7.0, 10.0			
Calibration Standard, Conductivity			
Camera, disposable			
Can, gas (OSHA 3-gallon plastic)			
Can, water (7-gallon plastic)			
Caution Tape			
Caution Tape - Red Danger Asbestos Hazard			
Chain, 5' chain link			
Clamp, hose 3/4"			
Clamp, hose - large			
Custody Seals			
Drums, 55-gallon			
Drums, 55-gallon Nalagene with valve at bottom			
Ear Plugs			
En Core sampler 5 gram			
Eyeglasses, safety (8 x UVEX lens only, no frames)			
Eyewash (Portable)			
Eyewash bottle holder with 2-16 oz bottles			
Filter, Glenman Sciences In-line 0.45 micron			
Flagging Tape (pink, orange and blue)			
Foil, aluminum			
Funnels, plastic			
Gaskets for plastic water sprayer (repair)			
Gloves, Cotton Liners			
Gloves - Low Voltage Gloves - electro-shock			
Gloves, Nitrile (12 inch)			
Gloves, Nitrile disposible 50 pr per box			
Gloves, Surgical (latex) 50 pr per box			
Gloves, Surgical (vinyl)			
Gloves, Work (cotton)			
Grass Seed			
HACH chloride test kit			

301508

Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ______________________ Date Required: ______________________

Requestor: ______________________ Date Returned: ______________________

Job No.: ______________________ Charge No.: ______________________

Date of Request: ______________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
HACH hydrogen sulfide test kit			
HACH CO2 test kit			
HACH alkalinity test kit			
HACH test reagents - Accu Vac SulfaVer 4 Sulfate Reagent Cat. # 25090-25			
HACH Accu Vac Ferrous Iron Reagent Cat. # 251-41-25			
HACH Accu Vac Monochloramine for Monochloramine and Free Ammonia Cat # 25230-25			
HACH Hypochlorite Solution for Free Ammonia Cat # 26072-36			
HACH Accu Vac PhosVer 3 Phosphate Reagent Cat. # 25080-25			
HACH Mercuric Thiocyanate 200 ml bottle			
Hand corer sample sleeves (2 feet) - Wildco			
Hand corer eggshells for sample sleeves - Wildco			
Kim Wipes - small (280/box)			
Knife, utility			
Liqui-nox			
Markal Paintstik (white/blue/yellow)			
Mosquito spray - Repel			
MSA Ventilation Smoke Tubes			
Nalgene Water Bottles			
Paint Cans/Lids (empty for shipping)			
Paint, Spray (blue, green, orange)			
Paper, PH			
Pipette (box of 500)			
Plain Vinyl Flags			
Poly Sheeting			
Respirator MSA Cartridges - Specify Type			
Respirator MSA full-face - plastic tearaways			
Respirator MSA full-face Nose Cups			
Respirator MSA Spectacle Kit			
Rope, Nylon 50ft			
Rope, Nylon 100ft			
Rope, poly (for pumps) 1/8"			
Rope, poly (for pumps) 1/4"			
Rope, Polyester 400 foot/real			
Smoke bombs			
Spill Clean Up Kit - Caustic Fisher Scientific Lot 884473			
Sprayer, pump extra parts (includes 3 gaskets)			
Stakes, wooden 1 foot			
Stakes, wooden 2 feet			
Stakes, wooden 3 feet			

301509

Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ______________________ Date Required: ______________________

Requestor: ______________________ Date Returned: ______________________

Job No.: ______________________ Charge No.: ______________________

Date of Request: ______________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
Stay Ties (100 ct)			
String			
Sudan IV Biologic stain			
Syringes 10cc			
Tape, clear			
Tape, duct			
Tape, electrical			
Tape, plumbers (teflon)			
Tape, strap			
Towels, paper			
Tubes, Draeger (10/carton)			
Tubing connector (1/2 inch ID)			
Tubing, Polyethylene 1/2" ID			
Tubing, Teflon Lined 1/2" ID			
Tubing, Flexible Plastic (vinal 3/16" ID)			
Poly Coated Blue Tyvek (Coveralls w/Hood, Elasitc Wrists & Ankles - XXX Large, 12/case)			
Tyvek (Standard Coveralls w/Hood, Elasitc Wrists & Ankles - XX Large, 25/case)			
Tyvek (Standard Coveralls no Hood - XX Large)			
Tyvek - yellow poly coated (XXL, 12/case)			
Tyvek - yellow poly coated (XL, 12/case)			
Tyvek - booties			
Vermiculite			
Wasp killer			
Water, Deionized (5 gallon case)			
Water, Reagent Grade (4 liter bottle)			
WD-40			
Well cap 6 inch			
Well cap 4 inch			
Well cap 2 inch			
Wipes, respirator			
Wire, teflon coated			
OFFICE FURNITURE			
Answering Machine - Single line			
Answering Machine - 2 line			
Bulletin Board			
Card Table			
Chair, Desk with arms			
Copier, single sheet Xerox 5305 S/N 124115			
ax machine			
Folding Chairs			

301510

Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ______________________ Date Required: ______________________

Requestor: ______________________ Date Returned: ______________________

Job No.: ______________________ Charge No.: ______________________

Date of Request: ______________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
Folding Chairs - padded			
Heater - electric radiant			
Light - 2 foot florecent			
Microwave			
Printer			
Refrigerator			
Shelves, 5-shelf unit - plastic			
Tables, Work			
Telephone - Cell Motorola (Verizon)			
Telephone - Single line			
Telephone - 2 line			
White Board (Dry Erase)			
DURABLE / REUSABLE GOODS			
Auger T-handle with 5 foot extension			
Auger (T-handle, bucket 2.5 inch dia. and 5 foot pole)			
Auger T-handle			
Auger Head - Mud (4 inch dia.)			
Auger Head - Mud (2.5 inch dia.)			
Auger Head - bucket (2.5 inch dia.)			
Auger 4 or 5 foot extensions			
Balance, Electronic			
Balance, electronic Ohaus CS2000			
Backpack			
Bailer - Stainless Steel 3 foot x 1inch			
Bailer - Teflon 3 foot x 1 inch			
Bailer - Plastic or Teflon sectional 4 foot x 1 inch			
Bailer - PVC (1 gallon) 3 feet x 3 inches			
Boots, chest waders (Size 9, 12)			
Boots, hipwaders			
Boots, Slush			
Bowls, Stainless Steel			
Bucket, plastic w/cover			
Bucket, Stainless Steel			
Buoy - orange plastic marker			
Camera, Digital Mavica (Sony)			
Clipboard, box			
Clipboard, standard			
Compass			
Coolers - Large			
Coolers - Medium			
Coolers - Small			
Crab drop line with sinker (orange reel)			
Data Logger Cover (metal box)			

301511

Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ____________________ Date Required: ____________________

Requestor: ____________________ Date Returned: ____________________

Job No.: ____________________ Charge No.: ____________________

Date of Request: ____________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
Decon Tub			
En Core Extrusion Tool (T handle)			
Extension cords			
Eyewash Station (15 min)			
Fence Post Driver			
Fire extinguisher			
First Aid Kit			
Fish Measuring Board - 24 inches			
Fish Net - Wildco D-Frame Aquatic Dip Net			
Fish Net - Electro-Shock Dip Net w/ 6 ft ext handle			
Fish Net - Polyester Seine 10' x 4' x 1/4" mesh			
Fish Net - Nylon Minnow Seine 4' x 30' x 1/4" mesh			
Flow-thru cells, PVC			
Folding Rules, Lufkin Red End Engineer's			
Garbage pail			
Gauge Rain			
HACH colorimeter model 890			
HACH test kit parts - Miscelaneous			
Hand corers - Wildco (with case)			
Hand corer sample extruder - Wildco			
Hand corer 5-foot extension - Wildco			
Hard Hat			
Hard Hat Liners			
Hearing Protection, Ear Muffs			
Hose, garden			
Ice Packs (blue)			
Inverter 550 (Tripplite 550V DC to AC)			
nverter 220 (Tripplite 220V DC to AC)			
Jumper Cables			
Lamps - hand held (small)			
.amps - hand held (large)			
Lamp (Head) & battery			
Life Vest			
ight, flash			
Lights - halogen work			
Lights 2 X 500 watt halogen on tripod			
ocks (Dolphin/Master) with keys			
Locks-keyed alike (Master)			
Manometer, digital			
easuring cups (glass or plastic)			
...easuring cup, stainless steel 64 oz			
Measuring tape 10 meter			

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Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ______________________ Date Required: ______________________

Requestor: ______________________ Date Returned: ______________________

Job No.: ______________________ Charge No.: ______________________

Date of Request: ______________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
Measuring tape 100ft			
Measuring tape 200ft			
Measuring tape 300ft			
Measuring wheel, Rolatape Model 300			
MSA Ventilation Smoke Tube Assembly			
Munsell Color Chart			
Pan, Stainless Steel (10" x 1 5 ft)			
Piezometer, temporary			
Ponar Dredge			
Portable UV light & replacement light tube			
Power Washer - McCulloch Mac M1000 High Pressure			
Pump, sump			
Pump, high vacuum - Model E2M5, SN 12570			
Pump, Nalgene filter vaccume hand pumps (Milyvac)			
Quikchek ORP meter Model 108 (Redox)			
Rain Suit			
Regulator - 0 25 LPM Max inlet 500 PSIG Model PR150-025-600			
Regulator - 0 5 LPM Max inlet 500 PSIG Model PR150-05-600			
Regulator - HP 2.5 LPM Max inlet 1000 PSIG Victor Speciality Gas Products			
Regulator - HP 2.5 LPM Max inlet 1000 PSIG Model PR160			
Safety vests - orange			
Scale, heavy duty utility 250 pound			
Scrub brush, long handle			
Scrub brush, short handle			
Scrub brush, bottle			
Scupula Spatulas			
Sieve, Standard (6 sieve sizes 0 0029, 0 0049, 0 0098, 0 0197, 0 0394, 0 0937 inches)			
Slide Hammer			
Slug - Solid PVC 3-inch diameter			
Slug - Solid PVC 1 5-inch diameter			
Soil Core Samplers, 4 inch, Stainless Steel (Burpee Wolf Garate)			
Spatula, Straight (small)			
Spoons, Stainless Steel (large)			
Spoons, Stainless Steel (small)			
Sprayer, stainless steel pump (2 gallon)			
Sprayer, plastic pump (2 gallon)			
Stop watches			
Stream depth gauge (2 ft long x 3 in wide)			
Surge Protector			
Tape gun			
Tarp, plastic			
Tent - Panorama II Model 36034			

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Inventory Request/Return

List of Consumables and Reusable Equipment Requested for Project Use

Project: ______________________ Date Required: ______________________

Requestor: ______________________ Date Returned: ______________________

Job No.: ______________________ Charge No.: ______________________

Date of Request: ______________________

ITEM DESCRIPTION	QUANTITY REQUIRED	QUANTITY RETURNED	ITEM TRACKING NO.
Tool Box w/ tools metal			
Tool Box - empty plastic			
Tools - various			
Bolt Cutters (18 inch)			
Bungee Cords			
Caulk gun with silicon sealant			
Chisel			
Clamp - plastic			
Crowbar			
Hammer - regular			
Hammer - sledge			
Hose Cutter			
Machete			
Pliers - needle nose			
Plumb Bob			
Post Hole Digger			
Rake, three prong hand			
Rake, metal garden			
Saw, hand			
Screw Driver, philips head			
Screw Driver, small flat tip			
Shovel			
Socket Set			
Socket Wrench with 15/16th socket for drums			
Stake - 10 inch plastic			
Wrench Adjustible			
Wrench, Crescent			
Wrench, Monkey/Pipe (large)			
Wrench, non-sparking bung (drum opener)			
Traffic Cones			
Traps - Crab			
Trowel, Stainless Steel			
Turkey Baster			
Vacuum Cleaner			

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