N69321.AR.000043
VIEQUES EAST
5090.3a

Final
Supplemental Expanded Site Inspection and Pilot Study Sampling and Analysis Plan

Photo-Identified Site 4 (PI 4)

Former Vieques Naval Training Range
Vieques, Puerto Rico

Prepared for

Department of the Navy
NAVFAC ATLANTIC

Contract No.
N62470-08-D-1000
CTO-113

September 2011

Prepared by

CH2MHILL

ES012711103507TPA

This page intentionally left blank.

Final

Supplemental Expanded Site Inspection and Pilot Study Sampling and Analysis Plan

Photo-Identified Site 4 (PI 4)

Former Vieques Naval Training Range
Vieques, Puerto Rico

Contract Task Order 113

September 2011

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic Division

Under the

NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by

CH2MHILL

Virginia Beach, Virginia

This page intentionally left blank

Contents

Section **Page**

Contents iii
Attachments v
Acronyms and Abbreviations vii
Executive Summary xi
Resumen Ejecutivo xv
SAP Worksheet #1 — Title and Approval Page 1
SAP Worksheet #2 — SAP Identifying Information 3
SAP Worksheet #3 — Distribution List 5
SAP Worksheet #4 — Project Personnel Sign-Off Sheet 7
SAP Worksheet #5 — Project Organizational Chart 9
SAP Worksheet #6 — Communication Pathways 11
SAP Worksheet #7 — Personnel Responsibilities and Qualifications Table 13
SAP Worksheet #8 — Special Personnel Training Requirements Table 15
SAP Worksheet #9 — Project Scoping Session Participants Sheet 17
SAP Worksheet #10 — Problem Definition 19
SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements 25
SAP Worksheet #12-1 — Measurement Performance Criteria Table – Field QC Samples 31
SAP Worksheet #12-2 — Measurement Performance Criteria Table – Field QC Samples 32
SAP Worksheet #12-3 — Measurement Performance Criteria Table – Field QC Samples 33
SAP Worksheet #12-4 — Measurement Performance Criteria Table – Field QC Samples 34
SAP Worksheet #12-5 — Measurement Performance Criteria Table – Field QC Samples 35
SAP Worksheet #13 — Secondary Data Criteria and Limitations Table 37
SAP Worksheet #14 — Summary of Project Tasks 39
SAP Worksheet #15-1 — Reference Limits and Evaluation Table 47
SAP Worksheet #15-2 — Reference Limits and Evaluation Table 48
SAP Worksheet #15-3 — Reference Limits and Evaluation Table 49
SAP Worksheet #15-4 — Reference Limits and Evaluation Table 50
SAP Worksheet #15-5 — Reference Limits and Evaluation Table 51
SAP Worksheet #16 — PI 4 Project Schedule / Timeline Table 53
SAP Worksheet #17 — Sampling Design and Rationale 55
SAP Worksheet #18-a — PI 4 Sampling Locations and Methods/SOP Requirements Table Soil Sampling, Baseline Groundwater, and Post-Injection Groundwater (for ERD Pilot Study) 57

SAP Worksheet #18-b — PI 4 Sampling Locations and Methods/SOP Requirements Table Post-Injection Groundwater (for ISCO Pilot Study) 59
SAP Worksheet #19 — Analytical SOP Requirements Table 61
SAP Worksheet #20-a — Field Quality Control Sample Summary Table Soil Sampling, Baseline Groundwater, and Post-Injection Groundwater (for ERD Pilot Study)....63
SAP Worksheet #20-b — Field Quality Control Sample Summary Table Post-Injection Groundwater (for ISCO Pilot Study)....64
SAP Worksheet #21 — Project Sampling SOP References Table 65
SAP Worksheet #22 — Field Equipment Calibration, Maintenance, Testing, and Inspection Table....67
SAP Worksheet #23 — Analytical SOP References Table 69
SAP Worksheet #24 — Analytical Instrument Calibration Table 71
SAP Worksheet #25 — Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table 75
SAP Worksheet #26 — Sample Handling System....77
SAP Worksheet #27 — Sample Custody Requirements Table 79
SAP Worksheet #28-1 — Laboratory QC Samples Table 81
SAP Worksheet #28-2 — Laboratory QC Samples Table 83
SAP Worksheet #28-3 — Laboratory QC Samples Table 84
SAP Worksheet #28-4 — Laboratory QC Samples Table 88
SAP Worksheet #28-5 — Laboratory QC Samples Table 90
SAP Worksheet #29 — Project Documents and Records Table....91
SAP Worksheet #30 — Analytical Services Table 93
SAP Worksheet #31 — Planned Project Assessments Table....95
SAP Worksheet #32 — Assessment Findings and Corrective Action Responses....97
SAP Worksheet #32-1 — Corrective Action Form 98
SAP Worksheet #32-2 — Field Performance Audit Checklist 99
SAP Worksheet #32-3 — Safe Work Observation Form....101
SAP Worksheet #33 — QA Management Reports Table 103
SAP Worksheet #34 — Verification (Step I) Process Table 105
SAP Worksheet #35 — Validation (Steps IIa and IIb) Process Table....107
SAP Worksheet #36 — Analytical Data Validation (Steps IIa and IIb) Summary Table 109
SAP Worksheet #37 — Usability Assessment....111
References 115

Attachments

A Figures

1 PI 4 Site Location Map
2 1962 Aerial Photograph of PI 4 Site
3 Geologic Cross Section A - A′
4 Geologic Cross Section B - B′
5 PI4 Conceptual Site Model
6 Proposed Subsurface Sampling Locations and Wells - PI 4 Site

B Laboratory Analysis SOP

C Chemetrics and Hach Field Test Kits SOPs

D EVO/ISCO Technical Documentation

E Sampling Nomenclature

F Lab Accreditation

G Final Responses to EPA and EQB Comments

This page intentionally left blank

Acronyms and Abbreviations

AHA	Activity Hazard Analysis
amsl	above mean sea level
AOC	Area of Concern
ASTM	American Society for Standards and Materials
BFB	bromofluorobenzene
bgs	below ground surface
CA	corrective action
CCB	continuing calibration blank
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	Constituents of Concern
C-O-C	chain of custody
CSM	Conceptual Site Model
CTO	Contract Task Order
°C	degrees Celsius
1,1-DCE	1,1-dichloroethene
cis-1,2-DCE	1,2-dichloroethene, *cis*-
trans-1,2-DCE	1,2-dichloroethene, *trans*-
DAF	dilution attenuation factor
DLs	detection limits
DoD	Department of Defense
DQE	data quality evaluation
DQI	data quality indicator
DQO	data quality objective
EDD	electronic data deliverable
EIS	Environmental Information Specialist
ELAP	Environmental Laboratory Accreditation Program
EQB	Environmental Quality Board
ERA	Ecological Risk Assessment
ERD	enhanced reductive dechlorination
ERP	Environmental Restoration Program
ESI	Expanded Site Inspection
ESV	Ecological Screening Values
EVO	Emulsified Vegetable Oil
FID	Flame Ionization Detector
FS	Feasibility Study
ft	foot/feet
FTL	Field Team Leader

GC	gas chromatograph
g/L	grams per liter
gpm	gallon per minute
GPS	Global Positioning System
GW	Groundwater
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
IC	Ion Chromatograph
ICAL	Initial Calibration
ICB	Initial Calibration Blank
ICV	Initial Calibration Verification
IDW	investigation-derived waste
IS	Internal Standards
ISCO	in-situ chemical oxidation
LCS	laboratory control sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management Systems
LOD	limit of detection
LOQs	limits of quantitation
LTM	long-term monitoring
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MCL	maximum contaminant level
MDL	method detection limit
mg/kg	milligrams per kilogram
MQAPP	Master Quality Assurance Project Plan
MRP	Munitions Response Program
MS	mass spectrometer
MS/MSD	matrix spike/matrix spike duplicate
MW	monitoring well(s)
N/A	not applicable
Navy	Department of the Navy
NAVFAC	Naval Facilities Engineering Command
NFA	no further action
NIRIS	Navy Installation Restoration Information System
NOAA	National Oceanic and Atmospheric Administration
NOD	natural oxidant demand
ORP	Oxidation Redox Potential
OU	operable unit
OVA	Organic Vapor analyzer
OVM	organic vapor monitor
PA/SI	Preliminary Assessment/Site Investigation
PAL	project action limit

PAOC	potential area of concern
PCE	tetracholoroethene
PCR	polymerase chain reaction
PDF	portable document format
PI	Photo-Identified area
PID	photoionization detector
PILs	Project Indicator Limits
PM	Project Manager
POC	Point of Contact
ppb	parts per billion
PQO	project quality objective
PREQB	Puerto Rico Environmental Quality Board
PRGs	Preliminary Remedial Goals
Psi	pounds per square inch
PT	proficiency testing
PTSP	Pre-task Safety Plan
PV	pore volume
QA	quality assurance
QAMS	Quality Assurance Management Section
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RAB	Restoration Advisory Board
RI	Remedial Investigation
ROI	radius of influence
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	Regional Screening Level
RT	retention time
RTK	Real Time Kinematic
SAP	Sampling and Analysis Plan
SB	Subsurface Soil
SSC	Site Safety Coordinator
SI	Site Inspection
SO	Soil Sample
SOP	standard operating procedure
SSL	soil screening levels
STAC	Safety Task Analysis Card
SW	surface water
SWO	Safe Work Observation

TAL	target analyte list
TAT	turn-around time
TBD	to be determined
TCE	trichloroethene
TCL	target compound list
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TOC	total organic carbon
TTA	Targeted Treatment Area
USCS	Unified Soils Classification System
U.S.	United States
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VDMS	Validation Data Management System
VC	vinyl chloride
VNTR	Vieques Naval Training Range
VOA	volatile organic analytes
VOC	volatile organic compound
WCHEM	wet chemistry

Executive Summary

A Preliminary Assessment/Site Inspection (PA/SI) and Expanded Site Inspection (ESI) were performed in 2006 and 2009, respectively, at Photo-Identified Site 4 (PI 4), located on the Former Vieques Naval Training Range, Vieques, Puerto Rico. During the PA/SI, relatively low levels (with respect to screening criteria) of several volatile organic compounds (VOCs) were detected in groundwater, including an exceedance of the Federal Maximum Contaminant Level (MCL) for trichloroethene (TCE) of 5 micrograms per liter (µg/L). TCE was detected in a single well (MW05) at a concentration of 9.3 µg/L. Based on the PA/SI findings, a second round of groundwater samples was collected during the ESI, which confirmed the presence of the localized and low concentration of TCE. TCE was detected in well MW05 at a concentration of 17 µg/L.

Based on the information gathered during the PA/SI and ESI, the SI/ESI Report (CH2M HILL, 2010a) concluded for PI 4: (1) no unacceptable risks exist for potential ecological exposure to soil; (2) no unacceptable risks exist for potential human exposure to soil or groundwater; (3) no unacceptable leaching concern exists for groundwater; (4) TCE is present in a localized area (represented by well MW05) above the MCL.

On December 15, 2010, a Sampling and Analysis Plan (SAP) scoping session was held among representatives of the Department of the Navy (Navy), U.S. Environmental Protection Agency (USEPA), Puerto Rico Environmental Quality Board (PREQB), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), and their associated contractors, collectively referred to as the Vieques Environmental Technical Subcommittee. The purpose of the scoping session was to discuss and concur on the conceptual site model (CSM) and appropriate path forward for PI 4. Based on the meeting discussions, the following are the objectives for conducting a supplemental ESI (and potential pilot study) at PI 4:

1. Confirm no TCE source area is present in soil in the vicinity of well MW05
2. Confirm the area of TCE groundwater contamination above the MCL is localized around well MW05
3. Evaluate natural attenuation conditions in the vicinity of well MW05
4. Determine if a pilot study is warranted to determine if in-situ degradation/destruction of TCE can be stimulated (and perform the pilot study, if warranted)
5. If a pilot study is conducted, determine if in-situ enhanced reductive dechlorination (ERD) or in-situ chemical oxidation (ISCO) is effective at reducing groundwater volatile organic compound (VOC) levels to acceptable levels (i.e., concentrations at or below the lower of the MCLs and Puerto Rico Water Quality Standards)

To achieve objectives above, the following activities will be conducted:

- Drilling and installing up to approximately six soil borings/wells at various incremental distances up- and downgradient of well MW05. The borings will be used for multiple purposes: (1) determine if a source of the TCE in well MW05 remains in the soil; (2) confirm the localized presence of elevated (with respect to the MCL) TCE in groundwater; (3) collect data pertinent

for determining if a pilot study is warranted and the type of pilot study to perform; (4) place wells that can be used for injection if a pilot study is deemed warranted.

- If a pilot study is deemed warranted, evaluate the potential to remediate groundwater using an in-situ technology.
- Analyze soil and groundwater samples for TCE and its reductive dechlorination parent and degradation products, as well as other VOCs historically detected at PI 4, as shown below:

VOCs	Rationale
trichloroethene (TCE)	MCL exceedance in MW05
1,1-dichloroethene (1,1-DCE)	detected in MW05
tetrachloroethene (PCE)	detected in MW05
vinyl chloride (VC)	detected in MW05/daughter product
cis-1,2-dichloroethene (cis-1,2-DCE)	daughter product
trans-1,2-dichloroethene (trans-1,2-DCE)	daughter product

Note: General chemistry and natural attenuation parameters to be analyzed are summarized in SAP Worksheets #14, 15, 17, and 18.

Based on the information collected during the supplemental ESI, the following decisions will be made:

1. If no source area is identified and all VOC concentrations are less than their respective MCL or Puerto Rico Water Quality Standard (whichever is lower), then an additional round of groundwater data will be collected to confirm the initial results. If the initial results are confirmed, no further investigation or action will be necessary for the site and the site will proceed to a supplemental ESI report and no action decision document. If the initial results are not confirmed, the decision process will proceed to #2 below.
2. If no source area is identified and VOC concentration(s) exceed their respective MCL or Puerto Rico Water Quality Standard (whichever is lower), and the data confirm the area of contamination is localized and conditions favor ERD or ISCO (either existing or likely induced), a pilot study will be performed.
3. If the supplemental ESI data suggest the area of VOC groundwater contamination is not localized, a remedial investigation (RI) will be recommended to determine the nature and extent of contamination. In this case, the results of the supplemental ESI will be summarized in the RI SAP as rationale for the RI, rather than in a supplemental ESI report.
4. If a potential source area in soil is identified, a determination will be made whether: (1) further delineation is warranted via an RI (which would include an assessment of potential risk); or (2) an interim action can be implemented to more efficiently address the potential source area.

If a pilot study is conducted, the associated data will be evaluated in order to determine the appropriate path forward. Based on the outcome of the pilot study, one of the following recommendations will be made:

1. No further action (NFA) is warranted because groundwater concentrations have been reduced to acceptable levels throughout the area of contamination. The site will then proceed to a supplemental ESI/pilot study report and NFA decision document.
2. Document the findings of the historical investigations in an RI Report and proceed to a Feasibility Study (FS) using the information gathered during the historical investigations and pilot study.

NOTE: THIS SUMMARY IS PRESENTED IN ENGLISH AND SPANISH FOR THE CONVENIENCE OF THE READER. EVERY EFFORT HAS BEEN MADE FOR THE TRANSLATIONS TO BE AS ACCURATE AS REASONABLY POSSIBLE. HOWEVER, READERS SHOULD BE AWARE THAT THE ENGLISH VERSION OF THE TEXT IS THE OFFICIAL VERSION.
NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HA HECHO TODO LO POSIBLE PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

3. Implement additional pilot study if the data collected suggest additional information is necessary or beneficial to making the final remedy determination for the site. It is recognized here that another round(s) beyond those included in the pilot study portion of this SAP may be required prior to approval of NFA. The need for additional groundwater sampling will be made upon completion of the pilot study.

NOTE: THIS SUMMARY IS PRESENTED IN ENGLISH AND SPANISH FOR THE CONVENIENCE OF THE READER. EVERY EFFORT HAS BEEN MADE FOR THE TRANSLATIONS TO BE AS ACCURATE AS REASONABLY POSSIBLE. HOWEVER, READERS SHOULD BE AWARE THAT THE ENGLISH VERSION OF THE TEXT IS THE OFFICIAL VERSION.

NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HA HECHO TODO LO POSIBLE PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

This page intentionally left blank

NOTE: THIS SUMMARY IS PRESENTED IN ENGLISH AND SPANISH FOR THE CONVENIENCE OF THE READER. EVERY EFFORT HAS BEEN MADE FOR THE TRANSLATIONS TO BE AS ACCURATE AS REASONABLY POSSIBLE. HOWEVER, READERS SHOULD BE AWARE THAT THE ENGLISH VERSION OF THE TEXT IS THE OFFICIAL VERSION.

NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HA HECHO TODO LO POSIBLE PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

Resumen Ejecutivo

Se llevó a cabo una Evaluación Preliminar/Inspección del sitio (PA/SI, por sus siglas en inglés) y una Inspección del Sitio Expandida (ESI, por sus siglas en inglés) en el 2006 y 2009, respectivamente, en el Sitio Identificado por Fotografía 4 (PI 4), en el Antiguo Campo de Adiestramiento Naval de Vieques, Puerto Rico. Durante el PA/SI, se detectaron niveles relativamente bajos (en comparación a los niveles de evaluación) de varios compuestos volátiles orgánicos (VOCs) en el agua subterránea, incluyendo un excedente del Nivel Máximo de Contaminantes Federal (MCL) para tricloroetano (TCE) de 5 microgramos por litro (µg/L). Se detectó TCE solamente en un pozo (MW05) a una concentración de 9.3 µg/L. En base a los hallazgos del PA/SI, se llevó a cabo una segunda ronda de muestreo del agua subterránea durante el ESI, la cual confirmó la presencia localizada y la baja concentración de TCE. Se detectó TCE en el pozo MW05 en una concentración de 17 µg/L.

En base a la información obtenida durante el PA/SI y ESI, el Informe SI/ESI (CH2M HILL, 2010a) concluyó que para el PI 4: (1) no existen riesgos inaceptables por una potencial exposición ecológica a los suelos; (2) no existen riesgos inaceptables por una potencial exposición humana a suelos o agua subterránea; (3) no existen preocupaciones inaceptables de lixiviación para el agua subterránea; (4) TCE se encuentra sobre el MCL en un área localizada (representada por el pozo MW05).

El 15 de diciembre de 2010, se llevó a cabo una sesión de planificación entre los representantes del Departamento de la Marina (Navy), Agencia de Protección Ambiental de los EE.UU (USEPA), Junta de Calidad Ambiental de Puerto Rico (EQB), Servicio de Pesca y Vida Silvestre de los EE.UU (USFWS), Administración Nacional Oceánica y Atmosférica (NOAA), y sus contratistas asociados, quienes colectivamente forman el Subcomité Técnico Ambiental de Vieques para desarrollar el Plan de Muestreo y Análisis (SAP, por sus siglas en inglés). El propósito de la sesión de planificación fue el discutir y llegar a un acuerdo sobre el Modelo Conceptual del Sitio (CSM) y los pasos siguientes adecuados para PI 4. En base a las discusiones de la reunión, los siguientes son los objetivos para llevar a cabo un ESI suplementario (y un potencial estudio piloto) en PI 4:

1. Confirmar que no hay presencia de una fuente de TCE en los suelos de la vecindad del pozo MW05
2. Confirmar que el área de contaminación de TCE en aguas subterráneas sobre el MCL se encuentra alrededor del pozo MW05
3. Evaluar las condiciones de atenuación natural en la vecindad del pozo MW05
4. Determinar si se amerita un estudio piloto para decidir si la degradación/destrucción "in-situ" puede ser estimulada (y de ser necesario, llevar a cabo el estudio piloto,)
5. Si se lleva a cabo el estudio piloto, determinar si la declorinación reductora mejorada in-situ (ERD, por sus siglas en inglés) o la oxidación química in-situ (ISCO, por sus siglas en inglés) es efectiva para reducir los niveles de VOCs a niveles aceptables (ej., concentraciones a/o por debajo de los estándares de los MCLs y los Estándares de Calidad de Agua de Puerto Rico).

Para lograr los objetivos antes mencionados, se llevarán a cabo las siguientes actividades:

- Perforación e instalación de aproximadamente seis (6) excavaciones de suelo/pozos a varias distancias incrementadas vertiente arriba y vertiente abajo del pozo MW05. Las excavaciones se usarán para múltiples propósitos: (1) determinar si una fuente de TCE en el pozo MW05 permanece en el suelo; (2) confirmar la presencia localizada de concentraciones de TCE elevadas (con relación a los MCL) en aguas subterráneas; (3) obtener datos pertinentes para determinar la necesidad y el tipo de estudio piloto que va a llevarse a cabo; (4) de ser necesario un estudio piloto, colocar pozos que puedan usarse para inyecciones.
- Si es que se necesita un estudio piloto, evaluar el potencial para remediar el agua subterránea usando tecnología in-situ.
- Analizar muestras de suelos y aguas subterráneas para TCE y su declorinación reductiva y productos degradantes, así como otros VOCs detectados históricamente en PI 4, según se muestra a continuación:

VOCs	Razón Fundamental
tricloroetano (TCE)	MCL excedido in MW05
1,1-dicloroetano (1,1-DCE)	Detectado en MW05
Tetracloroetano (PCE)	Detectado en MW05
vinyl chloride (VC)	Detectado en MW05/producto derivado
cis-1,2-dichloroethene (cis-1,2-DCE)	Producto derivado
trans-1,2-dichloroethene (trans-1,2-DCE)	Producto derivado

Nota: Los parámetros de química general y de atenuación natural a ser analizados se resumen en el SAP, Hojas de Trabajo #14, 15, 17, y18.

En base a la información obtenida durante el ESI suplementario, se tomarán las siguientes decisiones:

1. De no identificarse una fuente de área y si todas las concentraciones de VOCs son menores que sus respectivos MCL o Estándares de Calidad de Agua de Puerto Rico (el menor valor), se obtendrán un conjunto de datos de agua subterránea adicional para confirmar los resultados iniciales. De confirmarse los resultados iniciales, no será necesaria más investigación o acción para el sitio y el sitio procederá a un Informe ESI suplementario y a un documento de Ninguna Acción Adicional. De no confirmarse los resultados iniciales, el proceso de decisión procederá con la opción #2 siguiente.
2. De no identificarse fuente de área y la(s) concentración(es) de VOC exceden sus respectivos MCLs o Estándares de Calidad de Agua de Puerto Rico (el menor valor), y los datos confirman que el área de contaminación ha sido localizada y las condiciones favorecen ERD o ISCO (ya sea existentes o posiblemente inducidos), se llevará a cabo un estudio piloto.
3. Si los datos suplementarios ESI sugieren que el área de contaminación de aguas subterráneas VOC no está localizada, se recomendará una investigación de remediación (RI, por sus siglas en inglés) para determinar la naturaleza y extensión de la contaminación. En este caso, los resultados del ESI Suplementario se resumirán en el RI SAP como la razón fundamental para el RI, en vez de estar en un Informe ESI Suplementario.
4. Si se identifica una fuente de área potencial en el suelo, se determinará si (1) es necesario más delineación a través de un RI (el cual incluiría una evaluación de riesgo potencial); ó (2) se podría implementar una acción interina para tratar más eficientemente la fuente de área potencial.

De llevarse a cabo un estudio piloto, los datos asociados serán evaluados para determinar l los pasos siguientes adecuados. En base a los resultados del estudio piloto, se tomará una de las siguientes recomendaciones.

1. Amerita Ninguna Acción Adicional (NFA, por sus siglas en ingleé) debido a que las concentraciones de agua subterránea se han reducido a niveles aceptables a través del área de contaminación. El sitio procederá con el Informe ESI Suplementario/Estudio Piloto y el Documento de Decisión NFA.
2. Documentar los hallazgos de las investigaciones históricas en un Informe RI y proceder con un Estudio de Viabilidad (FS, por sus siglas en inglés) usando la información obtenida durante las investigaciones históricas y el estudio piloto.
3. Implementar estudios pilotos adicionales si los datos obtenidos sugieren la necesidad o el beneficio de evaluar información adicional para tomar la determinación de la remediación final para el sitio. Aquí se reconoce que podría requerirse una ronda adicional además de las que se incluyen en la porción del estudio piloto de este SAP antes de la aprobación del NFA. La decisión de la necesidad de un muestreo de agua subterránea adicional se tomará después de completarse el estudio piloto.

NOTE: THIS SUMMARY IS PRESENTED IN ENGLISH AND SPANISH FOR THE CONVENIENCE OF THE READER. EVERY EFFORT HAS BEEN MADE FOR THE TRANSLATIONS TO BE AS ACCURATE AS REASONABLY POSSIBLE. HOWEVER, READERS SHOULD BE AWARE THAT THE ENGLISH VERSION OF THE TEXT IS THE OFFICIAL VERSION.
NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HA HECHO TODO LO POSIBLE PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

This page intentionally left blank

SAP Worksheet #1 — Title and Approval Page

Final
Supplemental Expanded Site Inspection and Pilot Study Sampling and Analysis Plan
Photo-Identified Site 4 (PI 4)
Former Vieques Naval Training Range
Vieques, Puerto Rico
September 2011

Prepared for:
Department of the Navy
Naval Facilities Engineering Command
Atlantic Division
6506 Hampton Boulevard
Norfolk, VA 23508-1278

Prepared by:

CH2MHILL

5700 Cleveland Street, Suite 101
Virginia Beach, VA 23462
Office phone # 757-671-6219

Prepared under:
Navy CLEAN 1000 Program
Contract N62470-08-D-1000
Contract Task Order - 113 Mod 1

QA REVIEW SIGNATURE:

BRETT DOERR
VIEQUES ACTIVITY QUALITY MANAGER

OTHER APPROVAL SIGNATURES:

KEVIN CLOE
NAVFAC – REMEDIAL PROJECT MANAGER

DANIEL RODRIGUEZ
USEPA REGION 2 – REMEDIAL PROJECT MANAGER

WILMARIE RIVERA
PREQB – REMEDIAL PROJECT MANAGER

This page intentionally left blank

SAP Worksheet #2 — SAP Identifying Information

Site Name/Number: Photo-Identified Site 4 (PI 4) at the Former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico
Operable Unit (OU):
Contractor Name: CH2M HILL
Contract Number: N62470-08-D-1000
Contract Title: Navy Comprehensive Long-term Environmental Action—Navy (CLEAN) Program 1000
Work Assignment Number (optional): Contract Task Order (CTO) 113 Mod 1 (Investigation & Pilot Study Sampling and Analysis Plan [SAP])

1. This SAP was prepared in accordance with the requirements of the Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP) (USEPA, 2005) and United States (U.S.) Environmental Protection Agency (USEPA) Guidance for QAPPs, USEPA QA/G-5, Quality Assurance Management Section (QAMS) (USEPA, 2002).
2. Regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
3. This SAP is a project-specific SAP.
4. Dates of scoping sessions:

Scoping Session	Date
Environmental Restoration Program (ERP)/ Munitions Response Program (MRP) Subcommittee Meeting, Vieques Superfund Site —Vieques, Puerto Rico	December 15, 2010

5. Dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
Master Standard Operating Procedures, Protocols, and Plans, (ERP), Vieques, Puerto Rico	April 2010
Site Inspection/Expanded Site Inspection Sampling and Analysis Plan, 7 Consent Order Sites and 16 PI/PAOC Sites, Former Vieques Naval Training Range, Vieques, Puerto Rico.	February 2009

SAP Worksheet #2 — SAP Identifying Information (continued)

6. Organizational partners (stakeholders) and connection with lead organization:
   - USFWS – Land management branch of land owner organization (US Department of Interior) on which the site is located
   - **USEPA Region 2 –** Regulatory stakeholder overseeing CERCLA Vieques environmental restoration program (ERP) implemented by lead organization
   - **Puerto Rico Environmental Quality Board (PREQB) –** Regulatory stakeholder overseeing CERCLA Vieques ERP implemented by lead organization
7. Lead organization (see Worksheet #7 for detailed list of data users):
   - U.S. Department of Navy (Navy).
8. The omitted SAP elements excluded and provide an explanation for their exclusion below:
   - Crosswalk table is excluded as all required information is provided in this SAP.

SAP Worksheet #3 — Distribution List

Name of SAP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
Kevin Cloe	Vieques Remedial Project Manager (RPM)/Lead Agency Point of Contact (POC)	Navy	757-322-4736	kevin.cloe@navy.mil	A	CL	A
Daniel Hood	Vieques RPM/No project-specific role	Navy	757-322-4630	daniel.r.hood@navy.mil	CL	CL	CL
Madeline Rivera	Vieques Environmental Restoration Program Site Manager /On-island coordination	Navy	757-286-6457 (cell)	llamasmad@gmail.com	A	LTR	A
Daniel Rodriguez	Vieques RPM/ Regulatory Agency POC	USEPA	787-741-5201 787-671-9879 (cell)	rodriguez.daniel@epa.gov	A	CL	A
Carl Soderberg	Caribbean Environmental Protection Division Director	USEPA	787-977-5814	soderberg.carl@epa.gov	CL		CL
Sergio Lopez	Quality Control (QC) Specialist/Technical input and draft document review	USEPA	732-321-6778	lopez.sergio@epa.gov	A		A
Michael Sivak	Human Health Risk Assessment (HHRA) Lead/Technical input and draft document review	USEPA	212-637-4310	sivak.michael@epa.gov	A		A
Diana Cutt	Geology/Hydrogeology Lead/Technical input and draft document review	USEPA	212-637-4311	cutt.diana@epa.gov	A		A
Mindy Pensak	Ecological Risk Assessment (ERA) Lead/Technical input and draft document review	USEPA	732-321-6705	pensak.mindy@epa.gov	A		A
Angela Carpenter	Chief Special Projects Branch, Emergency and Remedial Response Division	USEPA	212-637-4435	Carpenter.Angela@epamail.epa.gov	CL		CL
Julio F. Vazquez	RPM, U.S. EPA - Region 2, Special Projects Branch/ Federal Facilities Section	USEPA	212-637-4323	Vazquez.julio@epa.gov	A		A
Pedro J. Nieves, Esq.	President/No project-specific role	PREQB	787-767-8056	pedronieves@jca.gobierno.pr	CL		CL
Wilmarie Rivera	Vieques RPM/ Regulatory agency POC	PREQB	787-767-8181 (x6129) (work) 787-365-8573 (cell)	wilmarierivera@jca.gobierno.pr	A	CL	A
Katarina Rutkowski	Technical Support Consultant for Environmental Quality Board (EQB)/EQB contractor primary POC	TRC	860-298-6202	krutkowski@trcsolutions.com	A		
Elizabeth Denly	Senior QA Chemist	TRC	978-656-3577 (work) 978-328-2551 (cell)		A		
Scott Heim	Senior Ecologist	TRC	978-656-3583-O 508-320-2678-C	sheim@trcsolutions.com	CD		
Marya B. Mahoney	Project Geologist	TRC	860-298-6226		A		
Mike Barandiaran	Refuge Manager/No project-specific role	USFWS	787-741-2138	Mike_barandiaran@fws.gov	CD		A
Susan Silander	Caribbean Islands Refuges Supervisor/No project-specific role	USFWS	787-851-7258 (x238)	susan.silander@fws.gov	CD		
Richard Henry	Vieques RPM/ Land management agency POC/No project-specific role	USFWS	732-906-6987	richard_henry@fws.gov	A	CL	A
Felix Lopez Arroyo	Environmental Contaminants Specialist/Technical input and draft document review/No project-specific role	USFWS	787-851-7297(x226)	felix_lopez@fws.gov	A		A

SAP Worksheet #3 — Distribution List (continued)

Name of SAP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
Bradley Martin		TechLaw, Inc.	312-345-8960	bmartin@techlawinc.com	A		A
Diane Wehner	Regional Resource Coordinator/Technical input and draft document review/No project-specific role	NOAA	732-872-3030	diane.wehner@noaa.gov	A		A
Brett Doerr	Contractor Environmental Manager/Activity Quality Manager/Navy contractor primary POC	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	A	A	A
John Swenfurth	Project Manager	CH2M HILL	813-281-7762	John.swenfurth@ch2m.com	A	A	A
Monica Marrow	Administrative Record Coordinator	CH2M HILL	757-671-6272	Monica.marrow@ch2m.com			A
Mike Zamboni	Project Chemist	CH2M HILL	703-376-5301	mike.zamboni@ch2m.com			A
Susanne Borchert	Senior Technologist	CH2M HILL	815-233-1051	Susanne.borchert@ch2m.com			A
Kui Tan	Project Engineer	CH2M HILL	281-721-8534	Kui.tan@ch2m.com			A
John Tomik	Vieques Activity Manager	CH2M HILL	757-671-8311 (x413)	John.Tomik@ch2m.com			CL
Anita Dodson	Navy Program Chemist/ SAP review	CH2M HILL	757-671-6218	Anita.Dodson@ch2m.com			CD
Hillary Ott	Environmental Information Specialist (EIS)/Data tracking and management	CH2M HILL	757-671-5165	Hillary.Ott@ch2m.com			CD
Keith Becker	Project Manager/POC	Orin	608-838-6699 (Ext. 305)	kbecker@orinrt.com			CD
Bhavana Reddy	Data Manager/loading of data	Critigen	703-462-3784	Bhavana.Reddy@critigen.com			CD
C. James Stellrecht	Project Manager, Laboratory POC	TestAmerica	716-691-2600	jim.stellrecht@testamericainc.com			CD
Anita Biernacki	Project Manager, Laboratory POC	Microbial Insights, Inc.	865-573-8188	abiernacki@microbe.com			CD
Sonya Gordon	Project Manager, Laboratory POC	Empirical Laboratories, LLC	615-345-1115	sgordon@empirlabs.com			CD
Laura Maschoff	Project Manager, POC at primary location	DataQual Environmental Services, LLC	314-330-1327	dataqual@charter.net			CD
Michael Diaz	N/A	RAB	787-667-2804	diazmmdo@aol.com		CD	
Wanda Bermudez	N/A	RAB	787-435-2841	wbromero@yahoo.com		CD	
Colleen McNamara	N/A	RAB	787-380-2545	lacolina@hughes.com		CD	
Stacie D. Notine	N/A	RAB	N/A	N/A		HC	
Jorge Fernandez Porto	N/A	RAB	787-726-2839	jfporto@onelinkpr.net		CD	
Lionel Sanchez	N/A	RAB	787-241-0063	sanchezcarambot@yahoo.com		CD	
Lirio Marquez D'Acunti	N/A	RAB	787-726-2839	liriomarquez@gmail.com		None	

A = All CL = Cover Letter DF = Draft Final F = Final CD = Compact Disc HC = Hard Copy D = Draft

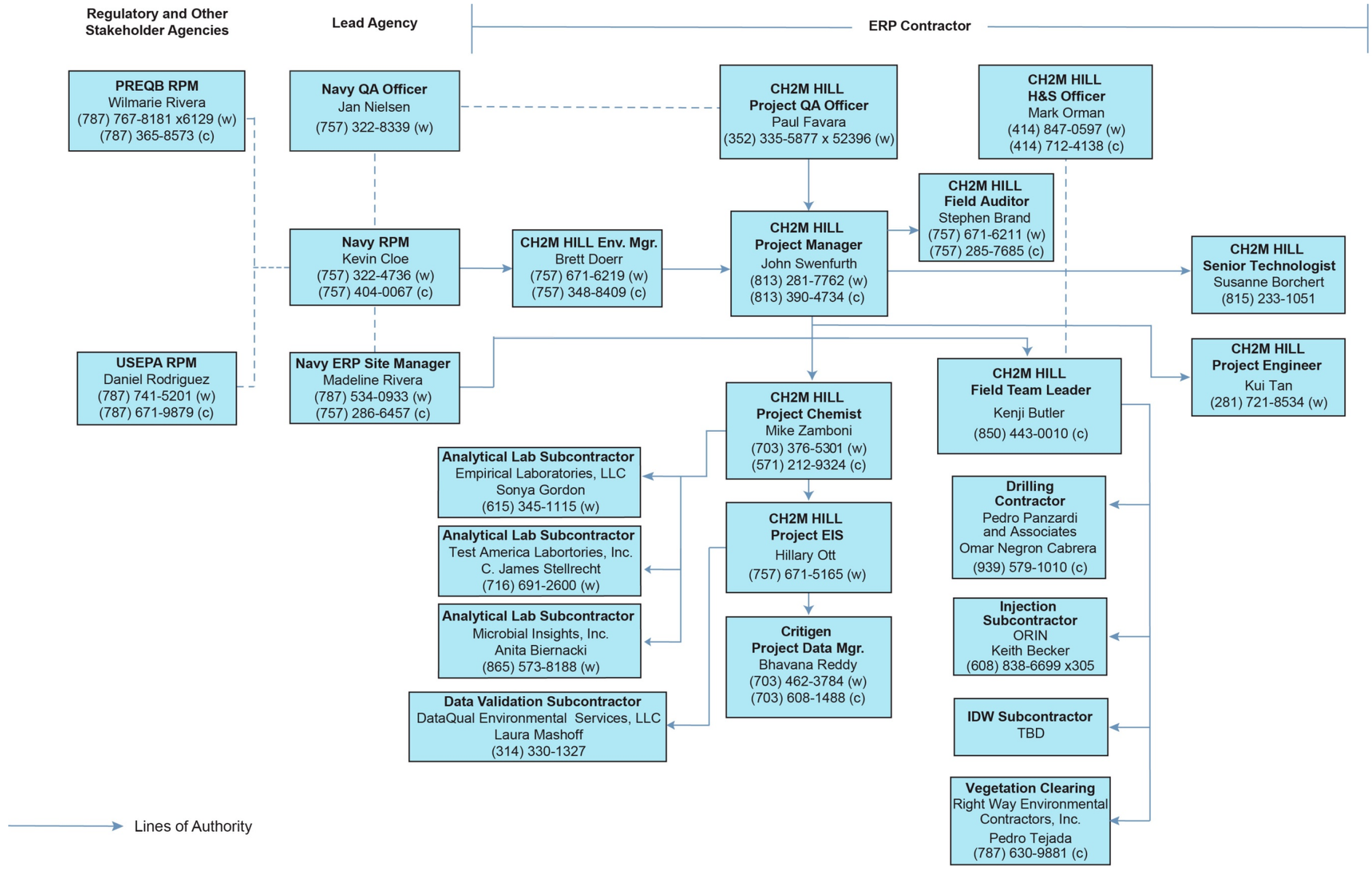
SAP Worksheet #4 — Project Personnel Sign-Off Sheet

Name	Organization/Title/Project Role	Telephone Number (optional)	Signature/email receipt	SAP Section Reviewed	Date SAP Read
Brett Doerr	CH2M HILL/Vieques Environmental Program Manager/Activity Quality Manager/SAP review	757-671-6219			
Anita Dodson	CH2M HILL/Navy Program Chemist/ SAP review	757-671-6218			
John Swenfurth	CH2M HILL/Contractor Project Manager (PM)/Logistics and administration	813-281-7762			
Hillary Ott	CH2M HILL/Environmental Information Specialist (EIS)/Data tracking and management	757-671-5165			
Mike Zamboni	CH2M HILL/Project Chemist	703-376-5301			
Susanne Borchert	CH2M HILL/Senior Technologist	815-233-1051			
Kui Tan	CH2M HILL/Project Engineer	281-721-8534			
C. James Stellrecht	TestAmerica Laboratories, Inc.	716-691-2600			
Anita Biernacki	Microbial Insights, Inc.	865-573-8188			
Sonya Gordon	Empirical Laboratories, LLC	615-345-1115			
Keith Becker	Orin	608-838-6699 (Ext. 305)			
Laura Maschoff	Data Validator/Project Manager	314-3301327			
Bhavana Reddy	Critigen Project/Data Manager	703-462-3784			

Signed versions of Worksheet #4 will be kept on file at CH2M HILL along with other project documents.

This page intentionally left blank

SAP Worksheet #5 — Project Organizational Chart



SAP Worksheet #5
Project Organization Chart
Investigation and Pilot Study Sampling and Analysis Plan
Vieques, Puerto Rico

This page intentionally left blank

SAP Worksheet #6 — Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Communication to/from Navy (e.g., submission of SAP for review; receipt of regulatory comments, etc.)	Navy RPM	Kevin Cloe	757-322-4736	Primary POC for Navy (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from USEPA (e.g., receipt of SAP for review; submission of USEPA comments)	USEPA RPM	Daniel Rodriguez	787-741-5201 787-671-9879 (cell)	Primary POC for USEPA (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from PREQB (e.g., receipt of SAP for review; submission of PREQB comments)	PREQB RPM	Wilmarie Rivera	787-767-8181 (x 6129)	Primary POC for PREQB (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Navy QA/QC input	Navy (QAO)	Jan Nielsen	757-322-8339	Provides review comments to Navy contractor on pre-draft SAP via e-mail through Kevin Cloe. Provides overall Navy guidance via direct communication with Navy contractor QAO, as warranted.
Communication to/from Navy contractor (e.g., submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations, etc.)	CH2M HILL Environmental Manager	Brett Doerr	757-671-6219	Primary POC for Navy contractor (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other contractor staff, as appropriate.
Project administration and logistics	CH2M HILL PM	John Swenfurth	813-390-4734 (w) 813-390-4734 (cell)	Direct communication (via e-mail, telephone, hardcopy, or in-person, as warranted) to/from Navy contractor project staff to ensure appropriate project implementation.
Health and safety expectations and procedures	CH2M HILL Health and Safety Officer	Mark Orman	414-847-0597 414-712-4138 (cell)	Review of Health and Safety Plan (HASP). Direct communication (via e-mail, telephone, hardcopy, or in-person, will be notified within 24 hours of incident) to/from Navy contractor project staff to ensure implementation of appropriate health and safety procedures.
Field Auditor	CH2M HILL Vieques field auditor	Stephen Brand	757-671-6211 (w) 757-285-7685 (c)	Ensure field teams comply with SAP by providing oversight and direction. Project administration; coordinates staffing; monitors project performance; directs and oversees project staff.
Implementation of pilot study injection and sampling activities; SAP changes in the field	CH2M HILL Field Team Leader (FTL)	Kenji Butler	850-443-0010 9 (c)	Documentation of implementation of SAP in field logbooks, including deviations and their rationale; assistance in material procurement and delivery; injection oversight and implementation; deviations made only with approval from contractor PM and/or environmental manager. The EPA and PREQB RPMs will be notified within 24 hours of significant SAP changes (changes that significantly affect the ability to meet the project objectives) in the field.
Field corrective actions	CH2M HILL FTL	Stephen Brand	757-671-6211 (w) 757-285-7685 (c)	See Worksheet 32 Assessment Findings and Corrective Action (CA) Responses and Worksheet 32-1 CA Form. The EPA and PREQB RPMs will be notified within 24 hours of significant field corrective actions.

SAP Worksheet #6 — Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Daily Field Progress Reports	CH2M HILL FTL	Kenji Butler	850-443-0010 (c)	FTL will e-mail or fax daily field progress reports to contractor PMs weekly; telephone communication with PMs on as-needed basis
Ensure staff health and safety in the field	CH2M HILL Site Safety Coordinator (SSC)	Kenji Butler	850-443-0010 (c)	Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff.
Performing pilot study injection	Orin Project Manager	Keith Becker	608-838-6699 (Ext. 305)	Implementation of injection activities at PI 4, in accordance with UFP-SAP
Data tracking from collection through upload to database	CH2M HILL EIS	Hillary Ott	757-671-5165	EIS will track data from sample collection through upload to database, ensuring QAPP requirements are met by laboratory and field staff. Tracking involves receipt of electronic and hardcopy data from laboratory and data validator. EIS communicates with CH2M HILL project chemist, laboratory PM, and data validator PM, as warranted, to ensure adherence to project analysis and validation requirements. EIS also coordinates data upload with contractor database manager.
Uploading project data and maintaining the database to ensure data are stored properly and can be retrieved by the EIS.	Critigen Database Manager	Bhavana Reddy	703-471-1441	Once contractor chemist ensures data are appropriate for upload to database, EIS submits data electronically to contractor database manager, who uploads data to database.
Reporting Lab Data Quality Issues	Empirical Laboratories, LLC TestAmerica Laboratories, Inc. Microbial Insights, Inc.	Sonya Gordon C. James Stellrecht Anita Biernacki	615-345-1115 716-691-2600 865- 573-8188	All QA/QC issues with project field samples will be reported by the lab to the EIS, Project Chemist, and Contractor QAO via e-mail within 2 business days.
Quality Control on Laboratory Data	CH2M HILL Project Chemist	Michael Zamboni	703-376-5301	See Worksheets 24, 25, and 28 for analytical CAs.
In-situ Injection Technical Support and Reporting	CH2M HILL Senior Technologist	Susanne Borchert	815-233-1051	Data evaluation, analysis, and reporting
Validated data	Data Qual Environmental Services, LLC	Laura Maschroff	314-330-1327	Data validator provides data validation reports (electronic and hardcopy) that provide the data qualifiers and associated explanations.
Release of analytical data for upload to database	CH2M HILL Project Chemist	Michael Zamboni	703-376-5301	Upon review of validated data to ensure adherence to project requirements, project chemist communicates via e-mail to EIS that data are ready for release (i.e., upload to database). After upload, the project chemist reviews analytical data tables prior to use by the project team.
Significant Analytical Laboratory QA/QC Issues	CH2M HILL Project Chemist	Michael Zamboni	703-376-5301	If significant laboratory QA/QC issues are identified that impact the schedule or usability of the data, then the project chemist will inform the Navy project manager as soon as possible, within 2 business days.
Kickoff calls with laboratories	CH2M HILL Project Chemist	Michael Zamboni	703-376-5301	Project chemist schedules a kickoff call with the laboratory(s) prior to their receipt of analytical samples. This is necessary to ensure compliance with the UFP-SAP work plan.

SAP Worksheet #7 — Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities
Kevin Cloe	Vieques RPM	Navy	Environmental restoration program (ERP) activities implemented under this SAP
Jan Nielsen	QAO	Navy	Navy review of SAP and QA input
Madeline Rivera	Vieques ERP Site Manager	Navy	On-island Navy liaison; provides logistical support for implementation of environmental restoration program activities under this SAP
Brett Doerr	Environmental Manager	CH2M HILL	Responsible for ERP at Vieques; primary Navy contractor point of contact (POC); assists in data evaluation and interpretation; reviews report
John Swenfurth	PM	CH2M HILL	Project administration; coordinates staffing; monitors project performance; directs and oversees project staff
Susanne Borchert	Senior Technologist	CH2M HILL	As the technical lead, leads selection of in-situ remediation technology for pilot testing; oversees preparation of reports; and provides recommendations on path forward
Kui Tan	Project Engineer	CH2M HILL	Prepares injection protocol ; performs data evaluation, analysis, and report writing
Mike Zamboni	Project Chemist	CH2M HILL	Establishes laboratory scope of work; ensures selected laboratory can meet project-required analytical protocol; primary communications with laboratory and data validator; performs data quality evaluation to determine availability of analytical data
Stephen Brand	Vieques Field Auditor	CH2M HILL	Project administration; coordinates staffing; monitors project performance; directs and oversees project staff
Mark Orman	Health and Safety Officer	CH2M HILL	Responsible for overall Navy CLEAN program health and safety performance; reviews project-specific HASP; interacts with SSC to ensure project-specific safety of field personnel
Kenji Butler	FTL and SSC	CH2M HILL	Supervises field injection, sampling and coordinates all field activities; ensures onsite compliance with work plan; oversees and ensures safety of onsite personnel
Hillary Ott	EIS	CH2M HILL	Manages sample tracking; coordinates assimilation of data from field collection through analysis, validation, and upload to environmental database; performs data queries for data evaluation and report writing
Bhavana Reddy	Database Manager	Critigen	Uploads validated data to environmental database
Sonya Gordon	Project Manager, POC at primary location.	Empirical Laboratories, LLC	Responsible for oversight, QC, and data review of major organics and inorganics analysis
C. James Stellrecht	Project Manager, POC at primary location.	TestAmerica	Responsible for oversight, QC, and data review of volatile fatty acids analysis
Anita Biernacki	Project Manager, POC at primary location.	Microbial Insights, Inc.	Responsible for oversight, QC, and data review of microbial analysis
Laura Maschoff	Project Manager, POC at primary location	Data Validation Subcontractor	Responsible for validating analytical data in accordance with project-specific UFP-SAP
Omar Negron Cabrera	Principal ,Pedro Panzardi and Associates	Air Rotary or Hollow Stem Auger Drilling Subcontractor	Responsible for performing drilling under the oversight of CH2M HILL FTL for delineation soil borings , and installation monitoring or injection wells at PI 4
Pedro Tejada	President/Right Way Environmental Contractors	Vegetation Clearing	Responsible for performing vegetation clearing in the area of well installation at the PI 4 site.
Keith Becker	Manager, ORIN	Injection Subcontractor	Responsible for implementation of injection activities at PI 4, in accordance with UFP-SAP
TBD	TBD	Investigation-derived Waste (IDW) Subcontractor	Responsible for transport and disposal of IDW deemed necessary for offsite disposal

[1] Resumes are maintained by the individuals' organizations and are available upon request; upon execution of the project, staff may be removed (if unnecessary to project execution) and other staff may be added or substituted, as necessary and available.

This page intentionally left blank

SAP Worksheet #8 — Special Personnel Training Requirements Table

Project Function	Specialized Training by Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates

Note: No special personnel training required for this project.

This page intentionally left blank

SAP Worksheet #9 — Project Scoping Session Participants Sheet

Project Name: Investigation and Pilot Study at PI 4					
Projected Date(s) of Sampling: Anticipated to begin June 2011				Site Name: PI 4	
PM: John Swenfurth				**Site Location:** Vieques, Puerto Rico	
Dates of Session: December 15, 2010 **Scoping Session Purpose:** Review data related to groundwater contamination at PI-4 and agree to the CSM and path forward for the site.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Kevin Cloe	Vieques RPM	NAVFAC	757-322-4736	Kevin.cloe@navy.mil	Primary Navy POC.
Michael Sivak	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Human health risk technical support
Diana Cutt	Geology/Hydrogeology Lead	USEPA	212-637-4311	Cutt.diana@epa.gov	Geology/hydrogeology technical support
Wilmarie Rivera	Vieques RPM	PREQB	787-767-8181	wilmarierivera@jca.gobierno.pr	Primary PREQB POC.
Katarina Rutkowski	Technical Support Contractor Human Health Risk Assessment Lead	TRC	860-298-6202	krutkowski@trcsolutions.com	Technical input and review of human health risk aspects on behalf of EQB. Primary TRC POC.
Richard Henry	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC/No project-specific role
Felix Lopez (by phone)	Environmental Contaminants Specialist	USFWS	787-851-7297 ext 226	Felix_lopez@fws.gov	No project-specific role
Daniel Rodriguez	Vieques RPM	USEPA	787-741-5201 787-671-9879 (c)	Rodriguez.daniel@epamail.gov	Co-Primary USEPA POC
Daniel Hood	Vieques RPM	NAVFAC	757-322-4630	Daniel.r.hood@navy.mil	No project-specific role
Stacin Martin	NAVFAC Technical Support	NAVFAC	757-322-4780	Stacin.martin@navy.mil	No project-specific role
Julio Vazquez	EPA RPM	USEPA			Co-Primary USEPA POC
Mindy Pensak	Ecological Risk Assessor	USEPA	732-321-6705	Pensak.mindy@epa.gov	Ecological risk technical support
Diane Wehner	Ecological Risk Assessor	NOAA	732-872-3030	Diane.wehner@noaa.com	Ecological risk technical support
Keith Fulton	Facilitator	Fulton Communications	702-934-5877	fultoncom@fultoncom.com	No project-specific role
Sandy Martinez	Facilitator	Fulton Communications	702-934-5877	fultoncom@fultoncom.com	No project-specific role
Brett Doerr	Environmental Manager	CH2M HILL	757-671-6219	Brett.doerr@CH2M.com	Scope development and technical review. Primary CH2M HILL POC.
John Martin	Ecological Risk Assessor	CH2M HILL	352-384-7122	John.martin@ch2m.com	Ecological risk technical support
Barrie Selcoe	Human Health Risk Assessor	CH2M HILL	281-721-8527	Barrie.selcoe@ch2m.com	Human health risk technical support
John Tomik	Activity Manager	CH2M HILL	757-671-6259	John.tomik@ch2m.com	Navy CLEAN Activity Manager for CH2M HILL
Tim Wenk	Minute Taker	CH2M HILL	757-671-6265	Tim.wenk@ch2m.com	No project-specific role

Comments/Decisions: See meeting minutes from December 15, 2010 ERP/MRP Subcommittee Meeting below.
Action Items: See below
Consensus Decisions: See below

SAP Worksheet #9 — Project Scoping Session Participants Sheet (continued)

Excerpt from the December 15, 2010 Final ERP/MRP Subcommittee Meeting Minutes

During the ESI at PI-4, no contaminant source area was found in the soil, but one well, MW-5, had TCE at a concentration of about 10 parts per billion (ppb). The SI report suggested NFA for the site but the USEPA and PREQB did not allow NFA because the concentration is above the MCL. A second round of groundwater samples was collected that confirmed the previous results (i.e., presence of localized, low concentration). Therefore, the Navy presented a "seed" file that proposes taking soil and groundwater (temporary wells) samples from around MW-5 in order to: 1) confirm no source area is present; 2) confirm the area of groundwater contamination is localized; 3) evaluate natural attenuation conditions; and 4) determine if a pilot study is warranted to see if the degradation of TCE can be accelerated. To support this investigation and subsequent action at the site, a UFP-SAP would be written that has a decision tree with specified metrics for decisions that would allow for follow up work, as appropriate, including a pilot study. This would allow the process to proceed more efficiently because it would not require a new SAP to be created if the findings suggest one is warranted. However, prior to making a decision for the site, the investigation data will be reviewed by the team in order to reach consensus on an appropriate path forward.

Michael Sivak/USEPA questioned whether a pilot study can be done at the SI phase. Brett Doerr/CH2M HILL noted that there is no known law or guidance to the contrary and that this is a common practice at sites. Further, it is very appropriate for this site given the seemingly localized area of groundwater contamination and the already low levels, neither of which warrant elevation to an RI.

Consensus Decisions
The Navy, USEPA, PREQB, and USFWS concurred on the following:

- USEPA will verify the appropriateness of conducting a pilot study at the Site Inspection (SI) stage. Note: since the December 2010 meeting, USEPA confirmed conducting a pilot study at the SI stage is appropriate.
- In the meantime, proceed with a UFP-SAP for PI 4 that contains the proposed groundwater investigation and potential pilot study.

Action Items
- USEPA will verify the appropriateness of conducting a pilot study at the SI stage and report back to the team before the SAP process gets too far along. Note: since the December 2010 meeting, USEPA confirmed conducting a pilot study at the SI stage is appropriate.
- CH2M HILL to add natural attenuation parameters to the PI 4 sampling suite for the next investigation.

SAP Worksheet #10 — Problem Definition

Introduction

This worksheet provides a summary of site background and key elements of the conceptual site model (CSM), followed by a narrative description of the problems to be addressed during the supplemental ESI and potential pilot study.

Background

This section provides a summary of the site background, key elements of the CSM (including the site setting and history, geology, and hydrogeology), a summary of the groundwater data, supplemental ESI and pilot study objectives, the pilot study approach and preliminary remediation goals (PRGs). More detailed information about the site's characteristics can be found in the Site Inspection/Expanded Site Inspection (SI/ESI) Report (CH2M HILL, 2010a).

Site Setting and History

PI 4, approximately 6 acres in size, is located on the south side of the main access road leading from the main gate of Camp Garcia. **Figure 1** shows the location of PI 4 within the former Vieques Naval Training Range (VNTR). Historical information suggests the site was active from 1959 to 1964, and comprised a former helicopter maintenance area, barracks, mess hall, trenched area, and a bermed area for storage of fuel bladders. Currently there are no buildings present at the site.

Figure 2 shows the 1962 Aerial Photograph of the PI 4 and includes the current monitoring well locations and estimated potentiometric contour from water levels taken in March 2009, as well as the locations of soil samples collected at the site. The site slopes gently to the southeast with elevations dropping from about 45 feet above mean sea level (ft amsl) to approximately 30 ft amsl. The land around PI 4 was at one time maintained as cleared, but became re-vegetated since operations ceased. The site is currently overgrown with vegetation. No federally protected species or preferred habitats were identified in the area. For more information on the ecological survey, see Appendix C of the Final PA/SI Report (CH2M HILL, 2008). Currently, there is no continuous human presence or use at the site. No cultural resources are located at PI 4.

Site Geology

Soil borings at PI 4 encountered primarily dry sands and silty sand. For more details on the unconsolidated material overlying bedrock, see the site-specific boring logs in Appendix D of the Final PA/SI Report (CH2M HILL, 2008), and Appendix A of the SI/ESI Report (CH2M HILL, 2010a). PI 4 lies within the KTd formation, which is characterized by plutonic rocks, largely granodiorite and quartz diorite. Bedrock cores for MW04 and MW02 encountered granite and some fine grained volcanic rock. Bedrock boreholes for MW05 and MW03 encountered granodiorite. Bedrock was encountered in the monitoring well borings at depths between 17 and 28 feet (ft) below ground surface (bgs). Weathered bedrock was encountered at MW06 and MW07 (CH2M HILL,2010a). **Figures 3 and 4** present geologic cross sections (A-A′ and B-B′, respectively) based on lithologic information from the historical borings.

SAP Worksheet #10 — Problem Definition (continued)

Site Hydrogeology

The closest surface water body topographically downgradient of the site is Bahia Tapon along the coast, approximately a half mile southeast of the site. Based on water level readings from PI 4 monitoring wells, groundwater flows as a subdued replica of the topography, through the fractured bedrock aquifer toward the southeast with an estimated hydraulic gradient of approximately 0.001 foot per foot (ft/ft). For the purposes of generating the piezometric surface map (**Figure 2**), the groundwater levels in wells MW05, MW06, and MW07 were treated as generally the same level. The difference in elevations between these wells is less than an inch, indicating that the piezometric surface in that area is very flat. Hydraulic conductivity data are not available for wells at PI 4; however, the hydraulic conductivity for Area of Concern (AOC) E and AOC I at Vieques with similar geologic conditions ranged from 0.1 foot per day to 8.6 feet per day (CH2M HILL, 2010b). This information, coupled with the generally flat hydraulic gradient, suggests the groundwater velocity at the site is relatively low (i.e., on the order of a hundredth of a foot per day or less).

Conceptual Site Model

The CSM of PI 4 is presented in **Figure 5**, which shows the historical features as well as sample and well locations from the PA/SI and ESI. Based on the historical activities and extent of contamination identified during the PA/SI/ESI, the release mechanism at the site is unknown, primarily because little contamination was identified at the site and the most significant contamination (i.e., TCE in well MW05) was identified in an area with no known or suspected source.

The primary route of contaminant migration is likely vertical leaching through soil to groundwater and subsequent transport with groundwater flow through interstitial spaces in the fractured rock (and to a lesser extent, the unconsolidated material overlying the fractured rock). Because the fractured rock is highly weathered, the fractures consist of relatively "tight" material and the hydraulic gradient across the site is low; therefore, the rate of contaminant transport is likely very low. This supposition is supported by the general absence of contamination downgradient of MW05 in MW07.

Summary of Historical Groundwater Data (Synopsis of Relevant Secondary Data)

Based on the information gathered during the PA/SI and ESI, the SI/ESI Report (CH2M HILL, 2010a) concluded there were no unacceptable risks for potential ecological exposure to soil, no unacceptable risks for potential human exposure to soil or groundwater, and no unacceptable leaching concern for groundwater. However, the concentration of TCE was found to exceed its MCL at one well (MW05). Three other VOCs, comprising 1,1-dichloroethene (1,1-DCE), tetrachloroethene (PCE), and vinyl chloride (VC), were detected at MW05 but at concentrations far below the human health screening levels and MCLs.

Supplemental ESI and Pilot Study Problem Statement and Objectives

TCE has been identified and confirmed in a single PI 4 well at relatively low concentrations (i.e., 9 µg/L and 17 µg/L), but above the Federal MCL of 5 µg/L. However, no source area has been identified, which may be because the source area no longer exists or was not encountered during previous sampling. In addition, it is not known whether the single location of MCL exceedance

SAP Worksheet #10 — Problem Definition (continued)

represents a small, isolated area. In addition, although the area of relatively low levels of groundwater contamination may be localized, an extended period of time may be required for TCE to meet the MCL, given that the geochemical conditions measured during previous investigations implied slightly aerobic conditions. The Navy no longer owns nor is present at PI 4 and, therefore, institutional controls and groundwater long-term monitoring (LTM) would be required as the TCE concentrations naturally attenuate. The Navy and USFWS would likely benefit from releasing the site unencumbered (i.e., without restrictions) in a predictable and shorter timeframe. Therefore, a pilot study at PI 4 may help assess the implementability and effectiveness of in-situ remediation in reducing the concentrations of TCE and other chlorinated VOCs (if present at elevated concentrations) in groundwater. Therefore, the specific objectives of the supplemental ESI (and potential pilot study) are:

1. Confirm no TCE source area is present in soil in the vicinity of well MW05
2. Confirm the area of TCE groundwater contamination above the MCL is localized around well MW05
3. Evaluate natural attenuation conditions in the vicinity of well MW05
4. Determine if a pilot study is warranted to determine if in-situ degradation/destruction of TCE can be stimulated (and perform the pilot study, if warranted)
5. If a pilot study is conducted, determine if in-situ enhanced reductive dechlorination (ERD) or in-situ chemical oxidation (ISCO) is effective at reducing groundwater VOC levels to acceptable levels (i.e., concentrations at or below the lower of the MCLs and Puerto Rico Water Quality Standards)

Environmental Questions to be Answered by the Supplemental ESI and Potential Pilot Study:

1. <u>Is there a TCE source area in soil in the vicinity of well MW05?</u>

This question will be answered by installing one soil boring approximately 10 ft upgradient of MW05, and four borings approximately 50 ft upgradient, 50 ft downgradient, and 50 ft in each sidegradient direction from MW05, as shown in **Figure 6**. Soil will be collected and screened with an organic vapor monitor (OVM) continuously from ground surface to the base of the unconsolidated zone. One soil sample from each boring will be submitted to the offsite laboratory for analysis of TCE and its parent and degradation products. Each sample will be collected from the area of highest VOC readings on the OVM. If OVM readings suggest VOC contamination may be present across a vertical profile of the boring, additional soil samples will be collected to provide vertical delineation of potential VOC contamination. In the absence of VOC readings above background, the soil sample will be collected from the base of the unconsolidated zone. Additional soil samples may be collected if additional borings are drilled (see Environmental Question to be Answered #2, below).

SAP Worksheet #10 — Problem Definition (continued)

2. **Is the area of TCE groundwater contamination above the MCL localized around well MW05?**

   This question will be answered by installing monitoring wells in each of the borings discussed in Environmental Question to be Answered #1, above. Following installation of all wells, a round of groundwater-level measurements will be collected to verify the groundwater flow direction in the immediate area of MW05. Groundwater samples will be collected from each new well and existing wells MW05, MW06, and MW07 and submitted to the laboratory for 24-hour turn-around time (TAT) analysis of TCE, its parent and degradation products, and natural attenuation parameters. Up to approximately two additional monitoring wells may be installed based on the analytical results to help refine the understanding of the area of contamination and, if necessary, to place additional wells for use as injection or monitoring wells during the potential pilot study. If additional monitoring wells are installed, additional soil samples will be collected in accordance with the process described under Environmental Question to be Answered #1, above.

3. **Is a pilot study warranted to determine if degradation/destruction of TCE can be stimulated?**

   This question will be answered by evaluating the groundwater data with respect to MCLs and Puerto Rico Water Quality Standards (whichever is lower) and conditions favorable for reductive dechlorination or chemical destruction. If VOC concentration(s) exceed their respective MCL or Puerto Rico Water Quality Standard (whichever is lower) and the data confirm the area of contamination is localized and conditions favor ERD or ISCO (either existing or likely induced), a pilot study will be performed. Prior to conducting the pilot study, the data collected during the supplemental ESI and the conclusions drawn regarding the potential benefit and type of pilot study will be discussed among the representatives of the Environmental Technical Subcommittee to concur upon the conclusions made with respect to conducting the pilot study.

4. **Is ERD or ISCO an appropriate remedial technology for reducing the PI 4 groundwater TCE (and parent/daughter products) concentrations to acceptable levels (lower of MCLs and Puerto Rico Water Quality Standards)?**

   If a pilot study is deemed warranted based on evaluation of the supplemental ESI findings, discussion and concurrence among the Navy, USEPA, PREQB, and USFWS will be reached on whether ISCO or ERD technologies should be implemented during the pilot study. Therefore, this environmental question will be answered by either injecting potassium permanganate solution (if ISCO is selected) or injecting emulsified vegetable oil (EVO) substrate (if ERD is selected) and performing approximately three post-injection groundwater sampling events. The network of proposed ISCO or ERD injection wells is shown in **Figure 6**.

   ISCO uses chemical oxidants to react with and destroy a variety of organic contaminants in groundwater. In addition to being suitable for the destruction of TCE, permanganate does not require activation, and is highly stable and persistent (several months to one year) depending on the hydrogeochemical condition. Based on the current conceptual understanding, the localized affected groundwater at MW05 has a low TCE concentration (slightly above the MCL), and is under slightly aerobic conditions. The natural oxidant demand (NOD) in the bedrock aquifer is anticipated to be relatively low. All these characteristics appear to be amenable for permanganate treatment from a single injection event. However, this information will be verified during the supplemental ESI.

SAP Worksheet #10 — Problem Definition (continued)

ERD is generally effective for treatment of chlorinated VOCs present in the dissolved phase or adsorbed to solid aquifer materials within the saturated zone and capillary fringe. The injection of carbon source substrate such as EVO should drive the aquifer to an anaerobic condition (i.e., ORP < -100 mV) suitable for ERD. Under the ERD pathway, PCE can be sequentially biodegraded to TCE, cis (or trans)-1,2DCE, VC, ethene, and methane. Based on past experience, the EVO longevity is also relative to the dosage applied. Under an EVO dose of approximately 0.00075 lbs EVO/lb soil, the expected effective life of EVO would be 9 months to 1.5 years. Note that at the time of this SAP preparation, EVO (EOS®598B42 from EOS Remediation, LLC) is proposed as the substrate amenable for ERD of TCE, due to its longer effective life (persistence of 1 to 2 years pending on dosage and subsurface conditions) and current site conditions. EOS® provides both quickly available carbon (lactate) and slow-release carbon (soybean oil) with nutrients required for biotic stimulation. Should additional site investigation findings warrant the flexibility of utilizing other soluble substrate with shorter effective life (weeks up to 3 months), such as sodium lactate, the different substrate will be considered.

5. **How will monitoring data be collected and evaluated to ensure they are representative of the aquifer conditions, not of the injected material?**

   For the pilot study, one or more of the new wells/MW05 will be used as injection wells and the remaining wells in the vicinity of MW05 will be used as monitoring wells. The actual wells to be used for injection versus monitoring will be discussed with the Environmental Technical Subcommittee prior to implementation. Water quality parameters will be closely monitored when collecting performance monitoring groundwater samples to ensure that these are stable and reflect expected groundwater conditions.

6. **Is application of ERD or ISCO likely to be effective and reduce the overall cleanup time?**

   It is anticipated that TCE concentrations (as well as other chlorinated VOCs) will decrease to or below MCLs/Puerto Rico Water Quality Standards within a few years following the ERD or ISCO treatment. If necessary, trend curves depicting constituent concentrations versus time or distance can be produced from the site data prior to and following implementation of ERD or ISCO. These graphs will be evaluated for first order degradation rates to help assess the degree of reduced time (relative to the baseline prior to injection) for reaching the remediation goals.

This page intentionally left blank

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements

1. Who will use the data and for what will the data be used?

The Navy, USEPA, EQB, and USFWS will use the data collected during the supplemental ESI and potential pilot study to confirm the conceptual understanding of the environmental conditions at PI 4 and to determine whether ERD or ISCO can (1) reduce groundwater TCE (and other chlorinated VOC) concentrations to or below the MCLs/Puerto Rico Water Quality Standards, and (2) reduce the cleanup timeframe. Based on the results of the supplemental ESI and potential pilot study, the Navy, USEPA, EQB, and USFWS will make a decision whether no further action, a feasibility study (FS), or another path forward is warranted.

2. What are the Project Action Limits (PALs)?

TCE is the only VOC detected in PI 4 groundwater above its MCL. Although several other chlorinated VOCs were historically detected at the site, their concentrations were below MCLs. However, because one of the primary objectives of the supplemental ESI is to confirm the localized area of contamination, these additional VOCs will be included in the analytical protocol. In addition, degradation daughter products of TCE not historically detected will be included in the analytical protocol given the above objective and the potential pilot study objective to evaluate the efficacy of ERD.

Based on the above information, the following groundwater PALs will be utilized for the supplemental ESI and potential pilot study. They are based on the lower of Federal MCLs and Puerto Rico Water Quality Standards Regulation Groundwater Class SG Criteria (PR GW Regs Class SG).

Constituents	PAL	Source of PAL
Trichloroethene (TCE)	5 µg/L	MCL*
1,1-dichloroethene (1,1-DCE)	7 µg/L	MCL*
cis-1,2-dichloroethene (cis-1,2-DCE)	70 µg/L	MCL*
trans-1,2-dichloroethene (trans-1,2-DCE)	100 µg/L	MCL*
Tetrachloroethene (PCE)	5 µg/L	MCL*
Vinyl chloride (VC)	0.25 µg/L	PR GW Regs Class SG (March, 2010)**

*PR GW Regs Class SG criterion equals the MCL.

** MCL for VC is 2 µg/L; however, the PRGW Regs Class SG criterion value of 0.25 µg/L is the PAL.

The Project Indicator Limits (PILs) for groundwater geochemical and microbial parameters are described in SAP Worksheets #15-2 and #15-3.

The PALs for the soil samples are the lowest of the USEPA Regional Screening Levels (RSLs) for residential soil (adjusted as applicable), ecological screening values (ESVs), and USEPA soil screening levels (SSLs) at a dilution attenuation factor (DAF) of 1, as described in SAP Worksheet #15-4. Vieques ecological screening values for soil, which are listed in the Vieques Master Ecological Risk Assessment Protocol (CH2M HILL, 2010c) and associated Master ERA Protocol Update 1 (CH2M HILL, 2010d).

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

Worksheet #15-4 shows that the laboratory limit of detection (LOD) is below the RSLs and ESVs for all the target constituents. For only three constituents (VC, TCE, and PCE), the LODs are above the SSLs. However, the detection limits (DLs) for TCE and PCE are below the SSLs, which indicates if TCE or PCE are detected below the LODs, they will be reported, but qualified as estimated. In addition, the Vieques screening values upon which PALs are based are not of equal importance. The SSLs are more qualitative than quantitative (versus the RSLs and ESVs) and past experience on Vieques has shown that they are not reliable predictors of leaching to groundwater (i.e., they are overly conservative; (see multiple site-specific SSL discussions contained in the SI/ESI Report [CH2M HILL, 2010a)), even when they are calculated using site-specific data. The SSLs in Worksheet #15-4 are the generic SSLs provided by USEPA, so they are likely significantly less applicable than even site-specific SSLs. The generic SSL for vinyl chloride is 0.69 μg/kg. The DL for vinyl chloride is 1.25 μg/kg. However, at a DAF of 2, the DL for vinyl chloride is less than the SSL for vinyl chloride (1.38 μg/kg).

3. **What types of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)?**

   Worksheets #10, #15, #17, and #18 define the matrices, analytical groups, and, where applicable, specific target analytes for PI 4. Based on historical data and project objectives, the analyses are tailored to the six select VOCs in groundwater and soil, and various indicator parameters in groundwater.

4. **How "good" do the data need to be in order to support the environmental decision?**

   Several types of data will be collected during the supplemental ESI and potential pilot study. How good the data need to be is discussed by data type below.

   - **Visual Observations and Photoionization Detector (PID) Readings –** Visual observations and OVM readings will be used at PI 4 during soil boring sampling activities. Calibrating and operating the OVM in accordance with Standard Operating Procedure (SOP) C-1 of the Master Standard Operating Procedures, Protocols, and Plans (CH2M HILL, 2010c) are sufficient to provide data of appropriate quality.

   - **Laboratory Analytical Data**. Appropriate analytical protocol, data validation, QA/QC samples, and performing a data quality evaluation (DQE) to assess the availability and usability of the data will be used as the tools to ensure "good" data are acquired. Each of these is further discussed below:

     - **Appropriate Analytical Protocol –** See Worksheets #15, 19, 23, 24, 25, 28, and 30 and Question 5 below.

     - **Data Validation –** Validation of data increases the level of confidence in a data set for a particular data use. Offsite laboratory data will be validated by an independent, third party data validator using guidance from the validation criteria outlined by the USEPA. Use of an independent, third party validator may serve to increase the public's confidence in the data because the validator provides an assessment of the data quality outside of any

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

influence by the stakeholder parties. The validation criteria and guidance documents are listed in Worksheet #36. These documents will help the validator create a thorough and systematic approach to the validation process. The data validator will also recalculate 10 percent of the results from the raw laboratory data, which may identify laboratory errors in identification or quantification, if present.

- **QA/QC Samples –** QA/QC samples will be collected with the various media samples for the target VOCs (i.e., definitive data) as a check on sampling and analytical protocol. Like data validation, the appropriate type and quantity of QA/QC samples is not an absolute. Field duplicates will be collected at a frequency of 1 per 10 field samples per matrix. Field duplicates help assess sample collection techniques and laboratory precision. Matrix spike/matrix spike duplicates (MS/MSDs) are collected at a frequency of 1 pair per 20 field samples per matrix. The frequency is such that there is one MS/MSD pair per laboratory analytical batch. MS/MSD samples are often required by the analytical method and/or data validation guidance. Equipment blanks are collected at a frequency of 1 per day per medium sampled when non-disposable equipment is utilized. Equipment blanks help assess equipment decontamination techniques and identify when contamination may have been carried over from one sample location to another. Equipment blanks will be collected in the field such that they are also subject to ambient field contamination. Trip blanks are collected at a frequency of 1 per cooler containing volatiles. Trip blanks accompany the empty sample containers while they are stored at the laboratory and shipped to the site, and while they are full and shipped back to the laboratory. Trip blanks are useful for assessing whether or not there is any contamination during periods of time when the samples are not directly supervised.
- **Data Quality Evaluation –** In order to support the environmental decisions, each result must be *available* to and *usable* for the project team. All data sets will undergo a DQE prior to using the data to make site-specific determinations. The terms *data availability* and *data usability* and the DQE process in general are described in Worksheet #37.

5. How much data should be collected (number of samples for each analytical group, matrix, and concentration)?

Worksheet #18 contains the number of samples per matrix per analytical group for PI 4. Worksheets #15 contain the particular analytes, PALs, and limits of quantitation (LOQs), LODs, and DLs. Worksheet #17 provides the rationale for samples.

6. Where, when, and how should the data be collected/generated?

The soil and groundwater samples will be collected based on the scheduled sampling events in Worksheets #16 for PI 4. See Question #3 above and Worksheet #14 for how the data will be collected or generated.

7. Who will collect and generate the data? How will the data be reported?

CH2M HILL and its subcontractors will collect the data. Empirical Laboratories, LLC, TestAmerica Laboratories, Inc., and Microbial Insights, Inc. will generate the laboratory analytical data. Under most circumstances, the data will be evaluated and reported in a Supplemental ESI (and Pilot Study) Report. However, if the findings of the ESI suggest an RI is warranted, the results of the supplemental ESI will be documented in an RI SAP instead.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

8. How will the data be archived?

The electronic data will be loaded into the Navy Installation Restoration Information System (NIRIS) database. Raw data, as well as data summary tables, will be included in the associated reporting document(s). Hardcopy data will be archived by CH2M HILL and the Navy in accordance with contract requirements.

9. List the Project Quality Objectives (PQOs) in the form of if/then qualitative and quantitative statements.

In order to meet the supplemental ESI and potential pilot study objectives as defined in Worksheet #10, the following specific project quality objective (PQO) statements are developed for decision analysis:

Supplemental ESI PQO Statements:

Initially, one boring (approximately 10 feet upgradient [northwest] of MW05) and four borings (approximately 50 feet upgradient, downgradient, and in both sidegradient directions from MW05) will be drilled for continuous soil sampling, and monitoring well installation, and groundwater sampling on a 24-hour TAT schedule for laboratory analysis. The need for additional, contaminant-area refinement borings/wells will be determined based on the following decision analysis:

1. If the soil data from the initial borings indicate the presence of chlorinated VOCs, up to two additional step-out borings will be installed in the applicable direction(s) to refine the understanding of the source area.
2. If the groundwater data collected from the initial wells identify the presence of VOCs at concentrations above MCLs/Puerto Rico Water Quality Standards, up to two step-out wells will be installed in the applicable direction(s) to refine the understanding of the contaminated groundwater area.
3. If the soil and groundwater data collected from the initial borings/wells confirm no source area and no groundwater VOCs above MCLs/Puerto Rico Water Quality Standards, no step-out borings or wells will be installed.
4. If OVM readings suggest VOC contamination may be present across a vertical profile of the boring, additional soil samples will be collected to provide vertical delineation of potential VOC contamination.

Based on the information collected during the supplemental ESI, the following determinations will be made:

1. If no source area is identified and all VOC concentrations are less than their respective MCL or Puerto Rico Water Quality Standard (whichever is lower), then an additional round of groundwater data will be collected to confirm the initial results. If the initial results are confirmed, no further investigation or action will be necessary for the site and the site will proceed to a supplemental ESI report and no action decision document. If the initial results are not confirmed, the decision process will proceed to #2 below.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

2. If no source area is identified and VOC concentration(s) exceed their respective MCL or Puerto Rico Water Quality Standard (whichever is lower), and the data confirm the area of contamination is localized and conditions favor ERD or ISCO (either existing or likely induced), a pilot study will be performed.
3. If the supplemental ESI data suggest the area of VOC groundwater contamination is not localized, a remedial investigation (RI) will be recommended to determine the nature and extent of contamination. In this case, the results of the supplemental ESI will be summarized in the RI SAP as rationale for the RI, rather than in a supplemental ESI report.
4. If a potential source area is identified in soil, a determination will be made whether: (1) further delineation is warranted via an RI (which would include an assessment of potential risk); or (2) an interim action can be implemented to more efficiently address the potential source area.

Pilot Study PQO Statements:

1. If the results of the pilot study indicate VOC concentrations in groundwater are equal to or less than the PALs, then the pilot study met its objectives. In this case, NFA will be warranted, and PI 4 will proceed through a ESI/Pilot Study Report to a NFA decision document.
2. If the results of the pilot study indicate VOC concentrations in groundwater are above the PALs, the path forward (e.g., FS, additional pilot study, etc.) will be recommended. The cleanup timeframe will be estimated based on the concentration trends and, potentially, observed degradation rate constants, and will be compared with an estimated untreated natural attenuation timeframe to assist in making path forward recommendations. Because of the many combinations of concentrations detected and trends that may be observed, it is not possible at the preparation of the SAP to determine which scenario(s) would result in recommendations for an FS, additional pilot study, or other action.

This page intentionally left blank

SAP Worksheet #12-1 — Measurement Performance Criteria Table – Field QC Samples

Matrix: Groundwater
Analytical Group: VOC
Concentration Level: Low (Surface Water (SW)-846 8260B)

QC Sample	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Matrix Spike	VOC	1 per 20 field samples	Accuracy/Bias	See Worksheet 15-1	A
Matrix Spike Duplicate	VOC	1 per 20 field samples	Accuracy/Bias, Precision	See Worksheet 15-1	A
Field Duplicate	VOC	1 per 10 field samples	Precision	relative percent difference (RPD) < 20%	S&A
Equipment Rinseate Blank	VOC	1 per day of sampling	Bias/Contamination	Same as method blank. Refer to Worksheet 28-1	S&A
Trip Blank	VOC	1 per cooler containing VOCs	Bias/Contamination	Same as method blank. Refer to Worksheet 28-1	S&A
Temperature Blank	VOC	1 per cooler	Representativeness	4±2 degrees Celsius (°C)	S

[1]If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-2 — Measurement Performance Criteria Table – Field QC Samples

Matrix: Groundwater
Analytical Group: MICRO
Concentration Level: Low (qPCR)

QC Sample	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Temperature Blank	MICRO	1 per cooler	Representativeness	4±2°C	S

[1]If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-3 — Measurement Performance Criteria Table – Field QC Samples

Matrix: Groundwater
Analytical Group: WCHEM
Concentration Level: Medium (EPA 300.0, SM4500-S2-F, RSK-175, BF-MB-009, SW-846 9060, SM2320B, SM2540C)

QC Sample	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Temperature Blank	WCHEM	1 per cooler	Representativeness	4±2°C	S

[1]If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-4 — Measurement Performance Criteria Table – Field QC Samples

Matrix: Soil
Analytical Group: VOC
Concentration Level: Low (SW-846 8260B)

QC Sample	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Matrix Spike	VOC	1 per 20 field samples	Accuracy/Bias	See Worksheet 15-4	A
Matrix Spike Duplicate	VOC	1 per 20 field samples	Accuracy/Bias, Precision	See Worksheet 15-4	A
Field Duplicate	VOC	1 per 10 field samples	Precision	RPD < 30%	S&A
Equipment Rinseate Blank	VOC	1 per sampling event with disposable equipment	Bias/Contamination	Same as method blank. Refer to Worksheet 28-4	S
Trip Blank	VOC	1 per cooler containing VOCs	Bias/Contamination	Same as method blank. Refer to Worksheet 28-4	S&A
Temperature Blank	VOC	1 per cooler	Representativeness	4±2°C	S

[1] If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-5 — Measurement Performance Criteria Table – Field QC Samples

Matrix: Soil
Analytical Group: WCHEM
Concentration Level: Medium (Lloyd Kahn)

QC Sample	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Temperature Blank	WCHEM	1 per cooler	Representativeness	4±2°C	S

[1]If information varies within an analytical group, separate by individual analyte.

This page intentionally left blank

SAP Worksheet #13 — Secondary Data Criteria and Limitations Table

The table below provides general information on how secondary data will be used in meeting the current project objectives and the limitations on their use in developing the SAP. Secondary data criteria and limitations tables are presented where historical analytical data exist (applicable to the scope of work covered by this SAP), specifically to address the use and limitations of the historical analytical data.

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use
Sampling of 15 soil borings and installation and sampling of 5 monitoring wells (MW01 through MW05).	Preliminary Assessment/Site Inspection, U.S. Naval Training Range, Vieques Island, Puerto Rico (CH2M HILL, 2008).	All groundwater and soil samples were analyzed for TCL VOCs, SVOCs, pesticides and TAL inorganics. A few soil and all ground water was tested for PCBs.	Data were used to determine the target contaminants. Data may be used to estimate natural attenuation rate before ERD pilot study	No significant limitations on the data use since they were collected, analyzed, and validated using protocols sufficient for use in making site-specific decisions. For any sample location where more recent data are collected during the supplemental ESI/pilot study, those data will supersede the historical data for representing current conditions.
Installation of two monitoring wells (MW06 and MW07), and sampling of all seven wells on site.	Site Inspection/Expanded Site inspection, Former Naval Training Range, Vieques Island, Puerto Rico CH2M HILL, 2010a).	Groundwater was sampled in all seven wells for TCL VOCs	Data may be used to estimate natural attenuation rate before ERD pilot study.	No significant limitations on the data use since they were collected, analyzed, and validated using protocols sufficient for use in making site-specific decisions. For any sample location where more recent data are collected during the supplemental ESI/pilot study, those data will supersede the historical data for representing current conditions.

This page intentionally left blank

SAP Worksheet #14 — Summary of Project Tasks

The supplemental ESI and potential pilot study consist of the following primary field activities:

- Pre-investigation activities (utility clearance and mobilization)
- Installation of a network of borings and monitoring/injection wells to support the project objectives
- Collection of at least one round and up to four rounds of groundwater samples (baseline and confirmation or post-injection 3-month, 9-month, and 15-month) for performance evaluation

The following summarizes the project tasks.

Utility Clearance

Naval Facilities Engineering Command (NAVFAC) Atlantic will be contacted for clearance of potential subsurface utilities at PI 4 prior to the soil boring and well installation activities. If necessary, each location will be excavated by hand or other approved method (i.e., posthole digger, air knife, etc.) from the zero to five-foot interval before drilling activities begin.

Mobilization

Mobilizations will include CH2M HILL staff and subcontractors traveling to the island of Vieques to perform the field activities in accordance with the schedule in Worksheet #16.

Soil Sampling and Well Installation

Figure 6 presents the soil sampling locations for the initial soil borings (Subsurface Soil (SB)-16 through SB-20). Five borings will be drilled to the top of the unconsolidated zone which is approximately 17 to 28 ft bgs. Split spoon soil samples will be collected continuously from ground surface to the base of the unconsolidated zone and screened with an OVM. Soil samples will be collected in general accordance with *Master Standard Operating Procedures, Protocols, and Plans* (CH2M HILL, 2010c). One soil sample from each boring will be submitted to an offsite laboratory for analysis of TCE and its parent and degradation products. Samples will also be analyzed for total organic carbon (TOC). Each sample will be collected from the area of highest VOC readings on the OVM. If OVM readings suggest VOC contamination may be present across a vertical profile of the boring, additional soil samples will be collected to provide vertical delineation of potential VOC contamination. As each split spoon is opened, it will be screened by an OVM. If a soil interval has measurable OVM readings above background suggestive of the presence of contamination, a VOC sample will be collected at that depth and stored temporarily in the cooler until the boring is completed. At the completion of the borehole, sample(s) representative of the vertical profile of suspected contamination will be sent to the laboratory for VOC analysis. In the absence of VOC readings above background, the soil sample will be collected from the base of the unconsolidated zone. Additional soil samples will be collected if additional borings are drilled (see Environmental Question to be Answered #2, in Worksheet 10).

The well borehole will be advanced with post-hole diggers to a depth of at least 4 feet bgs to provide clearance of underground utilities (if necessary), then drilled with hollow-stem augers or air rotary rigs to the appropriate depth. Continuous soil samples will be collected using a 2-foot split spoon sampler or comparable method during installation prior to reaching bedrock (top of

SAP Worksheet #14 — Summary of Project Tasks (continued)

bedrock typically occurs approximately 17 to 28 ft bgs based on historical borings) to supplement the lithologic descriptions at PI 4. These samples will be logged in the field in accordance with the Unified Soils Classification System (USCS). Specifically, sample descriptions included soil type, USCS symbols, predominant and secondary grain sizes with relative proportions (Modified Wentworth Scale), color (Munsell Color System), and lithologic boundaries. In addition, the samples will be screened with an OVM and the associated readings will be recorded in the boring logs. OVM screening will be done by opening the split spoon sampler, inserting the PID probe at various locations along the soil core to get direct readings, and recording the readings on the soil boring.

Five monitoring wells will be installed in each of the five borings adjacent to MW-05 as discussed above. The total depth and well screen intervals of five new monitoring wells will be similar to that of MW-05 (i.e., first encountered water in saturated zone). The proposed well total depth is approximately 45 ft bgs, with screen intervals of approximately 35 to 45 ft bgs. The field personnel will make appropriate adjustment of total depth and screen intervals based on observed geologic and depth-to-water conditions. Each monitoring well will be installed in general accordance with the *Master Standard Operating Procedures, Protocols, and Plans, SOPs D-1 and D-2* (CH2M HILL, 2010c). Following installation of all wells, a round of groundwater-level measurements will be collected to verify the groundwater flow direction in the immediate area of MW05. Monitoring wells will be developed no sooner than 24 hours after the well has been installed in order to give the grout time to cure. Additionally, the wells will be sampled no sooner than 48 hours after development, in order to give the wells time to re-equilibrate after development. Groundwater samples will be collected from each of the five new wells and each of the three existing wells MW05, MW06, and MW07. Samples will be submitted to the laboratory for next-day (see Worksheet #30) analysis of TCE and, its parent and degradation products. Natural attenuation (geochemical) parameters, comprising TOC, methane, ethane, ethene, volatile fatty acids (acetic, butyric, lactic, propionic, and pyruvic acids), *dehalococcoides*, alkalinity, total dissolved solids (TDS), chloride, nitrate, nitrite, sulfate, and sulfide, will also be analyzed from existing well MW05 using a standard turnaround time (TAT) of 28 calendar days (See Worksheet #18-a and #30). Up to approximately two additional monitoring wells may be installed based on the analytical results to help refine the understanding of the area of contamination and, if necessary, to place additional wells for use as injection or monitoring wells during the potential pilot study. Groundwater samples will be collected in general accordance with the *Master Standard Operating Procedures, Protocols, and Plans, SOP B-1* (CH2M HILL, 2010c). Development water will e containerized in 55-gallon drums for IDW disposal.

ISCO Pilot Study

The information in this subsection is based on the current understanding of site conditions. If evaluation of the supplemental ESI data alters this understanding, the information below will be adjusted accordingly and discussed with the Environmental Technical Subcommittee prior to implementation.

If conducted, the ISCO pilot study will involve injecting approximately 0.7 percent potassium permanganate solution (or 7 grams per liter [g/L]) into the aquifer (approximately 35 ft bgs; to be verified based on field borings) via up to five newly installed 2-inch-diameter injection wells: MW08 through MW12 with low pressure (up to 30 psi). The exact quantity and concentration of

SAP Worksheet #14 — Summary of Project Tasks (continued)

permanganate solution, numbers of wells used for injection, an injection mode will be based on evaluation of the supplemental ESI findings and concurred upon among the stakeholder agencies prior to implementation. For the proposed pilot study, it is assumed that the targeted treatment area (TTA) is approximately 50 ft by 50 ft adjacent to MW05. The lateral and vertical extent of the TTA is based on the Constituents of Concern (COC) concentrations in monitoring wells MW05 through MW07. The TTA may be revised based on the supplemental ESI data. Potassium permanganate technical literature is located in Attachment D.

Potassium permanganate solution between half and one full pore volume will be injected at the TTA during one single injection event. Initially, approximately 50 percent of the required oxidant mass will be injected into the injection wells without extraction, for the purpose of maximizing the horizontal radius of influence (ROI) and minimizing vertical short circuiting. Subsequently, the remaining 50 percent of the oxidant demand may be injected under recirculation mode to promote subsurface distribution of the oxidant solution through increased hydraulic gradient. Up to two downgradient wells would be used as extraction wells to increase the hydraulic gradient for recirculation and distribution of permanganate in the entire TTA. The extracted groundwater may be dosed with permanganate and reinjected through the injection wells. If the extracted water at

downgradient extraction wells contains relatively high permanganate concentration (i.e. > 3 g/L) or shown as purple color, reinjection without addition of new permanganate may be considered.

As part of the supplemental ESI sampling, the groundwater samples will be analyzed for the parameters defined in Worksheet #18-a. The results will serve as the baseline conditions for evaluating ISCO performance.

The following paragraphs describe the oxidant demand and the protocol that will be followed during the ISCO injection.

Oxidant Demand: A total of approximately 2,800 pounds of potassium permanganate (8 drums; 330 pounds per drum; RemOx®-S ISCO Reagent from CARUS or equal) will be required for an approximately 50 ft by 50 ft TTA. The mass of potassium permanganate was based on an assumed natural oxidant demand (NOD) of 1 g permanganate/Kg soil for bedrock aquifer with anticipated low natural organic matter, as well as TCE concentration of approximately 20 µg/L throughout the TTA.

The total injection volume would target injection of half to one pore volume (PV) (assuming porosity of 0.25) during one single injection-recirculation event, to address the target treatment interval from approximately 35 to 45 ft bgs (or adjusted by field geologist based on actual well screen intervals installed per field lithologic conditions and groundwater table).

Injection Protocol:

- 2,800 pounds of RemOx®-S ISCO Reagent will be mixed with approximately 46,700 gallons of water and prepared in a polytank (1,000 to 1,500-gallon, or as appropriate) in batches to prepare a 7 g/L potassium permanganate solution of approximately 46,700 gallons (one pore volume).
- The injection amount and sequence is listed below:
  - Inject approximately 4,600 gallons of 7 g/L potassium permanganate solution per well
  - Inject approximately 20 gallons of water chaser per well

SAP Worksheet #14 — Summary of Project Tasks (continued)

- The potassium permanganate solution will be delivered using an injection (and potentially recirculation system) that includes a water storage (or equalization) tank, polyethylene mixing tank, injection pumps, bag filter, secondary containment pads, electrical generator, delivery hose(s), and flow meters and pressure gauges. The injection will be completed under a low to moderate wellhead pressure of 5 to 30 psi. The injection pump will be rated at 5 to 500 psi with a flowrate capacity of up to 10 gallons per minute (gpm). Water to develop the potassium permanganate solutions will be provided via water truck.
- If 4,600 gallons per injection well is too high for the formation to accept during injection, the amount of water mixed with potassium permanganate may be decreased, resulting in an increase in potassium permanganate concentration up to 14 g/L being applied (23,000 gallons; half pore volume). If daylighting (i.e., surfacing of injectate) occurs, the injection work would move to the next injection well. The injection of remaining potassium permanganate solution into the well(s) with daylighting will be completed next day or the following days during the same mobilization.

ERD Pilot Study

The information in this subsection is based on the current understanding of site conditions. If evaluation of the supplemental ESI data alters this understanding, the information below will be adjusted accordingly and discussed with the Environmental Technical Subcommittee prior to implementation.

If conducted, the ERD pilot study involves injecting approximately 1 percent EVO solution into the aquifer (approximately 35 ft bgs; to be verified based on field borings) via up to five newly installed 2-inch-diameter injection wells: MW08 through MW12 with low pressure (up to 30 psi). The exact quantity and concentration of EVO solution, numbers of wells used for injection, an injection mode will be based on evaluation of the supplemental ESI findings and concurred upon among the stakeholder agencies prior to implementation. For the proposed pilot study, it is assumed that the TTA is approximately 50 ft by 50 ft adjacent to MW05. The lateral and vertical extent of the TTA is based on the COC concentrations in monitoring wells MW05 through MW07. The TTA may be revised based on the supplemental ESI data. EVO technical literature is located in Attachment D.

As part of the supplemental ESI sampling, the groundwater samples will be analyzed for parameters defined in Worksheet #18-a. The results will serve as the baseline conditions for evaluating ERD performance.

The following paragraphs describe the substrate demand and the protocol that will be followed during the ERD injection.

EVO Demand: A total of approximately 1,200 pounds of EVO (3 drums; EOS®598B42 at 420 pounds per 55-gallon drum) will be required for an approximately 50 ft by 50 ft TTA. The mass of EVO is based on the loading of 0.00075 pound of EVO per pound of soil in the TTA (to meet the natural adsorptive capacity of soil). A total of 13,000 gallons of 1 percent EVO solution (1,200 pounds of EVO) will be injected into the aquifer to address the target treatment interval from approximately 35 to 45 ft bgs (or adjusted by field geologist based on actual well screen intervals installed per field lithologic conditions and groundwater table).

SAP Worksheet #14 — Summary of Project Tasks (continued)

Injection Protocol:

- 1,200 pounds of EOS®598B42 will be mixed with approximately 12,000 gallons of water and prepared in a polytank (tank volume between 200 and 1,000 gallons) in batches to prepare a 1percent EVO solution of approximately 13,000 gallons.
- The injection amount and sequence is listed below:
  - Inject approximately 2,600 gallons of 1 percent EVO solution per well
  - Inject approximately 20 gallons of water chaser per well
- The EVO solution will be delivered using an injection trailer that includes a water storage (or equalization) tank, EVO storage tank, injection pump, electrical generator, delivery hose(s), and flow meters and pressure gauges. Inline diluters such as the D8R150 manufactured by Dosatron® International, Inc. may be included on the trailer to allow in-line addition and mixing of the EVO, if necessary. The injection will be completed under a low to moderate wellhead pressure of 5 to 30 psi. The injection pump will be rated at 5 to 500 psi with a flowrate capacity of up to 10 gpm. Water to develop the substrate solutions will be provided via water truck.
- If 2,600 gallons per injection well is too high for the formation to accept during injection, the amount of water mixed with EVO will be decreased, resulting in an increase in EVO concentration up to 2 percent being applied. If daylighting (i.e., surfacing of EVO solution) occurs, the injection work would move to the next injection well. The injection of remaining EVO solution into the well(s) with daylighting will be completed next day or the following days during the same mobilization.

Baseline and Post-Injection Groundwater Sampling

One round of groundwater samples will be collected from up to eight monitoring wells in the area around MW05 (MW05 through MW12) during the supplemental ESI as baseline data. If the pilot study is performed, an estimated three rounds of post-injection performance groundwater sampling will be conducted at 3 months, 9 months, and 15 months post injection as listed in the schedule in Worksheet #16. Additional post-injection sampling may be conducted based on evaluation of the first three post-injection events. The sampling will be conducted in general accordance with groundwater sampling SOPs in Final Master Standard Operating Procedures, Protocols, and Plans, SOP B-1.

Because one of the purposes of the supplemental ESI is to collect additional data to help determine whether an ISCO or ERD pilot study is warranted, parameters associated with both ISCO and ERD characterization will be analyzed during the supplemental ESI baseline groundwater sampling event. The overall analytical approach for groundwater is as follows:

- The supplemental ESI baseline groundwater samples will be analyzed for the COCs identified in Worksheet #10, comprising select VOCs (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC). In addition, well MW-05 will be sampled for natural attenuation parameters, comprising TOC, methane, ethane, ethene, volatile fatty acids (acetic, butyric, lactic, propionic, and pyruvic acids), *dehalococcoides*, alkalinity, total dissolved solids (TDS), chloride, nitrate, nitrite, sulfate, and sulfide.

SAP Worksheet #14 — Summary of Project Tasks (continued)

- If an ERD pilot study is selected and conducted, the post-injection groundwater samples will be analyzed as stated in the previous bullet.
- If an ISCO pilot study is selected and conducted, the post-injection groundwater samples will be analyzed for select VOCs (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC). Well MW05 will also be analyzed for TOC.

See numbers of samples and parameters in Worksheets #15, #18-a (baseline and ERD), #18-b (ISCO), #20-a (baseline and ERD), and #20-b (ISCO).

Baseline and post-injection field parameters, comprising pH, temperature, specific conductivity, ORP, turbidity, and DO will be measured in all wells. In addition, during the baseline event, total iron (II + III), ferrous iron (II), dissolved manganese (II) will be monitored in all wells in general accordance with the Final Master SOPs, Protocols, and Plans SOP C-1 (Calibration and Measurement with Field Instruments) and Master SOPs H2 (Water Level Measurement). Chemetrics Field Test Kits will be used for monitoring total iron via Chemetrics K-6210, ferrous iron via Chemetrics K-6210, and manganese via Chemetrics K-6502 or Hach 8034 or Color Chart (Appendix C).

If ERD is the selected pilot study approach, all of the above field parameters will be measured in each well during each post-injection event. If ISCO is the selected pilot study approach, total iron, ferrous iron, and dissolved manganese will not be monitored, but potassium permanganate via Hach DR 850 (or comparable) (Attachment C) will be done.

Monitoring Well Development

Wells MW05, MW06, and MW07 will be redeveloped if turbidity readings do not stabilize to within approximately 10 percent of each other over three consecutive readings during low-flow sampling (assuming the well has sufficient capacity to sustain low-flow purging and sampling). To the extent practicable, the development protocol in the well installation SOP will be followed for existing wells being redeveloped and any deviation from the SOP will be documented in field notes and the associated report.

Equipment Decontamination

Equipment decontamination will follow SOPs in the Final Master SOPs, SOPs E1 and E2.

Investigation-Derived Waste Management

IDW will be managed and disposed of in accordance with the Master Waste Management Plan (CH2M HILL, 2010c). Liquid and solid IDW will be sampled for full Toxicity Characteristic Leaching Procedure (TCLP) and RCI to determine the disposal options unless historical IDW sample data for this site is deemed sufficient by the disposal subcontractor.

Surveying

The locations and elevations of newly installed monitoring wells will be surveyed by a licensed surveyor in accordance with the Attachment H-7 of the Master SOPs. All locations of new soil borings will be determined using Real Time Kinematic (RTK) Global Positioning System (GPS)

SAP Worksheet #14 — Summary of Project Tasks (continued)

coordinates, accurate to approximately 2 centimeters, depending on ambient conditions such as canopy cover.

Shipments

All analytical samples will be sent by Fed Ex which has on-island staff. All equipment will be shipped to the Camp Garcia CH2M HILL office on Vieques. All samples will be shipped in accordance with the SOP in Master SOPs H-5 "Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods."

Quality Control

All quality control samples are listed on Worksheet #20. In reference to the field tasks, all field work will be overseen by a field team leader who is responsible for the quality control of the sampling and make sure the proper SOPs are followed for each task.

Sample Analysis

The laboratory will maintain, test, inspect, and calibrate analytical instruments (Worksheets #24 and #25). The laboratory will analyze soil and groundwater samples for various groups of parameters as shown on Worksheets # 15 and #18.

Data Management

The Project EIS is responsible for data tracking and storage. In addition a third party data validator will receive all analytical data from the laboratory and the data will be validated prior to its use by the Navy. All validated analytical data will be loaded into the NIRIS database.

Procedures for Recording and Correcting Data

Field data will be recorded in field logbooks.

Project Assessment/Audit: Worksheets #31 and #32.

Data Validation: Worksheets #35 and #36.

Data Usability Assessment: Worksheet #37.

This page intentionally left blank

SAP Worksheet #15-1 — Reference Limits and Evaluation Table

Matrix: Groundwater
Analytical Group: VOC

Analyte	CAS Number	Maximum Contaminant Level (µg/L)	PR GW Regs Class SG (µg /L)	RSLs-Tapwater Adjusted (µg /L)	Project Action Limit[1] (µg /L)	Project Quantitation Limit Goal[2] (µg /L)	Laboratory-Specific Limits (µg/L unless otherwise specified)					
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD (%)
Vinyl chloride	75-01-4	2	0.25	0.016	0.25	0.25	1	0.5	0.25	50	145	30
1,1-Dichloroethene	75-35-4	7	7	34	7	3.5	1	0.5	0.25	70	130	30
trans-1,2-Dichloroethene	156-60-5	100	100	11	100	50	1	0.5	0.25	60	140	30
cis-1,2-Dichloroethene	156-59-2	70	NC	7.3	70	35	1	0.5	0.25	70	125	30
Trichloroethene	79-01-6	5	5	2	5	2.5	1	0.5	0.25	70	125	30
Tetrachloroethene	127-18-4	5	5	0.11	5	5	1	0.5	0.25	45	150	30

Shading indicates instances where the laboratory specific LOD is greater than a screening level. If the only results exceeding PALs are U flagged, the constituents will be considered non-detect and not exceedances.

N/A: Not applicable; NC: No screening level

[1] The Project Action Limit is the minimum of the MCL or PR GW Regs Class SG. If there is no MCL or PR GW Regs Class SG, then the RSLs Tapwater Adjusted (current as of June 2011) is used. Because there is a MCL or PR GW Regs Class SG for each compound, the RSLs Tapwater Adjusted is presented for informational purposes only and shading is not consequential in that column.

[2] The Project Quantitation Limit Goal is 1/2 the PAL, the PAL, or the Laboratory Specific LOQ, as applicable.

SAP Worksheet #15-2 — Reference Limits and Evaluation Table

Matrix: Groundwater
Analytical Group: MICRO

Analyte	CAS Number[4]	Project Indicator Limit[2]	Project Quantitation Limit Goal[3]	Laboratory-specific[1] (cells/mL)		
				LOQ	LOD	DL
Dehalococcoides	DHC	N/A	0.5	0.5	0.1	0.1

N/A: Not applicable

1 QLs, MDLs, and limits for precision and accuracy are not applicable to all MICRO analyses.

2 There are no screening levels or project indicator limits for MICRO analyses.

3 The Project Quantitation Limit Goal is 1/2 the PIL, the PIL, or the Laboratory Specific LOQ, as applicable.

4 The CAS numbers for MICRO analytes are contractor-specific.

SAP Worksheet #15-3 — Reference Limits and Evaluation Table

Matrix: Groundwater
Analytical Group: WCHEM

Analyte	CAS Number[3]	Project Indicator Limit[1]	Project Quantitation Limit Goal[2]	Units	Laboratory-specific		
					LOQ	LOD	DL
Chloride	16887-00-6	N/A	0.500	mg/L	0.500	0.33	0.170
Nitrate	14797-55-8	N/A	0.20	mg/L	0.20	0.10	0.0330
Nitrite	14797-65-0	N/A	0.20	mg/L	0.20	0.10	0.0330
Sulfate	14808-79-8	N/A	2.0	mg/L	2.0	1.0	0.330
Sulfide	18496-25-8	N/A	4.0	mg/L	4.0	2.0	0.800
Methane	74-82-8	N/A	4.00	µg/L	4.00	2.00	1.00
Ethane	74-84-0	N/A	4.00	µg/L	4.00	2.00	1.00
Ethene	74-85-1	N/A	4.00	µg/L	4.00	2.00	1.00
Acetate	64-19-7	N/A	1.0	mg/L	1.0	0.375	0.15
Butyrate	107-92-6	N/A	1.0	mg/L	1.0	0.375	0.16
Lactic Acid	79-33-4	N/A	1.0	mg/L	1.0	0.375	0.30
Propionate	79-09-4	N/A	1.0	mg/L	1.0	0.375	0.17
Pyruvate	127-17-3	N/A	1.0	mg/L	1.0	0.375	0.25
Total organic carbon (TOC)	TOC	N/A	1.0	mg/L	1.0	0.50	0.25
Alkalinity	471-34-1	N/A	2.5	mg/L	2.5	1.0	1.0
Total Dissolved Solids (TDS)	TDS	N/A	20	mg/L	20.0	20.0	20.0

N/A: Not applicable

[1] There is no screening level or project indicator limit for these wet chemistry analytes.

[2] The Project Quantitation Limit Goal is 1/2 the PIL, the PIL, or the Laboratory Specific LOQ, as applicable.

[3] The CAS numbers for TOC and TDS are contractor-specific.

SAP Worksheet #15-4 — Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: VOC

Analyte	CAS Number	RSL Residential Soil Adjusted (µg/kg)	SSL (µg/kg)[3]	Soil ESV (µg/kg)	Project Action Limit[1] (µg/kg)	Project Quantitation Limit Goal[2] (µg/kg)	Laboratory-Specific Limits (µg/kg unless otherwise specified)					
							LOQ	LOD	DL	LCL (%)	UCL (%)	RPD (%)
Vinyl chloride	75-01-4	60	0.69	412	0.69	0.69	5	2.5	1.25	60	125	30
1,1-Dichloroethene	75-35-4	24000	2.5	173	2.5	2.5	5	2.5	1.25	65	135	30
trans-1,2-Dichloroethene	156-60-5	15000	29	447	29	14.5	5	2.5	1.25	65	135	30
cis-1,2-Dichloroethene	156-59-2	16000	21	447	21	10.5	5	2.5	1.25	65	125	30
Trichloroethene	79-01-6	2500	1.8	10	1.8	1.8	5	2.5	1.25	75	125	30
Tetrachloroethene	127-18-4	550	2.3	200	2.3	2.3	5	2.5	1.25	65	140	30

Shading indicates instances where the laboratory specific LOD is greater a screening level. If the only results exceeding PALs are U flagged, the constituents will be considered non-detect and not exceedances

[1] The Project Action Limit is the minimum of the Regional Screening Level (RSL) Residential Soil Adjusted (Jun 2011), SSL (Jun 2011), and Soil ESV (Aug 2010).

[2] The Project Quantitation Limit Goal is 1/2 the PAL, the PAL, or the Laboratory Specific LOQ, as applicable.

[3] The SSLs presented above are MCL-based. It was intended that if no MCL-based SSL existed the risk-based SSL would be used, however, each of these VOCs has an MCL-based SSL.

SAP Worksheet #15-5 — Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: WCHEM

Analyte	CAS Number[3]	Project Action Limit[1]	Project Quantitation Limit Goal[2]	Laboratory-specific (mg/kg)		
				LOQ	LOD	DL
Total organic carbon (TOC)	TOC	N/A	800	800	400	200

N/A: Not applicable

[1] There is no screening level or project action limit for TOC.

[2] The Project Quantitation Limit Goal is 1/2 the PAL, the PAL, or the Laboratory Specific LOQ, as applicable.

[3] The CAS number TOC is contractor-specific.

This page intentionally left blank

SAP Worksheet #16 — PI 4 Project Schedule / Timeline Table

Estimated Project Start Date: October, 2011

Tasks	Months																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Soil Boring, Well Installation, and Sampling																					
Pre-injection Baseline Groundwater Sampling and Gauging																					
Pilot Study Injection (if warranted)																					
Post-injection Groundwater Sampling and Gauging (if warranted)																					

Notes:

Refer to worksheet #18 for list of field parameters to be monitored and list of analytes to be collected.

The assumed field investigation start date is subject to change per agency's approval of the SAP and site accessibility.

This page intentionally left blank

SAP Worksheet #17 — Sampling Design and Rationale

The sampling rationale and design are based on meeting the supplemental ESI and potential pilot study objectives defined in Worksheet #10.

The Final SI/ESI Report (CH2M HILL, 2010a) identified TCE exceedance of the MCL in one well (MW05). Three other VOCs, 1,1-DCE, PCE, and VC, were historically detected in MW05 at concentrations below MCLs. Two other VOCs, cis-1,2-DCE and tran-1,2-DCE, are daughter products of TCE through the reductive dechlorination pathway. Since the objective of the supplemental ESI is to confirm the localized extent of contamination and absence of a VOC source area, and the objective of the potential pilot study is to determine if ERD or ISCO is effective on the TCE at the site, the aforementioned six VOCs will be analyzed in both soil and groundwater during the project. The numbers, locations, and depths of the samples are approximate (as defined in Worksheets #10 and #11 and **Figure 6**), but will be positioned to ensure the goals of the study are met.

The TOC in soil samples (mg/kg) will be analyzed to help calculate site-specific soil-to-groundwater SSLs and VOC adsorption capacity in soil, should a source area in soil be identified.

The supplemental ESI groundwater samples will be analyzed for the COCs identified in Worksheet #10, comprising select VOCs (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC). In addition, well MW-05 will be sampled for natural attenuation parameters, comprising TOC, methane, ethane, ethene, volatile fatty acids (acetic, butyric, lactic, propionic, and pyruvic acids), *dehalococcoides*, alkalinity, total dissolved solids (TDS), chloride, nitrate, nitrite, sulfate, and sulfide. The latter information will serve to evaluate existing groundwater conditions and will provide baseline information for comparison to future data should an ERD pilot study be performed.

If an ERD pilot study is selected and conducted, the post-injection groundwater samples will be analyzed as stated in the previous bullet. If an ISCO pilot study is selected and conducted, the post-injection groundwater samples will be analyzed for select VOCs (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC). Well MW05 will also be analyzed for TOC.

The rationale for the matrices (soil and groundwater) to be sampled, the number of samples per matrix, the analytical groups, and the concentration levels are detailed in Worksheets #10, #11, #14, #15, #18-a (baseline and ERD) and #18-b (ISCO). Sample locations are shown in **Figure 6**.

This page intentionally left blank

SAP Worksheet #18-a — PI 4 Sampling Locations and Methods/SOP Requirements Table
Soil Sampling, Baseline Groundwater, and Post-Injection Groundwater (for ERD Pilot Study)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group[1]	Number of Samples (identify field duplicates)[2]	Sampling SOP Reference[3]
Soil Sampling						
VEP4-SO16	VEP4-SB16-TTBB-MMYY	Soil (Unsaturated Zone)	Continuous split spoon soil sampling from ground surface to the bottom of the unconsolidated zone. Highest OVM reading will be collected or if no readings above background then the sample directly above the consolidated zone will be collected.	Select VOCs (TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, and VC) and TOC	2 (includes 1 Field Duplicate)	See Worksheet 21
VEP4-SO17	VEP4-SB17-TTBB-MMYY	Soil (Unsaturated Zone)	Same as for VEP4-SO16	Select VOCs and TOC	1	
VEP4-SO18	VEP4-SB18-TTBB-MMYY	Soil (Unsaturated Zone)	Same as for VEP4-SO16	Select VOCs and TOC	1	
VEP4-SO19	VEP4-SB19-TTBB-MMYY	Soil (Unsaturated Zone)	Same as for VEP4-SO16	Select VOCs and TOC	1	
VEP4-SO20	VEP4-SB20-TTBB-MMYY	Soil (Unsaturated Zone)	Same as for VEP4-SO16	Select VOCs and TOC	1	

SAP Worksheet #18-a — PI 4 Sampling Locations and Methods/SOP Requirements Table
Soil Sampling, Baseline Groundwater, and Post-Injection Groundwater (for ERD Pilot Study)` (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group[1]	Number of Samples (identify field duplicates)[2]	Sampling SOP Reference[3]
Baseline Groundwater and/or Post-Injection Groundwater (for ERD Pilot Study). Select VOCs are next-day TAT for baseline only. Numbers below reflect a given field event.						
EPI04-MW05	VEP4-GW05-MMYY	Groundwater	33-43 ft bgs screen interval	Select VOCs (TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, and VC), TOC, alkalinity, TDS, chloride, nitrate, nitrite, sulfate, and sulfide, methane, ethane, ethene, volatile fatty acids (acetic acid, butyric acid, lactic acid, propionic acid, pyruvic acid), and *Dehalococcoides*	2 (includes 1 Field Duplicate for VOCs only)	See Worksheet 21
EPI04-MW06	VEP4-GW06-MMYY	Groundwater	40.58-50.58 ft bgs screen interval	Select VOCs	1	
EPI04-MW07	VEP4-GW07-MMYY	Groundwater	29.82-39.82 ft bgs screen interval	Select VOCs	1	
EPI04-MW08	VEP4-GW08-MMYY	Groundwater	TBD based on well installation	Select VOCs	1	
EPI04-MW09	VEP4-GW09-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	
EPI04-MW10	VEP4-GW10-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	
EPI04-MW11	VEP4-GW11-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	
EPI04-MW12	VEP4-GW12-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	

[1] In addition to the samples above collected for laboratory analysis, field parameters including pH, temperature, specific conductivity, ORP, turbidity, DO, total iron, ferrous iron (II), and dissolved manganese (II)will be measured per the field monitoring schedule described in Worksheet 16. The monitoring wells will be gauged for depth to water prior-injection and during each subsequent performance monitoring event.

[2] Other than duplicates, QA/QC samples are not included in this worksheet. Please refer to Worksheet #12 for required field QA/QC samples and Worksheet #28 for required laboratory QA/QC samples.

[3] SOP or worksheet that describes the sample collection procedures.

TTBB = depth below ground surface of the top of the sample interval (TT) and the bottom of the sample interval (BB).
MMYY = numerical date (month and year)

SAP Worksheet #18-b — PI 4 Sampling Locations and Methods/SOP Requirements Table Post-Injection Groundwater (for ISCO Pilot Study)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group[1]	Number of Samples (identify field duplicates)[2]	Sampling SOP Reference[3]
Refer to Worksheet #18-a for Soil Sampling and Baseline Groundwater						
Post-Injection Groundwater (for ISCO Pilot Study). Numbers below reflect a given field event.						
EPI04-MW05	VEP4-GW05-MMYY	Groundwater	33-43 ft bgs screen interval	Select VOCs (TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, and VC) and TOC	2 (includes 1 Field Duplicate for VOCs only)	See Worksheet 21
EPI04-MW06	VEP4-GW06-MMYY	Groundwater	40.58-50.58 ft bgs screen interval	Select VOCs	1	
EPI04-MW07	VEP4-GW07-MMYY	Groundwater	29.82-39.82 ft bgs screen interval	Select VOCs	1	
EPI04-MW08	VEP4-GW08-MMYY	Groundwater	TBD based on well installation	Select VOCs	1	
EPI04-MW09	VEP4-GW09-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	
EPI04-MW10	VEP4-GW10-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	
EPI04-MW11	VEP4-GW11-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	
EPI04-MW12	VEP4-GW12-MMYY	Groundwater	Same as for EPI04-MW08	Select VOCs	1	

1 In addition to the samples above collected for laboratory analysis, field parameters including pH, temperature, specific conductivity, ORP, turbidity, DO, potassium permanganate will be measured per the field monitoring schedule described in Worksheet 16. The monitoring wells will be gauged for depth to water prior-injection and during each subsequent performance monitoring event.

2 Other than duplicates, QA/QC samples are not included in this worksheet. Please refer to Worksheet #12 for required field QA/QC samples and Worksheet #28 for required laboratory QA/QC samples.

3 SOP or worksheet that describes the sample collection procedures.

TTBB = depth below ground surface of the top of the sample interval (TT) and the bottom of the sample interval (BB).
MMYY = numerical date (month and year)

This page intentionally left blank

SAP Worksheet #19 — Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference[1]	Containers[6] (number, size, and type)	Sample Amount[2] (units)	Preservation Requirements (chemical, temperature, light-protected)	Maximum Holding Time[3] (preparation / analysis)
SO	VOC	SW-846 8260C / SOP-225, SOP-202	2 of 40mL glass plus 2oz jar	5g	5mL DI water, 4±2°C	48 hours to freeze / 14 days[4]
			1 of 40mL glass	5g	5mL methanol, 4±2°C	14 days
	WCHEM	Lloyd Kahn / SOP-221	1 of 4oz glass	0.25g	Cool to 4±2°C	14 days
GW	VOC	SW-846 8260C / SOP-202	3 of 40mL glass	40mL	HCl to pH < 2[7], no headspace, Cool to 4±2°C	14 days / 7 days if not chemically-preserved
	MICRO	qPCR / DNA-qPCR	1 of 1L HDPE or 1 of Bio-flo filter	1000mL[5]	4±2°C	24-48 hours
	WCHEM	EPA 300.0 / SOP-145	1 of 500mL HDPE	50mL	Cool to 4±2°C	48 hours (NO_3 and NO_2), 28 days (Cl and SO_4)
		SM2320B / SOP-154		50mL		14 days
		SM2540C / SOP-186		100mL		7 days
		SM4500 S-2 F /SOP-153	1 of 250mL HDPE	250mL	2N Zn Acetate, 6 N NaOH to pH > 12, Cool to 4±2°C	7 days
		RSK-175 / SOP-236	2 of 40mL glass	40mL	HCl to pH < 2, no headspace, Cool to 4±2°C	14 days
		BF-MB-009	2 of 40mL Vials	40mL	Cool to 4±2°C	28 Days
		SW-846 9060 / SOP-221	1 of 250mL HDPE	5mL	H_2SO_4 or HCl to pH 2, Cool to 4±2°C	28 days

1 Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

2 Provide the minimum sample volume or mass requirement if it differs from the container volume.

3 Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

4 If the field team cannot ship on the same day as sample collection, the low-level pre-preserved vials will be placed into a freezer as soon as possible. Date/time in and date/time out of freezer will be recorded. In this instance, the holding time, 48-hours, will be evaluated against the time spent not frozen. It will be assumed that the samples are frozen while in the freezer. Samples are frozen while in transit if received frozen at the laboratory. Samples are not frozen while in transit if received thawed at the laboratory.

5 To provide HDPE containers, collect the entire sample volume. To provide Bio-flo filters (these are preferred), record the volume which has passed through the filter, discard the water, and submit the filter for analysis. Collect water until the filter clogs. If less than 100mL passes through the filter, collect a second Bio-flo filter. There is no need to collect more than 1000mL of water.

6 Sample container requirements (number, size, and type) may vary slightly.

7 Chemical preservation requirements for aqueous VOCs may change if deemed necessary due to the presence of treatment chemicals in the groundwater.

This page intentionally left blank

SAP Worksheet #20-a — Field Quality Control Sample Summary Table
Soil Sampling, Baseline Groundwater, and Post-Injection Groundwater (for ERD Pilot Study)

Matrix	Analytical Group	No. of Sampling Locations[1,6]	No. of Field Duplicates	No. of MS/MSDs[2]	No. of Field Blanks[3]	No. of Equip. Blanks[4]	No. of Volatile Organic Analytes (VOA) Trip Blanks[4]	No. of PT Samples[5]	Total No. of Samples to Lab
Soil Sampling									
Soil Sample (SO)	VOCs	5	1	1	0	3	3	0	14
	WCHEM (TOC)	5	0	0	0	0	0	0	5
Baseline Groundwater and/or Post-Injection Groundwater (for ERD Pilot Study). Numbers below reflect a given field event.									
GW	VOCs	8	1	1	0	4	4	0	19
	MICRO (DHC)	1	0	0	0	0	0	0	1
	WCHEM (Cl^-, NO_3^-, NO_2^-, SO_4^{2-}, S^{2-}, TOC, Alkalinity, TDS, methane, ethane, ethene, and volatile fatty acids (acetic acid, butyric acid, lactic acid, propionic acid, and pyruvic acid))	1	0	0	0	0	0	0	1

1 One soil sample will be collected from each new boring.

2 Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field.

3 Field blanks will not be collected.

4 The number of equipment blanks and trip blanks is based on a fundamental assumption of the number of sampling days each site will require and the type of sampling equipment used. Refer to Worksheet #12 for the required frequency.

5 The numbers of Batch or Project-specific proficiency testing (PT) samples are optional but highly recommended.

6 The sampling locations count provided represents the number of samples that may be collected. For groundwater, fewer than 8 MWs may be sampled post-injection, pending delineation of the TCE plume. If fewer locations are sampled, field QC samples will be collected according to the frequency listed in Worksheet 12.

SAP Worksheet #20-b — Field Quality Control Sample Summary Table Post-Injection Groundwater (for ISCO Pilot Study)

Matrix	Analytical Group	No. of Sampling Locations[5]	No. of Field Duplicates	No. of MS/MSDs[1]	No. of Field Blanks[2]	No. of Equip. Blanks[3]	No. of VOA Trip Blanks[3]	No. of PT Samples[4]	Total No. of Samples to Lab
Refer to Worksheet #20-a for Soil Sampling and Baseline Groundwater									
Post-Injection Groundwater (for ISCO Pilot Study). Numbers below reflect a given field event.									
GW	VOCs	8	1	1	0	4	4	0	19
	WCHEM (TOC)	1	0	0	0	0	0	0	1

1 Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field.

2 Field blanks will not be collected.

3 The number of equipment blanks and trip blanks is based on a fundamental assumption of the number of sampling days each site will require and the type of sampling equipment used. Refer to Worksheet #12 for the required frequency.

4 The numbers of Batch or Project-specific proficiency testing (PT) samples are optional but highly recommended.

5 The sampling locations count provided represents the number of samples that may be collected. For groundwater, fewer than 8 MWs may be sampled post-injection, pending delineation of the TCE plume. If fewer locations are sampled, field QC samples will be collected according to the frequency listed in Worksheet 12.

SAP Worksheet #21 — Project Sampling SOP References Table

Master SOPs (CH2M HILL, 2010c) Reference numbers refer to the SOP number in the Draft Final Master Standard Operating Procedures, Protocols and Plans, Environmental Restoration Program, Vieques, Puerto Rico.

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
Master SOPs, A-2	Soil Sampling (revised April 2010)	CH2M HILL	Drill rig	N	
Master SOPs, A-3	Homogenization of Soil and Sediment Samples (revised April 2010)	CH2M HILL	Sample containers, stainless steel spoons and stainless steel bowls	N	
Master SOPs, A-6	Soil Sampling for VOCs Using the Terra Core Sampler (revised April 2010)	CH2M HILL	Terra Core Sampler	N	
Master SOPs, A-2	Soil Sampling (revised April 2010)	CH2M HILL	Split Spoon	N	
Master SOPs, A-2, attachment	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (revised April 2010)	American Society for Standards and Materials (ASTM) D 2488-00	ASTM document	N	
Master SOPs, A-1	Soil Boring Drilling and Abandonment (revised April 2010)	CH2M HILL	Drill rig	N	
Master SOPs, B-1	Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling (revised April 2010)	CH2M HILL	Low Flow pump	N	
Master SOPs, C-1	Calibration and measurement with Field Instruments (revised April 2010)	CH2M HILL	Multi-parameter groundwater monitoring instrument, PID	N	
Master SOPs, E-1	Decontamination of Personnel and Equipment (revised April 2010)	CH2M HILL	Decon equipment	N	
Master SOPs, E-2	Decontamination of Drilling Rigs and Equipment (revised April 2010)	CH2M HILL	Pressure washer	N	
Master SOPs, H-1	Preparing Field Log Books (revised April 2010)	CH2M HILL	Log book	N	
Master SOPs, H-2	Water Level Measurements (revised April 2010)	CH2M HILL	Electric water level device	N	
Master SOPs, Master WMP	Master Waste Management Plan (revised April 2010)	CH2M HILL	Water and soil drums	N	
Master SOPs, H-4	Chain-of-Custody (revised April 2010)	CH2M HILL	SOP, tape, custody seals, electronic chain of custody forms	N	

SAP Worksheet #21 — Project Sampling SOP References Table (continued)

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
Master SOPs, H-5	Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods (revised April 2010)	CH2M HILL	SOP	N	
Master SOPs, H-6	Equipment Blank Preparation (revised April 2010)	CH2M HILL	Sample containers	N	
Attachment C	Operational Instructions for Chemetrics Field Test Kits (total iron, ferrous iron, and dissolved manganese) (revised April 2010) and Hach field text kits	Vendor (Chemetrics and Hach)	CHEMet ampouls and sample cup and Hach test kit or color chart.	N	Manufacturers SOP included as attachment Not included in Master Quality Assurance Project Plan (MQAPP

SAP Worksheet #22 — Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Resp. Person	SOP Reference
YSI pH probe	Calibrate probe using YSI Auto-Calibration Standard Solution	Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Visual Inspection	Daily, before use	Std X-0.2<Reading<Std X+0.2	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	MQAPP Attachment 1 C-1
YSI Specific conductance Probe	Calibrate probe using YSI Calibration Standard Solution	Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Visual Inspection	Daily, before use	±3%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	MQAPP Attachment 1 C-1
Hach Turbidity Meter	Calibrate probe using Hach-Calibration Standard	Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Visual Inspection	Daily, before use	0.1 to 10 NTU standard - ±10%; 11 to 40 NTU standard - ±8%; 41 to 100 NTU standard - ±6.5%; >100 NTU standard - ±5%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	MQAPP Attachment 1 C-1
YSI Dissolved oxygen and Temperature Probes	Calibrate probe using YSI-Calibration Standard Solution	Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	During calibration of other probes, check these readings against the day's atmospheric pressure and ambient temperature Check sensor for bubbles and membrane for wrinkles or tear. Visual Inspection	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	±3 mg/L DO of what the tabulated DO is for the measured temperature	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly. Follow manufacturer's instructions to remove bubble or replace torn membrane	FTL	MQAPP Attachment 1 C-1
YSI multi-meter	Calibrate probe using multiple Calibration Standard Solutions	Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check.	Visual Inspection	Daily before use, at the end of the day (if practicable), and when unstable readings occur.	Stable readings after 3 minutes pH reads 4.0 +/- 3% conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	MQAPP Attachment 1 C-1

SAP Worksheet #22 — Field Equipment Calibration, Maintenance, Testing, and Inspection Table (continued)

Field Equipment	Calibration Activity	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Resp. Person	SOP Reference
PID	Calibrate using ambient air and isobutylene 100ppm calibration gas	Recharge battery daily	Visual Inspection	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	Ambient air reads 0.0 ppm +/- 3% Isobutylene gas reads 100 ppm +/- 3% ambient air reads 0.0 ppm ±3%: (if possible).	Follow instructions in manual to clean sensor. Do not use this instrument if unable to calibrate properly.	FTL	MQAPP Attachment 1 C-8
ORP	Calibrate using ORP standard solution	Check batteries and have a replacement set on hand	Visual inspection	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	±10 mV of the theoretical redox standard value at that temperature	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly	FTL	MQAPP Attachment C-1
Groundwater sampling pumps and tubing	No calibration required	N/A	Inspect pumps, tubing and air/sample line quick-connects	Regularly	Maintained in good working order per manufacturer's recommendations	Replace items	FTL	MQAPP Attachment 1 B-1

SAP Worksheet #23 — Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Date Last Reviewed if not Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?[1] (y/n)
SOP-145	Determination of Inorganic Anions in water by ION Chromatograph using the Dionex dx-500 Ion Chromatograph with Hydroxide Eluent And Dionex AS18 Column, USEPA Method 300.0/SW846 Method 9056, 3/25/10, Rev 7		Screening	GW / WCHEM	Ion Chromatograph (IC)	Empirical Laboratories	N
SOP-153	Sulfide by Method 376.1 and Standard Methods SM4500S F(21st ED, Titrimetric, Iodine) with Sample Pretreatment to Remove Interfering Substances or to Concentrate the Sulfide, 9/7/10, Rev 4		Screening	GW / WCHEM	Spectrophotometer		N
SOP-154	Total Alkalinity, Carbonate, Bicarbonate by Method USEPA 310.1, SM2320B (20th and 21st Edition), 9/21/10, Rev 7		Screening	GW / WCHEM	N/A		N
SOP-186	Filterable Residue Total Dissolved Solids and Total Dissolved Volatile Solids by Method 160.1 and Standard Methods 2540C (Gravimetric, Dried at 180°C), 9/7/10, Rev 5		Screening	GW / WCHEM	N/A		N
SOP-202	GC/MS Volatiles by EPA Method 624 & SW846 Method 8260B Including Appendix IX Compounds, 9/9/10, Rev 23		Definitive	GW, SO / VOC	GC/MS		N
SOP-221	Total Organic Carbon (TOC) by SM5310C, SW846 Method 9060/9060A and Lloyd Kahn Method "Determination of TOC in Sediment", 7/12/10, Rev 9		Screening	GW, SO / WCHEM	TOC Analyzer		N[2]
SOP-225	GC/MS Volatile Non-Aqueous Matrix Extraction Using SW-846 Method 5035 for 8260B Analysis, 9/7/10, Rev 9		Definitive	SO / VOC	N/A		N
SOP-236	Methane, Ethane, Ethene in Aqueous Samples by Modified RSK-175 (Automated Headspace), 9/7/10, Rev 2		Screening	GW / WCHEM	Gas Chromatograph (GC)/ Flame Ionization Detector (FID)		N
SOP-QS10	Laboratory Sample Receiving, Log In and Storage, 11/17/10, Rev 16		N/A	N/A	N/A		N
SOP-QS14	Analytical Laboratory Waste Disposal, 8/31/10, Rev 6		N/A	N/A	N/A		N
BF-MB-009	Volatile Fatty Acids (VFA), 4/30/10, Rev 1		Screening	GW / WCHEM	IC	TestAmerica	N
DNA-qPCR	Quantitative Polymerase Chain Reaction (qPCR), 1/10/06, Rev 1.0	6/19/10	Screening	GW / MICRO	PCR System	Microbial Insights	N
DNA-EXT	Extraction of DNA from Environmental Samples (Matrix-Water, Soil, Biofilm, Bio-Sep Beads), 1/5/06, Rev 1.0	6/19/10	N/A	N/A	N/A	Microbial Insights	N
Waste Disposal	Waste Disposal, 3/1/08, Rev 1.0	6/19/10	N/A	N/A	N/A	Microbial Insights	N

[1] If yes, then specify the modification that has been made. Note that any analytical SOP modification made relative to project specific needs must be reviewed and approved by the Navy QAO.

[2] TOC analysis is performed in quadruplicate. All four runs and the average are reported in the hardcopy. Only the average is reported in the EDD.

This page intentionally left blank

SAP Worksheet #24 — Analytical Instrument Calibration Table

Instrument	Calibration Procedure[3]	Frequency of Calibration[3]	Acceptance Criteria[3]	Corrective Action (CA)[3]	Person Responsible for CA[2]	SOP Reference[1]
GC/MS (VOCs)	Tuning	Prior to ICAL and at the beginning of 12-hour analytical sequence	Refer to EPA Method SW-846 8260C for specific ion criteria.	Retune instrument and verify; rerun affected samples.	Empirical Analyst / Laboratory Manager	SOP-202
	ICAL	After major instrument maintenance; prior to sample analysis (five points required for linear calibration, six points required for quadratic calibration, or seven points required for cubic calibration)	1. Average response factor (RF) for VOC system performance check compounds (SPCCs) *if target analytes:* ≥0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. Relative standard deviation (RSD) for calibration check compounds (CCCs) *if target analytes* for VOCs ≤ 30% and one option below: Option 1 - RSD for each analyte ≤ 15% Option 2 - linear least squares regression r ≥ 0.995 Option 3 - non-linear regression-coefficient of determination (COD) r^2 ≥ 0.990 (6 points shall be used for quadratic or 7 points shall be used for cubic regression)	Correct problem then repeat ICAL		
	ICV	After each ICAL (second source)	All target analytes within ± 20% of the true value.	Correct problem and verify second source standard; *prepare new standard(s);* if that fails correct problem and repeat ICAL.		
	CCV	Daily before sample analyses and once per 12-hour analysis period	1. Average RF for VOC SPCCs, *if target analytes:* ≥0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane 2. %Difference/Drift for all target analytes and surrogates ≤20%D (note: D = Difference when using RFs, or Drift when using lease squares regression or non-linear calibration).	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.		
	Retention time window position establishment	For each target analyte and surrogate; once per ICAL	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	N/A		
	Evaluation of relative retention time (RRT)	With each sample	RRT of each target analyte within ±*0.05* RRT units	Correct problem then rerun *CCV and/or* ICAL		

SAP Worksheet #24 — Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure[3]	Frequency of Calibration[3]	Acceptance Criteria[3]	Corrective Action (CA)[3]	Person Responsible for CA[2]	SOP Reference[1]
IC (Cl, NO_3, NO_2, SO_4)	ICAL	Daily before analysis	r ≥ 0.995	Correct problem and repeat ICAL.	Empirical Analyst / Laboratory Manager	SOP-145
	ICB	Once after each ICAL, prior to analytical sequence	Target analytes less than the LOQ.	Correct problem and repeat ICAL.		
	ICV	Once after each ICAL, prior to analytical sequence	The percent recovery of all analytes must be 90-110%.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat initial calibration.		
	CCB	Every 10 samples and at the end of the analytical sequence	Target analytes ≤ 1/2 LOQ.	Correct problem. Then rerun calibration verification. If that fails, repeat ICAL and reanalyze all samples run since last acceptable CCV		
	CCV	Perform after each 10 samples and at the end of the analysis sequence.	The percent recovery of all analytes must be 90-110%.	Correct problem. Then rerun calibration verification. If that fails, repeat ICAL and reanalyze all samples run since last acceptable CCV		
GC/FID (Methane, Ethane, Ethene)	ICAL	After major instrument maintenance; upon 2nd consecutive failure of CCV standard (five point calibration)	RSD between the calibration factors must be ≤ 20%	Recalibrate	Empirical Analyst / Laboratory Manager	SOP-236
	ICV	After each ICAL (second source)	Run at midpoint of the curve. All target analytes within ± 20% of the true value.	Correct problem and verify second source standard; prepare new standard(s) if that fails and repeat ICAL.		
	CCV	At the beginning of the analytical sequence; after each 10 field samples; at the end of the analytical sequence	%D between the calibration factors in the CCV and the average calibration factors must be ≤20%	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.		
IC (VFAs)	ICAL	Once every six months at a minimum	Linear five points plus origin; r ≥ 0.995	Correct problem and repeat ICAL.	Test America-Buffalo Analyst / Laboratory Manager	BF-MB-009
	ICV	Once after a new calibration curve	80-120%	Correct problem. Repeat ICV. Repeat ICAL if necessary.		
	ICB	Once after a new calibration curve	< reporting limit	Correct problem. Repeat ICB. Repeat ICAL if necessary.		
	CCB	Every 10 samples; refer to Worksheet 28-3	< reporting limit	Investigate source of contamination. Rerun method		

SAP Worksheet #24 — Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure[3]	Frequency of Calibration[3]	Acceptance Criteria[3]	Corrective Action (CA)[3]	Person Responsible for CA[2]	SOP Reference[1]
		for method blank		blank.		
	CCV	Every 10 samples; refer to Worksheet 28-3 for laboratory control sample	80-120%	Reanalyze. Investigate standards and recalibrate if necessary.		
TOC Analyzer	ICAL	Quarterly	r ≥ 0.995	Correct problem and repeat ICAL.	Empirical Analyst / Laboratory Manager	SOP-221
	ICV/CCV	Beginning and end of analysis and every 10 samples	All target analytes within ± 15% of the true value.	Reprepare and reanalyze. If it fails again, repeat ICAL.		
pH Meter	Calibration	Before analysis then check every 3 hours	4 ± 0.05 pH units; 7 ± 0.05 pH units; pH 10 ±0.10 pH units; ±0.20 pH units for check	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.	Empirical Analyst / Laboratory Manager	SOP-154
ABI 7300 (DHC)	ICAL	Primary – annual	Standard curve r^2 >0.95	Rerun assay / check reagents.	Analyst	DNA-qPCR
	CCV	Secondary – every plate (assay)	CT value within 2 units of same point on standard curve	Rerun assay / check reagents.		

1 Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

2 Name or title of responsible person may be used.

3 DoD QSM v. 4.1 is the basis for specifications on this table. Information in italics is in addition to or a clarification of DoD QSM v. 4.1 information. For Cl, NO3, NO2, SO4, Methane, Ethane, Ethene, VFAs, TOC, pH, and DHC, analytical laboratory SOPs are the basis for specifications on this table.

This page intentionally left blank

SAP Worksheet #25 — Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person[2]	SOP Reference[1]
GC/MS (VOCs)	Check pressure and gas supply daily. Bake out trap and column, manual tune if BFB not in criteria, change septa as needed, cut column as needed, change trap as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Tune (BFB or DFTPP), Continuing Calibration Verification	Ion source, injector liner, column, column flow, purge lines, purge flow, trap.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Empirical Analyst / Laboratory Manager	SOP-202
GC/FID (Methane, Ethane, Ethene)	Check pressure and gas supply daily. Change septa and/or liner as needed, replace or cut column as needed. Check flame and FID jet. Other maintenance specified in lab Equipment Maintenance SOP.	Continuing Calibration Verification	Injector liner, septa, column, column flow, flame, jet	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Empirical Analyst / Laboratory Manager	SOP-236
IC (Cl, NO3, NO2, SO4)	Change analytical column as needed, change mobile phase when insufficient for run or contamination, change inlet filters as needed for contamination	Initial Calibration Verification and ICBlank	Check pump pressure, check for leaks, check for adequate mobile phase	Daily or as needed	Acceptable ICAL and CCV.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data	Empirical Analyst / Laboratory Manager	SOP-145
TOC Analyzer	Clean syringe, replace scrubber as needed, change filters as needed (water). Replace sample tubing, clean sample boat, replace syringe (soil).	Standard Check sample	Check gas supply, check lamp, tubing, reagent volumes (water). Check tubing, sample boat, syringe (soil).	Daily or as needed	Acceptable ICAL and CCV.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data	Empirical Analyst / Laboratory Manager	SOP-221
Burrette	Clean burette	Inspection	Check burette tip for breakage	Before each use	Clean and unbroken	Replace broken burettes. Reanalyze	Empirical Analyst / Laboratory Manager	SOP-153; SOP-154
pH Meter	Change buffer solutions or pH probe	Calibrate meter	Change buffer solutions or pH probe	Before analysis begins, check every 3 hours	4 ± 0.05 pH units; 7 ± 0.05 pH units; pH 10 ±0.10 pH units; ±0.20 pH units for check	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data	Empirical Analyst / Laboratory Manager	SOP-154
ABI 7300 (DHC)	Background check monthly; Dye calibration annually	Initial Calibration Verification and Background check	Monitor instrument performance via Initial Calibration Verification and Blank	Daily, after every 10 samples	Standard curve r^2 value >0.95: CT value within 2 units of same point on standard curve	Clean wells, rerun background assay. See SOP	Analyst	DNA-qPCR
IC (VFAs)	Change guard columns as required, Change pump seals Semi-annually or as required, replace tubing as required, Filter all samples and solvents daily.	Initial Calibration Verification	Monitor instrument performance via Initial Calibration Verification and Blank	After every 10 samples or less	80-120%, r value of curve ≥ 0.995.	See SOP	Test America-Buffalo Analyst / Laboratory Manager	BF-MB-009

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

[2] Name or title of responsible person may be used.

This page intentionally left blank

SAP Worksheet #26 — Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team Leader (Kenji Butler)/CH2M HILL
Sample Packaging (Personnel/Organization): Sample Processor or Field Team Member (Charlotte Cisneros)/CH2M HILL
Coordination of Shipment (Personnel/Organization): Sample Processor or Field Team Member (Charlotte Cisneros)/CH2M HILL
Type of Shipment/Carrier: Overnight/FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receipt Personnel/Empirical Laboratories; Note all analytical fractions will be shipped directly to Empirical with the exception of MICRO. Empirical will ship applicable fractions to Test America-Buffalo. Due to holding time constraints, MICRO fractions will be shipped directly to Microbial Insights.
Sample Custody and Storage (Personnel/Organization): Sample Receipt Personnel/Empirical Laboratories, Microbial Insights, Test America-Buffalo
Sample Preparation (Personnel/Organization): Extractions Personnel/Empirical Laboratories, Microbial Insights, Test America-Buffalo
Sample Determinative Analysis (Personnel/Organization): Analyst/Empirical Laboratories, Microbial Insights, Test America-Buffalo
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 45 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Extracts may be disposed of 90 days after extraction.
Biological Sample Storage (No. of days from sample collection): Microbial Insights, 90 days or until sample is consumed
SAMPLE DISPOSAL
Personnel/Organization: Environmental Health and Safety Officer/Empirical Laboratories, Microbial Insights, Test America-Buffalo
Number of Days from Analysis: Samples may be disposed of 45 days after analysis

This page intentionally left blank

SAP Worksheet #27 — Sample Custody Requirements Table

Sample Labeling:

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservative, and sampler's initials. Standard sample nomenclature for blind field duplicates includes a "P" after the station identifier. Labels will be taped to the jar to ensure that they do not separate. The following exceptions apply:

Aqueous VOCs: Labels will not be taped onto the 40mL VOA vials because the tape interferes with the laboratory's robotic autosampler. Instead, indelible ink will be used on a waterproof label.

Solid VOCs: Labels will not be applied to the 40mL VOA vials because the vials are pre-weighed. The labels cover up the tare weight and add to the tare weight. Tape will not be applied because it adds to the tare weight. Instead, indelible ink will be used on the label already applied to each vial.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Samples will be collected by field team members under the supervision of the field team leader. As samples are collected, they will be placed into containers and labeled, as outlined above. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples below 4°C until they are received by the laboratory. The chain of custody (C-O-C) will also be placed into the cooler. Coolers will be shipped to the laboratory via FedEx, with the airbill number indicated on the C-O-C (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples. See SOP H-4 for details regarding use of custody seals.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Please refer to SOP SOP-QS14 Sample Receipt, Storage, Tracking and Disposal".

Sample Identification Procedures:

Upon opening the cooler, the receiving clerk signs the C-O-C and then takes the temperature using the temperature blank (if absent, then a sample container or infrared thermometer is used). The sample containers in the cooler are unpacked and checked against the client's C-O-C and any discrepancies or breakage is noted on the C-O-C. Next, if any water samples require preservative, the clerk will check the pH values to see if they are in the acceptable pH range. The pH of aqueous VOCs samples will not be checked upon receipt at the laboratory. The clerk will deliver the C-O-C (and any other paperwork; e.g. temperature or pH QA notice) to the project manager for Laboratory Information Management Systems (LIMS) entry and client contact (if needed).

The field logbook will identify the sample ID with the location, depth, date/time collected, and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain of custody. The laboratory will send sample log-in forms to EIS to check sample IDs and parameters are correct.

Chain-of-Custody Procedures:

Chains of custody will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID, date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain of custody will also have the sampler's name and signature. The chain of custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the LIMS database for each sample.

This page intentionally left blank

SAP Worksheet #28-1 — Laboratory QC Samples Table

Matrix: GW						
Analytical Group: VOC						
Analytical Method / SOP Reference: SW-846 8260C / SOP-202						
QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Method Blank	One per prep batch of twenty or fewer samples of similar matrix	Target analytes must be < ½ LOQ or <1/10 the concentration found in the sample or <1/10th the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL.	Correct problem, then see criteria in Box D-1 of QSM 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per prep batch of twenty or fewer samples of similar matrix	See Worksheet 15-1	Correct the problem, then reprep and reanalyze the LCD and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. *If the LCS recoveries are high but the sample results are <QL narrate. Flag with * on Recovery Form. LCS exceedances may indicate the need to recalibrate as described in Worksheet #24.*	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤ 20%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as QC acceptance limits.
Matrix Spike	One per prep batch of twenty or fewer samples of similar matrix	Same as LCS, see Worksheets 15-1	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. *If recoveries are outside limits and surrogate and LCS criteria are met, note in narrative. If both the LCS and MS/MSD are unacceptable reprep the samples and QC. Check standard prep. Flag outliers with * on Recovery Form.*	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.

SAP Worksheet #28-1 — Laboratory QC Samples Table (continued)

Matrix: GW
Analytical Group: VOC
Analytical Method / SOP Reference: SW-846 8260C / SOP-202

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Matrix Spike Duplicate	One per prep batch of twenty or fewer samples of similar matrix	Same as MS, RPD ≤ 30%	Same as MS	Analyst, Supervisor, QA Manager	Accuracy/Bias, Precision	Same as QC acceptance limits.
Internal Standards (IS)	All field, QC, and standard samples	Retention time (RT) ±0.5 minutes compared to RT of the midpoint standard in the ICAL. Extracted Ion Current Profile (EICP) area within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer (MS) and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory. *If similar results, report both runs. Flag outliers with an * on Form 8.*	Analyst	Accuracy	Same as QC acceptance limits.
Surrogates	All field and QC samples	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits. DoD criteria: 1,2-Dichloroethane-d4 70-120% Bromofluorobenzene 75-120% Dibromofluoromethane 85-115% Toluene-d8 85-120% *One out allowed if the exceedance is high and the sample is nondetect, or if there is obvious chromatographic interference.*	For QC and field samples, correct the problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. *Report both if second successful analysis is outside Holding Time or both fail QC criteria. Flag with * on Form 2.*	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.

DoD QSM v. 4.1 is the basis for specifications on this table. Information in italics is in addition to or a clarification of DoD QSM v. 4.1 information.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

SAP Worksheet #28-2 — Laboratory QC Samples Table

Matrix: GW
Analytical Group: MICRO
Analytical Method / SOP Reference: qPCR / DNA-qPCR

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Assay Negative Control (Blank)	1 per analytical assay plate	Values for positive samples are set above any fluorescence for the negative control.	Rerun assay; may have to reoptimize assay.	Analyst	Accuracy/Bias, Contamination	Values for positive samples are set above any fluorescence for the negative control.
DNA extraction negative control	1 per analytical batch	CT ≤ Assay Negative Control	Rerun assay or reextract samples if problem persists	Analyst	Accuracy/Bias	CT ≤ Assay Negative Control
Positive Control	1 per analytical assay plate	CT value within 2 units of same point on standard curve	Rerun assay / check reagents	Analyst	Accuracy/Bias	CT value within 2 units of same point on standard curve

Analytical laboratory SOPs are the basis for specifications on this table.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

SAP Worksheet #28-3 — Laboratory QC Samples Table

Matrix: GW
Analytical Group: WCHEM
Analytical Method / SOP Reference: EPA 300.0, SM4500-S2-F, RSK-175, Lab SOP, SW-846 9060, SM2320B, SM2540C; SOP-145, SOP-153, SOP-236, BF-MB-009, SOP-221, SOP-154, SOP-186

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Chloride, Nitrate, Nitrite, Sulfate (EPA 300.0)						
Method Blank	One per batch	< 1/2 LOQ or <1/10 the concentration found in the sample	Investigate source of contamination. Rerun method blank.	Analyst, Laboratory Supervisor	Bias/Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per batch of 20 or fewer samples	90-110% recovery	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy/Bias	Same as QC acceptance limits.
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤20%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Bias, Precision	Same as QC acceptance limits.
Matrix Spike	If deemed necessary by the laboratory	80-120% recovery	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy/Bias	Same as QC acceptance limits.
Matrix Spike Duplicate	If deemed necessary by the laboratory	Same as MS, RPD ≤20%	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy, Bias, Precision	Same as QC acceptance limits.
Sulfide (SM4500-S2-F)						
Method Blank	One per batch	< 1/2 LOQ or <1/10 the concentration found in the sample	Investigate source of contamination. Rerun method blank.	Analyst, Laboratory Supervisor	Bias/Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per batch of 20 or fewer samples	80-120% recovery	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy	Same as QC acceptance limits.
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤20%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as QC acceptance limits.
Matrix Spike (MS)	One per batch of 20 or fewer samples	75-125% recovery	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy	Same as QC acceptance limits.

SAP Worksheet #28-3 — Laboratory QC Samples Table (continued)

Matrix: GW
Analytical Group: WCHEM
Analytical Method / SOP Reference: EPA 300.0, SM4500-S2-F, RSK-175, Lab SOP, SW-846 9060, SM2320B, SM2540C; SOP-145, SOP-153, SOP-236, BF-MB-009, SOP-221, SOP-154, SOP-186

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Matrix Spike Duplicate (MSD)	One per batch of 20 or fewer samples	Same as MS, RPD ≤20%	Same as MS.	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as QC acceptance limits.
Laboratory Replicate	One per batch	RPD ≤20%	Reanalyze.	Analyst, Laboratory Supervisor	Precision	Same as QC acceptance limits.
Dissolved Gasses (RSK-175)						
Method Blank	One per batch of 20 or fewer samples	< 1/2 LOQ or <1/10 the concentration found in the sample	Reanalyze if sample volume remains or qualify.	Analyst, Laboratory Supervisor	Bias/Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per batch of 20 or fewer samples	80-120% recovery	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy	Same as QC acceptance limits.
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤30%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as QC acceptance limits.
Matrix Spike (MS)	One per batch of 20 or fewer samples	75-125% recovery	CA will not be taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable reanalyze samples and QC.	Analyst, Laboratory Supervisor	Accuracy	Same as QC acceptance limits.
Matrix Spike Duplicate (MSD)	One per batch of 20 or fewer samples	Same as MS, RPD ≤30%	Same as MS.	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as QC acceptance limits.
Volatile Fatty Acids (Lab SOP)						
Method Blank	One per batch	< LOQ	Investigate source of contamination. Rerun method blank.	Analyst, Laboratory Supervisor	Bias/Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per batch of 10 or fewer samples	80-120% recovery	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy/Bias	Same as QC acceptance limits.

SAP Worksheet #28-3 — Laboratory QC Samples Table (continued)

Matrix: GW
Analytical Group: WCHEM
Analytical Method / SOP Reference: EPA 300.0, SM4500-S2-F, RSK-175, Lab SOP, SW-846 9060, SM2320B, SM2540C; SOP-145, SOP-153, SOP-236, BF-MB-009, SOP-221, SOP-154, SOP-186

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤20%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Bias, Precision	Same as QC acceptance limits.
Matrix Spike	If deemed necessary by the laboratory	80-120% recovery	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy/Bias	Same as QC acceptance limits.
Matrix Spike Duplicate	If deemed necessary by the laboratory	Same as LCS, RPD ≤20%	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy, Bias, Precision	Same as QC acceptance limits.
Total Organic Carbon (SW-846 9060)						
Method Blank	One per batch of 20 or fewer samples	< 1/2 LOQ or <1/10 the concentration found in the sample	Investigate source of contamination. Rerun method blank.	Analyst, Laboratory Supervisor	Bias/Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per batch of 20 or fewer samples	80-120% recovery	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy/Bias	Same as QC acceptance limits.
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤20%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Bias, Precision	Same as QC acceptance limits.
Laboratory Duplicate	One per batch	RPD ≤20%	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Precision	Same as QC acceptance limits.
Matrix Spike	One per batch of 20 or fewer samples	75-125% recovery	CA will not be taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable reanalyze samples and QC.	Analyst, Laboratory Supervisor	Accuracy/Bias	Same as QC acceptance limits.
Matrix Spike Duplicate (MSD)	One per batch of 20 or fewer samples	Same as MS, RPD ≤20%	Same as MS.	Analyst, Laboratory Supervisor	Accuracy/Precision	Same as QC acceptance limits.

SAP Worksheet #28-3 — Laboratory QC Samples Table (continued)

Matrix: GW
Analytical Group: WCHEM
Analytical Method / SOP Reference: EPA 300.0, SM4500-S2-F, RSK-175, Lab SOP, SW-846 9060, SM2320B, SM2540C; SOP-145, SOP-153, SOP-236, BF-MB-009, SOP-221, SOP-154, SOP-186

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Alkalinity (SM2320B)						
Method Blank	One per preparatory batch	Result < LOQ	Reanalyze samples	Analyst/Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
Laboratory Control Sample	One per preparatory batch	80-120%	If LCS is out high and sample concentrations are < LOQ, no CA. Otherwise all samples must be reanalyzed	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Sample Duplicate	One per preparatory batch	RPD ≤20%	If RPD > 20%, sample should be reanalyzed. If still high, result is flagged.	Analyst/Supervisor	Precision	Same as QC Acceptance Limits
Total Dissolved Solids (SM2540C)						
Method Blank	One per preparatory batch	Result < LOQ	Reanalyze samples	Analyst/Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
Laboratory Control Sample	One per preparatory batch	80-120%	Reanalyze samples	Analyst/Supervisor	Accuracy/Bias	Same as QC Acceptance Limits
Sample Duplicate	Minimum of 10% of lab samples	RPD ≤20%	If RPD > 20%, sample should be reanalyzed. If still high, result is flagged.	Analyst/Supervisor	Precision	Same as QC Acceptance Limits

Analytical laboratory SOPs are the basis for specifications on this table.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

SAP Worksheet #28-4 — Laboratory QC Samples Table

Matrix: Soil(SO)
Analytical Group: VOC
Analytical Method / SOP Reference: SW-846 8260C / SOP-202

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per prep batch of twenty or fewer samples of similar matrix	Target analytes must be < ½ LOQ or <1/10 the concentration found in the sample or <1/10th the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL.	Correct problem, then see criteria in Box D-1 of QSM 4.1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	Analyst, Supervisor, QA Manager	Accuracy/Bias, Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per prep batch of twenty or fewer samples of similar matrix	See Worksheet 15-4	Correct the problem, then reprep and reanalyze the LCD and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. *If the LCS recoveries are high but the sample results are <QL narrate. Flag with * on Recovery Form. LCS exceedances may indicate the need to recalibrate as described in Worksheet #24.*	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤ 30%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as QC acceptance limits.
Matrix Spike	One per prep batch of twenty or fewer samples of similar matrix	Same as LCS, see Worksheets 15-4	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. If recoveries are outside limits and surrogate and LCS criteria are met, note in narrative. If both the LCS and MS/MSD are unacceptable reprep the samples and QC. Check standard prep. Flag outliers with * on Recovery Form.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.

SAP Worksheet #28-4 — Laboratory QC Samples Table (continued)

Matrix: Soil (SO)
Analytical Group: VOC
Analytical Method / SOP Reference: SW-846 8260C / SOP-202

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Matrix Spike Duplicate	One per prep batch of twenty or fewer samples of similar matrix	Same as MS, RPD ≤ 30%	Same as MS	Analyst, Supervisor, QA Manager	Accuracy/Bias, Precision	Same as QC acceptance limits.
Internal Standards (IS)	All field, QC, and standard samples	Retention time ±0.5 minutes compared to RT of the midpoint standard in the ICAL. Extracted Ion Current Profile (EICP) area within -50% to +100% of ICAL midpoint standard.	Inspect MS and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.If similar results, report both runs. Flag outliers with an * on Form 8.	Analyst	Accuracy	Same as QC acceptance limits.
Surrogates	All field and QC samples	QC acceptance criteria specified by DoD if available. Otherwise, use in-house control limits. DoD criteria: Bromofluorobenzene 85-120% Toluene-d8 85-115% In-house control limits: 1,2-Dichloroethane-d4 65-128% Dibromofluoromethane 65-132% One out allowed if the exceedance is high and the sample is nondetect, or if there is obvious chromatographic interference.	For QC and field samples, correct the problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. Report both if second successful analysis is outside Holding Time or both fail QC criteria. Flag with * on Form 2.	Analyst, Supervisor, QA Manager	Accuracy/Bias	Same as QC acceptance limits.

DoD QSM v. 4.1 is the basis for specifications on this table. Information in italics is in addition to or a clarification of DoD QSM v. 4.1 information.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

SAP Worksheet #28-5 — Laboratory QC Samples Table

Matrix: Soil (SO)
Analytical Group: WCHEM
Analytical Method / SOP Reference: Lloyd Kahn / SOP-221

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per batch	< LOQ	Investigate source of contamination. Rerun method blank.	Analyst, Laboratory Supervisor	Bias/Contamination	Same as QC acceptance limits.
Laboratory Control Sample (LCS)	One per batch of 20 or fewer samples	80-120% recovery	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy/Bias	Same as QC acceptance limits.
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS, RPD ≤ 20%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Bias, Precision	Same as QC acceptance limits.
Matrix Spike (MS)	One per batch of 20 or fewer samples	75-125% recovery	CA will not be taken for samples when recoveries are outside limits and LCS criteria are met. If both the LCS and MS/MSD are unacceptable reanalyze samples and QC.	Analyst, Laboratory Supervisor	Accuracy	Same as QC acceptance limits.
Matrix Spike Duplicate (MSD)	One per batch of 20 or fewer samples	Same as MS, RPD ≤ 20%	Same as MS.	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as QC acceptance limits.
Laboratory Quadruplicate	One per batch	%RSD ≤20%	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Precision	Same as QC acceptance limits.

Analytical laboratory SOPs are the basis for specifications on this table.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

SAP Worksheet #29 — Project Documents and Records Table

Document	Where Maintained
Field Notebooks	Electronic portable document format (.pdf) copies in the project file. Hardcopy (bound notebook) in the project file. Archived at project closeout at a private storage facility*.
Chain-of-Custody Records	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout at a private storage facility*.
Air Bills	Hardcopy in the project file. Archived at project closeout at a private storage facility*.
Telephone Logs	Hardcopy in the project file. Archived at project closeout at a private storage facility*.
Corrective Action Forms	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout at a private storage facility*.
PID/FID readings	Recorded in Field Notebook. Stored in VDMS and archived at project closeout at a private storage facility*.
Water quality field parameters collected during groundwater sampling	Recorded in Field Notebook. Stored in VDMS and archived at project closeout at a private storage facility*.
OVM/OVA readings	Recorded in Field Notebook. Stored in VDMS and archived at project closeout at a private storage facility*.
Various field measurements	Recorded in Field Notebooks which are archived at project closeout at a private storage facility*.
All field equipment calibration information	Recorded in Field Notebooks which are archived at project closeout at a private storage facility*.
Pertinent telephone conversations	Recorded in Field Notebooks which are archived at project closeout at a private storage facility*.
Field equipment maintenance records	Inspected by Field Team Leader. Not maintained.
Sample Receipt, Custody, and Tracking Records	Electronic .pdf copies in the project file. Hardcopy in the full data package[1].
Equipment Calibration Logs	Hardcopy in the full data package[1]. Archived at project closeout at a private storage facility*.
Sample Prep Logs	Hardcopy in the full data package[1]. Archived at project closeout at a private storage facility*.
Run Logs	Hardcopy in the full data package[1]. Archived at project closeout at a private storage facility*.
Reported Field Sample Results	Electronic .pdf copies in the project file. Hardcopy in the full data package[1]. Archived at project closeout at a private storage facility*.
Reported Results for Standards, QC Checks, and QC Samples	Hardcopy in the full data package[1]. Archived at project closeout at a private storage facility*.
Instrument Printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples	Hardcopy in the full data package[1]. Archived at project closeout at a private storage facility*.
Sample Disposal Records	Maintained by the laboratory.
Extraction/Clean-up Records	Hardcopy in the full data package[1].
Raw Data	Hardcopy in the full data package[1].
Field Sampling Audit Checklists	Hardcopy in the project file. Archived at project closeout. at a private storage facility*.
Fixed Laboratory Audit Checklists	If completed, hardcopy in the project file. Archived at project closeout at a private storage facility*.
Data Validation Reports	Electronic .pdf copies in the project file. Hardcopy stored with the data package. Archived at project closeout at a private storage facility*.
Vieques ERP Master Health and Safety Plan	Hardcopy in office and field, maintained during project duration.
PI 4 Site Specific HASP	Hardcopy in office and field, maintained during project duration.
Manual Integration Documentation	Hardcopy in the full data package. Archived at project closeout at a private storage facility*.
Investigation and Pilot Study Report	Electronic .pdf copies in the project file. Hardcopy (bound notebook) in the project file. Archived at project closeout*. at a private storage facility*. Also maintained at the Navy Document library[2]

* Data archiving will be done by CH2M HILL and data will be stored at a private storage facility for approximately 10 years.

1 The format of the full hardcopy data package is described in lab SOPs. CH2M HILL requires a “Level 4” package which generally includes a case narrative, chain of custody, Form 1: Results, Form 2: Surrogates or System Monitoring Compounds, Form 3: MS/MSD or LCS, Form 4: Method Blanks (summary), Form 5: Instrument Performance Check or Tuning, Form 6: Initial Calibration, Form 7: Continuing Calibration, Form 8: Internal Standards, and Raw Data.

2 Investigation and Pilot Study reports are also kept with the Navy Document library and maintained by Bonnie Capito (NAVFAC Atlantic).

This page intentionally left blank

SAP Worksheet #30 — Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization2 (name and address, contact person, and telephone number)	Backup Laboratory / Organization (name and address, contact person, and telephone number)
Soil Sampling						
SO	VOC	5	VOCs by SW-846 8260C	28 Calendar-day TAT	Empirical Laboratories, LLC 621 Mainstream Drive; Suite 270 Nashville, TN 37228 Sonya Gordon (615) 345-1115	TBD
	WCHEM		Total Organic Carbon (TOC) by Lloyd Kahn			
Baseline Groundwater and/or Post-Injection Groundwater (for ERD Pilot Study)[1]						
GW	VOC	8	VOCs by SW-846 8260C	Next Day[3]	Empirical Laboratories, LLC	TBD
	WCHEM	1	Chloride, Nitrate, Nitrite and Sulfate by EPA 300.0 Sulfide by SM4500-S2-F Methane, Ethane and Ethene by RSK-175 Total Organic Carbon (TOC) by SW-846 9060 Alkalinity by SM2320B Total Dissolved Solids (TDS) by EPA 2540C	28 Calendar-day TAT		
			Volatile Fatty Acids by Lab SOP		TestAmerica Laboratories, Inc. (Buffalo) 10 Hazelwood Drive Amherst, NY 14228 C. James Stellrecht	TBD
	MICRO		Dehalococcoides (DHC) by DNA-qPCR		Microbial Insights, Inc. 2340 Stock Creek Blvd Rockford, TN 37853 Anita Biernacki (865) 573-8188	TBD
Post-Injection Groundwater (for ISCO Pilot Study)[1]						
GW	VOC	8	VOCs by SW-846 8260C	28 Calendar-day TAT	Empirical Laboratories, LLC	TBD
	WCHEM	1	Total Organic Carbon (TOC) by SW-846 9060			

[1] Sample numbers reflect a given event.
[2] If the laboratory is not known at time of SAP submission, put "TBD" in the column as a placeholder.
[3] Results will be reported by close of business the day after sample receipt. Next Day applies to Baseline Groundwater samples. For Post-Injection Groundwater samples, 28 Calendar-day TAT is required.

This page intentionally left blank

SAP Worksheet #31 — Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)
Field Performance Audit	Up to one during sampling activities	Internal	CH2M HILL	Stephen Brand/ CH2M HILL	Project Field Team CH2M HILL	John Swenfurth PM CH2M HILL	Brett Doerr Environmental Manager CH2M HILL
Safe Work Observation	One per week during field activities	Internal	CH2M HILL	FTL, or any CH2M HILL team member	Project Field Team CH2M HILL	Mark Orman H & S Officer CH2M HILL	Stephen Brand PM CH2M HILL
Offsite Laboratory Technical Systems Audit	As necessary (DoD ELAP Letter indicates Expiration)	External	DoD ELAP Accrediting Body	DoD ELAP Accrediting Body	Sonya Gordon/Empirical PM	Sonya Gordon/Empirical PM	Anita Dodson/CH2M HILL Program Chemist

Note: Analytical laboratory audits by the contractor are not project-specific, but are done on a Navy CLEAN program-wide basis.

This page intentionally left blank

SAP Worksheet #32 — Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action (CA) Response Documentation	Individual(s) Receiving CA Response (name, title, organization)	Timeframe for Response
Field Performance Audit	Field Performance Audit Checklist	Field Team PM Environmental Manager	Within one day of audit	Verbal and CA Form	FTL CH2M HILL	Within one day of receipt of CA Form
Safe Work Observation (SWO)	Safe Work Observation Form	FTL Field Team PM	Immediately (person involved or observed person). Following day (field team). Within 1 week if worthy of elevation (H&S officer)	On SWO Form	FTL and individual being observed, and the PM and if elevated to the H&S officer.	Corrected in the field immediately, and within 1 week if elevated.
Offsite Laboratory Technical Systems Audit	Written audit report from DoD ELAP accrediting body	Sonya Gordon/Empirical PM	Within 2 months of audit	Memorandum	DoD ELAP Accrediting Body	Within two months of receipt of initial notification

Note: If a particular deviation from the SAP will prevent the objectives defined herein from being met, the regulatory agencies will be notified as soon as an alternative approach has been considered between the Navy and CH2M HILL.

SAP Worksheet #32-1 — Corrective Action Form

Person initiating CA _____ **Date** _____

Description of problem and when identified: _____

_____

_____

_____

_____

Cause of problem, if known or suspected: _____

_____

_____

_____

<u>Sequence of CA:</u> (including date implemented, action planned and personnel/data affected)

_____

_____

_____

_____

_____

_____

_____

_____

CA implemented by: _____ **Date:** _____

CA initially approved by: _____ **Date:** _____

Follow-up date: _____

Final CA approved by: _____ **Date:** _____

Information copies to:

_____

_____

_____

_____

SAP Worksheet #32-2 — Field Performance Audit Checklist

Project Responsibilities

Project No.: _____ **Date:** _____

Project Location: _____ **Signature:** _____

Team Members

Yes _____ No _____ 1) Is the approved work plan being followed?
Comments

Yes _____ No _____ 2) Was a briefing held for project participants?
Comments

Yes _____ No _____ 3) Were additional instructions given to project participants?
Comments

Sample Collection

Yes _____ No _____ 1) Is there a written list of sampling locations and descriptions?
Comments

Yes _____ No _____ 2) Are samples collected as stated in the Master SOPs?
Comments

Yes _____ No _____ 3) Are samples collected in the type of containers specified in the work plan?
Comments

Yes _____ No _____ 4) Are samples preserved as specified in the work plan?
Comments

Yes _____ No _____ 5) Are the number, frequency, and type of samples collected as specified in the work plan?
Comments

SAP Worksheet #32-2 — Field Performance Audit Checklist (continued)

Yes _____ No _____ 6) Are QA checks performed as specified in the work plan?
Comments

Yes _____ No _____ 7) Are photographs taken and documented?
Comments

Document Control

Yes _____ No _____ 1) Have any accountable documents been lost?
Comments

Yes _____ No _____ 2) Have any accountable documents been voided?
Comments

Yes _____ No _____ 3) Have any accountable documents been disposed of?
Comments

Yes _____ No _____ 4) Are the samples identified with sample tags?
Comments

Yes _____ No _____ 5) Are blank and duplicate samples properly identified?
Comments

Yes _____ No _____ 6) Are samples listed on a chain-of-custody record?
Comments

Yes _____ No _____ 7) Is chain-of-custody documented and maintained?
Comments

SAP Worksheet #32-3 — Safe Work Observation Form

Project:		**Observer:**	**Date:**
Position/Title of worker observed:		**Background Information/comments:**	
Task/Observation Observed:			

- Identify and reinforce safe work practices/behaviors
- Identify and improve on at-risk practices/acts
- Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			Positive Observations/Safe Work Practices:
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			Questionable Activity/Unsafe Condition Observed:
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			Observer's CAs/Comments:
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			Observed Worker's CAs/Comments:
Other…			

This page intentionally left blank

SAP Worksheet #33 — QA Management Reports Table

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliations)
Field Audit Report	Up to one during sampling activities	Submitted with report in which data are analyzed and presented	Project Manager: John Swenfurth/CH2M HILL	Regional Health, Safety, Environment, and Quality Manager: Mark Orman/CH2M HILL Environmental Manager: Brett Doerr/CH2M HILL (Included in project files)
Data Validation Reports	Once, after analysis by laboratory, for all definitive laboratory analyses (VOC).	Submitted by the data validator within 21 calendar-days of receipt of analytical data (from laboratory)	Project Manager: Data Validator (Laura Maschoff/DataQual)	Project Chemist: Michael Zamboni/CH2M HILL Project EIS: Hillary Ott/CH2M HILL Project Manager: John Swenfurth/CH2M HILL
Data Usability Assessments (Data Quality Evaluation)	Once, as an appendix to the report in which data are analyzed and presented.	Along with the project report.	Project Chemist: Michael Zamboni/CH2M HILL	Vieques Environmental Restoration Subcommittee, Restoration Advisory Board, Administrative Record

This page intentionally left blank

SAP Worksheet #34 — Verification (Step I) Process Table

Verification Input	Description	Internal / External[1]	Responsible for Verification (name, organization)
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	Internal	Field Team Leader: Kenji Butler/CH2M HILL
Chains of Custody and Shipping Forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	Internal / External	Field Team Leader: Kenji Butler/CH2M HILL Project EIS: Hillary Ott/CH2M HILL
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the project EIS in the form of laboratory logins.	External	Project EIS: Hillary Ott/CH2M HILL
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the project chemist. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	Internal	Project Chemist: Michael Zamboni/CH2M HILL
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check).	Internal	Project EIS: Hillary Ott/CH2M HILL
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and applicable to the data packages.	External	Data Validation Subcontractor: Laura Maschoff/DataQual
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Internal	Laboratory QA Officer (Empirical) Laboratory QA Officer (Test America-Buffalo) Laboratory QA Officer (Microbial Insights)
Laboratory Data	The data will be verified for completeness by an Environmental Information System (EIS) specialist.	External	Project EIS: Hillary Ott/CH2M HILL
Validation Changes	Validation qualifiers are applied to the electronic deliverable prior to loading in the database. A 100% check on data validation changes (between the hardcopy data validation report and electronic deliverable) is performed by the project chemist.	Internal	Data Validation Subcontractor: Laura Maschoff/DataQual Project Chemist: Michael Zamboni/CH2M HILL
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and corrective action forms will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the site manager will be notified to ensure action is taken.	Internal	Project Manager: John Swenfurth/CH2M HILL Project Chemist: Michael Zamboni/CH2M HILL
Corrective Action Reports	Corrective action reports will be reviewed by the project chemist or project manager and placed into the project file for archival at project closeout.	Internal	Project Manager: John Swenfurth/CH2M HILL Project Chemist: Michael Zamboni/CH2M HILL

[1]Internal / External is with respect to the data generator.

This page intentionally left blank

SAP Worksheet #35 — Validation (Steps IIa and IIb) Process Table

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	Project Chemist: Michael Zamboni/CH2M HILL
IIa	Target Compound List and Target Analyte List	Ensure the laboratory reported all analytes from each analysis group unless a site-specific requirement dictates a different list.	Project Chemist: Michael Zamboni/CH2M HILL
IIb	Reporting Limits	Ensure the laboratory met the project-designated quantitation limits. If quantitation limits were not met, the reason will be determined and documented.	Project Chemist: Michael Zamboni/CH2M HILL
IIa	Field SOPs	Ensure that all field SOPs were followed.	Field Team Leader: Kenji Butler
IIa	Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Respective Laboratory Quality Assurance Officer
IIa	Raw Data	10 percent review of raw data to confirm laboratory calculations.	Data Validation Subcontractor: Laura Maschoff/DataQual
IIb	Onsite Screening	All non-analytical field data will be reviewed against QAPP requirements for completeness and accuracy based on the field calibration records.	Field Team Leader: Kenji Butler
IIa	Documentation of Method QC Results	Establish that all required QC samples were run.	Data Validation Subcontractor: Laura Maschoff/DataQual
IIb	Documentation of Field QC Sample Results	Establish that all required QC samples were run.	Data Validation Subcontractor: Laura Maschoff/DataQual
IIb	DoD ELAP Evaluation	Ensure that each laboratory is DoD ELAP Certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	Project Chemist: Michael Zamboni/CH2M HILL

[1]IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]

IIb=comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

This page intentionally left blank

SAP Worksheet #36 — Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa and IIb	GW	VOA	SOP HW-24. "Validating Volatile Organic Compounds by SW-846 Method 8260B". Rev 2. August, 2009. Note that this document is specific to SW-846 8260B and the data validator will use the QC limits specified in this UFP-SAP such that the data validation guidance is applicable to SW-846 8260C. The data validator considers manual integration.	Data Validation Subcontractor: Laura Maschoff/DataQual
	SO			
	GW	MICRO	MICRO and WCHEM data will not undergo third-party data validation. However, they are still subject to the verification and validation procedures specified in Worksheets 34 and 35. The case narratives will be read, any issues will be investigated, and the impact (if any) on data quality or data usability will be discussed with the project team.	Project Chemist: Michael Zamboni/CH2M HILL
	SO	WCHEM		

This page intentionally left blank

SAP Worksheet #37 — Usability Assessment

Data usability evaluation comprises critical assessment of the data with respect to the project objective. Given the objectives stated previously, the comprehensive dataset will be reviewed to determine if it is adequate for making the project-specific determinations.

While the Navy contractor typically makes recommendations with respect to the availability and usability of the analytical data, it is the responsibility of the project team as a whole to determine whether or not analytical data are 'usable' for project-specific determinations.

Some specific examples of data availability and usability protocol are:

- The third-party data validator is the only party that may apply qualifiers to the data. Minor QC exceedances will result in "estimated" data, represented by J, NJ, and UJ qualifiers. Results affected by blank contamination will be U-qualified. Major QC exceedances will result in "rejected" data, represented by R-qualifiers. The effect on availability and usability of rejected results will be evaluated.
- The use of "estimated" data will be discussed in the report. "Estimated" data are generally considered usable for all purposes. The project team may choose to use "rejected" data in a qualitative manner under some circumstances, if the direction of bias and proximity to a project action limit are known. For example, if there were a hypothetical location where a benzene detection was rejected because of an extremely low bias, yet the result was still greater than the project action limit, the project team may designate this rejected result as usable for demonstrating that an exceedance has occurred.
- While all non-rejected data are available for use to the project team, non-detect (and attributable to blank contamination) results may not be useful if the LOD is greater than the associated project action limit. In these cases, the project team will determine whether or not the laboratory would likely have reported the contaminant (qualified, as applicable) if present at or greater than the PAL (i.e., evaluation of the PAL versus the DL).
- Ten percent of hardcopy analytical data will be checked against the electronic data to identify discrepancies. This check will be performed manually. The check will verify results and data validation qualifiers. This process is intended to identify discrepancies between the hardcopy and electronic data. If any discrepancies are identified during the ten percent verification, the laboratory or data validator will be contacted, the discrepancies will be communicated, and the laboratory or data validator will resolve the discrepancies.
- If significant deviation is evident between parent samples and their field duplicate or laboratory replicate, the cause will be investigated. The possibility of a switched sample will be examined. Field duplicates are expected to exhibit greater deviation than laboratory duplicates. Field duplicate and laboratory duplicate reproducibility is outlined in Worksheets 12 and 28, respectively.
- Significant biases may be evident based on LCS, MS/MSD, and spiked surrogate exceedances. The third-party data validator will consider QC exceedances and biases when applying qualifiers to data. The project team will consider the direction of bias when determining the usability of qualified data compared to PALs. Low biases are expected to occur more frequently than high biases. In the case of rejected non-detect data, low biases may represent the inability

SAP Worksheet #37 — Usability Assessment (continued)

of the laboratory to detect contaminants that may or may not be present at the site. The project team will act conservatively and understand that it is not known whether or not these compounds are present below, at, or above the PAL. High biases indicate that a result may be lower than it is reported. When high-biased data are greater than a PAL, the project team will examine the proximity of the result to the PAL to determine whether additional data are needed or if the result should simply be considered a PAL exceedance.

- After completion of the data validation, the distribution of applied data validation qualifiers will be examined to determine if there are patterns that negatively affect the usability of data. This information will be compiled into a DQE, which will be presented as an appendix to the project report.
- Deviations from the SAP sampling and analytical protocols will be reviewed to ascertain whether or not they are significant enough to negatively affect the usability of data.
- Precision is assessed via percent difference or relative percent difference. Percent difference is typically used when one value is considered theoretically correct and relative percent difference is typically used when both values are experimental. Percent difference is calculated by taking the absolute value of the difference divided by the theoretical value. This is also expressed as

$$((|X_1 - X_2|) / X_1) * 100$$

where X_1 is the theoretical value and X_2 is the experimental value. If it is necessary to imply the direction of a bias, such as for percent drift, the absolute value need not be considered. Relative percent difference is calculated by taking the absolute value of the difference divided by the mean. This is also expressed as

$$((|X_1 - X_2|) / ((X_1 + X_2)/2)) * 100$$

where X_1 and X_2 are both measured values. Percent difference and relative percent difference often have upper control limits for precision.

- Accuracy is assessed via percent recovery. This is calculated by taking the measured value divided by the theoretical value. This is also expressed as

$$(X_2 / X_1) * 100$$

where X_1 is the theoretical value and X_2 is the experimental value, both positive numbers because they are 'amounts' or concentrations. Percent recovery can be negative, such as for MS and MSD recovery, if X_2 is calculated by subtracting a parent concentration from an experimental recovery. Percent recovery often has upper and lower control limits for accuracy.

- Completeness is calculated by taking the number of available results divided by the total number of results. This is also expressed as

$$(X_2 / X_1) * 100$$

where X_2 is the number of distinct results deemed "available for use" (not rejected) and X_1 is the total number of distinct results (not excluded). Completeness is calculated for the entire data set, for each matrix, and for each combination of matrix and analysis group. If patterns of

SAP Worksheet #37 — Usability Assessment (continued)

rejection are evident in the data set, completeness may also be calculated for select combinations of matrix, analysis group, and analyte or other combinations as applicable for the data quality evaluation. Completeness has a lower control limit (completeness goal) and cannot exceed 100%.

Notes:

1. Completeness is defined as the percentage of measurements that are judged to be available compared to the total number of measurements made. The objective of the overall completeness goal for this project is set at 95% available data. This goal is inclusive of both field and laboratory analytical data.
2. Discussions of precision, accuracy, representativeness, completeness, and comparability will be included in the data quality review to describe the impact of data quality on project data quality objectives and data usability

This page intentionally left blank

References

CH2M HILL, 2010a. *Final Site Inspection/Expanded Site Inspection Report, 7 Consent Order Sites and 16 PI/PAOC Sites, Former Vieques Naval Training Range, Vieques, Puerto Rico.* August.

CH2M HILL, 2010b. *In-situ Remediation Pilot Studies (AOC E and AOC I Sites) Sampling and Analysis Plan, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico.* February.

CH2M HILL, 2010c. *Final Master Standard Operating Procedures, Protocols, and Plans, Environmental Restoration Program, Vieques, Puerto Rico*. April.

CH2M HILL, Inc. 2010d. *Master Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program – Update 1 (Addendum).* Draft. August.

CH2M HILL, 2009. *Site Inspection/Expanded Site Inspection Sampling and Analysis Plan, 7 Consent Order Sites and 16 PI/PAOC Sites, Former Vieques Naval Training Range, Vieques, Puerto Rico.* February.

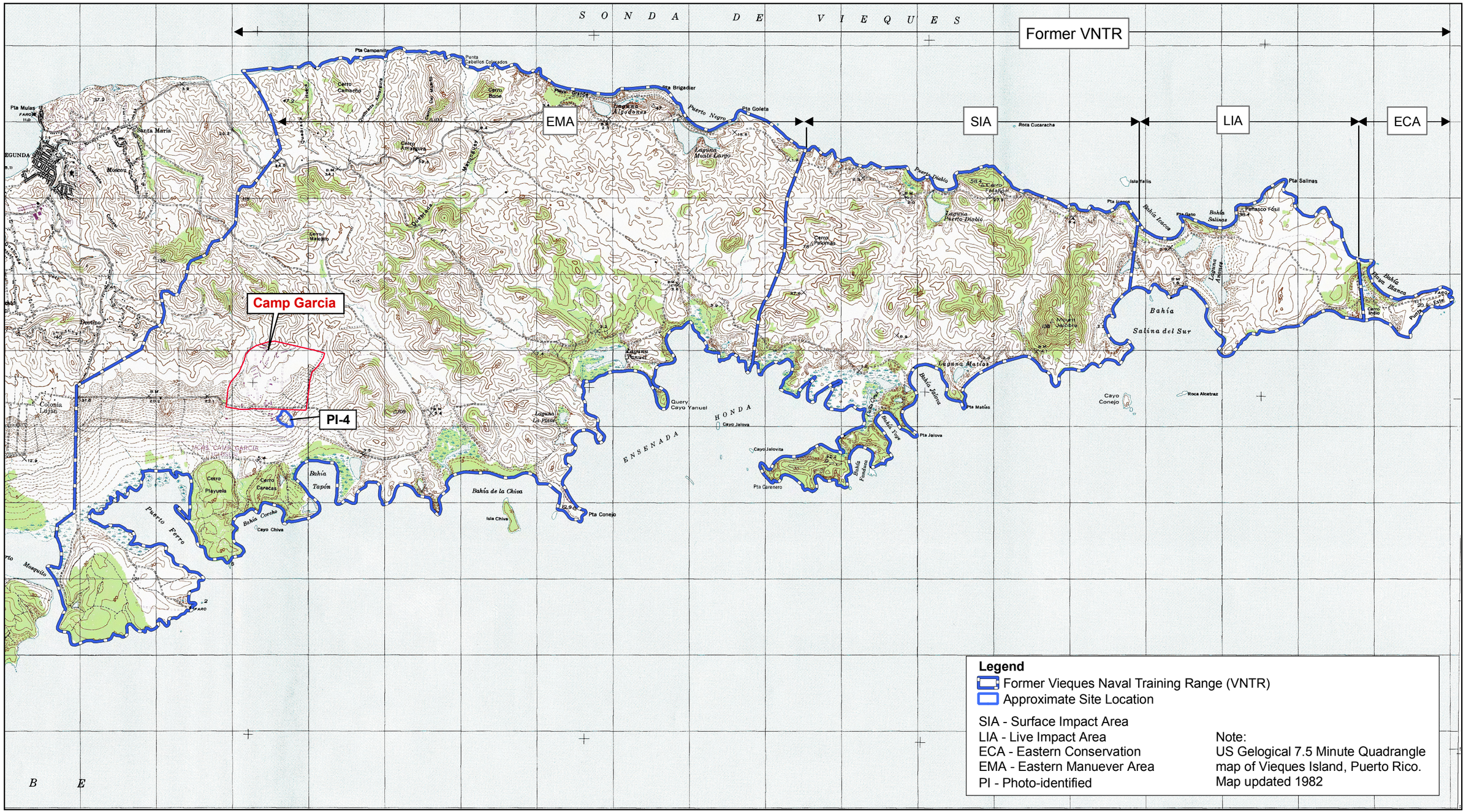
CH2M HILL, 2008. *Preliminary Assessment/Site Inspection Report, 12 Consent Order Sites and 8 PI/PAOC Sites, Former Vieques Naval Training Range, Vieques, Puerto Rico.* June.

Naval Facilities Engineering Command (NAVFACENGCOM). 2003. *Draft Final Environmental Baseline Survey, Vieques Naval Training Range, Vieques, Puerto Rico.* April.

This page intentionally left blank

Attachment A
Figures

This page intentionally left blank



N
W E
S

0 2,000 4,000 8,000 Feet

FIGURE 1
PI 4 Site Location Map
PI 4 Investigation and Pilot Study Sampling and Analysis Plan

CH2MHILL

PHOTO DATE 1962

PHOTO DATE 1983

LEGEND

- PA/SI Monitoring Well Location with Water Elevation, Feet Above Mean Sea Level
- SI/ESI Monitoring Well Location
- PA/SI Surface and Subsurface Soil Sample Location
- PA/SI Surface and Subsurface Soil Sample Location Co-located with EBS Surface Soil Sample Location
- PA/SI Surface Water Sample Location
- PA/SI Surface and Subsurface Soil Sample and Monitoring Well Location
- Estimated Potentiometric Contour from Water Levels taken on 3/23/09
- -2.0 Dashed Where Inferred Interval = 0.3'
- Cross Section Location A-A' and B-B'

0 100 200 Feet

N W E S

FIGURE 2
1962 Aerial Photograph of PI 4 Site
PI 4 Investigation and Pilot Study Sampling and Analysis Plan

CH2MHILL

ES012711103507TPA F2 1962 Aerial Photograph of PI 4 Site.ai mstuart

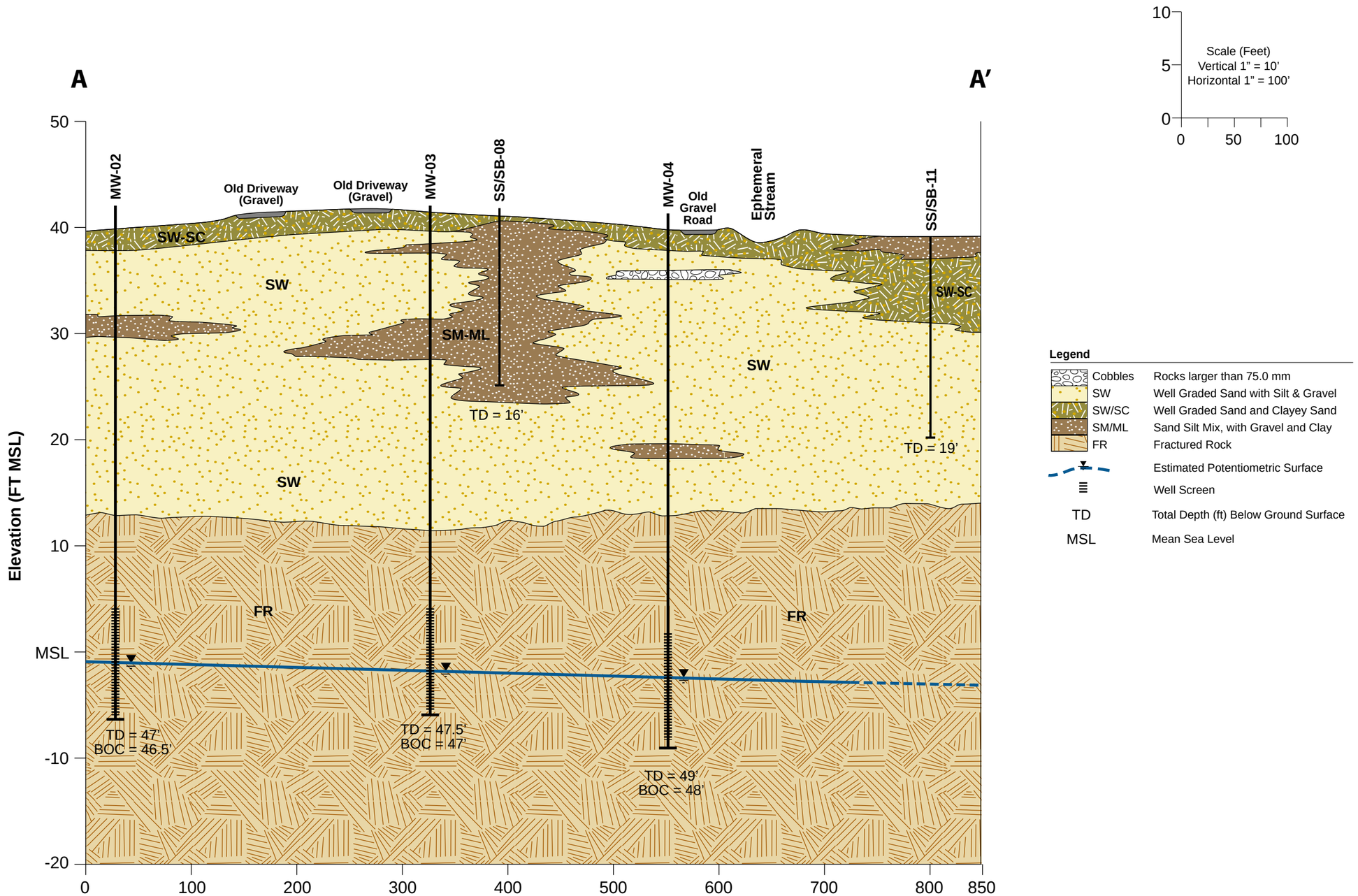


FIGURE 3
Geologic Cross Section A - A'
PI 4 Investigation and Pilot Study
Sampling and Analysis Plan

CH2MHILL

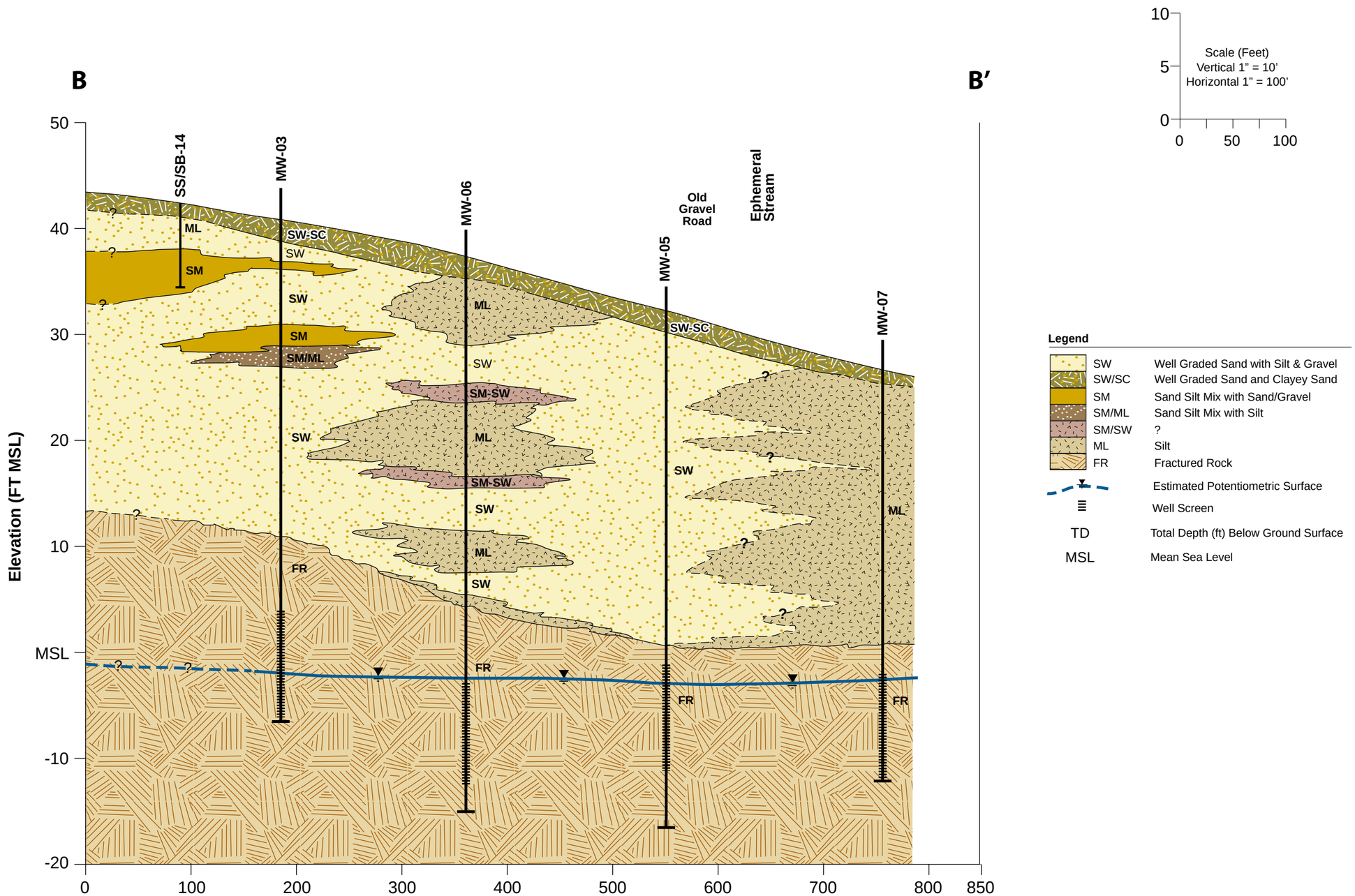


FIGURE 4
Geologic Cross Section B - B'
PI 4 Investigation and Pilot Study
Sampling and Analysis Plan

CH2MHILL

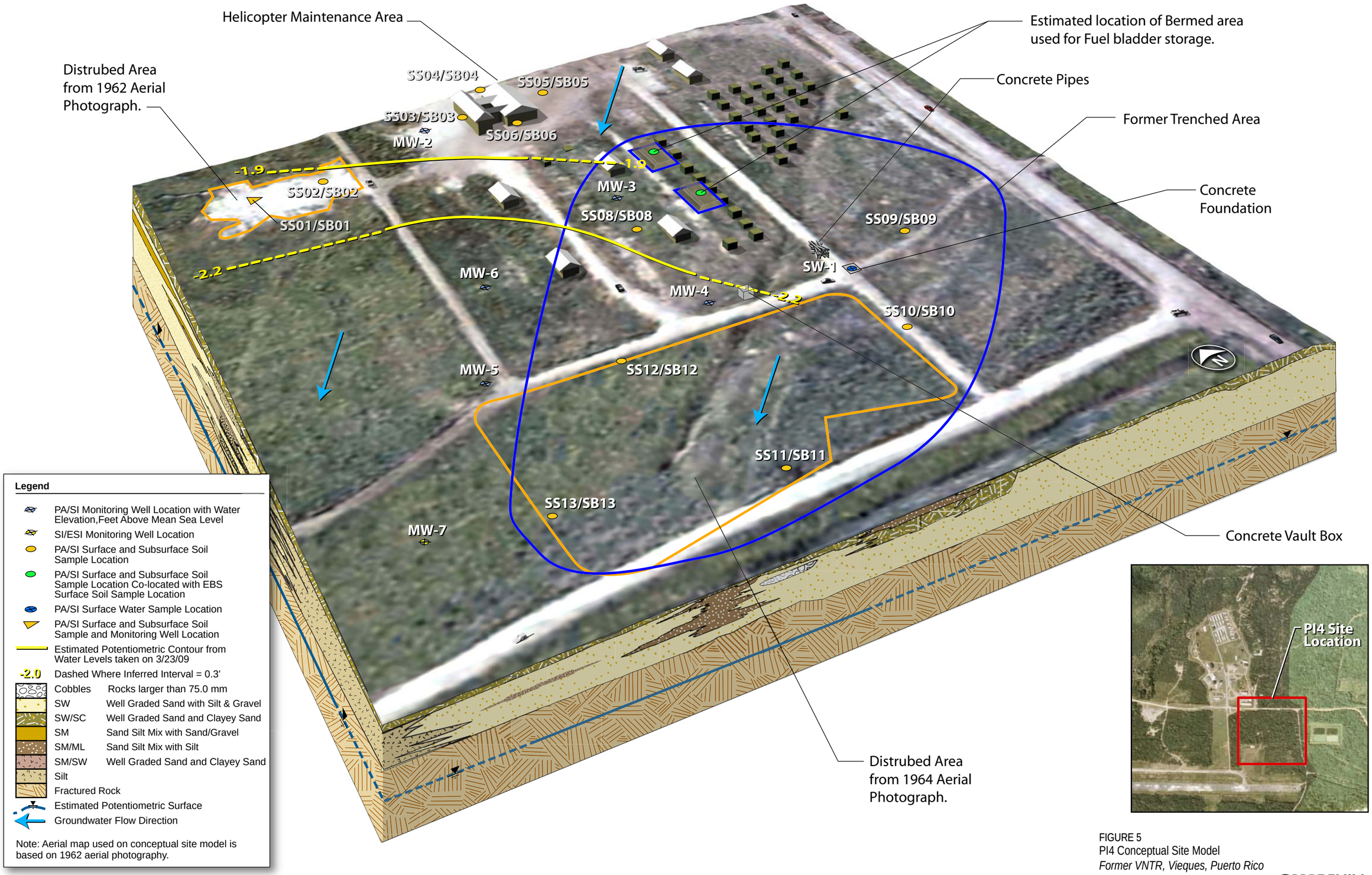


FIGURE 5
PI4 Conceptual Site Model
Former VNTR, Vieques, Puerto Rico

CH2MHILL

ES012711103507TPA F5_PI4_Conceptual_Site_Model_rev1.ai 03-01-2011 LED

PHOTO DATE 1962

PHOTO DATE 1983

LEGEND

- PA/SI Monitoring Well Location with Water Elevation, Feet Above Mean Sea Level
- SI/ESI Monitoring Well Location
- PA/SI Surface and Subsurface Soil Sample Location
- PA/SI Surface and Subsurface Soil Sample Location Co-located with EBS Surface Soil Sample Location
- PA/SI Surface Water Sample Location
- PA/SI Surface and Subsurface Soil Sample and Monitoring Well Location
- Estimated Potentiometric Contour from Water Levels taken on 3/23/09
- -2.0 Dashed Where Inferred Interval = 0.3'
- Proposed Initial Boring/Monitoring Well Locations

Notes:
1. It is anticipated that up to 5 wells (MW08 through MW12) will be installed at the proposed boring locations pending soil boring results
2. Proposed ERD or ISCO monitoring monitoring network would include MW5 through MW12 (to be determined)

0 100 200 Feet

N W E S

FIGURE 6
Proposed Subsurface Sampling Locations and Wells - PI 4 Site
PI 4 Investigation and Pilot Study Sampling and Analysis Plan

CH2MHILL

ES012711103507TPA F6-Proposed Subsurface Sampling Locations.ai mstuart

Attachment B
Lab Analysis SOPs

This page intentionally left blank

Due to their proprietary and confidential nature, analytical laboratory SOPs are removed from this document and not available to the general public.

This page intentionally left blank

Attachment C
Chemetrics and Hach Field Test Kits SOPs

This page intentionally left blank

Iron CHEMets®
0 - 1 & 1 - 10 ppm

Ferrous Iron Procedure

1. Fill the sample cup to the 25 mL mark with the sample (fig 1).
2. Place the CHEMet ampoule in the sample cup. Snap the tip by pressing the ampoule against the side of the cup. The ampoule will fill leaving a small bubble to facilitate mixing (fig 2).
3. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end each time. Wipe all liquid from the exterior of the ampoule. Wait **1 minute** for color development.
4. Use the appropriate comparator to determine the level of iron in the sample. If the color of the CHEMet ampoule is between two color standards, a concentration estimate can be made.
   a. Place the CHEMet ampoule, flat end downward into the center tube of the low range comparator. Direct the top of the comparator up toward a source of bright light while viewing from the bottom. Rotate the comparator until the color standard below the CHEMet ampoule shows the closest match (fig 3).
   b. Hold the high range comparator in a nearly horizontal position while standing directly beneath a bright source of light. Place the CHEMet ampoule between the color standards moving it from left to right along the comparator until the best color match is found (fig 4).

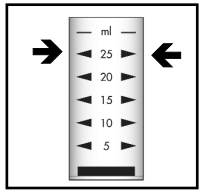


Figure 1

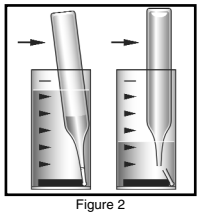


Figure 2

Figure 3

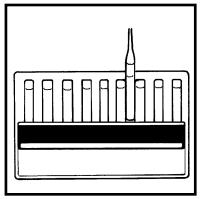


Figure 4

Total Iron Procedure

1. Fill the sample cup to the 25 mL mark with the sample.
2. Add 5 drops of A-6000 Activator Solution. Stir briefly. Wait **4 minutes**.
3. After 4 minutes, stir the sample once again and then perform the **Ferrous Iron Procedure** using this pretreated sample.

Test Method

The Iron CHEMets®[1] test method employs the phenanthroline chemistry.[2,3] Ferrous iron reacts with 1,10-phenanthroline to form an orange colored complex in direct proportion to the ferrous iron concentration. Total iron is determined by adding a mixture of thioglycolic acid and ammonia to the sample. This mixture dissolves most forms of particulate iron. Results are expressed in ppm (mg/Liter) Fe. Various metals will produce high test results. Certain forms of very insoluble iron (magnetite, ferrite, etc.) require the following digestion procedure in place of the Total Iron Procedure:

A. Fill a heat-resistant, glass container to 25 mL with sample.
B. Add 5 drops of A-6000 Solution. Stir briefly.
C. Gently boil the sample to reduce volume to 10-15 mL.
D. Cool the sample and dilute to 25 mL with iron-free water.
E. Perform the **Ferrous Iron Procedure** using this pretreated sample.

1. CHEMets is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. APHA Standard Methods, 20th ed., p. 3-76, method 3500-Fe B (1998)
3. ASTM D 1068 - 77, Iron in Water, Test Method A

Safety Information

Read MSDS before performing this test procedure. Wear safety glasses.

Reorder Information — Cat. No.

***Test Kit**, complete*	*K-6210*
***Refill**, 30 CHEMet ampoules*	*R-6201*
***Sample Cup**, 25 mL, package of six*	*A-0013*
***Activator Solution**, six 10 mL bottles*	*A-6000*
***Comparator**, 0-1 ppm*	*C-6001*
***Comparator**, 1-10 ppm*	*C-6010*

CHEMetrics, Inc., 4295 Catlett Road, Calverton, VA 20138-0214 U.S.A.
Phone: (800) 356-3072; Fax: (540) 788-4856; E-Mail: orders@chemetrics.com
www.chemetrics.com
Jan. 07, Rev. 3

Methods

Iron is present in nature in the form of its oxides, or in combination with silicon or sulfur. The soluble iron content of surface waters rarely exceeds 1 mg/L, while ground waters often contain higher concentrations. The National Secondary Drinking Water Standard for iron is 0.3 mg/L, as iron concentrations in excess of 0.3 mg/L impart a foul taste and cause staining. High concentrations in surface waters can indicate the presence of industrial effluents or runoff.

Iron contamination in oil field brines are typically a result of corrosion processes of iron-containing metallic components and equipment. Accumulation of insoluble iron salts in a brine completion fluid can result in substantial formation damage and can significantly affect the productivity of an oil well. Quantifying total iron in brine is critical.

The Phenanthroline Method (total & soluble; total & ferrous)

References: APHA Standard Methods, 21st ed., Method 3500-Fe B (2005). ASTM D 1068-77, Iron in Water, Test Method A.

With the Phenanthroline Method, ferrous iron reacts with 1,10-phenanthroline to form an orange-colored chelate. To determine total iron, thioglycolic acid solution is added to reduce ferric iron to the ferrous state. The reagent formulation minimizes interferences from various metals. Results are expressed as ppm (mg/L) Fe.

The PDTS Method (total)

Reference: J. A. Tetlow and A. L. Wilson, "Determination of Iron in Boiler Feedwater," *Analyst*, 1958.

CHEMetrics' colorimetric method for determining total iron uses thioglycolic acid to dissolve particulate iron and to reduce iron from the ferric to the ferrous state. Ferrous iron then reacts with PDTS (3-(2-pyridyl)-5,6-bis(4-phenylsulfonic acid)-1,2,4-triazine disodium salt) in acid solution to form a purple-colored chelate. Results are expressed as ppm (mg/L) Fe.

The Ferric Thiocyanate (Iron in Brine)

Reference: D. F. Boltz and J. A. Howell, eds., Colorimetric Determination of Nonmetals, 2nd. ed., Vol. 8, p. 304 (1978).

The Iron in Brine test employs the ferric thiocyanate chemistry. In an acidic solution, hydrogen peroxide oxidizes ferrous iron. The resulting ferric iron reacts with ammonium thiocyanate forming a red-orange colored thiocyanate complex, in direct proportion to the iron concentration.

The method expresses total iron content in units of mg/L. By simply dividing the measured mg/L by the density of the brine expressed in units of kg/L, the ppm value can be obtained in mg/kg.

Visual Kits

Range: 0-1 &1-10 ppm
MDL: 0.05 ppm / Method: Phenanthroline

Iron (total & ferrous) CHEMets Kit	Cat# K-6210
CHEMets Refill, 30 ampoules	R-6201
Activator Solution Pack, six 10 mL bottles	A-6000[1]
Low Range Comparator 0, 0.1, 0.2, 0.3, 0.4, 0.6, 0.8, 1.0 ppm	C-6001
High Range Comparator 1, 2, 3, 4, 5, 6, 7, 8, 10 ppm	C-6010

Kit comes in a plastic case and contains everything needed to perform 30 tests: Refill, Low and High Range Comparators, Activator Solution, 25 mL sample cup, instructions, and MSDS.

Range: 0-1 &1-10 ppm
MDL: 0.05 ppm / Method: Phenanthroline

Iron (total & soluble) CHEMets Kit	Cat# K-6010
CHEMets Refill, 30 ampoules	R-6001
Activator Solution Pack, six 10 mL bottles	A-6000[1]
Low Range Comparator 0, 0.1, 0.2, 0.3, 0.4, 0.6, 0.8, 1.0 ppm	C-6001
High Range Comparator 1, 2, 3, 4, 5, 6, 7, 8, 10 ppm	C-6010

Kit comes in a plastic case and contains everything needed to perform 30 tests: Refill, Low and High Range Comparators, Activator Solution, 25 mL sample cup, instructions, and MSDS.

Range: 0-30 & 30-300 ppm
MDL: 5 ppm / Method: Phenanthroline

Iron (total & soluble) VACUettes Kit	Cat# K-6010D
VACUettes Refill, 30 ampoules	R-6001D
Activator Solution Pack, six 10 mL bottles	A-6000[1]
Low Range Comparator 0, 5, 7.5, 10, 15, 20, 25, 30 ppm	C-6001D
High Range Comparator 30, 60, 90, 120, 150, 175, 200, 250, 300 ppm	C-6010D

Kit comes in a plastic case and contains everything needed to perform 30 tests (except distilled water): Refill, Low and High Range Comparators, Activator Solution, dilutor snapper cup, micro test tube, 5 mL sample cup and top, instructions, and MSDS.

Range: 0-60 & 60-600 ppm
MDL: 10 ppm / Method: Phenanthroline

	Cat#
Iron (total & soluble) VACUettes Kit	**K-6010A**
VACUettes Refill, 30 ampoules	R-6001A
Activator Solution Pack, six 10 mL bottles	A-6000[1]
Low Range Comparator 0, 10, 15, 20, 30, 40, 50, 60 ppm	C-6001A
High Range Comparator 60, 120, 180, 240, 300, 350, 400, 500, 600 ppm	C-6010A

Kit comes in a plastic case and contains everything needed to perform 30 tests (except distilled water): Refill, Low and High Range Comparators, Activator Solution, dilutor snapper cup, micro test tube, 5 mL sample cup and top, instructions, and MSDS.

Range: 0-120 & 120-1200 ppm
MDL: 20 ppm / Method: Phenanthroline

	Cat#
Iron (total & soluble) VACUettes Kit	**K-6010B**
VACUettes Refill, 30 ampoules	R-6001B
Activator Solution Pack, six 10 mL bottles	A-6000[1]
Low Range Comparator 0, 20, 30, 40, 60, 80, 100, 120 ppm	C-6001B
High Range Comparator 120, 240, 360, 480, 600, 700, 800, 1000, 1200 ppm	C-6010B

Kit comes in a plastic case and contains everything needed to perform 30 tests (except distilled water): Refill, Low and High Range Comparators, Activator Solution, dilutor snapper cup, micro test tube, 5 mL sample cup and top, instructions, and MSDS.

Range: 0-1200 & 1200-12,000 ppm
MDL: 200 ppm / Method: Phenanthroline

	Cat#
Iron (total & soluble) VACUettes Kit	**K-6010C**
VACUettes Refill, 30 ampoules	R-6001C
Activator Solution Pack, six 10 mL bottles	A-6000[1]
Low Range Comparator 0, 200, 300, 400, 600, 800, 1000, 1200 ppm	C-6001C
High Range Comparator 1200, 2400, 3600, 4800, 6000, 7000, 8000, 10,000, 12,000 ppm	C-6010C

Kit comes in a plastic case and contains everything needed to perform 30 tests (except distilled water): Refill, Low and High Range Comparators, Activator Solution, dilutor snapper cup, micro test tube, 5 mL sample cup and top, instructions, and MSDS.

Range: 0-100 &100-1000 mg/L
MDL: 5 mg/L / Method: Ferric Thiocyanate

	Cat#
Iron in Brine CHEMets Kit	**K-6002**
CHEMets Refill, 30 ampoules	R-6002
Acidifier Solution Pack, six 20 mL bottles	A-6001[1]
Activator Solution Pack, six 20 mL bottles	A-6002[1]
Low Range Comparator 0, 10, 20, 30, 40, 60, 80, 100 mg/L	C-6002
High Range Comparator 100, 200, 300, 400, 500, 600, 700, 800, 1000 mg/L	C-6012

Kit comes in a plastic case and contains everything needed to perform 30 tests (except distilled water): Refill, Low and High Range Comparators, Acidifier Solution, Activator Solution, 50 mL sample cup with cap, 1.0 mL syringe (2 ea), instructions, and MSDS.

If no shelf-life is listed for a product, then the shelf-life is at least 2 years.

Instrumental Kits

V-2000 Multi-Analyte Photometer

(See page 12 for instrumental features)

Range: 0.10-2.50 ppm
Method: PDTS

	Cat#
Iron (total) Vacu-vials Kit	**K-6023**

Kit comes in a cardboard box and contains everything needed to perform 30 tests: thirty ampoules, Activator Solution, 25 mL sample cup, ampoule blank, instructions, calibration table, and MSDS.

Range: 0.20-6.00 ppm
Method: Phenanthroline

	Cat#
Iron (total & ferrous) Vacu-vials Kit	**K-6203**

Kit comes in a cardboard box and contains everything needed to perform 30 tests: thirty ampoules, Activator Solution, 25 mL sample cup, ampoule blank, instructions, calibration table, and MSDS.

Range: 0.20-6.00 ppm
Method: Phenanthroline

	Cat#
Iron (total & soluble) Vacu-vials Kit	**K-6003**

Kit comes in a cardboard box and contains everything needed to perform 30 tests: thirty ampoules, Activator Solution, 25 mL sample cup, ampoule blank, instructions, calibration table, and MSDS.

Range: 1.0-25.0 ppm
Method: Phenanthroline

	Cat#
Iron (total & soluble) Vacu-vials Kit	**K-6013**

Kit comes in a cardboard box and contains everything needed to perform 30 tests: thirty ampoules, Activator Solution, 25 mL sample cup, ampoule blank, instructions, calibration table, and MSDS.

Vacu-vials Kits require the use of the V-2000 Photometer or a spectrophotometer capable of accepting a 13 mm diameter round cell. Instrument sold separately.

Kit Components common to Iron

Description	Cat#
Sample Cup Pack, 25 mL (6 ea)	A-0013
Micro Test Tube Pack (10 ea)	A-0015
Dilutor Snapper Cup Pack (6 ea)	A-0018
Ampoule Blank Pack (5 ea)	A-0023
Syringe Pack, 1.0 mL (6 ea)	A-0027
Sample Cup & Cap Pack, 50 mL (6 ea)	A-0058
Sample Cup & Top Pack, 5 mL (6 ea)	A-0105

[1]The accessory pack supplies enough solution to perform at least 100 CHEMet or Vacu-vial tests and 42 VACUette tests. A-6000 Activator Solution is required for total iron analysis only.

Instructions are posted on our website.

Technical Data Sheet

Iron (total, soluble, ferrous)

Phenanthroline Method

Applications and Industries: Industrial wastewater influent and effluent, industrial process waters, surface and ground water, seawater, drinking water; Power generation

References: APHA Standard Methods, 21st ed., Method 3500-Fe B (2005). ASTM D 1068-77, Iron in Water, Test Method A.

Chemistry: Ferrous iron reacts with 1,10-phenanthroline to form an orange colored complex in direct proportion to the ferrous iron concentration. Soluble iron consists primarily of ferrous iron, but can also contain a small portion of ferric iron. The **soluble iron reagent** contains hydroxylamine hydrochloride, which converts any dissolved ferric iron to ferrous. The **ferrous iron reagent** does not contain hydroxylamine hydrochloride and will not measure soluble ferric iron. **Total iron** is determined by adding a mixture of thioglycolic acid and ammonia to the sample. This mixture dissolves most forms of particulate iron and converts ferric iron to ferrous. Certain forms of very insoluble iron (magnetite, ferrite, etc.) require a digestion prior to analysis. Results are expressed as ppm (mg/L) Fe.

Interference Information: Strong oxidizing agents may interfere. To minimize these interferences, excess hydroxylamine hydrochloride has been added to the total & soluble iron reagent; however, the ferrous iron reagent does not contain hydroxylamine hydrochloride. Zinc (at levels greater than ten times those of iron), chromium, cobalt, copper, and nickel have the potential to interfere, and cadmium, silver, mercury, and bismuth may precipitate the reagent. Excess phenanthroline has been added to the reagents to minimize interferences from these metals. Cyanide and polyphosphates may interfere. Molybdate may precipitate the reagent, causing low results for soluble and ferrous iron. Upon addition of thioglycolic acid during total analysis, samples containing molybdate will turn blue, and those containing nitrite will turn yellow, orange, or red. Nitrite is a significant positive interference during total analysis and may cause a false negative result during soluble and ferrous analysis. Sulfide and ammonia do not interfere. If necessary, sample pH should be adjusted to fall within the pH range of 2 - 7.

Safety Information: Material Safety Data Sheets (MSDSs) are included with the test kits and are available upon request and on our website. Read MSDS before using these kits. Breaking the tip of an ampoule in air rather than water may cause the glass ampoule to shatter. Wear eye protection.

Available Analysis Systems: Visual colorimetric: CHEMets® and VACUettes®; Instrumental colorimetric: Vacu-vials®

Storage Requirements: Kits should be stored in the dark and at room temperature.

Shelf Life: Visual colorimetric: The CHEMets and VACUettes refills have shelf lives of 4 years. The color comparators and accessory solution have 2-year shelf lives. Instrumental colorimetric: The Vacu-vials kits have shelf lives of 2 years.

Accuracy: CHEMets kit: +/- ½ of a color standard increment; VACUettes kits: +/- 1 color standard increment; Vacu-vials kits: +/- 10% error at 75% of full range, +/- 20% error at 25% of full range, +/- 30% error at CHEMetrics' Practical Detection Limit (PDL).

CHEMetrics, Inc.
4295 Catlett Rd., Calverton, VA 20138
(800) 356-3072 (540) 788-9026
Fax (540) 788-4856 E-mail technical@chemetrics.com

After Hours Emergency Nos.: **(703) 447-9550**
(540) 272-3874
Creation Date: **01/02/98 (2742-7)**
Revision Date: **10/30/09**

MATERIAL SAFETY DATA SHEET

I. CHEMICAL IDENTIFICATION

TRADE NAME: IRON CHEMets®

CATALOG NO.: R-6201

DESCRIPTION: Reagent ampoules for the determination of iron in water. Each CHEMet™ ampoule contains approximately 0.5 mL of liquid reagent sealed under vacuum.

NFPA RATINGS: HEALTH: 1 FLAMMABILITY: 0 REACTIVITY: 0

II. COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENT: 1,10-Phenanthroline, Monohydrate
CAS NO.: 5144-89-8 PERCENT: < 0.5

COMPONENT: Isopropyl Alcohol
CAS NO.: 67-63-0 PERCENT: < 0.5

COMPONENT: Ammonium Hydroxide
CAS NO.: 1336-21-6 PERCENT: < 4.0

COMPONENT: Acetic Acid, Glacial
CAS NO.: 64-19-7 PERCENT: < 15.0

COMPONENT: Deionized Water
CAS NO.: 7732-18-5 PERCENT: > 80.0

III. HAZARDS IDENTIFICATION

ACUTE TOXICITY: Irritation, nausea, vomiting, diarrhea, dizziness
CHRONIC TOXICITY: Irritation, methemoglobinemia, cyanosis, liver and kidney damage
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Eye, skin and respiratory disorders

IV. FIRST AID MEASURES

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes.
INGESTION: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Seek medical attention.
INHALATION: Remove individual to fresh air. Seek medical advice.

V. FIRE FIGHTING MEASURES

FLASH POINT: N/A AUTOIGNITION POINT: N/A
FLAMMABILITY LIMITS: UPPER: N/A LOWER: N/A
EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, water spray or foam

VI. ACCIDENTAL RELEASE MEASURES

Take up with absorbent material. Place in small containers for disposal.

VII. HANDLING AND STORAGE

Always wear eye protection when working with these ampoules.
WARNING: Do not break the tip of the ampoule unless it is completely immersed in your sample. Breaking the tip in the air may cause the glass ampoule to shatter.
If this product is used as directed, the user will not come in contact with or be exposed to any of its chemical components.
Wash thoroughly after handling. Avoid contact with eyes.
Fragile. Liquid in glass. Handle with care.
Exposure of this product to temperatures up to 120°F (49°C) or even below 32°F (0°C) will not create a safety hazard. For optimum analytical accuracy, the product should be stored in the dark and at room temperature and, if applicable, should not be used beyond expiration date.

VIII. EXPOSURE CONTROLS/PERSONAL PROTECTION

ACGIH TLV: 10 ppm TWA Glacial Acetic Acid, 200 ppm TWA Isopropyl Alcohol, 25 ppm TWA Ammonia
OSHA PEL: 10 ppm TWA Glacial Acetic Acid, 400 ppm TWA Isopropyl Alcohol, 50 ppm TWA Ammonia
PROTECTIVE EQUIPMENT: Safety glasses, protective gloves

IX. PHYSICAL AND CHEMICAL PROPERTIES

STATE: Liquid APPEARANCE: Colorless ODOR: Mild vinegar-like
SOLUBILITY IN WATER: Miscible pH: 4.2
BOILING POINT: 115°C MELTING POINT: -15°C
VAPOR PRESSURE: N/A SPECIFIC GRAVITY: 1.0
VAPOR DENSITY: N/A

X. STABILITY AND REACTIVITY

INCOMPATIBILITIES: strong oxidizing agents
HAZARDOUS DECOMPOSITION PRODUCTS: ammonia, oxides of carbon and nitrogen
Stable under normal conditions.

XI. TOXICOLOGICAL INFORMATION

CARCINOGENIC STATUS: Isopropyl alcohol: IARC - Group 3, not classifiable as to its carcinogenicity to humans.
No other data available at this time.

XII. ECOLOGICAL INFORMATION

Acetic acid has high BOD which may cause oxygen depletion in aquatic systems and is expected to biodegrade rapidly. Ammonium hydroxide is very toxic to aquatic life.
No other data available at this time.

XIII. DISPOSAL CONSIDERATIONS

Dispose of in a manner consistent with Federal, State, and Local Regulations.

XIV. TRANSPORT INFORMATION

Not regulated.

XV. REGULATORY INFORMATION

EUROPEAN INFORMATION:
EU Symbols: Xi - IRRITANT
Risk Phrases: Irritating to eyes and skin.
Safety Phrases: Avoid contact with skin and eyes. In case of contact with skin or eyes, rinse immediately with plenty of water and seek medical advice. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

CANADIAN INFORMATION:
WHMIS Classification: D1B
All chemical components of this product are listed on Canada's DSL or are exempt.

U.S. INFORMATION:
OSHA: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard (29 CFR 1910.1200).
SARA Section 313: This product contains isopropyl alcohol and ammonium hydroxide which are subject to the reporting requirements of Section 313 of SARA Title III.
All chemical components of this product are listed on the TSCA Inventory.

XVI. OTHER INFORMATION

THE ABOVE INFORMATION IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. ALL PRODUCTS ARE OFFERED IN ACCORDANCE WITH THE MANUFACTURER'S CURRENT PRODUCTION SPECIFICATIONS AND ARE INTENDED SOLELY FOR USE IN ANALYTICAL TESTING. THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY INJURY, LOSS OR DAMAGE RESULTING FROM THE HANDLING, USE OR MISUSE OF THESE PRODUCTS.

CHEMets® is a registered trademark of CHEMetrics, Inc.

CHEMetrics, Inc.
4295 Catlett Rd., Calverton, VA 20138
(800) 356-3072 (540) 788-9026
Fax (540) 788-4856 E-mail technical@chemetrics.com

After Hours Emergency Nos.: (703) 447-9550
(540) 272-3874
Creation Date: 12/10/85 (1075-13)
Revision Date: 12/18/08

MATERIAL SAFETY DATA SHEET

I. CHEMICAL IDENTIFICATION

TRADE NAME: IRON ACTIVATOR SOLUTION

CATALOG NO.: A-6000

DESCRIPTION: An accessory solution used in conjunction with reagent ampoules in the determination of total iron in water. Each bottle contains approximately 10 mL of accessory solution.

NFPA RATINGS: HEALTH: 3 FLAMMABILITY: 0 REACTIVITY: 1

II. COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENT: Deionized Water
CAS NO.: 7732-18-5 PERCENT: > 13.0

COMPONENT: Ammonium Hydroxide
CAS NO.: 1336-21-6 PERCENT: < 23.0

COMPONENT: Thioglycolic Acid
CAS NO.: 68-11-1 PERCENT: < 64.0

III. HAZARDS IDENTIFICATION

Toxic! Corrosive! Causes burns.
ACUTE TOXICITY: Irritation, nausea, vomiting
CHRONIC TOXICITY: Irritation, dermatitis
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Eye and respiratory disorders

IV. FIRST AID MEASURES

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes.
INGESTION: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Seek medical attention.
INHALATION: Remove individual to fresh air. If necessary, provide artificial respiration by mechanical means, do not use mouth to mouth resuscitation, seek medical attention.

V. FIRE FIGHTING MEASURES

FLASH POINT: 125°C (closed cup) AUTOIGNITION POINT: 350°C
FLAMMABILITY LIMITS: UPPER: Unknown LOWER: None to 5.9%
EXTINGUISHING MEDIA: Water, dry chemical, carbon dioxide or foam

VI. ACCIDENTAL RELEASE MEASURES

Take up with absorbent material. Place in small containers for disposal. Ventilate spill area.

VII. HANDLING AND STORAGE

If this product is used as directed, the user will not come in contact with or be exposed to any of its chemical components.
Wash thoroughly after handling. Avoid contact with eyes.
Exposure of this product to temperatures up to 120°F (49°C) or even below 32°F (0°C) will not create a safety hazard. For optimum analytical accuracy, the product should be stored in the dark and at room temperature, and if applicable, should not be used beyond expiration date.

VIII. EXPOSURE CONTROLS/PERSONAL PROTECTION

ACGIH TLV: 1 ppm TWA Thioglycolic Acid (skin), 25 ppm TWA Ammonia
OSHA PEL: 50 ppm TWA Ammonia
PROTECTIVE EQUIPMENT: Safety glasses, protective gloves

IX. PHYSICAL AND CHEMICAL PROPERTIES

STATE: Liquid APPEARANCE: Colorless ODOR: Strong, unpleasant
SOLUBILITY IN WATER: Miscible pH: 4 - 5
BOILING POINT: 96°C MELTING POINT: -16.5°C
VAPOR PRESSURE: Not determined SPECIFIC GRAVITY: 1.2
VAPOR DENSITY: Not determined

X. STABILITY AND REACTIVITY

INCOMPATIBILITIES: Oxidizing materials, metals, strong acids or bases
HAZARDOUS DECOMPOSITION PRODUCTS: When heated to decomposition, hydrogen sulfide, ammonia, and oxides of sulfur, nitrogen, and carbon may be emitted.
Stable under normal conditions.

XI. TOXICOLOGICAL INFORMATION

CARCINOGENIC STATUS: None
No other data available at this time.

XII. ECOLOGICAL INFORMATION

Not expected to bioaccumulate. Ammonium hydroxide is very toxic to aquatic life.
No other data available at this time.

XIII. DISPOSAL CONSIDERATIONS

Dispose of in a manner consistent with Federal, State, and Local Regulations.

XIV. TRANSPORT INFORMATION

U.S. DOT: 49 CFR, 173.4 Exceptions for Small Quantities
IATA: Dangerous Goods in Excepted Quantities
IMDG: Dangerous Goods in Limited Quantities
Hazard Class: 8 ID: UN 1760 GROUP: II

XV. REGULATORY INFORMATION

EUROPEAN INFORMATION:
EU Symbols: T - TOXIC, C - CORROSIVE, N - DANGEROUS FOR THE ENVIRONMENT
Risk Phrases: Causes burns. Toxic by inhalation, in contact with skin and if swallowed. Very toxic to aquatic organisms.
Safety Phrases: Avoid contact with skin and eyes. Wear suitable protective clothing, gloves, and eye/face protection. In case of contact with skin or eyes, rinse immediately with plenty of water and seek medical advice. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). Avoid release to the environment.

CANADIAN INFORMATION:
WHMIS Classification: D1A, D1B, E
All chemical components of this product are listed on Canada's DSL.

U.S. INFORMATION:
OSHA: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard (29 CFR 1910.1200).
SARA Section 313: This product contains ammonium hydroxide which is subject to the reporting requirements of Section 313 of SARA Title III.
All chemical components of this product are listed on the TSCA Inventory.

XVI. OTHER INFORMATION

THE ABOVE INFORMATION IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. ALL PRODUCTS ARE OFFERED IN ACCORDANCE WITH THE MANUFACTURER'S CURRENT PRODUCTION SPECIFICATIONS AND ARE INTENDED SOLELY FOR USE IN ANALYTICAL TESTING. THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY INJURY, LOSS OR DAMAGE RESULTING FROM THE HANDLING, USE OR MISUSE OF THESE PRODUCTS.

Manganese CHEMets®
0 - 2 ppm

Test Procedure

1. Fill the sample cup to the 5 mL mark with the sample (fig 1).
2. Add 5 drops of A-6500 Activator Solution (fig 2). Stir briefly with the tip of the ampoule to mix the contents of the sample cup.
3. Place the CHEMet ampoule in the sample cup. Snap the tip by pressing the ampoule against the side of the cup. The ampoule will fill leaving a small bubble to facilitate mixing (fig 3).
4. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end each time. Wipe all liquid from the exterior of the ampoule. Wait **1 minute** for color development.
5. Place the CHEMet ampoule, flat end downward into the center tube of the comparator. Direct the top of the comparator up toward a source of bright light while viewing from the bottom. Rotate the comparator until the color standard below the CHEMet ampoule shows the closest match (fig 4). If the color of the CHEMet ampoule is between two color standards, a concentration estimate can be made.

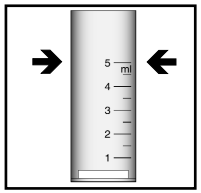


Figure 1

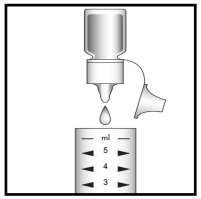


Figure 2

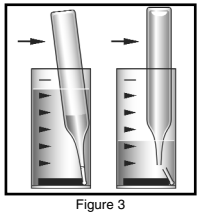


Figure 3

Figure 4

Test Method

The Manganese CHEMets®[1] test method employs the periodate oxidation chemistry.[2] Soluble manganous compounds are oxidized by periodate in a slightly acidic solution to form permanganate ion. The resulting pink color is proportional to the manganese concentration in the sample. Results are expressed in ppm (mg/Liter) Mn.

1. CHEMets is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 3,634,038
2. APHA Standard Methods, 14th ed., p.227, method 314C (1975).

Safety Information

Read MSDS before performing this test procedure. Wear safety glasses.

Reorder Information	Cat. No.
***Test Kit**, complete*	*K-6502*
***Refill**, 30 CHEMet ampoules*	*R-6502*
***Activator Solution**, six 20 mL bottles*	*A-6500*
***Sample Cup**, 5 mL, package of six*	*A-0105*
***Comparator**, 0-2 ppm*	*C-6502*

CHEMetrics
Water Analysis Systems

CHEMetrics, Inc., 4295 Catlett Road, Calverton, VA 20138-0214 U.S.A.
Phone: (800) 356-3072; Fax: (540) 788-4856; E-Mail: orders@chemetrics.com
www.chemetrics.com
Jan. 07, Rev. 7

Method

Reference: APHA Standard Methods, 14th ed. Method 314 C (1975).

Surface and ground waters rarely contain more than 1 mg/L of soluble or suspended manganese. Manganese can act as an oxidizing or a reducing agent depending on its valence state. Manganese is also used in the manufacture of batteries and as an alloying metal in the manufacture of steel and aluminum. The National Secondary Drinking Water Standard for manganese is 0.05 mg/L, as higher concentrations will impart a foul taste to water and discolor laundry and porcelain surfaces.

CHEMetrics' tests employ the periodate chemistry that measures soluble manganese compounds but does not differentiate the various valence states. Results are expressed as ppm (mg/L) Mn.

Visual Kits

Range: 0-2 ppm
MDL: 0.15 ppm / Method: Periodate

CHEMets Kit	Cat# K-6502
CHEMets Refill, 30 ampoules	R-6502
Activator Solution Pack, six 20 mL bottles	A-6500[1]
Comparator, Shelf-life 1 year: 0, 0.3, 0.6, 0.8, 1.0, 1.5, 1.8, 2.0 ppm	C-6502

Kit comes in a plastic case and contains everything needed to perform 30 tests: Refill, Comparator, Activator Solution, 5 mL sample cup with top, instructions, and MSDS.

Range: 0-50 ppm
MDL: 7.5 ppm / Method: Periodate

VACUettes Kit	Cat# K-6502D
VACUettes Refill, 30 ampoules	R-6502D
Activator Solution Pack, six 20 mL bottles	A-6500[1]
Comparator, Shelf-life 1 year: 0, 7.5, 15, 20, 25, 37.5, 45, 50 ppm	C-6502D

Kit comes in a plastic case and contains everything needed to perform 30 tests (except distilled water): Refill, Comparator, Activator Solution, dilutor snapper cup, micro test tube, instructions, and MSDS.

[1] **The accessory pack supplies enough solution to perform at least 200 tests.**

If no shelf-life is listed for a product, then the shelf-life is at least 2 years.

Instrumental Kits

V-2000 Multi-Analyte Photometer

(See page 12 for instrumental features)

Range: 2.0-30.0 ppm
Method: Periodate

Vacu-vials Kit	Cat# K-6503

Kit comes in a cardboard box and contains everything needed to perform 30 tests: thirty ampoules, Activator Solution, 25 mL sample cup, 1.0 mL syringe, ampoule blank, instructions, calibration table, and MSDS.

Vacu-vials Kits require the use of the V-2000 Photometer or a spectrophotometer capable of accepting a 13 mm diameter round cell. Instrument sold separately.

Kit Components common to Manganese

Description	Cat#
Sample Cup Pack, 25 mL (6 ea)	A-0013
Micro Test Tube Pack (10 ea)	A-0015
Dilutor Snapper Cup Pack (6 ea)	A-0018
Ampoule Blank Pack (5 ea)	A-0023
Syringe Pack, 1.0 mL (6 ea)	A-0027
Sample Cup and Top Pack, 5 mL (6 ea)	A-0105

Instructions are posted on our website.

Technical Data Sheet

Manganese
Periodate Method

Applications and Industries: Drinking water, natural waters, treated wastewater effluent

References: APHA Standard Methods, 14th ed., Method 314 C (1975).

Chemistry: Soluble manganese is oxidized by periodate in a slightly acidic solution to form permanganate ion. The resulting pink color is proportional to the manganese concentration in the sample. Results are expressed in ppm (mg/L) Mn.

Interference Information: This chemistry measures soluble manganese but does not differentiate the various valence states. Oxidizable substances, including organic materials, may interfere negatively. Reducing agents such as sulfide, thiosulfate, sulfite, and ferrous iron may prevent the oxidation step, causing low test results. Calcium at greater than 700 mg/L, chloride at greater than 70,000 mg/L, and magnesium greater than 100,000 mg/L may interfere. Colored or turbid samples may make a visual color match difficult or cause a false positive result during instrumental analysis. Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagent. For such samples, pH should be adjusted to 4-5 prior to analysis. Manganese may precipitate above pH 6.

Safety Information: Material Safety Data Sheets (MSDSs) are included with the test kits and are available upon request and on our website. Read MSDS before using these kits. Breaking the tip of an ampoule in air rather than water may cause the glass ampoule to shatter. Wear eye protection.

Available Analysis Systems: Visual colorimetric: CHEMets®, VACUettes®. Instrumental colorimetric: Vacu-vials®

Storage Requirements: Kits should be stored in the dark and at room temperature.

Shelf Life: Visual colorimetric: The CHEMets and VACUettes refills have shelf lives of 4 years. The accessory solution has a 2-year shelf life and the color comparators have shelf lives of 12 months. Instrumental colorimetric: The Vacu-vials kit has a shelf life of 2 years.

Accuracy: CHEMets kits: ± ½ of a color standard increment; VACUettes kits: ± 1 color standard increment; Vacu-vials kits: ± 10% error at 75% of full range, ± 20% error at 25% of full range, and ± 30% error at CHEMetrics' Practical Detection Limit (PDL).

CHEMetrics, Inc., 4295 Catlett Road, Calverton, VA 20138, www.chemetrics.com
ph: 800-356-3072 or 540-788-9026, fax: 540-788-4856, email: technical@chemetrics.com

CHEMetrics, Inc.
4295 Catlett Rd., Calverton, VA 20138
(800) 356-3072 (540) 788-9026
Fax (540) 788-4856 E-mail technical@chemetrics.com

After Hours Emergency Nos.: **(703) 447-9550**
(540) 272-3874
Creation Date: **01/30/87 (1235-15)**
Revision Date: **10/30/09**

MATERIAL SAFETY DATA SHEET

I. CHEMICAL IDENTIFICATION

TRADE NAMES: MANGANESE CHEMets® and VACUettes®

CATALOG NOS.: R-6502 and R-6502D

DESCRIPTION: Reagent ampoules for the determination of manganese in water. Each CHEMet™ and VACUette™ contains approximately 0.5 mL of liquid reagent sealed under vacuum.

NFPA RATINGS: HEALTH: 1 FLAMMABILITY: 0 REACTIVITY: 0

II. COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENT: Sodium Periodate
CAS NO.: 7790-28-5 PERCENT: < 4.5

COMPONENT: Deionized Water
CAS NO.: 7732-18-5 PERCENT: >95.5

III. HAZARDS IDENTIFICATION

ACUTE TOXICITY: Irritation
CHRONIC TOXICITY: Irritation, dermatitis
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: No data available.

IV. FIRST AID MEASURES

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes.
INGESTION: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Seek medical advice.
INHALATION: Remove individual to fresh air.

V. FIRE FIGHTING MEASURES

FLASH POINT: Non-combustible AUTOIGNITION POINT: N/A
FLAMMABILITY LIMITS: UPPER: N/A LOWER: N/A
EXTINGUISHING MEDIA: Dry chemical, carbon dioxide or water spray

VI. ACCIDENTAL RELEASE MEASURES

Take up with absorbent material. Place in small containers for disposal.

VII. HANDLING AND STORAGE

Always wear eye protection when working with these ampoules.
WARNING: Do not break the tip of the ampoule unless it is completely immersed in your sample. Breaking the tip in the air may cause the glass ampoule to shatter.
If this product is used as directed, the user will not come in contact with or be exposed to any of its chemical components.
Wash thoroughly after handling. Avoid contact with eyes.
Fragile. Liquid in glass. Handle with care.
Exposure of this product to temperatures up to 120°F (49°C) or even below 32°F (0°C) will not create a safety hazard. For optimum analytical accuracy, the product should be stored in the dark and at room temperature and, if applicable, should not be used beyond expiration date.

VIII. EXPOSURE CONTROLS/PERSONAL PROTECTION

OSHA PEL & ACGIH TLV: None established
PROTECTIVE EQUIPMENT: Safety glasses

IX. PHYSICAL AND CHEMICAL PROPERTIES

STATE: Liquid APPEARANCE: Colorless ODOR: None
SOLUBILITY IN WATER: Complete pH: 4.3
BOILING POINT: 104°C MELTING POINT: 2°C
VAPOR PRESSURE: N/A SPECIFIC GRAVITY: 1.02
VAPOR DENSITY: N/A

X. STABILITY AND REACTIVITY

INCOMPATIBILITIES: strong reducing agents, metals
HAZARDOUS DECOMPOSITION PRODUCTS: hydrogen iodide, iodine, sodium oxide
Stable under normal conditions.

XI. TOXICOLOGICAL INFORMATION

CARCINOGENIC STATUS: None.
No other data available at this time.

XII. ECOLOGICAL INFORMATION

No data available.

XIII. DISPOSAL CONSIDERATIONS

Dispose of in a manner consistent with Federal, State, and Local Regulations.

XIV. TRANSPORT INFORMATION

Not regulated.

XV. REGULATORY INFORMATION

EUROPEAN INFORMATION:
EU Symbols: None
Risk/Safety Phrases: None

CANADIAN INFORMATION:
WHMIS Classification: Uncontrolled
All chemical components of this product are listed on Canada's DSL.

U.S. INFORMATION:
OSHA: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard (29 CFR 1910.1200).
All chemical components of this product are listed on the TSCA Inventory.

XVI. OTHER INFORMATION

THE ABOVE INFORMATION IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. ALL PRODUCTS ARE OFFERED IN ACCORDANCE WITH THE MANUFACTURER'S CURRENT PRODUCTION SPECIFICATIONS AND ARE INTENDED SOLELY FOR USE IN ANALYTICAL TESTING. THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY INJURY, LOSS OR DAMAGE RESULTING FROM THE HANDLING, USE OR MISUSE OF THESE PRODUCTS.

CHEMets® and VACUettes® are registered trademarks of CHEMetrics, Inc.

CHEMetrics, Inc.
4295 Catlett Rd., Calverton, VA 20138
(800) 356-3072 (540) 788-9026
Fax (540) 788-4856 E-mail technical@chemetrics.com

After Hours Emergency Nos.: **(703) 447-9550**
(540) 272-3874
Creation Date: **06/27/86 (1236-15)**
Revision Date: **10/30/09**

MATERIAL SAFETY DATA SHEET

I. CHEMICAL IDENTIFICATION

TRADE NAME: MANGANESE ACTIVATOR SOLUTION

CATALOG NO.: A-6500

DESCRIPTION: An accessory solution used in conjunction with reagent ampoules in the determination of manganese in water. Each bottle contains approximately 18 mL of accessory solution.

NFPA RATINGS: HEALTH: 1 FLAMMABILITY: 0 REACTIVITY: 0

II. COMPOSITION / INFORMATION ON INGREDIENTS

COMPONENT: Citric Acid, Monohydrate
CAS NO.: 5949-29-1 PERCENT: < 2.5

COMPONENT: Sodium Sulfate
CAS NO.: 7757-82-6 PERCENT: 3.0

COMPONENT: Sodium Phosphate Dibasic
CAS NO.: 7558-79-4 PERCENT: 5.0

COMPONENT: Deionized Water
CAS NO.: 7732-18-5 PERCENT: >89.5

III. HAZARDS IDENTIFICATION

ACUTE TOXICITY: Irritation
CHRONIC TOXICITY: Irritation
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: No data available.

IV. FIRST AID MEASURES

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes.
INGESTION: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Seek medical advice.
INHALATION: Remove individual to fresh air.

V. FIRE FIGHTING MEASURES

FLASH POINT: N/A AUTOIGNITION POINT: N/A
FLAMMABILITY LIMITS: UPPER: N/A LOWER: N/A
EXTINGUISHING MEDIA: Dry chemical, water spray or foam

VI. ACCIDENTAL RELEASE MEASURES

Take up with absorbent material. Place in small containers for disposal.

VII. HANDLING AND STORAGE

If this product is used as directed, the user will not come in contact with or be exposed to any of its chemical components.
Wash thoroughly after handling. Avoid contact with eyes.
Exposure of this product to temperatures up to 120°F (49°C) or even below 32°F (0°C) will not create a safety hazard. For optimum analytical accuracy, the product should be stored in the dark and at room temperature and, if applicable, should not be used beyond expiration date.

VIII. EXPOSURE CONTROLS / PERSONAL PROTECTION

OSHA & ACGIH THRESHOLD LIMIT VALUE: None established
PROTECTIVE EQUIPMENT: Safety glasses

IX. PHYSICAL AND CHEMICAL PROPERTIES

STATE: Liquid APPEARANCE: Colorless ODOR: None
SOLUBILITY IN WATER: Miscible pH: 5.6
BOILING POINT: 107°C MELTING POINT: 5°C
VAPOR PRESSURE: Not determined SPECIFIC GRAVITY: 1.05
VAPOR DENSITY: Not determined

X. STABILITY AND REACTIVITY

INCOMPATIBILITIES: strong oxidizing agents, strong bases
HAZARDOUS DECOMPOSITION PRODUCTS: oxides of carbon, sulfur, sodium and phosphorus
Stable under normal conditions.

XI. TOXICOLOGICAL INFORMATION

CARCINOGENIC STATUS: None.
No other data available at this time.

XII. ECOLOGICAL INFORMATION

Citric acid can cause nitrification inhibition. Sodium sulfate may persist indefinitely but diluted, it is not expected to have a significant impact on the environment.
No other data available at this time.

XIII. DISPOSAL CONSIDERATIONS

Dispose of in a manner consistent with Federal, State, and Local Regulations.

XIV. TRANSPORT INFORMATION

Not regulated.

XV. REGULATORY INFORMATION

EUROPEAN INFORMATION:
EU Symbols: None
Risk Phrases: None
Safety Phrases: Avoid contact with eyes.

CANADIAN INFORMATION:
WHMIS Classification: E
All chemical components of this product are listed on Canada's DSL.

U.S. INFORMATION:
All chemical components of this product are listed on the TSCA Inventory.

XVI. OTHER INFORMATION

THE ABOVE INFORMATION IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. ALL PRODUCTS ARE OFFERED IN ACCORDANCE WITH THE MANUFACTURER'S CURRENT PRODUCTION SPECIFICATIONS AND ARE INTENDED SOLELY FOR USE IN ANALYTICAL TESTING. THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY INJURY, LOSS OR DAMAGE RESULTING FROM THE HANDLING, USE OR MISUSE OF THESE PRODUCTS.

CHEMetrics, Inc.
4295 Catlett Rd., Calverton, VA 20138
(800) 356-3072 (540) 788-9026
Fax (540) 788-4856 E-mail technical@chemetrics.com

After Hours Emergency Nos.: (703) 447-9550
(540) 272-3874
Creation Date: 12/08/08 (2984-3)
Revision Date: 10/06/09

MATERIAL SAFETY DATA SHEET

I. CHEMICAL IDENTIFICATION

TRADE NAME: COLOR COMPARATOR

CATALOG NOS.: C-1602, C-2500, C-2501, C-2501A, C-2501B, C-2501C, C-2501D, C-2504, C-2506, C-2511, C-2702, C-2710, C-2810, C-2810A, C-2810B, C-2810C, C-2810D, C-3810, C-3901, C-3902, C-4601, C-4601A, C-4601B, C-4601C, C-4601D, C-4605, C-4605A, C-4605B, C-4605C, C-4605D, C-4815, C-4815C, C-5504, C-6502, C-6502D, C-7401, C-7501, C-7501L, C-7511, C-7518, C-7540, C-7599, C-7901, C-9011

DESCRIPTION: Color standard ampoules used to quantify test results for the determination of various analytes in water. Each CHEMet™ and VACUette™ comparator ampoule contains approximately 1.7 mL of liquid reagent. Each ULR CHEMet™ comparator ampoule contains approximately 6.7 mL of liquid reagent.

NFPA RATINGS: HEALTH: 1 FLAMMABILITY: 0 REACTIVITY: 0

II. COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENT: Diethylene Glycol
CAS NO.: 111-46-6 PERCENT: $\leq$ 25.0

COMPONENT: Deionized Water
CAS NO.: 7732-18-5 PERCENT: > 70

COMPONENT: Other components
CAS NO.: N/A PERCENT: < 1.0

Any component of this mixture not specifically listed (e.g. "other components") is not considered to present a carcinogen hazard.

III. HAZARDS IDENTIFICATION

Harmful if swallowed.
ACUTE TOXICITY: Irritation, nausea, diarrhea, nerve depression
CHRONIC TOXICITY: Irritation, liver or kidney lesions
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Eye, skin, liver or kidney disorders

IV. FIRST AID MEASURES

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes.
INGESTION: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Seek medical attention.
INHALATION: Remove individual to fresh air.

V. FIRE FIGHTING MEASURES

FLASH POINT: N/A AUTOIGNITION POINT: N/A
FLAMMABILITY LIMITS: UPPER: N/A LOWER: N/A
EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, water spray or foam

VI. ACCIDENTAL RELEASE MEASURES

Take up with absorbent material. Place in small containers for disposal.

VII. HANDLING AND STORAGE

If this product is used as directed, the user will not come in contact with or be exposed to any of its chemical components.
Wash thoroughly after handling. Avoid contact with eyes.
Fragile. Liquid in glass. Handle with care.
Exposure of this product to temperatures up to 120°F (49°C) or even below 32°F (0°C) will not create a safety hazard. For optimum analytical accuracy, these products should be stored in the dark and at room temperature and should not be used beyond expiration date.

VIII. EXPOSURE CONTROLS/PERSONAL PROTECTION

OSHA PEL & ACGIH TLV: None established
PROTECTIVE EQUIPMENT: Safety glasses

IX. PHYSICAL AND CHEMICAL PROPERTIES

STATE: Liquid APPEARANCE: Various colors ODOR: None
SOLUBILITY IN WATER: Miscible pH RANGE: 2.5 - 11.5
BOILING POINT: $\geq$ 100°C MELTING POINT: $\leq$ 0°C
VAPOR PRESSURE: N/A SPECIFIC GRAVITY: 1.0
VAPOR DENSITY: N/A

X. STABILITY AND REACTIVITY

INCOMPATIBILITIES: acids, bases
HAZARDOUS DECOMPOSITION PRODUCTS: oxides of carbon
Stable under normal conditions.

XI. TOXICOLOGICAL INFORMATION

CARCINOGEN STATUS: None
No other data available at this time.

XII. ECOLOGICAL INFORMATION

Diethylene glycol has a low bioconcentration potential and is practically non-toxic to aquatic organisms.
No other data available at this time.

XIII. DISPOSAL CONSIDERATIONS

Dispose of in a manner consistent with Federal, State and Local Regulations.

XIV. TRANSPORT INFORMATION

Not regulated.

XV. REGULATORY INFORMATION

EUROPEAN INFORMATION:
EU Symbols: Xn - HARMFUL
Risk Phrases: Harmful if swallowed.
Safety Phrases: If swallowed, seek medical advice immediately (show the label where possible).

CANADIAN INFORMATION:
WHMIS Classification: D2A
All chemical components of this product are listed on Canada's DSL.

U.S. INFORMATION:
All chemical components of this product are listed on the TSCA Inventory.

XVI. OTHER INFORMATION

THE ABOVE INFORMATION IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. ALL PRODUCTS ARE OFFERED IN ACCORDANCE WITH THE MANUFACTURER'S CURRENT PRODUCTION SPECIFICATIONS AND ARE INTENDED SOLELY FOR USE IN ANALYTICAL TESTING. THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY INJURY, LOSS OR DAMAGE RESULTING FROM THE HANDLING, USE OR MISUSE OF THESE PRODUCTS.

Permanganate Titrets®
0.3 - 3 percent (%)

Test Procedure

1. Fill the sample cup to the 25 mL mark with sample (fig. 1).
2. Gently snap the tip of the glass ampoule at the black snap ring (fig. 2).

   NOTE: When the tip is snapped, the flexible tubing will remain in place on the tapered neck of the ampoule.
3. Lift the control bar and insert the Titret assembly into the Titrettor (fig. 3).

   NOTE: The rigid sample pipe will extend approximately 1.5 inches beyond the body of the Titrettor.
4. Hold the Titrettor with the sample pipe in the sample and press the control bar firmly, but briefly, to pull in a small amount of sample (fig. 4).

   NOTE: NEVER press the control bar unless the sample pipe is immersed in the sample.
5. With the sample pipe in the sample, press the control bar again briefly to allow another small amount of sample to be drawn into the ampoule.
6. After each addition, rock the entire assembly to mix the contents of the ampoule. Watch for a color change from **COLORLESS to PINK**.

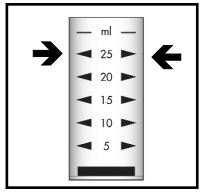


Figure 1

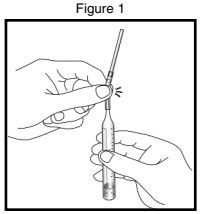


Figure 2

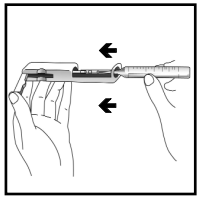


Figure 3

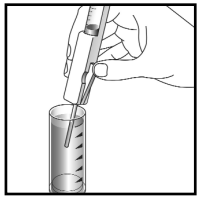


Figure 4

7. Repeat steps 5 and 6 until a permanent color change occurs.
8. When the color of the liquid in the ampoule changes to **PINK**, remove the ampoule from the Titrettor. Hold the ampoule in a vertical position and read the scale opposite the liquid level (fig. 5).
9. Multiply scale units on the Titret by 0.3 for test results in percent (%) permanganate as $KMnO_4$.

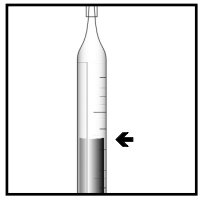


Figure 5

Test Method

The Permanganate Titrets®[1] test method employs a ferrous ammonium sulfate titrimetric chemistry.[2] Results are expressed as permanganate as $KMnO_4$.

1. Titrets is a registered trademark of CHEMetrics, Inc. U.S. Patent No. 4,332,769
2. Developed by CHEMetrics, Inc.

Safety Information

Read MSDS before performing this test procedure. Wear safety glasses.

Reorder Information **Cat. No.**

***Test Kit**, complete* *K-7630*

4295 Catlett Road, Calverton, VA 20138-0214 U.S.A.
Phone: (800) 356-3072; Fax: (540) 788-4856
E-Mail: orders@chemetrics.com
Web: www.chemetrics.com

Oct. 07, Rev. 9

Method

Reference: Developed by CHEMetrics, Inc.

Potassium permanganate is a very strong oxidizing agent. Its primary use is in the treatment of industrial and domestic water to remove various compounds.

The CHEMetrics' permanganate test kit is applicable to monitoring the concentration of permanganate in feed solutions used to treat potable water and wastewaters. The test method employs a titrimetric chemistry in which ferrous ammonium sulfate is the titrant. No additional indicator is required. A color change from colorless to pink signals the end of the test. Results are expressed as percent (%) $KMnO_4$.

Visual Kits

Range: 0.3-3%
MDL: 0.30% / Method: Ferrous Ammonium Sulfate

	Cat#
Titrets Kit	**K-7630**

Increments:
0.30, 0.33, 0.36, 0.39, 0.42, 0.45, 0.48, 0.54, 0.60, 0.75, 0.90, 1.05, 1.2, 1.5, 2.1, 3.0 %

Kit comes in a cardboard box and contains everything needed to perform 30 tests: thirty ampoules with valve assemblies, titrettor, 25 mL sample cup, instructions, and MSDS.

Kit Components common to Permanganate

Description	Cat#
Sample Cup Pack, 25 mL (6 ea)	A-0013
Titrettor Pack (1 ea)	A-0053

Instructions are posted on our website.
If no shelf-life is listed for a product, then the shelf-life is at least 2 years.

CHEMetrics, Inc.
4295 Catlett Rd., Calverton, VA 20138
(800) 356-3072 (540) 788-9026
Fax (540) 788-4856 E-mail technical@chemetrics.com

After Hours Emergency Nos.: **(703) 447-9550**
(540) 272-3874
Creation Date: **07/15/87 (1760-10)**
Revision Date: **08/06/09**

MATERIAL SAFETY DATA SHEET

I. CHEMICAL IDENTIFICATION

TRADE NAME: PERMANGANATE Titrets®

KIT CATALOG NO.: K-7630

DESCRIPTION: Reagent ampoules and valve assemblies for the titrimetric determination of permanganate in water. Each ampoule contains approximately 1 mL of liquid reagent sealed under vacuum. Each valve assembly contains approximately 0.05 mL of liquid reagent.

In the Ampoule:
NFPA RATINGS: HEALTH: 3 FLAMMABILITY: 0 REACTIVITY: 1

In the Valve Assembly:
NFPA RATINGS: HEALTH: 2 FLAMMABILITY: 0 REACTIVITY: 0

II. COMPOSITION/INFORMATION ON INGREDIENTS

In the Ampoule:
COMPONENT: Sulfuric Acid
CAS NO.: 7664-93-9 PERCENT: < 8.5

COMPONENT: Ferrous Ammonium Sulfate, Hexahydrate
CAS NO.: 7783-85-9 PERCENT: < 19.0

COMPONENT: Deionized Water
CAS NO.: 7732-18-5 PERCENT: > 73.5

In the Valve Assembly:
COMPONENT: Phosphoric Acid
CAS NO.: 7664-38-2 PERCENT: 100

III. HAZARDS IDENTIFICATION

ACUTE TOXICITY: Irritation, burns, conjunctivitis, eye damage, shock, cardiac disturbances, cough, abdominal pain
CHRONIC TOXICITY: Irritation, tooth erosion, cyanosis, bronchitis, conjunctivitis, liver damage, pulmonary edema. Effects may be delayed.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Eye, skin and respiratory disorders

IV. FIRST AID MEASURES

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes.
INGESTION: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Seek medical attention.
INHALATION: Remove to fresh air. If necessary, give artificial respiration by mechanical means, do not use mouth to mouth resuscitation, seek medical attention.

V. FIRE FIGHTING MEASURES

FLASH POINT: N/A AUTOIGNITION POINT: N/A
FLAMMABILITY LIMITS: UPPER: N/A LOWER: N/A
EXTINGUISHING MEDIA: Dry chemical or carbon dioxide

VI. ACCIDENTAL RELEASE MEASURES

Take up with absorbent material. Place in small containers for disposal.

VII. HANDLING AND STORAGE

Always wear eye protection when working with these ampoules.
WARNING: Do not break the tip of the ampoule unless it is completely immersed in your sample. Breaking the tip in the air may cause the glass ampoule to shatter. If this product is used as directed, the user will not come in contact with or be exposed to any of its chemical components.
Wash thoroughly after handling. Avoid contact with eyes.
Fragile. Liquid in glass. Handle with care.
Exposure of this product to temperatures up to 120°F (49°C) or even below 32°F (0°C) will not create a safety hazard. For optimum analytical accuracy, the product should be stored in the dark at room temperature, and if applicable, product components should not be used beyond expiration date.

VIII. EXPOSURE CONTROLS/PERSONAL PROTECTION

OSHA PEL & ACGIH TLV: 1 mg/m^3 TWA sulfuric acid, 1 mg/m^3 TWA phosphoric acid, 1 mg/m^3 TWA as iron (ACGIH TLV only)
PROTECTIVE EQUIPMENT: Safety glasses, protective gloves

IX. PHYSICAL AND CHEMICAL PROPERTIES

In the Ampoule:
STATE: Liquid APPEARANCE: Colorless to pale green ODOR: None
SOLUBILITY IN WATER: Miscible pH: < 1.0 SPECIFIC GRAVITY: 1.1
BOILING POINT: 108°C MELTING POINT: 4°C
VAPOR PRESSURE: N/A VAPOR DENSITY: N/A

In the Valve Assembly:
STATE: Syrupy liquid APPEARANCE: Colorless ODOR: None
SOLUBILITY IN WATER: Complete pH: 1.5 @ 0.1 N solution
BOILING POINT: 158°C MELTING POINT: 21°C
VAPOR PRESSURE: 2.2 mm Hg @ 21°C SPECIFIC GRAVITY: 1.87

X. STABILITY AND REACTIVITY

INCOMPATIBILITIES: strong bases, strong oxidizers, metals
HAZARDOUS DECOMPOSITION PRODUCTS: ammonia gas, oxides of phosphorus and sulfur
Stable under normal conditions.

XI. TOXICOLOGICAL INFORMATION

CARCINOGENIC STATUS: None.
No other data available at this time.

XII. ECOLOGICAL INFORMATION

Sulfuric acid is harmful to aquatic organisms. Phosphoric acid may leach to groundwater; acidity reduced in water by water hardness but phosphate may persist indefinitely.
No other data available at this time.

XIII. DISPOSAL CONSIDERATIONS

Dispose of in a manner consistent with Federal, State, and Local Regulations.

XIV. TRANSPORT INFORMATION

U.S. DOT, IATA, and IMDG: Dangerous Goods in Excepted Quantities
Hazard Class: 9 UN No.: 3316 Packing Group: II

XV. REGULATORY INFORMATION

EUROPEAN INFORMATION:
EU Symbols: C - CORROSIVE
Risk Phrases: Causes burns.
Safety Phrases: Avoid contact with skin and eyes. In case of contact with skin or eyes, rinse immediately with plenty of water and seek medical advice. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

CANADIAN INFORMATION:
WHMIS Classification: D1B, E
All chemical components of this product are listed on Canada's DSL or are exempt.

U.S. INFORMATION:
RCRA: Contains RCRA regulated substances. EPA Waste ID No.:
Ampoules and Valve Assemblies: D002
OSHA: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard (29 CFR 1910.1200).
SARA Section 313: This product contains an ammonium salt which is subject to the reporting requirements of Section 313 of SARA Title III.
All chemical components of this product are listed on the TSCA Inventory.

XVI. OTHER INFORMATION

THE ABOVE INFORMATION IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. ALL PRODUCTS ARE OFFERED IN ACCORDANCE WITH THE MANUFACTURER'S CURRENT PRODUCTION SPECIFICATIONS AND ARE INTENDED SOLELY FOR USE IN ANALYTICAL TESTING. THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY INJURY, LOSS OR DAMAGE RESULTING FROM THE HANDLING, USE OR MISUSE OF THESE PRODUCTS.

Titrets® is a registered trademark of CHEMetrics, Inc.

Hach does not have a direct method for potassium permanganate, however Hach method 8034, periodate oxidation for high range manganese can be adapted to measure permanganate.

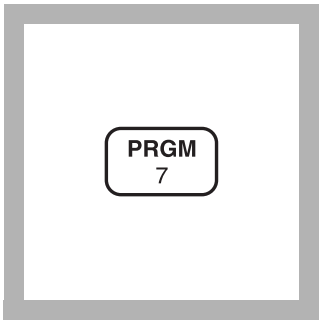
To adapt this method for permanganate, do not add the sodium periodate reagent. Add the buffer reagent as usual. The reaction time is not necessary.

Multiply your manganese results by 2.16 to get results as permanganate (MnO_4), or by 2.88 for results as potassium permanganate ($KMnO_4$), or select the MnO_4 or $KMnO_4$ form display on your instrument. This is not a highly sensitive test and may not measure below 1.5 - 2 mg/L $KMnO_4$ accurately.

MANGANESE, High Range (0 to 20.0 mg/L)

For water and wastewater

Periodate Oxidation Method* USEPA approved for reporting wastewater analysis (digestion is required; see Section 2)**

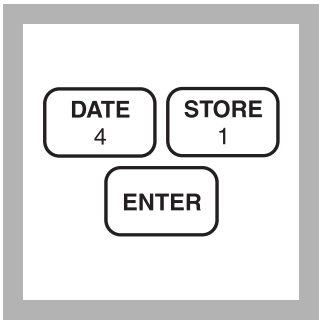


1. Enter the stored program number for manganese, periodate oxidation method.

Press: **PRGM**

The display will show:

PRGM ?



2. Press: **41 ENTER**

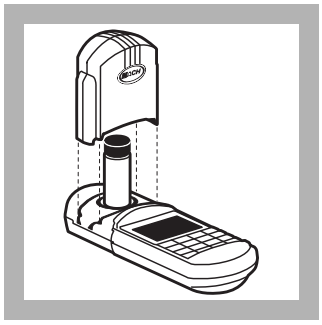
The display will show **mg/L, Mn** and the **ZERO** icon**.**

Note: *For alternate forms ($KMnO_4$, MnO_4), press the* **CONC** *key.*

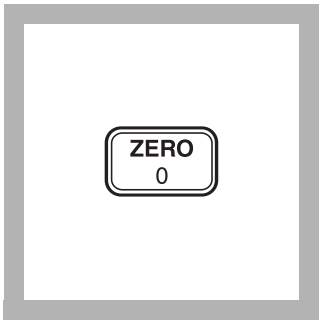
3. Fill a sample cell with 10 mL of sample (the blank).

Note: *For total manganese determination perform a digestion (see Section 2).*

Note: *Adjust the pH of stored samples before analysis.*



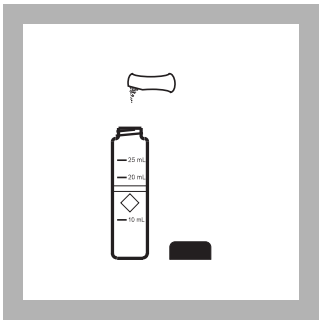
4. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



5. Press: **ZERO**

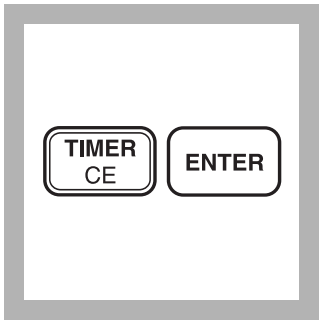
The cursor will move to the right, then the display will show:

0.0 mg/L Mn



6. Remove the cell from the instrument. Add the contents of one Buffer Powder Pillow, citrate type, to the cell. Cap the cell and invert until the powder is dissolved. Remove cap.

7. Add the contents of one Sodium Periodate Powder Pillow to the sample cell (the prepared sample). Cap the sample cell. Invert for 10 seconds to mix.



8. Press:**TIMER ENTER**

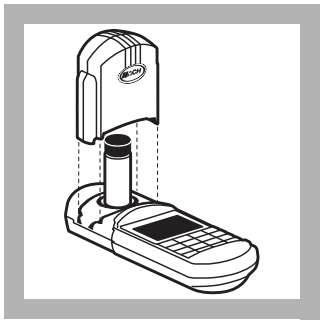
A two-minute reaction period will begin.

Note: *A violet color will form if manganese is present.*

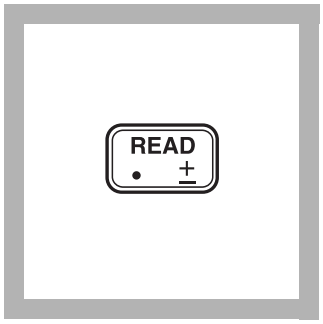
---

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

** *Federal Register*, 44 (116) 34193 (June 14, 1979).



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



10. Press: **READ**

The cursor will move to the right, then the result in mg/L manganese will be displayed.

Note: *Standard Adjust may be performed using a prepared standard (see Section 1).*

Sampling and Storage

Collect samples in acid-washed plastic bottles. Manganese may be lost by adsorption to glass container walls. Adjust the pH to less than 2 with nitric acid (about 2 mL per liter). Preserved samples may be stored up to six months at room temperature. Adjust the pH to 4 to 5 with 5.0 N sodium hydroxide before analysis. Do not exceed pH 5, as manganese may be lost as a precipitate. Correct the test result for volume additions; see *Correction for Volume Additions* in *Section 1* for more information. If only dissolved Mn is to be determined, filter before acid addition.

Accuracy Check

Standard Additions Method

a) Snap the neck off a Manganese Voluette Ampule Standard Solution, 250 mg/L Mn.

b) Use the TenSette Pipet to add 0.1, 0.2 and 0.3 mL of standard, respectively, to the three 25-mL water samples. Swirl to mix.

c) Transfer only 10 mL of each solution to the 10-mL sample cells.

d) Analyze each standard addition sample as described in the procedure. The manganese concentration should increase 1.0 mg/L for each 0.1 mL of standard added.

e) If these increases do not occur, see *Standard Additions* in *Section 1* for troubleshooting information.

Standard Solution Method

Prepare a 5.0 mg/L manganese standard solution by pipetting (use a TenSette or Class A volumetric pipet) 5.00 mL of Manganese Standard Solution, 1000 mg/L Mn, into a 1000-mL volumetric flask. Dilute to the mark with deionized water. Or, prepare this standard by diluting 1.00 mL of a High Range Manganese Standard Voluette Ampule, 250 mg/L, to 50 mL. Prepare these solutions daily. Use these solutions as the sample in the procedure.

Method Performance

Precision

In a single laboratory, using a standard solution of 10.00 mg/L Mn and two representative lots of reagent with the instrument, a single operator obtained a standard deviation of ±0.18 mg/L Mn.

Estimated Detection Limit

The estimated detection limit for program 41 is 0.2 mg/L Mn. For more information on the estimated detection limit, see *Section 1*.

Interferences

The following may interfere when present in concentrations exceeding those listed below:

Calcium	700 mg/L
Chloride	70,000 mg/L
Iron	5 mg/L
Magnesium	100,000 mg/L

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see *pH Interferences* in *Section 1*.

Summary of Method

Manganese in the sample is oxidized to the purple permanganate state by sodium periodate, after buffering the sample with citrate. The purple color is directly proportional to the manganese concentration.

REQUIRED REAGENTS

	Cat. No.
High Range Manganese Reagent Set (100 tests) 10 mL	24300-00
Includes: (1) 21076-69, (1) 21077-69	

Description	Quantity Required Per Test	Unit	Cat. No.
Buffer Powder Pillows, citrate type for Manganese	1 pillow	100/pkg	21076-69
Sodium Periodate Powder Pillows for Manganese	1 pillow	100/pkg	21077-69

REQUIRED APPARATUS

Sample Cell, 10-20-25 mL, w/cap	2	6/pkg	24019-06

OPTIONAL REAGENTS

Drinking Water Standard, Metals, HR (Cu, Fe, Mn)	500 mL	28336-49
Hydrochloric Acid, 6 N	500 mL	884-49
Manganese Standard Solution, 1000 mg/L Mn	100 mL	12791-42
Manganese Standard Solution, Voluette ampule, High Range, 250 mg/L Mn, 10 mL	16/pkg	14258-10
Nitric Acid, ACS	500 mL	152-49
Nitric Acid Solution 1:1	500 mL	2540-49
Sodium Hydroxide Solution, 5.0 N	100 mL MDB	2450-32
Water, deionized	4 L	272-56

OPTIONAL APPARATUS

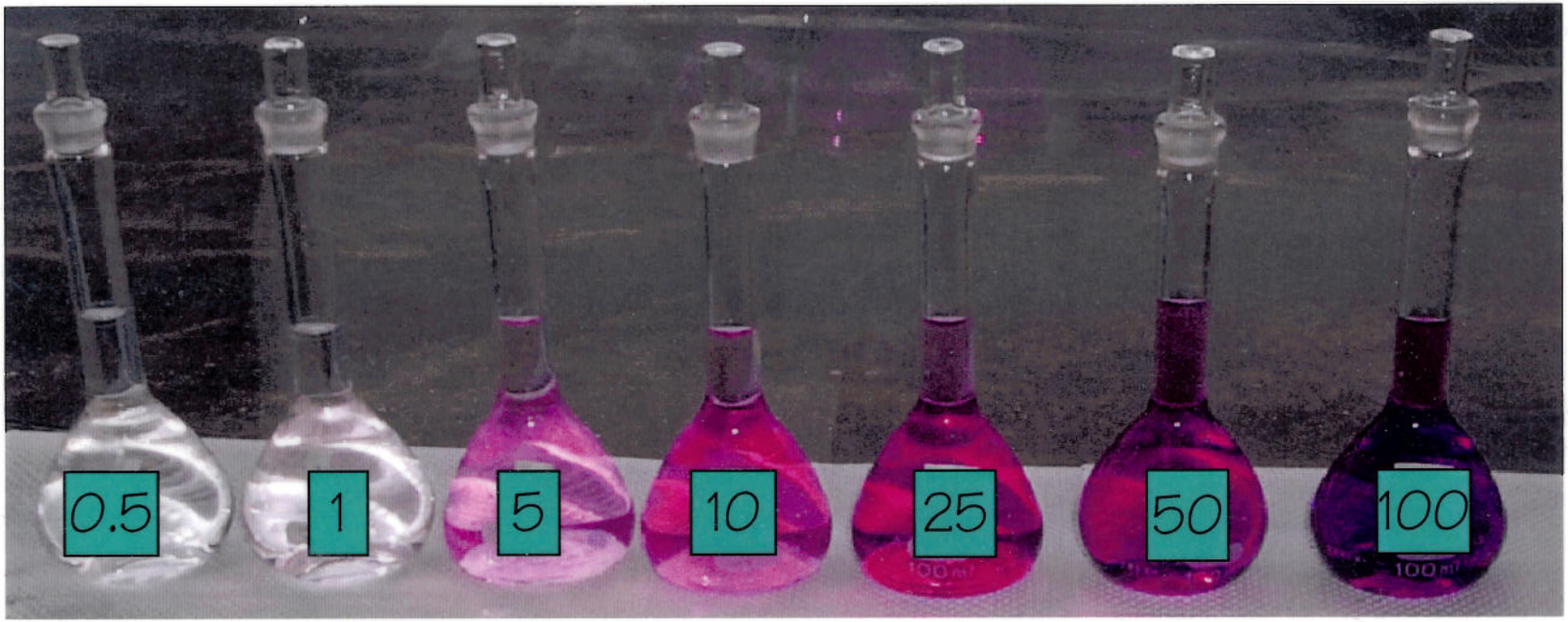
Ampule Breaker Kit	each	21968-00
Flask, Erlenmeyer, 250 mL	each	505-46
Flask, volumetric, Class A, 50 mL	each	14574-41
Flask, volumetric, Class A, 100 mL	each	14574-42
Flask, volumetric, Class A, 1000 mL	each	14574-53
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
pH Meter, *sension*™*1*, portable, with electrode	each	51700-10
Pipet, serological, 5 mL	each	532-37
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet, TenSette, 1.0 to 10.0 mL	each	19700-10
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96Pipet
Tips, for 19700-01 TenSette Pipet	1000/pkg	21856-28
Pipet Tips, for 19700-10 TenSette Pipet	50/pkg	21997-96
Pipet, volumetric, Class A, 5.00 mL	each	14515-37
Pipet, volumetric, Class A, 1.00 mL	each	14515-35
Pipet Filler, safety bulb	each	14651-00

For Technical Assistance, Price and Ordering

In the U.S.A.—Call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.

Approximate Permanganate Concentration



Permanganate Concentration, milligrams $KMnO_4$ / Liter = ppm

Conversion Factors:

(milligrams $KMnO_4$ / Liter) x (0.8978) = (milligrams $NaMnO_4$ / Liter)

(milligrams $KMnO_4$ / Liter) x (0.7516) = (milligrams MnO_4^- / Liter)

Note: ppm x 10,000 = %

Attachment D
EVO/ISCO Technical Documentation

This page intentionally left blank

MATERIAL SAFETY DATA SHEET

EMULSIFIED EDIBLE OIL SUBSTRATE (EOS® 598B42)

D.O.T. HAZARD CLASSIFICATION: NONE

----HMIS----	
HEALTH	1
FLAMMABILITY	0
REACTIVITY	0
PERSONAL PROTECTION	B

MANUFACTURER'S NAME

EOS Remediation, LLC
1101 Nowell Road
Raleigh, NC 27607
www.EOSRemediation.com

DATE OF PREPARATION
01/24/03, Rev. 04/19/05, Rev. 12/22/2010

INFORMATION TELEPHONE NO.
919-873-2204

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME **EOS®CONCENTRATE 598B42**
PRODUCT CLASS **VEGETABLE OIL BASED EMULSION**
CAS NUMBER **MIXTURE**

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT(S)	% BY WEIGHT	CAS NO.	EXPOSURE LIMIT OSHA PEL	EXPOSURE LIMIT ACGIH TLV - TWA
SOYBEAN OIL	58-60	8001-22-7	15 mg/m3	NA
QUICK RELEASE SOLUBLE SUBSTRATE	4	867-56-1		
FOOD ADDITIVES / EMULSIFIERS / PRESERVATIVES (PROPRIETARY)	6 – 10			
NUTRIENTS/EXTRACTS	1.98-2.02			
WATER	BALANCE			

SECTION III - PHYSICAL DATA

BOILING POINT:	**212°F**
SPECIFIC GRAVITY:	**0.97; .92 (pure oil phase)**
VAPOR PRESSURE:	**NOT ESTABLISHED**
PERCENT VOLATILE BY VOLUME (%):	**24 (AS WATER)**
VAPOR DENSITY:	**HEAVIER THAN AIR**
EVAPORATION RATE:	**NOT ESTABLISHED**
SOLUBILITY IN WATER:	**SOLUBLE**
APPEARANCE AND ODOR:	**OFF WHITE LIQUID WITH VEGETABLE OIL ODOR**

EMULSIFIED EDIBLE OIL SUBSTRATE

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:	**>300°F**
FLAMMABLE LIMITS:	**NOT ESTABLISHED**
EXTINGUISHING MEDIA:	**CO_2, FOAM, DRY CHEMICAL** **NOTE: WATER, FOG, AND FOAM MAY CAUSE FROTHING AND SPATTERING.**
UNUSUAL FIRE AND EXPLOSION HAZARDS:	**BURNING WILL CAUSE OXIDES OF CARBON.**
SPECIAL FIRE FIGHTING PROCEDURES:	**WEAR SELF CONTAINED BREATHING APPARATUS AND CHEMICAL RESISTANT CLOTHING. USE WATER SPRAY TO COOL FIRE EXPOSED CONTAINERS.**

SECTION V - PHYSICAL HAZARDS

STABILITY:	**STABLE**
CONDITIONS TO AVOID:	**NONE**
INCOMPATIBILITY:	**STRONG ACIDS AND OXIDIZERS.**
HAZARDOUS DECOMPOSITION PRODUCTS:	**THERMAL DECOMPOSITION MAY PRODUCE OXIDES OF CARBON.**
HAZARDOUS POLYMERIZATION:	**WILL NOT OCCUR**

SECTION VI - HEALTH HAZARDS

SIGNS AND SYMPTOMS OF EXPOSURE:

1. Acute Overexposure - **NONE**
2. Chronic Overexposure - **NONE**

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: **NONE KNOWN**

CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN:

N.T.P. - **NO** I.A.R.C. - **NO** OSHA - **NO**

EMERGENCY AND FIRST AID PROCEDURES:

1.) Inhalation- **REMOVE TO FRESH AIR.**
2.) Eyes- **FLUSH WITH WATER FOR 15 MINUTES, IF IRRITATION PERSISTS SEE PHYSICIAN.**
3.) Skin- **WASH WITH MILD SOAP AND WATER.**
4.) Ingestion- **PRODUCT IS NON-TOXIC. IF NAUSEA OCCURS, INDUCE VOMITING AND SEEK MEDICAL ATTENTION.**

SECTION VII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:	**NOT NORMALLY REQUIRED**
VENTILATION:	**LOCAL EXHAUST**
PROTECTIVE GLOVES:	**NOT NORMALLY REQUIRED**
EYE PROTECTION:	**NOT NORMALLY REQUIRED**
OTHER PROTECTIVE CLOTHING OR EQUIPMENT:	**NONE**

SECTION VIII - SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:	**DO NOT STORE NEAR EXCESSIVE HEAT OR OXIDIZERS.**
OTHER PRECAUTIONS:	**NONE**
STEPS TO BE TAKEN IN CASE MATERIAL IS SPILLED:	**SOAK UP WITH DRY ABSORBENT AND FLUSH AREA WITH LARGE AMOUNTS OF WATER.**
WASTE DISPOSAL METHODS:	**DISPOSE OF ACCORDING TO FEDERAL, STATE, AND LOCAL REGULATIONS.**

SECTION IX - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III

UNDER THE PROVISIONS OF TITLE 111, SECTION 311/312 OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATIONS ACT, THIS PRODUCT IS CLASSIFIED INTO THE FOLLOWING HAZARD CATEGORIES: **NONE**

THIS PRODUCT DOES **NOT** CONTAIN SECTION 313 REPORTABLE INGREDIENTS.

THE INFORMATION CONTAINED HEREIN IS BASED ON AVAILABLE DATA AND IS BELIEVED TO BE CORRECT. HOWEVER, EOS REMEDIATION, INC. MAKES NO WARRANTY, EXPRESSED OR IMPLIED, REGARDING THE ACCURACY OF THIS DATA OR THE RESULTS TO BE OBTAINED THEREOF. THIS INFORMATION AND PRODUCT ARE FURNISHED ON THE CONDITION THAT THE PERSON RECEIVING THEM SHALL MAKE HIS/HER OWN DETERMINATION AS TO THE SUITABILITY OF THE PRODUCT FOR HIS/HER PARTICULAR PURPOSE.

Carus Corporation
Peru, IL U.S.A
Tel + 1 815 223 1500
Fax + 1 815 224 6697

Carus Europe
Asturias, Spain
Tel + 34 985 78 55 13
Fax + 34 985 78 55 10

Web: www.caruscorporation.com
Email: salesmkt@caruscorporation.com
1 800 435 6856
(Toll free US Only)

REMOX® S ISCO

RemOx® S ISCO reagent has been specifically manufactured for environmental applications such as remediation of soils and associated groundwater. This product can be used to degrade a variety of contaminants including chlorinated solvents, polyaromatic hydrocarbons, phenolics, organo-pesticides, and substituted aromatics. RemOx S is shipped with a certificate of analysis (COA) to document assay and trace metals.

CHEMICAL/PHYSICAL DATA

Formula $KMnO_4$
Formula Weight 158.0 g/mol
Form Granular Crystalline
Specific Gravity
Solid 2.703 g/cm^3
3% Solution 1.020 g/mL by weight, 20° C / 4° C
Bulk Density Approximately 100 lb/ft^3
Decomposition may start at 150° C / 302° F

DESCRIPTION

Crystals or granules are dark purple with a metallic sheen, sometimes with a dark bronze-like appearance. RemOx S has a sweetish, astringent taste and is odorless.

HANDLING, STORAGE, AND INCOMPATIBILITY

Protect containers against physical damage. When handling RemOx S respirators should be worn to avoid irritation of, or damage to, mucous membranes. Eye protection should also be worn when handling RemOx S as a solid or in solution.

RemOx S is stable and will keep indefinitely if stored in a cool, dry area in closed containers. Concrete floors are preferred to wooden decks. To clean up spills and leaks, follow the steps recommended in the MSDS. Be sure to use goggles, rubber gloves, and respirator when cleaning up a spill or leak.

Avoid contact with acids, peroxides, and all combustible organic or readily oxidizable materials including inorganic oxidizable materials and metal powders. With hydrochloric acid, chlorine gas is liberated. RemOx S is not combustible, but it will support combustion. It may decompose if exposed to intense heat.

Fires may be controlled and extinguished by using large quantities of water. Refer to the MSDS for more information.

SHIPPING

RemOx S is classified by the Hazardous Materials Transportation Board (HMTB) as an oxidizer. It is shipped under Interstate Commerce Commission's (ICC) Tariff 19.

Proper Shipping Name: Potassium Permanganate
(RQ-100/45.4)
Hazard Class: Oxidizer
Identification Number: UN 1490
Label Requirements: Oxidizer
Packaging Requirements: 49 CFR Parts 100 to 199
Sections: 173.152, 173.153, 173.194
Shipping Limitations:
Minimum quantities:
Rail car: See Tariff for destination
Truck: No minimum
Postal regulations:
Information applicable to packaging of oxidizers for shipment by the U.S. Postal Service to domestic and foreign destinations is readily available from the local postmaster. United Parcel Service accepts 25 lbs as largest unit quantity properly packaged; (consult United Parcel Service). Regulations concerning shipping and packing should be consulted regularly due to frequent changes.

CORROSIVE PROPERTIES

RemOx S is compatible with many metals and synthetic materials. Natural rubbers and fibers are often incompatible. Solution pH and temperature are also important factors. The material must be compatible with either the acid or alkali also being used.

In neutral and alkaline solutions, RemOx S is not corrosive to iron, mild steel, or stainless steel; however, chloride corrosion of metals may be accelerated when an oxidant such as permanganate is present in solution. Plastics such as polypropylene, polyvinyl chloride Type I (PVC I), epoxy resins, fiberglass reinforced plastic (FRP), Penton, Lucite, Viton A, and Hypalon are suitable. Teflon FEP and TFE, and Tefzel ETFE are best. Refer to Material Compatibility Chart.

Aluminum, zinc, copper, lead, and alloys containing these metals may be (slightly) affected by RemOx S solutions. Actual studies should be made under the conditions in which permanganate will be used.

APPLICATIONS

RemOx S is used for soil and groundwater remediation by *in situ* or *ex situ* chemical oxidation and as an active agent in subsurface reactive barriers for treatment of: chlorinated ethenes, phenolic compounds, polyaromatic hydrocarbons, TNT, RDX, HMX, and various pesticides.

© 2011 CARUS CORPORATION

Section 1 Chemical Product and Company Identification

PRODUCT NAME: RemOx® S ISCO Reagent **TRADE NAME:** RemOx® S ISCO Reagent	**Revised Date: April 2008**
USES OF SUBSTANCE: RemOx® S ISCO Reagent is an oxidant recommended for applications that require a strong oxidant.	

COMPANY NAME (Europe): CARUS NALON S.L.	**COMPANY ADDRESS:** Carus Nalon S.L. Barrio Nalon, s/n 33100 Trubia-Oviedo Espana, Spain **INFORMATION:** (34) 985-785-513 (34) 985-785-513 www.caruseurope.com (Web) carus@carusnalon.com (Email) **EMERGENCY TELEPHONE:** (34) 985-785-513
COMPANY NAME (US): CARUS CORPORATION	**COMPANY ADDRESS:** 315 Fifth Street Peru, IL 61354, USA **INFORMATION:** (815)-223-1500 www.caruscorporation.com (Web) salesmkt@caruscorporation.com (Email) **EMERGENCY TELEPHONE:** (800) 435 –6856 (USA) (800) 424-9300 (CHEMTREC, USA) (815-223-1500 (Other countries)

Section 2 Hazards Identification

1. **EYE CONTACT**
   RemOx® S ISCO Reagent is damaging to eye tissue on contact. It may cause severe burns that result in damage to the eye.

2. **SKIN CONTACT**
   Contact of solutions at room temperature may be irritating to the skin, leaving brown stains.
   Concentrated solutions at elevated temperature and crystals are damaging to the skin.

3. **INHALATION**
   Acute inhalation toxicity data are not available. However, airborne concentrations of RemOx® S ISCO Reagent the form of dust or mist may cause damage to the respiratory tract.

4. **INGESTION**
   RemOx® S ISCO Reagent , if swallowed, may cause severe burns to mucous membranes of the mouth, throat, esophagus, and stomach.

Section 3 Hazardous Ingredients

MATERIAL OR COMPONENT	CAS NO.	EINECS	HAZARD DATA
Potassium Permanganate	7722-64-7	231-760-3	**PEL/C** 5 mg Mn per cubic meter of air
			TLV-TWA 0.2 mg Mn per cubic meter of air

HAZARD SYMBOLS:

O

Xn

N

RISK PHRASES:

8 Contact with combustibles may case fire.
22 Harmful if swallowed.
50/53 Very toxic to aquatic organisms, may cause long-term effects in the aquatic environment.

SAFETY PHRASES:

60 This material and its container must be disposed of as hazardous waste.
61 Avoid releases to the environment. Refer to special instructions / Safety data sheet.

Section 4 First Aid Measures

1. **EYES**
   Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Do not attempt to neutralize chemically. Seek medical attention immediately. **Note to physician**: Soluble decomposition products are alkaline. Insoluble decomposition product is brown manganese dioxide.

2. **SKIN**
   Immediately wash contaminated areas with water. Remove contaminated clothing and footwear. Wash clothing and decontaminate footwear before reuse. Seek medical attention immediately if irritation is severe or persistent.

3. **INHALATION**
   Remove person from contaminated area to fresh air. If breathing has stopped, resuscitate and administer oxygen if readily available. Seek medical attention immediately.

4. **INGESTION**
   Never give anything by mouth to an unconscious or convulsing person. If person is conscious, give large quantities of water. Seek medical attention immediately.

Section 5 Fire Fighting Measures

NFPA* HAZARD SIGNS

Health Hazard	1	=	Materials which under fire conditions would give off irritating combustion products. (less than 1 hour exposure) Materials that on the skin could cause irritation.
Flammability Hazard	0	=	Materials that will not burn.
Reactivity Hazard	0	=	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.
Special Hazard	OX	=	Oxidizer

***National Fire Protection Association 704 (USA)**

FIRST RESPONDERS:	Wear protective gloves, boots, goggles, and respirator. In case of fire, wear positive pressure breathing apparatus. Approach incident with caution.
FLASHPOINT	None
FLAMMABLE OR EXPLOSIVE LIMITS	Lower: Nonflammable Upper: Nonflammable
EXTINGUISHING MEDIA	Use large quantities of water. Water will turn pink to purple if in contact with RemOx® S ISCO Reagent. Dike to contain. Do not use dry chemicals, CO_2 Halon® or foams.
SPECIAL FIREFIGHTING PROCEDURES	If material is involved in fire, flood with water. Cool all affected containers with large quantities of water. Apply water from as far a distance as possible. Wear self-contained breathing apparatus and full protective clothing.
UNUSUAL FIRE AND EXPLOSION	Powerful oxidizing material. May decompose spontaneously if exposed to heat (150°C / 302°F). May be explosive in contact with certain other chemicals (Section 10). May react violently with finely divided and readily oxidizable substances. Increases burning rate of combustible material.

Section 6 Accidental Release Measures

PERSONAL PRECAUTIONS:

Ensure adequate ventilation. Avoid dust formation. Avoid inhalation and contact with eyes and skin. Personnel should wear protective clothing suitable for the task. Remove all ignition sources and incompatible materials before attempting clean up.

ENVIRONMENTAL PRECAUTIONS:
Do not flush into sanitary sewer system or surface water. If accidental release into the environment occurs, inform the responsible authorities. Keep the product away from drains, sewers, surface and ground water and soil.

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Clean up spills immediately by sweeping or shoveling up the material. Do not return spilled material to the original container – transfer to a clean metal drum. To clean contaminated surfaces or floors, flush with abundant quantities of water into sewer, if permitted by federal, state, and local regulations - if not, collect water and treat chemically (Section 13).

Section 7 Handling and Storage

WORK/HYGIENIC PRACTICES
Wash hands thoroughly with soap and water after handling RemOx® S ISCO Reagent. Do not eat, drink or smoke when working with RemOx® S ISCO Reagent. Wear proper protective equipment. Remove clothing, if it becomes contaminated.

VENTILATION REQUIREMETNS
Provide sufficient mechanical and/or local exhaust to maintain exposure below the TLV/TWA.

CONDITIONS FOR SAFE STORAGE
Store in accordance with NFPA 430 requirements for Class II oxidizers. Protect containers from physical damage. Store in a cool, dry area in closed containers. Segregate from acids, peroxides, formaldehyde, and all combustible, organic, or easily oxidizable materials including antifreeze and hydraulic fluid.

Section 8 Exposure Controls and Personal Protection

RESPIRATORY PROTECTION
In cases where overexposure to dust may occur, the use of an approved NIOSH-MSHA dust respirator or an air supplied respirator is advised. Engineering or administrative controls should be implemented to control dust

EYE
Faceshield, goggles, or safety glasses with side shields should be worn. Provide eyewash in working area.

GLOVES
Rubber or plastic gloves should be worn.

OTHER PROTECTIVE EQUIPMENT
Normal work clothing covering arms and legs, and rubber, or plastic apron should be worn.

Section 9 Physical and Chemical Properties

APPEARANCE AND ODOR	Dark purple solid with metallic luster, odorless
BOILING POINT, 760 mm Hg	Not applicable
VAPOR PRESSURE (mm Hg)	Not applicable
SOLUBILITY IN WATER % BY SOLUTION	6% at 20°C (68°F) and 20% at 65°C (149°F)
PERCENT VOLATILE BY VOLUME	Not volatile
EVAPORATION RATE	Not applicable
MELTING POINT	Starts to decompose with evolution of oxygen (O_2) at temperatures above 150°C (302°F). Once initiated, the decomposition is exothermic and self-sustaining.
SPECIFIC GRAVITY	2.7 at 20°C (68°F)
BULK DENSITY	Approximately 1.45 - 1.6 kg / l
VAPOR DENSITY (AIR=1)	Not applicable
OXIDIZING PROPERTIES	Strong oxidizer

Section 10 Stability and Reactivity

STABILITY	Under normal conditions, the material is stable.
CONDITIONS TO AVOID	Contact with incompatible materials or heat (150°C / 302ºF) could result in violent exothermic chemical reaction.
INCOMPATIBLE MATERIALS	Acids, peroxides, formaldehyde, anti-freeze, hydraulic fluids and all combustible organic or readily oxidizable inorganic materials including metal powders. With hydrochloric acid, chlorine gas is liberated.
HAZARDOUS DECOMPOSITION PRODUCTS	When involved in a fire, RemOx® S ISCO Reagent may liberate corrosive fumes.
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION	Material is not known to polymerize.

Section 11 Toxicological Information

POTASSIUM PERMANGANATE:

1. ACUTE TOXICITY

INGESTION:
LD 50 oral rat: 780 mg/kg male (14 days); 525 mg/kg female (14 days).
Harmful if swallowed. ALD: 10g. Ingestion may cause nausea, vomiting, sore throat, stomach-ache and eventually lead to a perforation of the intestine. Liver and kidney injuries may occur.

SKIN CONTACT:
LD 5O dermal no data available.
The product may be absorbed into the body through the skin. Major effects of exposure: severe irritation, brown staining of skin.

INHALATION:
LC 5O inhalation: No data available.
The product may be absorbed into the body by inhalation. Major effects of exposure: respiratory disorder, cough.

2. CHRONIC TOXICITY
No known cases of chronic poisoning due to permanganates have been reported. Prolonged exposure, usually over many years, to heavy concentrations of manganese oxides in the form of dust and fumes may lead to chronic manganese poisoning, chiefly involving the central nervous system.

3. CARCINOGENICITY
Potassium permanganate has not been classified as a carcinogen by ACGIH, NIOSH, OSHA, NTP, or IARC.

4. MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
Potassium permanganate solution will cause further irritation of tissue, open wounds, burns or mucous membranes.

Section 12 Ecological Information

ENTRY TO THE ENVIRONMENT

Potassium permanganate has a low estimated lifetime in the environment, being readily converted by oxidizable materials to insoluble MnO_2.

BIOCONCENTRATION POTENTIAL

In non-reducing and non-acidic environments, MnO_2 is insoluble and has a very low bioaccumulative potential.

AQUATIC TOXICITY

The toxicity data for Potassium permanganate is given below:

Rainbow trout, 96 hour LC_{50}:	1.8 mg/L
Bluegill sunfish, 96 hour LC_{50}:	2.3 mg/L
Milk fish (Chanos Chanos)/ 96 hour LC_{50}:	>1.4mgl

Section 13 Disposal Considerations

Offer surplus and non-recyclable product or solutions to a licensed disposal company.

Reduce RemOx® S ISCO Reagent in aqueous solutions with sodium thiosulfate, a bisulfite or ferrous salt solution. The bisulfite or ferrous salt may require some dilute sulfuric acid (10% w/w) to promote reduction. Neutralize with sodium carbonate to neutral pH, if acid was used. Decant or filter and deposit sludge in approved landfill. Where permitted, the sludge may be drained into sewer with large quantities of water. Contact Carus Corporation for additional recommendations.

Packaging materials must be triple rinsed to remove all RemOx® S ISCO Reagent prior to re-cycling or disposal.

Section 14 Transport Information

USA (land, D.O.T.)	**Proper Shipping Name:** 49 CFR172.101….Potassium Permanganate **Hazard Class:** 49 CFR172.101….Oxidizer **ID Number:** 49 CFR172.101….UN 1490 **Packing Group:** 49 CFR172.101….II **Division:** 49 CFR172.101….5.1
European Labeling in accordance Road/Rail Transport (ADR/RID)	**ID Number:** UN 1490 **ADR/RID Class** 5.1 **Description of Goods:** Potassium Permanganate **Hazard Identification No.** 50
European Labeling in accordance with EC directive (Water, I.M.O.)	**Proper Shipping Name:** Potassium Permanganate **Hazard Class:** Oxidizer **ID Number:** UN 1490 **Packing Group:** II **Division:** 5.1 **Marine Pollutant**: No

Section 14 Transport Information (contd.)

European Labeling in accordance with EC directive (Air, I.C.A.O.)	**Proper Shipping Name:**	Potassium Permanganate
	Hazard Class:	Oxidizer
	ID Number:	UN 1490
	Packing Group:	II
	Division:	5.1

Section 15 Regulatory Information

EUROPEAN AND INTERNATIONAL REGULATIONS:

MARKINGS ACCORDING TO EU GUIDELINES:

The product has been classified and marked in accordance with EU directives/ordinances on hazardous materials.

CHEMICAL NAME	CAS NO.	EINECS	UN NUMBER
Potassium Permanganate	7722-64-7	231-760-3	UN 1490

CODE LETTER AND HAZARD DESIGNATION OF THE PRODUCT:

O
Oxidizer

Xn
Harmful

N
Dangerous to the Environment

RISK PHRASES:

8 Contact with combustibles may case fire.
22 Harmful if swallowed.
50/53 Very toxic to aquatic organisms, may cause long-term effects in the aquatic environment.

SAFETY PHRASES:

60 This material and its container must be disposed of as hazardous waste.
61 Avoid releases to the environment. Refer to special instructions / Safety data sheet.

Section 15 Regulatory Information (contd.)

US FEDERAL REGULATIONS:

CHEMICAL INVENTORY STATUS – PART 1

Ingredient	CAS. NO.	TSCA	EC	Japan	Australia
Potassium Permanganate	7722-64-7	Yes	Yes		

CHEMICAL INVENTORY STATUS – PART 2 --- CANADA---

Ingredient	CAS. NO.	Korea	DSL	NDSL	PHIL
Potassium Permanganate	7722-64-7	No	Yes		

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulation (CPR, Canada) and the MSDS contains all of the information required by the CPR.

FEDERAL, STATE & INTERNATIONAL REGULATIONS – PART 1

		SARA 302		SARA 313	
Ingredient	CAS. NO.	RQ	TPQ	List	Chemical Catg.
Potassium Permanganate	7722-64-7	N/A	N/A	Yes (Manganese compounds)	Yes

FEDERAL, STATE & INTERNATIONAL REGULATIONS – PART 2

Ingredient	CAS. NO.	CERCLA	RCRA	TSCA 8(d)
Potassium Permanganate	7722-64-7	Yes (RQ =100 lbs)	D001	No

Ingredient	CAS. NO.	CWC	TSCA 12(b)	CDTA 311/312	SARA
Potassium Permanganate	7722-64-7	No	No		4545 Kg

Ingredient	CAS. NO.	Acute	Chronic	Fire	Pressure	Reactivity	Pure/Liquid
Potassium Permanganate	7722-64-7	Yes	Yes	Yes	No	No	Pure

Ingredient	CAS. NO.	Australian Hazchem Code	Poison Schedule	WHMIS
Potassium Permanganate				C, D2B

Section 16 Other Information

NIOSH	National Institute for Occupational Safety and Health
MSHA	Mine Safety and Health Administration
OSHA	Occupational Safety and Health Administration
NTP	National Toxicology Program
IARC	International Agency for Research on Cancer
PEL	Permissible Exposure Limit
C	Ceiling Exposure Limit
TLV-TWA	Threshold Limit Value-Time Weighted Average
CAS	Chemical Abstract Service
EINECS	Inventory of Existing Chemical Substances (European)

Chithambarathanu Pillai (S.O.F.)
April 2008

The information contained herein is accurate to the best of our knowledge. However, data, safety standards and government regulations are subject to change and, therefore, holders and users should satisfy themselves that they are aware of all current data and regulations relevant to their particular use of product. CARUS CORPORATION DISCLAIMS ALL LIABILITY FOR RELIANCE ON THE COMPLETENESS OR ACCURACY OR THE INFORMATION INCLUDED HEREIN. CARUS CORPORATION MAKES NO WARRANTY, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTIABILITY OR FITNESS FOR PARTICULAR USE OR PURPOSE OF THE PRODUCT DESCRIBED HEREIN. All conditions relating to storage, handling, and use of the product are beyond the control of Carus Corporation, and shall be the sole responsibility of the holder or user of the product.

CARUS CORPORATION, 315 5TH STREET, PERU, ILLINOIS 61354
CARUS NALON S.L. IS A DIVISION OF CARUS CORPORATION, 315 5TH STREET, PERU, ILLINOIS 61354

Responsible Care®
Good Chemistry at Work

(Carus and Design) is a registered service mark of Carus Corporation. CARUS® is a registered trademark of Carus Corporation. RemOx® is a trademark of Carus Corporation. Responsible Care® is a registered service mark of the American Chemistry Council.

Attachment E
Sampling Nomenclature

This page intentionally left blank

Station Identification System

Field station data are information assigned to a physical location in the field at which some sort of sample is collected. For example, a monitoring well that has been installed will require a name that will uniquely identify it with respect to other monitoring wells or other types of sample locations. The station name provides a key in a database to which any samples collected from that location can be linked to form a relational database structure.

Before beginning fieldwork, the Field Team Leader will review the proposed level of effort and coordinate a list of unique station identification names, or station IDs, with the Data Management Coordinator (DMC). The Field Team Leader will be responsible for enforcing the use of the standardized numbering system during all field activities.

Each station will be uniquely identified by an alphanumeric code that will describe the station's attributes. These attributes are Facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, Location type, sequential Location number, and possibly an additional qualifier. The naming scheme that will be used to identify a sampling location is documented in Table 1.

This station designation format will be followed throughout the field activities conducted. Required deviations to this format in response to field conditions will be documented in the field logbook.

Sample Identification System

Field sample data are information assigned to a physical piece of material collected in the field for which some sort of analysis will be run. Before collecting samples the Field Team Leader will review the proposed level of effort and coordinate a list of unique sample identification names, or sample IDs, with the DMC.

A standardized numbering system will be used to identify all samples collected during sampling activities. The numbering system will provide a tracking procedure to ensure accurate data retrieval of all samples taken. A listing of the sample identification numbers will be maintained by the Field Team Leader, who will be responsible for enforcing the use of the standardized numbering system during all sampling activities. Sample identification for all samples collected during the investigations will use the format described below.

Each normal and duplicate sample will be uniquely identified by an alphanumeric code that will describe the sample's attributes. These attributes are Facility, AOC/Site/OU number, Location type, sequential Location number with possibly an additional qualifier, depth (as applicable) and date. Each field QC sample will also be uniquely identified by an alphanumeric code that will describe the sample's attributes. These attributes are Qualifier Code, Qualifier Number, and Date. Each unique set of sample attributes will be assigned a unique sample name. The naming scheme that will be used to identify a field sample is documented in Table 2.

This sample designation format will be followed throughout the field activities conducted. Required deviations to this format in response to field conditions will be documented in the field logbook.

This page intentionally left blank

Table 1 – Station ID Scheme
Navy Clean

First Segment	Second Segment	
Facility, Site Number	Station Type	Station Number, Modifier
AA,ANN	AA	NNN_A

Notes: "A"= alphabetic "N"= numeric

Facility:

A = ABL
AN = Anacostia
BA = Bainbridge
BW = Bloodsworth Island
BO = Bolling AFB
BR = Bremerton
CA = Cheatham Annex
CH = Cherry Point
CI = Craney Island
CL = Camp Lejeune
CP = Camp Peary
CR = Carderock
DA = Dahlgren
DN = Dam Neck
DR = Driver
IH = Indian Head
LS = Little Creek
NA = Naval Academy
NB = Naval Station Norfolk
NM = NNMC (Bethesda Naval Hospital)
NN = Norfolk Naval Shipyard
NR = Naval Research Laboratory
NWA = Northwest Annex
OC = Oceana
PA = Pax River
PI = Pineros Islands
Q = Quantico
RO = Rota
RR = Roosevelt Roads
SI = Sigonella
SJ = St. Juliens
SS = Sabana Seca
VE = Vieques East
VW = Vieques West
WN = Washington Navy Yard
WO = White Oak
Y = Yorktown

Site/AOC/SWMU Number – Sequential Number:

Site = S01, S02, S03…
Site Screening Area = SA01, SA02, SA03…
AOC = A01, A02, A03…
AOI = AI01, AI02, AI03…
SWMU = W01, W02…
Building = B01, B02, B03…
R01 = MWR Skeet Range
M01 = Marine Pistol and Rifle Range
LIA – LI Area, East Vieques

BSxx = Background locations outside of site (BS25 = Background Site 25)
BKL = Background locations outside of the facility
BKG = Background locations (inside base)

YNWS = Yorktown QC Samples Only
CHAX = Cheatham Annex QC Samples Only
SESA = Sabana Seca QC Samples Only
CAP = Camp Peary QC Samples Only

Station Type:

AGT = Above Ground Tank
AS = Ash
BH = Borehole
DP = Direct Push
DR = Drill Rig
EW = Extraction Well
FG = Frog
FS = Fish
GB = Geotechnical Boring
GP = Geoprobe
GV = Gas Vent
HP = Holding Pond/Lagoon
IW = Injection Well
LW = Leach Well
MA = Alluvial Monitoring Well
MB = Bedrock Monitoring Well
MU = UST Monitoring Well
MW = Monitoring Well (GW for Y)
PC = Paint Chip
PW = Production Well
RK = Rock
SW = Surface Water
RC = Recovery Well
RM = Remediation Well
RW = Residential Well
SD = Sediment Location
SG = Soil Gas
SL = Storm Sewer Line Sediment
SO = Soil Location
SP = Seep
ST = StormWater
SU = Sump
SV = Soil Vapor
SW = Surface Water
SWS = Surface Water Body (for SW and SD)
UST = Underground Storage Tank
TA = Tap Water
TD = Tidal Station
TI = Tissue Sample (general)
TO = Tadpole
TP = Test Pit
TR = Trench Sediment
TS = Treatment System
TW = Temporary Well
WA = Alluvial Extraction Well
WB = Bedrock Extraction Well
WL = Water Supply Well
WN = Pore Water
WP = Wipe Sample
WT = Water Table Piezometer
IDW = Investigation Derived Waste
QC = QA/QC blanks only

Station Number:
Sequential Station Number (i.e., 001, 002, 003…)

Modifier (used selectively):
D = Deep monitoring well
S = Shallow monitoring well

Example Station IDs:

YS01-DP002 = Direct push soil location #2 at Yorktown Naval Weapons Station Site 1
CHR05-MW002S = Shallow monitoring well location 2, at the Cheatham Annex facility, Range 5.
NMBKL-SD002 = Background sediment location #2 located outside of NNMC
CHBS03-SO05 = Soil location #5, located in reference area outside of Site 3 in Cherry Point

***Notes:* Location ID for any QA/QC blank samples (trip blanks, field blanks, equipment rinse blanks) will be Facility -QC and Facility–IDW for any IDW samples. The first segment indicates the Site ID.

Table 2 – Sample ID Scheme
Navy Clean

First Segment	Second Segment	Third Segment	Fourth Segment
Site ID Facility, AOC Number	Station/Sample Type, Station Number, Modifier	Depth (As Needed)	Date (MMYY) $_A$
AA,ANN	AANNN$_A$	A	NNNN$_A$

Notes: "A"= alphabetic "N"= numeric

A = ABL
AN = Anacostia
BA = Bainbridge
BW = Bloodsworth Island
BO = Bolling AFB
BR = Bremerton
CA = Cheatham Annex
CH = Cherry Point
CI = Craney Island
CL = Camp Lejeune
CP = Camp Peary
CR = Carderock
DA = Dahlgren
DN = Dam Neck
DR = Driver
IH = Indian Head
LS = Little Creek
NA = Naval Academy
NB = Naval Station Norfolk
NM = NNMC (Bethesda Naval Hospital)
NN = Norfolk Naval Shipyard
NR = Naval Research Laboratory
NWA = Northwest Annex
OC = Oceana
PA = Pax River
PI = Pineros Islands
QU = Quantico
RO = Rota
RR = Roosevelt Roads
SI = Sigonella
SJ = St. Juliens
SS = Sabana Seca
VE = Vieques East
VW = Vieques West
WN = Washington Navy Yard
WO = White Oak
Y = Yorktown

Site/AOC/SWMU – Sequential Number:

Site = S01, S02, S03…
Site Screening Area = SA01, SA02, SA03…
AOC = A01, A02, A03…
AOI = AI01, AI02, AI03…
SWMU = W01, W02…
Building = B01, B02, B03…
R01 = MWR Skeet Range
M01 = Marine Pistol and Rifle Range
LIA – LI Area, East Vieques

BSxx = Background locations outside of site (BS25 = Background Site 25)
BKL = Background locations outside of the facility
BKG Background locations (inside base)

YNWS = Yorktown QC Samples Only
CHAX = Cheatham Annex QC Samples
SESA = Sabana Seca QC Samples Only

Sample Type:
AGT = Above Ground Tank
AH = Air - Headspace
AS = Ash
BH = Borehole
DR = Drill Rig
DS = Direct Push—Soil
DW = Direct Push—Groundwater
EW = Extraction Well
FG = Frog
FS = Fish
GB = Geotechnical Boring
GP = Geoprobe
GV = Gas Vent
HP = Holding Pond/Lagoon
IW = Injection Well
LF = Free Product
LW = Leach Well
MA = Alluvial Monitoring Well
MB = Bedrock Monitoring Well
MU = UST Monitoring Well
MW = Monitoring Well (GW for Y)
PC = Paint Chip
PW = Production Well
RK = Rock
SW = Surface Water
RC = Recovery Well
RM = Remediation Well
RW = Residential Well
SB = Subsurface Soil
SD = Sediment Location
SG = Soil Gas
SL = Storm Sewer Line Sediment
SO = Soil Location (Composite)
SP = Seep
SS = Surface Soil
ST = StormWater
SU = Sump
SV = Soil Vapor
SW = Surface Water
UST = Underground Storage Tank
TA = Tap Water
TD = Tidal Station
TI = Tissue Sample (general)
TO = Tadpole
TP = Test Pit
TR = Trench Sediment
TS = Treatment System
TW = Temporary Well
WA = Alluvial Extraction Well
WB = Bedrock Extraction Well
WL = Water Supply Well
WN = Pore Water
WP = Wipe Sample
WT = Water Table Piezometer

Station Number:
Sequential Number (e.g., 001, 002, 003)

Modifier (used selectively):
D = Deep monitoring well
S = Shallow monitoring well
P = Duplicate

Depth:

Use only if applicable. A sequential letter is used to reflect varying depths, as actual depths can change in the field after sample planning has occurred. E.g. A, B, C…

Sample Number:

1. Duplicate Samples - Use a 'P' modifier in the second segment of the sample ID, directly after the location number to indicate a duplicate sample. E.g. AB01-MW11P-0506

2. QC & IDW Samples (Blank Samples & Waste Char.) - Format consists of Facility, AOC Number, Qualifier Code, Sequential Qualifier Number-Date (AAANN-AANN-MMDDYY). E.g. LSA05-TB02-061106

Qualifier Codes:
TB = Trip Blank
FB = Field Blank
EB = Equipment Blank
WS = Waste Char. Soil
WW = Waste Char. Water

3. Drill Rig Samples – Format consists of Facility, AOC Number, Station Type, Station Number, Date. E.g. YS12-DR02-020507

4. Multiple samples - Should multiple samples be collected from the same location in a given day/month (affects only samples not differentiated by depth), a sequential letter will be added to the end of the fourth segment (date). E.g. A, B, C…

Example Sample IDs:

PAS02-DS003-C-0805 = Direct push soil sample collected at location 3, in OU2 at the Pax River facility, from the third depth collected below ground surface (BGS) in August 2005.
NBBKL-SS011-0403 = Surface soil collected at location # 11, at a background location outside of Naval Station Norfolk in April 2003.
WNA01-MW102S-0105A = The first shallow groundwater sample collected at monitoring well location 102 in January 2005 in AOC01 at the Washington Navy Yard facility.
PIW01-SW023P-0306 = Pineros Island duplicate surface water sample collected at location 23 from SMWU-1 in March 2006.
SSW06-FB01-061106 = The first field blank collected on June 11, 2006 at SMWU-6 in Sabana Seca.

Attachment F
Lab Accreditation Sampling Nomenclature

This page intentionally left blank

LABORATORY ACCREDITATION BUREAU

Certificate of Accreditation

ISO/IEC 17025:2005 ***Certificate Number L2226***

Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation Granted through: November 30, 2012

R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 30th of November 2009

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Scope of Accreditation For Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
1-877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	8260B	1,1,2-Trichloroethane
GC/MS	8260B	1,1,2,2-Tetrachloroethane
GC/MS	8260B	1,1,1,2-Tetrachloroethane
GC/MS	8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	8260B	1,2,3-Trichlorobenzene
GC/MS	8260B	1,2,4-Trichlorobenzene
GC/MS	8260B	1,2,3-Trichloropropane
GC/MS	8260B	1,2,4-Trimethylbenzene
GC/MS	8260B	1,3,5-Trimethylbenzene
GC/MS	8260B	1,2-Dibromoethane (EDB)
GC/MS	8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260B	1,2-Dichlorobenzene
GC/MS	8260B	1,2-Dichloroethane (EDC)
GC/MS	8260B	1,2-Dichloropropane
GC/MS	8260B	1,3-Dichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,4-Dichlorobenzene
GC/MS	8260B	1,1-Dichloropropene
GC/MS	8260B	1,3-Dichloropropane
GC/MS	8260B	2,2-Dichloropropane
GC/MS	8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	8260B	Acetone
GC/MS	8260B	Benzene
GC/MS	8260B	Bromochloromethane
GC/MS	8260B	Bromodichloromethane
GC/MS	8260B	Bromobenzene
GC/MS	8260B	Bromoform
GC/MS	8260B	Bromomethane
GC/MS	8260B	n-Butylbenzene
GC/MS	8260B	sec-Butylbenzene
GC/MS	8260B	tert-Butylbenzene
GC/MS	8260B	Carbon Disulfide
GC/MS	8260B	Carbon Tetrachloride
GC/MS	8260B	Chlorobenzene
GC/MS	8260B	Chloroethane
GC/MS	8260B	Chloroform
GC/MS	8260B	Chloromethane
GC/MS	8260B	2-Chlorotoluene
GC/MS	8260B	4-Chlorotoluene
GC/MS	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	8260B	cis-1,3-Dichloropropene
GC/MS	8260B	Cyclohexane
GC/MS	8260B	Dibromochloromethane
GC/MS	8260B	Dibromomethane
GC/MS	8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	8260B	Ethylbenzene
GC/MS	8260B	Hexachlorobutadiene
GC/MS	8260B	Isopropylbenzene (Cumene)
GC/MS	8260B	p-Isopropyltoluene
GC/MS	8260B	Methyl Acetate
GC/MS	8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	8260B	Methylcyclohexane
GC/MS	8260B	Methylene Chloride, or Dichloromethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	Naphthalene
GC/MS	8260B	n-Propylbenzene
GC/MS	8260B	Styrene
GC/MS	8260B	Tetrachloroethene (PCE; PERC)
GC/MS	8260B	Toluene
GC/MS	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	8260B	trans-1,3-Dichloropropene
GC/MS	8260B	Trichloroethene (TCE)
GC/MS	8260B	Trichlorofluoromethane (CFC-11)
GC/MS	8260B	Vinyl Chloride (VC)
GC/MS	8260B	Xylenes (Total)
GC/MS	8260B	Acrolein
GC/MS	8260B	Acrylonitrile
GC/MS	8260B	Di-isopropyl ether
GC/MS	8260B	ETBE
GC/MS	8260B	Ethyl methacrylate
GC/MS	8260B	Iodomethane
GC/MS	8260B	Methyl methacrylate
GC/MS	8260B	t-Butyl alcohol
GC/MS	8260B	tert-Amyl methyl ether
GC/MS	8260B	2-Chloroethyl vinyl ether
GC/MS	8260B	1-Chlorohexane
GC/MS	8260B	Tetrahydrofuran
GC/MS	8260B	Vinyl acetate
GC/MS	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	8270C/D	1,2-Dichlorobenzene
GC/MS	8270C/D	1,3-Dichlorobenzene
GC/MS	8270C/D	1,4-Dichlorobenzene
GC/MS	8270C/D	2,4,5-Trichlorophenol
GC/MS	8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	8270C/D	2,4-Dimethylphenol
GC/MS	8270C/D	2,4-Dinitrophenol
GC/MS	8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	8270C/D	2,6-Dichlorophenol
GC/MS	8270C/D	2,6-Dinitrotoluene
GC/MS	8270C/D	1,2-Diphenylhydrazine
GC/MS	8270C/D	2-Chloronaphthalene
GC/MS	8270C/D	2-Chlorophenol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	2-Methylnaphthalene
GC/MS	8270C/D	2-Methylphenol (o-Cresol)
GC/MS	8270C/D	2-Nitroaniline
GC/MS	8270C/D	2-Nitrophenol (ONP)
GC/MS	8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	8270C/D	3-Methylphenol
GC/MS	8270C/D	3-Nitroaniline
GC/MS	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	8270C/D	4-Bromophenyl phenyl ether
GC/MS	8270C/D	4-Chloro-3-methylphenol
GC/MS	8270C/D	4-Chloroaniline
GC/MS	8270C/D	4-Chlorophenyl phenyl ether
GC/MS	8270C/D	4-Methylphenol (p-Cresol)
GC/MS	8270C/D	4-Nitroaniline (PNA)
GC/MS	8270C/D	4-Nitrophenol (PNP)
GC/MS	8270C/D	Acenaphthene
GC/MS	8270C/D	Acenaphthylene
GC/MS	8270C/D	Acetaphenone
GC/MS	8270C/D	Anthracene
GC/MS	8270C/D	Benzo(a)anthracene
GC/MS	8270C/D	Benzo(a)pyrene
GC/MS	8270C/D	Benzo(b)fluoranthene
GC/MS	8270C/D	Benzo(g,h,i)perylene
GC/MS	8270C/D	Benzo(k)fluoranthene
GC/MS	8270C/D	Benzyl alcohol
GC/MS	8270C/D	Benzoic Acid
GC/MS	8270C/D	bis(2-Chloroethoxy)methane
GC/MS	8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	8270C/D	Carbazole
GC/MS	8270C/D	Chrysene
GC/MS	8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	8270C/D	Dibenz(a,h)anthracene
GC/MS	8270C/D	Dibenzofuran (DBF)
GC/MS	8270C/D	Diethyl phthalate (DEP)
GC/MS	8270C/D	Dimethyl phthalate (DMP)
GC/MS	8270C/D	Fluoranthene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	Fluorene
GC/MS	8270C/D	Hexachlorobenzene (HCB)
GC/MS	8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	8270C/D	Hexachloroethane (HCE)
GC/MS	8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	8270C/D	Isophorone
GC/MS	8270C/D	N-Nitrosodimethylamine
GC/MS	8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	8270C/D	Naphthalene
GC/MS	8270C/D	Nitrobenzene
GC/MS	8270C/D	Pentachlorophenol
GC/MS	8270C/D	Phenanthrene
GC/MS	8270C/D	Phenol
GC/MS	8270C/D	Pyrene
GC/MS	8270C/D	Pyridine
GC/MS	8270C/D	1,2,4-Trichlorobenzene
GC/MS	8270C/D	1,1'-Biphenyl
GC/MS	8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	8270C/D	1,4-Dioxane
GC/MS	8270C/D	1-Methylnaphthalene
GC/MS	8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	8270C/D	Aniline
GC/MS	8270C/D	Atrazine
GC/MS	8270C/D	Benzaldehyde
GC/MS	8270C/D	Benzidine
GC/MS	8270C/D	7,12-Dimethylbenz(a)anthracene
GC/MS	8270C/D	Caprolactam
GC/ECD	8081A/B	4,4'-DDD
GC/ECD	8081A/B	4,4'-DDE
GC/ECD	8081A/B	4,4'-DDT
GC/ECD	8081A/B	Aldrin
GC/ECD	8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	8081A/B	alpha-Chlordane
GC/ECD	8081A/B	beta-BHC (beta-HCH)
GC/ECD	8081A/B	delta-BHC (delta-HCH)
GC/ECD	8081A/B	Dieldrin
GC/ECD	8081A/B	Endosulfan I

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	8081A/B	Endosulfan II
GC/ECD	8081A/B	Endosulfan sulfate
GC/ECD	8081A/B	Endrin
GC/ECD	8081A/B	Endrin aldehyde
GC/ECD	8081A/B	Endrin ketone
GC/ECD	8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	8081A/B	gamma-Chlordane
GC/ECD	8081A/B	Heptachlor
GC/ECD	8081A/B	Heptachlor epoxide
GC/ECD	8081A/B	Methoxychlor
GC/ECD	8081A/B	Chlordane
GC/ECD	8081A/B	Toxaphene
GC/ECD	8082 /A	Aroclor-1016
GC/ECD	8082 /A	Aroclor-1221
GC/ECD	8082 /A	Aroclor-1232
GC/ECD	8082 /A	Aroclor-1242
GC/ECD	8082 /A	Aroclor-1248
GC/ECD	8082 /A	Aroclor-1254
GC/ECD	8082 /A	Aroclor-1260
GC/ECD	8151A	2,4,5-T
GC/ECD	8151A	2,4,5-TP (Silvex)
GC/ECD	8151A	2,4-D
GC/ECD	8151A	2,4-DB
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichlorprop
GC/ECD	8151A	Dinoseb
GC/ECD	8151A	MCPA
GC/ECD	8151A	MCPP (Mecoprop)
HPLC/UV	8330A	1,3,5-Trinitrobenzene
HPLC/UV	8330A	1,3-Dinitrobenzene
HPLC/UV	8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	8330A	2,6-Dinitrotoluene
HPLC/UV	8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	8330A	2-Nitrotoluene (ONT)
HPLC/UV	8330A	3-Nitrotoluene
HPLC/UV	8330A	4-Amino-2,6-dinitrotoluene

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC/UV	8330A	4-Nitrotoluene (PNT)
HPLC/UV	8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	8330A	Nitroglycerin
HPLC/UV	8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	8330A	3,5-Dinitroaniline
HPLC/UV	8330A	Nitrobenzene
HPLC/UV	8330A	PETN
HPLC/UV	8330A	Nitroguanidine
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	8015B	TPH DRO
GC/FID	8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	8011	1,2-Dibromoethane (EDB)
GC/ECD	8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	6850	Perchlorate
ICP	6010B/C	Aluminum
ICP	6010B/C	Antimony
ICP	6010B/C	Arsenic
ICP	6010B/C	Barium
ICP	6010B/C	Beryllium
ICP	6010B/C	Cadmium
ICP	6010B/C	Calcium
ICP	6010B/C	Chromium, total
ICP	6010B/C	Cobalt
ICP	6010B/C	Copper
ICP	6010B/C	Iron
ICP	6010B/C	Lead
ICP	6010B/C	Magnesium
ICP	6010B/C	Manganese
CVAA	7470A	Mercury
ICP	6010B/C	Nickel
ICP	6010B/C	Potassium
ICP	6010B/C	Selenium
ICP	6010B/C	Silver
ICP	6010B/C	Sodium
ICP	6010B/C	Thallium
ICP	6010B/C	Vanadium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	6010B/C	Zinc
ICP	6010B/C	Molybdenum
ICP	6010B/C	Tin
ICP	6010B/C	Strontium
ICP	6010B/C	Titanium
IC	300.0	Chloride
IC	300.0	Fluoride
IC	300.0	Nitrate
IC	300.0	Nitrite
IC	300.0	Sulfate
IC	9056A	Chloride
IC	9056A	Fluoride
IC	9056A	Nitrate
IC	9056A	Nitrite
IC	9056A	Sulfate
Titration	SM 2320B 20th ed.	Alkalinity
ISE	SM 4500 B, D, 20th ed.	Ammonia
UV/Vis	7196A	Hexavalent Chromium
Colorimetric	353.2	Nitrocellulose
Colorimetric	353.2	Nitrate/Nitrite
Titration	Chap.7, Sect. 7.3 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20th edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20th edition	Total Phosphorus (as P)
UV/Vis	SM 4500 PE, 20th edition	Ortho-Phosphate (as P)
TOC	9060A/SM5310C, 20th edition	Total Organic Carbon
Gravimetric	SM 2540C, 20th edition	TDS
Colorimetric	9012A/B	Cyanide
Physical	1010A	Ignitability
Physical	9095B	Paint Filter
Probe	9040B/C	pH
Preparation	**Method**	**Type**
Preparation	1311	TCLP
Preparation	3005A	Metals digestion
Preparation	3010A	Metals digestion
Preparation	3510C	Organics Liquid Extraction
Preparation	5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	8260B	1,1,2-Trichloroethane
GC/MS	8260B	1,1,2,2-Tetrachloroethane
GC/MS	8260B	1,1,1,2-Tetrachloroethane
GC/MS	8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	8260B	1,2,3-Trichlorobenzene
GC/MS	8260B	1,2,4-Trichlorobenzene
GC/MS	8260B	1,2,3-Trichloropropane
GC/MS	8260B	1,2,4-Trimethylbenzene
GC/MS	8260B	1,3,5-Trimethylbenzene
GC/MS	8260B	1,2-Dibromoethane (EDB)
GC/MS	8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260B	1,2-Dichlorobenzene
GC/MS	8260B	1,2-Dichloroethane (EDC)
GC/MS	8260B	1,2-Dichloropropane
GC/MS	8260B	1,3-Dichlorobenzene
GC/MS	8260B	1,4-Dichlorobenzene
GC/MS	8260B	1,1-Dichloropropene
GC/MS	8260B	1,3-Dichloropropane
GC/MS	8260B	2,2-Dichloropropane
GC/MS	8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	8260B	Acetone
GC/MS	8260B	Benzene
GC/MS	8260B	Bromochloromethane
GC/MS	8260B	Bromodichloromethane
GC/MS	8260B	Bromobenzene
GC/MS	8260B	Bromoform
GC/MS	8260B	Bromomethane
GC/MS	8260B	n-Butylbenzene
GC/MS	8260B	sec-Butylbenzene
GC/MS	8260B	tert-Butylbenzene
GC/MS	8260B	Carbon Disulfide
GC/MS	8260B	Carbon Tetrachloride
GC/MS	8260B	Chlorobenzene
GC/MS	8260B	Chloroethane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8260B	Chloroform
GC/MS	8260B	Chloromethane
GC/MS	8260B	2-Chlorotoluene
GC/MS	8260B	4-Chlorotoluene
GC/MS	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	8260B	cis-1,3-Dichloropropene
GC/MS	8260B	Cyclohexane
GC/MS	8260B	Dibromochloromethane
GC/MS	8260B	Dibromomethane
GC/MS	8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	8260B	Ethylbenzene
GC/MS	8260B	Hexachlorobutadiene
GC/MS	8260B	Isopropylbenzene (Cumene)
GC/MS	8260B	p-Isopropyltoluene
GC/MS	8260B	Methyl Acetate
GC/MS	8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	8260B	Methylcyclohexane
GC/MS	8260B	Methylene Chloride, or Dichloromethane
GC/MS	8260B	Naphthalene
GC/MS	8260B	n-Propylbenzene
GC/MS	8260B	Styrene
GC/MS	8260B	Tetrachloroethene (PCE; PERC)
GC/MS	8260B	Toluene
GC/MS	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	8260B	trans-1,3-Dichloropropene
GC/MS	8260B	Trichloroethene (TCE)
GC/MS	8260B	Trichlorofluoromethane (CFC-11)
GC/MS	8260B	Vinyl Chloride (VC)
GC/MS	8260B	Xylenes (Total)
GC/MS	8260B	Acrolein
GC/MS	8260B	Acrylonitrile
GC/MS	8260B	Ethyl methacrylate
GC/MS	8260B	Iodomethane
GC/MS	8260B	Methyl methacrylate
GC/MS	8260B	Vinyl acetate
GC/MS	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	8270C/D	1,2-Dichlorobenzene
GC/MS	8270C/D	1,3-Dichlorobenzene
GC/MS	8270C/D	1,4-Dichlorobenzene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	2,4,5-Trichlorophenol
GC/MS	8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	8270C/D	2,4-Dimethylphenol
GC/MS	8270C/D	2,4-Dinitrophenol
GC/MS	8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	8270C/D	2,6-Dichlorophenol
GC/MS	8270C/D	2,6-Dinitrotoluene
GC/MS	8270C/D	1,2-Diphenylhydrazine
GC/MS	8270C/D	2-Chloronaphthalene
GC/MS	8270C/D	2-Chlorophenol
GC/MS	8270C/D	2-Methylnaphthalene
GC/MS	8270C/D	2-Methylphenol (o-Cresol)
GC/MS	8270C/D	2-Nitroaniline
GC/MS	8270C/D	2-Nitrophenol (ONP)
GC/MS	8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	8270C/D	3-Methylphenol
GC/MS	8270C/D	3-Nitroaniline
GC/MS	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	8270C/D	4-Bromophenyl phenyl ether
GC/MS	8270C/D	4-Chloro-3-methylphenol
GC/MS	8270C/D	4-Chloroaniline
GC/MS	8270C/D	4-Chlorophenyl phenyl ether
GC/MS	8270C/D	4-Methylphenol (p-Cresol)
GC/MS	8270C/D	4-Nitroaniline (PNA)
GC/MS	8270C/D	4-Nitrophenol (PNP)
GC/MS	8270C/D	Acenaphthene
GC/MS	8270C/D	Acenaphthylene
GC/MS	8270C/D	Acetaphenone
GC/MS	8270C/D	Anthracene
GC/MS	8270C/D	Benzo(a)anthracene
GC/MS	8270C/D	Benzo(a)pyrene
GC/MS	8270C/D	Benzo(b)fluoranthene
GC/MS	8270C/D	Benzo(g,h,i)perylene
GC/MS	8270C/D	Benzo(k)fluoranthene
GC/MS	8270C/D	Benzyl alcohol
GC/MS	8270C/D	Benzoic Acid
GC/MS	8270C/D	bis(2-Chloroethoxy)methane
GC/MS	8270C/D	bis(2-Chloroethyl)ether (BCEE)

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	8270C/D	Carbazole
GC/MS	8270C/D	Chrysene
GC/MS	8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	8270C/D	Dibenz(a,h)anthracene
GC/MS	8270C/D	Dibenzofuran (DBF)
GC/MS	8270C/D	Diethyl phthalate (DEP)
GC/MS	8270C/D	Dimethyl phthalate (DMP)
GC/MS	8270C/D	Fluoranthene
GC/MS	8270C/D	Fluorene
GC/MS	8270C/D	Hexachlorobenzene (HCB)
GC/MS	8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	8270C/D	Hexachloroethane (HCE)
GC/MS	8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	8270C/D	Isophorone
GC/MS	8270C/D	N-Nitrosodimethylamine
GC/MS	8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	8270C/D	Naphthalene
GC/MS	8270C/D	Nitrobenzene
GC/MS	8270C/D	Pentachlorophenol
GC/MS	8270C/D	Phenanthrene
GC/MS	8270C/D	Phenol
GC/MS	8270C/D	Pyrene
GC/MS	8270C/D	Pyridine
GC/MS	8270C/D	1,2,4-Trichlorobenzene
GC/MS	8270C/D	1,1'-Biphenyl
GC/MS	8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	8270C/D	1,4-Dioxane
GC/MS	8270C/D	1-Methylnaphthalene
GC/MS	8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	8270C/D	Aniline
GC/MS	8270C/D	Atrazine
GC/MS	8270C/D	Benzaldehyde
GC/MS	8270C/D	Benzidine
GC/MS	8270C/D	Benzo(a)anthracene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	Caprolactam
GC/ECD	8081A/B	4,4'-DDD
GC/ECD	8081A/B	4,4'-DDE
GC/ECD	8081A/B	4,4'-DDT
GC/ECD	8081A/B	Aldrin
GC/ECD	8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	8081A/B	alpha-Chlordane
GC/ECD	8081A/B	beta-BHC (beta-HCH)
GC/ECD	8081A/B	delta-BHC (delta-HCH)
GC/ECD	8081A/B	Dieldrin
GC/ECD	8081A/B	Endosulfan I
GC/ECD	8081A/B	Endosulfan II
GC/ECD	8081A/B	Endosulfan sulfate
GC/ECD	8081A/B	Endrin
GC/ECD	8081A/B	Endrin aldehyde
GC/ECD	8081A/B	Endrin ketone
GC/ECD	8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	8081A/B	gamma-Chlordane
GC/ECD	8081A/B	Heptachlor
GC/ECD	8081A/B	Heptachlor epoxide
GC/ECD	8081A/B	Methoxychlor
GC/ECD	8081A/B	Chlordane
GC/ECD	8081A/B	Toxaphene
GC/ECD	8082 /A	Aroclor-1016
GC/ECD	8082 /A	Aroclor-1221
GC/ECD	8082 /A	Aroclor-1232
GC/ECD	8082 /A	Aroclor-1242
GC/ECD	8082 /A	Aroclor-1248
GC/ECD	8082 /A	Aroclor-1254
GC/ECD	8082 /A	Aroclor-1260
GC/ECD	8151A	2,4,5-T
GC/ECD	8151A	2,4,5-TP (Silvex)
GC/ECD	8151A	2,4-D
GC/ECD	8151A	2,4-DB
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichlorprop
GC/ECD	8151A	Dinoseb
GC/ECD	8151A	MCPA

Solid and Chemical Materials

Technology	Method	Analyte
GC/ECD	8151A	MCPP (Mecoprop)
HPLC/UV	8330A	1,3,5-Trinitrobenzene
HPLC/UV	8330A	1,3-Dinitrobenzene
HPLC/UV	8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	8330A	2,6-Dinitrotoluene
HPLC/UV	8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	8330A	2-Nitrotoluene (ONT)
HPLC/UV	8330A	3-Nitrotoluene
HPLC/UV	8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	8330A	4-Nitrotoluene (PNT)
HPLC/UV	8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	8330A	Nitroglycerin
HPLC/UV	8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	8330A	Nitrobenzene
HPLC/UV	8330A	PETN
HPLC/UV	8330A	Nitroguanidine
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	8015B	TPH DRO
GC/FID	8015B	TPH GRO
HPLC/MS	6850	Perchlorate
ICP	6010B/C	Aluminum
ICP	6010B/C	Antimony
ICP	6010B/C	Arsenic
ICP	6010B/C	Barium
ICP	6010B/C	Beryllium
ICP	6010B/C	Cadmium
ICP	6010B/C	Calcium
ICP	6010B/C	Chromium, total
ICP	6010B/C	Cobalt
ICP	6010B/C	Copper
ICP	6010B/C	Iron
ICP	6010B/C	Lead
ICP	6010B/C	Magnesium
ICP	6010B/C	Manganese
CVAA	7471A/B	Mercury
ICP	6010B/C	Nickel
ICP	6010B/C	Potassium

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	6010B/C	Selenium
ICP	6010B/C	Silver
ICP	6010B/C	Sodium
ICP	6010B/C	Thallium
ICP	6010B/C	Vanadium
ICP	6010B/C	Zinc
ICP	6010B/C	Molybdenum
ICP	6010B/C	Tin
ICP	6010B/C	Strontium
ICP	6010B/C	Titanium
UV/Vis	7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	353.2	Nitrocellulose
Colorimetric	9012A/B	Cyanide
Titration	Chap.7, Sect. 7.3 Mod.	Reactive Sulfide
Titration	9034	Sulfide
Probe	9045D	pH
Preparation	**Method**	**Type**
Preparation	1311	TCLP
Preparation	1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	3050B	Metals Digestion
Preparation	3546	Organics Microwave Extraction
Preparation	3541	Organics Soxhlet Extraction
Preparation	3550B	Organics Sonication
Preparation	SM 2540B 20th edition	Percent Solids (Percent Moisture)
Preparation	5035 /A	Purge and Trap Solid

Notes:

1) This laboratory offers commercial testing service.

Approved By: _____ Date: March 31, 2010

R. Douglas Leonard
Chief Technical Officer

Issued: 11/30/09 Revised: 2/9/10 Revised: 3/31/10

Attachment G
Final Responses to EPA and EQB Comments

This page intentionally left blank

Final Responses to EPA Comments on the

Draft Supplemental Expanded Site Inspection and Pilot Study Sampling and Analysis Plan
Photo-Identified Site 4 (PI 4)
Former Vieques Naval Training Range
Vieques, Puerto Rico

April 2011

1. SAP Worksheet 15-1, Reference Limits and Evaluation Table, page 49: The "RSLsTap Water for Groundwater Adjusted" value for vinyl chloride should be 0.016 µg/l, not 0.16 µg/1.

   Navy Response:

   The value was revised as indicated.

2. SAP Worksheet 15-2, Reference Limitations and Evaluation Table, page 50: The rationale for sampling and analysis for dehalococcoides should be provided.

   Navy Response:

   The rationale for sampling and analysis for dehalococcoides is provided in Worksheet 17, 4th paragraph.

3. SAP Worksheet 28 pages 83-92: The Worksheet should include field QC, as required by Section 3.4.1 of the UFP-QAPP Manual.

   Navy Response:

   In order to prevent redundancy, field QC is assigned to Worksheet #12, and Worksheet #28 is limited to laboratory QC. However, Worksheet #28 includes MS/MSD because this is considered both field QC and laboratory QC. This is the same procedure followed for the most recent SWMU 6 SAP. Like that SAP, a note has been added to the bottom of each Worksheet #28 that states: "Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36."

Final Responses to PREQB Comments of the

Draft Supplemental Expanded Site Inspection and Pilot Study Sampling and Analysis Plan, Photo-Identified Site 4 (PI 4), Former Vieques Naval Training Range, Vieques, Puerto Rico,

Dated April 2011

I General Comments

1. Please consider the collection of more than one soil sample per boring (based on field observations and screening) to allow for a better vertical delineation.

   Navy Response:

   The following text has been added to Worksheet #10, Environmental Question to be Answered #1 and Worksheet #14, in the first paragraph under "Soil Sampling and Well Installation," after the sentence that ends ". . . highest VOC readings on the OVM.":

   "If OVM readings suggest VOC contamination may be present across a vertical profile of the boring, additional soil samples will be collected to provide vertical delineation of potential VOC contamination."

   This statement has also been added as a PQO statement in Worksheet #11, under "*Supplemental ESI PQO Statements*."

2. In addition, in light of the nature of the primary constituent of concern, please consider the potential need for the installation of at least one well cluster at some point (i.e., during this investigation or upon review of the results of this investigation) to assess the vertical gradient and contaminant distribution.

   Navy Response:

   Based on the current site information, which suggests an isolated area of very low TCE levels, well clusters to assess vertical gradient and contaminant distribution are not warranted. If the data collected during the Supplemental ESI suggest an RI is warranted, well clusters can be considered at that time.

II Page-Specific Comments

1. SAP Worksheet #3, Distribution List: Please revise Wilmarie Rivera's extension to 6129.

   Navy Response:

   The above mentioned edit has been made.

2. Worksheet #10:

   a. For clarity, please correct the text of the third line from the bottom of page 22.

      Navy Response:

      The above mentioned text has been edited.

   b. Page 23: Please clarify why determining whether there is a DNAPL source is not included as an objective of the supplemental EST. Determining whether DNAPL is present would be helpful in evaluating remedial options, should concentrations still be above Maximum Contaminant Levels (MCLs) or PR Water Quality Standards (WQS).

      Navy Response:

      The current levels observed at the site do not suggest the presence of DNAPL. Should the conceptual understanding of the site conditions change during the Supplemental ESI (i.e., significantly higher and broader area of contamination observed) such that an RI is warranted, potential DNAPL presence evaluation can be considered at that time.

3. Worksheet #11:

   a. Page 28, Process Statement 2: Please add a brief discussion of the magnitude of the project action limit (PAL) exceedance for the vinyl chloride detection limit (DL), discuss what dilution/attenuation factor (DAF) would result in a soil screening level (SSL) above the DL and provide some examples of similar sites on Vieques (e.g., vadose zone soil types and water table depth) supporting a higher dilution/attenuation factor SSL.

      Navy Response:

      The text already refers the reader to examples of where SSLs are not accurate predictors. The following text has been added at the end of the last paragraph under Process Statement 2:

      "The generic SSL for vinyl chloride is 0.69 µg/kg. The DL for vinyl chloride is 1.25 µg/kg. However, at a DAF of 2, the DL for vinyl chloride is less than the SSL for vinyl chloride (1.38 µg/kg)."

4. Worksheet #14:

   a. Page 41, Soil Sampling and Well Installation: Please revise this section to note that soil samples need to be immediately preserved for VOCs after the liner is split and screened with an OVM at each depth interval prior to obtaining final headspace readings. After the final headspace readings are obtained, the selection of samples for analysis will be performed. However, the preservation must be performed at each depth interval as soon as the soil is exposed to the atmosphere and not after the headspace reading is available to limit the volatilization. Please include the time frame between installation and development and the time frame between development and sampling of all monitoring wells.

Navy Response:

Page 41, Soil Sampling and Well Installation; the 7th sentence has been replaced with the following text: "If OVM readings suggest VOC contamination may be present across a vertical profile of the boring, additional soil samples will be collected to provide vertical delineation of potential VOC contamination. As each split spoon is opened, it will be screened by an OVM. If a soil interval has measurable OVM readings above background suggestive of the presence of contamination, a VOC sample will be collected at that depth and stored temporarily in the cooler until the boring is completed. At the completion of the borehole, sample(s) representative of the vertical profile of suspected contamination will be sent to the laboratory for VOC analysis."

Page 42, after the sixth sentence of the second paragraph, the following statement has been inserted , "Monitoring wells will be developed no sooner than 24 hours after the well has been installed in order to give the grout time to cure. Additionally, the wells will be sampled no sooner than 48 hours after development, in order to give the wells time to re-equilibrate after development."

b. Page 42:

i. Please provide the proposed well screen depths and the rationale for well screen depth placement in this worksheet or provide a reference to the worksheet that provides this information.

Navy Response:

The sentence on Paragraph 2 of page 42 "Five monitoring wells will be installed in each of the five borings…" has been revised to "Five monitoring wells will be installed in each of the five borings adjacent to MW-05 as discussed above. The total depth and well screen intervals of five new monitoring wells will be similar to that of MW-05 (i.e., first encountered water in saturated zone). The proposed well total depth is approximately 45 ft bgs, with screen intervals of approximately 35 to 45 ft bgs. The field personnel will make appropriate adjustment of total depth and screen intervals based on observed geologic and depth-to-water conditions."

ii. Paragraph 2: Please measure and record ground water levels once the wells have had the chance to equilibrate following not only installation, but development as well.

Navy Response:

As per the referenced *Master Standard Operating Procedures, Protocols, and Plans*, just prior to groundwater sampling, a synoptic round of water levels will be recorded.

iii. Please clarify the following sentence: "Natural attenuation (geochemical) parameters will also be analyzed from existing well MW05 using a TAT."

Navy Response:

The sentence has been revised as "Natural attenuation (geochemical) parameters, comprising TOC, methane, ethane, ethene, volatile fatty acids (acetic, butyric, lactic, propionic, and pyruvic acids), dehalococcoides, alkalinity, total dissolved solids (TDS), chloride, nitrate, nitrite, sulfate, and sulfide, will also be analyzed from existing well MW05 using a standard turnaround time (TAT) of 28 calendar days (See Worksheet #18-a and #30)."

iv. Paragraph 4:

1. What is meant by the indication that the TTA is based on "chain of custody (COC) concentrations" in the specified wells?

Navy Response:

This was caused by editorial error. For proper distinguishing of abbreviations, the entire document has been revised to use abbreviation "COC" for "Constituents of Concern" and C-O-C for "chain of custody." The sentence on page 42 has been revised as " …the TTA is based on the "Constituents of Concern (COC) concentrations …"

2. The text states that the planned injection effort, should an ISCO Pilot Study be determined to be warranted, will include the injection of a 0.7% permanganate solution with a total injected volume of 1 to 2 pore volumes. Typical injection scenarios include a higher (2 to 5%) permanagate concentration and lesser volumes (a fraction of the pore volume). The proposed scenario appears to more likely cause the dissolution/displacement of contaminated water rather than the treatment of contaminated water. Please clarify the rationale for the proposed injection volume and permanganate solution concentration and address the potential for contaminated water displacement with the current scenario.

Navy Response:

As proposed in the ISCO injection effort, concentrations between 0.7% and 1.4% potassium permanganate solution (corresponding to one 1 pore volume and 0.5 pore volume, respectively) would be injected at the TTA during one single injection event. The mass of potassium permanganate was based on an assumed natural oxidant demand (NOD) of 1 g permanganate/Kg soil for bedrock aquifer with anticipated low natural organic matter, as well as TCE concentration of approximately 20 µg/L throughout the TTA. Injection of 0.5 to 1 pore volume of permanganate solution will not cause dissolution/displacement of contaminated water, because ISCO is a contact technology which requires oxidant contact with the contaminant (ideally, injection of one pore volume would be the best option to deliver oxidant). In addition, groundwater sampling will be conducted in one upgradient well (MW-07) and one downgradient well

(MW-06), to ensure that the contaminant is removed by chemical oxidation, instead of dissolution or dilution.

5. Worksheet #15:

   a. Worksheet 15-1: The DL, LOD and LOQ for vinyl chloride in groundwater are above the project action limit based on the Puerto Rico Water Quality Standards. As discussed in SAP Worksheet #37, nondetect results may not be useful if the LOD is greater than the project action level. In this instance, since the DL is also above the project action limit, it cannot even be stated that the laboratory would be able to report an estimated value that can achieve the project action limit. Since vinyl chloride is a contaminant of concern at this site, the use of selective ion monitoring for the analysis of vinyl chloride should be considered in order to achieve this project action limit. At a minimum, this analysis would be needed for the final round of sampling to show compliance with the ARAR.

      Navy Response:

      The LOQ/LOD/DL for aqueous vinyl chloride was a typo and the laboratory-specific levels were inadvertently taken from the soil worksheet. The actual LOQ/LOD/DL is 1/0.5/0.25 ug/L. Worksheet #15-1 was updated with this information and the shading was removed for vinyl chloride's MCL. The DL is at the PR GW Regs Class SG screening level; therefore, this comment is no longer applicable.

   b. Please update the EPA RSL for vinyl chloride to 0.016 ug/L.

      Navy Response:

      The value was revised as indicated.

   c. Please update the EPA RSL reference to May 2011,

      Navy Response:

      The EPA RSL reference has been updated to June 2011.

6. Worksheet #17: Please revise the first paragraph to state that the sampling design and rationale meet the project objectives identified in Worksheet #10.

   Navy Response:

   The first paragraph has been revised to read:

   "The sampling rationale and design are based on meeting the supplemental ESI and potential pilot study objectives defined in Worksheet #10."

7. Worksheet #18-a, Sampling Locations and Method/SOP Requirements Table: Please remove the reference in footnote #1 to measuring potassium permanganate in the field as this measurement is associated with ISCO and this worksheet is only for the ERD Pilot Study.

   Navy Response:

   The text was revised as suggested.

8. Worksheet #18-b, Sampling Locations and Method/SOP Requirements Table: Please remove the reference in footnote #1 to measuring total iron, ferrous iron and dissolved manganese in the field as these measurements are associated with ERD and this worksheet is only for the ISCO Pilot Study.

   Navy Response:

   The text was revised as suggested.

9. Worksheet #19, Analytical SOP Requirements Table: Remove the holding time "7 days if not preserved" for VOCs in soil samples. VOC soil samples must be preserved in the field or collected in EnCore samplers and preserved within 48 hours.

   Navy Response:

   As indicated by Worksheet #19, samples are preserved immediately upon collection. The text was revised as suggested.

10. SAP Worksheet #24, Analytical Instrument Calibration Table: GC/FID: Per the SOP-236, the initial calibration %RSDs needs to be <20 (not 25) and the CCV %Ds needs to be <20 (not 25).

    Navy Response:

    The text was revised as suggested.

11. Worksheet #26, Sample Handling System: This worksheet refers to the Test America facility in Buffalo, NY. However, other worksheets within this SAP refer to the Test America facility in Amherst, NY. Please clarify and update all worksheets to be consistent.

    Navy Response:

    VFAs are analyzed at Test America-Buffalo which is located in Amherst, NY. The only mention of Amherst is within Worksheet #30. To avoid confusion, Worksheet #30 was updated to refer to Test America-Buffalo (located in Amherst, NY).

12. Worksheet #27, Sample Custody Requirements Table, Sample Identification Procedures: Please update this section to note that the pH of VOC water samples will not be checked upon receipt at the laboratory.

    Navy Response:

    The text was revised as suggested.

13. Figures 2 and 6: Minor editorial comment - Please change the reference to the Concrete "Valut" Box to the "Vault" Box.

    Navy Response:

    The above mentioned edit has been made.