FINAL REVISION 1
SITE INVESTIGATION OF POTENTIAL PERFLUORINATED COMPOUND (PFC) RELEASE AREAS AT MULTIPLE UNITED STATES AIR FORCE (USAF) BASE REALIGNMENT AND CLOSURE (BRAC) INSTALLATIONS

QUALITY PROGRAM PLAN

Prepared for:
Air Force Civil Engineer Center
Joint Base San Antonio – Lackland, Texas

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.

Contract FA8903-08-D-8766
Task Order 0218

September 2016

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TABLES

APPENDICES

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ACRONYMS

µg/L	micrograms per liter
AF	Air Force
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AFCEE	Air Force Center for Engineering and the Environment
AFFF	aqueous film forming foam
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
BRAC	Base Realignment and Closure
CAS	Chemical Abstract Service
CCL	Contaminant Candidate List
CCL3	Contaminant Candidate List Number 3
COR	Contracting Officer Representative
CSM	Conceptual Site Model
CT Labs	CT Laboratories, LLC
DL	detection limit
DoD	Department of Defense
DoDI	Department of Defense Instruction
DOT	Department of Transportation
DQA	Data Quality Assessment
DQO	Data Quality Objective
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EMAX	EMAX Laboratories, Inc.
ERPIf	Environmental Resources Program Information Management System
FAA	Federal Aviation Administration
ft	feet or foot
FTA	Fire Training Area
FTS	Fluorotelomer Sulfonate
GAC	granular activated carbon
GPS	Global Positioning System
HA	Health Advisory
HSP	Health and Safety Plan
IDW	investigation-derived waste
ISO	International Organization for Standardization

ISSIR	Installation-Specific Site Investigation Report
ISWP	Installation-Specific Work Plan
LC-MS-MS	Liquid Chromatography and Tandem Mass Spectrometry
LDA	Land Development Authority
LOD	limit of detection
LOQ	limit of quantitation
Maxxam	Maxxam Analytics International
NEtFOSA	n-Ethyl perfluorooctane Sulfonamide
NEtFOSAA	n-Ethylperfluorooctane Sulfonamidoacetic Acid
NEtFOSE	n-Ethyl Perfluorooctane Sulfonamidoethanol
NMeFOSA	n-Methyl Perfluorooctane Sulfonamide
N-MeFOSAA	n-Methylperfluorooctane Sulfonamidoacetic Acid
NMeFOSE	n-Methyl Perfluorooctane Sulfonamidoethanol
NAD	North American Datum
NAVD	North American Vertical Datum
NFG	National Functional Guidelines
ORP	oxidation-reduction potential
PA	Preliminary Assessment
PFBA	Perfluorobutanoic Acid
PFBS	Perfluorobutanesulfonic Acid
PFC	Perfluorinated Compounds
PFDA	Perfluorodecanoic Acid
PFDoA	Perfluorododecanoic Acid
PFDS	Perfluorodecanesulfonic Acid
PFHPA	Perfluoroheptanoic Acid
PFHpS	Perfluoroheptanesulfonic Acid
PFHxA	Perfluorohexanoic Acid
PFHxS	Perfluorohexanesulfonic Acid
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanesulfonic Acid
PFOSA	Perfluorooctane Sulfonamide
PFPeA	Perfluoropentanoic Acid
PFTeDA	Perfluorotetradecanoic Acid
PFTrDA	Perfluorotridecanoic Acid
PFUnA	Perfluoroundecanoic Acid
PHA	Provisional Health Advisory
POC	Point of Contact
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride

QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QPP	Quality Program Plan
QSM	Quality Systems Manual
RPD	relative percent difference
S2BVM	Stage 2B Manual
S4VM	Stage 4 Manual
SGS Accutest	SGS Accutest Laboratories
SI	Site Investigation
SOP	standard operating procedure
SOW	Statement of Work
TCEQ	Texas Commission on Environmental Quality
TRRP	Texas Risk Reduction Program
TO	Task Order
UCM	Unregulated Contaminant Monitoring
UCMR3	Unregulated Contaminant Monitoring Rule 3
UFP	Uniform Federal Policy
U.S.	United States
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USCS	Unified Soil Classification System
Vista	Vista Analytical Laboratory

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INTRODUCTION

This Quality Program Plan (QPP) presents data quality objectives (DQOs) and describes activities that will be conducted as part of site investigations (SIs) at aqueous film forming foam (AFFF) areas located at 10 United States Air Force (USAF) Base Realignment and Closure (BRAC) installations. This program-level QPP has been prepared under Contract No. FA8903-08-D-8766, Task Order (TO) 0218 between Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) and the Air Force Civil Engineer Center (AFCEC).

The 10 BRAC installations included under this General QPP include:

- Former Castle Air Force Base (AFB), California;
- Former Chanute AFB, Illinois;
- Former General Mitchell Air Reserve Station (ARS), Wisconsin;
- Former Griffiss AFB, New York;
- Former Kelly AFB, Texas
- Former KI Sawyer AFB, Michigan;
- Former Loring AFB, Maine;
- Former Plattsburgh AFB, New York;
- Former Reese AFB, Texas; and,
- Former Wurtsmith AFB, Michigan.

While the former Pease AFB, New Hampshire is included in the Contract No. FA8903-08-D-8766, TO 0218, this installation is not included under this General QPP as the work being conducted there will be covered under the installation-specific QPP.

The AFFF areas that are proposed for investigation under this TO, were identified during preliminary assessment (PA) research activities as locations where perfluorinated compounds (PFCs) may have been released to the environment. It should be noted that the list of AFFF areas identified in the PAs may be revised based upon additional research conducted during this TO.

This QPP has been prepared to: (1) clearly identify the SI objectives and DQOs for this project; (2) ensure that field investigations and survey protocols are documented and reviewed in a consistent manner; and (3) describe the means and methods necessary to achieve the SI objectives and DQOs and provide data that is scientifically valid and legally defensible. This QPP consists of the scope of activities that will be conducted under Contract FA8903-08-D-8766 and a general Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) (Optimized UFP-QAPP Worksheets, March 2012) in accordance with the July 2009 AFCEC (formerly the Air Force Center for Engineering and the Environment [AFCEE]), memorandum detailing the implementation of the UFP-QAPP on USAF Restoration Projects (AFCEE, 2009). This memorandum states that the UFP-QAPP will replace the formerly required Work Plan, Field Sampling Plan, and QAPP on all new USAF projects. The UFP-QAPP integrates all technical and quality aspects for the life cycle of the project, including planning, implementation, assessment, and decision-making. This QPP contains all required UFP-QAPP worksheets as well as the six appendices listed below:

- Appendix A General Health and Safety Plan (HSP)
- Appendix B QPP/QAPP Acknowledgement Form
- Appendix C Project Schedule
- Appendix D Standard Operating Procedures (SOPs)
- Appendix E Field Forms
- Appendix F Final Quality Assurance Laboratory Evaluation Summary

Subsequent to this QPP, an Installation-Specific Work Plan (ISWP) will be prepared for each of the 10 BRAC installations selected for investigations and surveys of PFCs. These work plans will document the field activities to be conducted at each installation and will identify installation-specific health and safety considerations.

BACKGROUND

PFCs are a class of synthetic compounds formed from carbon chains with fluorine attached. The chemical structure of PFCs gives them unique properties, such as thermal stability and the ability to repel both water and oil, that make them useful components in a wide variety of consumer and industrial products, including non-stick cookware, food packaging, waterproof clothing, fabric stain protectors, lubricants, paints, and firefighting foams such as AFFF. AFFF concentrate contains fluorocarbon surfactants to meet required performance standards (Department of Defense [DoD] Military Specification MIL-F-24385F [SH], Amendment 1, 5 August 1984). The surfactants provide AFFF with the low surface tension needed to enable film formation on top of the fuel to help suffocate the fire.

Several Federal government documents confirm the initial use of AFFF by the USAF beginning in 1970:

- Military Specification for AFFF (MIL-F-24385), formally issued in 1969;
- General Accounting Office determination on sole source award protest to provide AFFF to the Navy in December 1969; and,
- A History of USAF Fire Protection Training at Chanute Air Force Base, 1964-1976 (Coates, 1977).

The USAF began purchasing and using AFFF containing PFCs (PFOS and/or PFOA) for extinguishing petroleum fires and firefighting training activities in 1970 (USAF, 2012). AFFF was used at USAF installations in and around fire training areas (FTAs). Older firefighting training facilities were often not lined and were not constructed to prevent infiltration of firefighting foams and combustion products into soil. AFFF could also have been used at other areas within installations, such as in and around hangars that had AFFF fire suppression systems, plane crash and fire emergency response sites, firefighting equipment testing areas, wash racks, areas where fire trucks and/or emergency vehicles were washed, and AFFF storage areas.

Due to their persistence in the environment, bioaccumulation potential, and toxicity; PFCs pose a potential impact to human health and the environment and have been under increased scrutiny from the regulatory community. Initially, regulatory activity was primarily driven by concern over potential contamination near PFC manufacturing facilities. However, this concern has expanded to include other sites, such as firefighting training locations. Regulatory interest has focused on two PFCs: PFOS and PFOA, both of which have been identified in historically used AFFF. The Safe Drinking Water Act includes a process that the United States Environmental Protection Agency (USEPA) must follow to identify and list unregulated contaminants, which may require a national drinking water regulation in the future. Two primary methods used by the USEPA to evaluate contaminants in drinking water are the Contaminant Candidate List (CCL) and Unregulated Contaminant Monitoring (UCM) Programs. PFOS and PFOA were included on the USEPA CCL Number 3 (CCL3) and were part of the UCM Rule (UCMR) Number 3 (UCMR3), which require monitoring by public water systems to evaluate the presence of these compounds in the water supply. On 4 February 2015, the USEPA issued a draft list of contaminants to be included in the CCL Number 4 (CCL4) for review and public comment. The draft version included PFOA and PFOS. On 11 December 2015, the fourth UCMR (UCMR4) was proposed, which outlined monitoring for 30 unregulated contaminants between 2018 and 2020. The draft version of the UCMR4 did not contain PFOA or PFOS.

The USEPA Office of Water issued Provisional Health Advisories (PHAs) for PFOS (0.2 micrograms per liter [µg/L]) and PFOA (0.4 µg/L) in 2009 to protect humans from potential risk of exposure to these chemicals through drinking water (USEPA, 2009). In May 2016, The USEPA Office of Water issued lifetime drinking Health Advisories (HAs) for PFOS and PFOA that replace the 2009 PHA values. The HAs for PFOS and PFOA are 0.07 µg/L for each constituent. “When PFOS and PFOA co-occur at the same time and location in a drinking water source, a conservative and health-protective approach that USEPA recommends is to compare the sum of concentrations ([PFOA] + [PFOS]) to the HA (0.07 µg/L)” (USEPA, 2016a; USEPA, 2016b). HAs identify the concentration of a contaminant in drinking water at which adverse health effects are not anticipated to occur over specific exposure durations (e.g., one day, ten days, a lifetime). They serve as informal technical guidance to assist federal, state, and local officials, and managers of public or community water systems in protecting public health when emergency spills or other contamination situations occur. The USEPA drinking water health advisories for PFOA (USEPA, 2016a) and PFOS (USEPA, 2016b) provide information on the environmental properties, health effects, analytical methodology, and treatment technologies for removing PFOS and PFOA from drinking water. HA values are not to be construed as legally enforceable federal standards and are subject to change as new information becomes available.

Per DoD Instruction (DoDI) 4715.18, *Emerging Contaminants* (DoD, 2009)[1], the *Interim Air Force (AF) Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and BRAC Installations*

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[1] DoD, 2009. DoD Instruction Number 4715.18, Emerging Contaminants (ECs). Certified current through June 11, 2016.

(USAF, 2012)[2], and Air Force Instruction (AFI) 32-7020 (USAF, 2014)[3], If concentrations of an emerging contaminant are above applicable screening values (e.g., has the potential for exceeding unacceptable risk levels based upon current knowledge), the next step is to determine if a drinking water source has been, or may be, impacted, and confirm whether an actual human exposure pathway exists. When warranted, a site-specific risk assessment should be conducted to evaluate the extent of actual or potential exposure and risk using appropriate toxicity values approved by DODI 4715.18 or other promulgated requirements. In the absence of an applicable legal driver, the USAF may confirm a possible release of an emerging contaminant, such as PFCs, followed by delineation; if 1) a reasonable basis exists to suspect a potential release associated with USAF activities at an installation, 2) an exposure pathway exists for the probable contamination to threaten public health, and/or 3) potential for off-site migration of contaminants is likely.

SITE INVESTIGATION OBJECTIVES AND SCOPE

SIs will be conducted in accordance with the Statement of Work outlined under TO 0218 with AFCEC. It should be noted that any additional data required under CERLA Federal Facilities SI Guidance will be collected as part of future investigative activities, as necessary. The following five primary objectives will be accomplished as part of the SIs conducted under TO 0218:

1) Conduct initial SIs at identified AFFF areas to determine the presence (concentrations greater than the laboratories' detection limits [DLs], defined as the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence) or absence of PFCs in sampled media. Sampled media will include, but is not limited to, soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and drinking water;
2) Conduct follow-on investigation and step-out sampling at AFFF areas where PFCs are present at concentrations greater than USEPA HA values or other applicable state or federal standards. The follow-on investigations will: a) further evaluate each area where PFCs have been identified at concentrations exceeding applicable criteria (including the extent of impacts from fire training areas [FTAs] and other identified AFFF areas), b) delineate downgradient groundwater plumes (as applicable), c) define the environmental setting including potential mechanisms for PFC migration for each area where PFCs exceed applicable criteria, and d) identify AFFF areas with potential impacts to down-stream and/or downgradient receptors;
3) Conduct well surveys to assess the locations of downgradient drinking water supplies and determine potential exposure pathways that may be potential receptors;
4) Perform initial and follow-up sampling of public/private drinking water wells to identify and verify where PFCs are present in drinking water at concentrations above USEPA HAs and/or state-specific standards and evaluate potential exposure pathways with immediate threats to human health; and,

[2] USAF, 2012. Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and BRAC Installations.

[3] USAF, 2014. Air Force Instruction 32-7020, The Environmental Restoration Program, Chapter 18 – Emerging Contaminants. 7 November.

5) Apply mitigation measures to drinking water wells that present an imminent threat to human health from PFCs related to USAF activities at the 10 BRAC installations.

These objectives will be achieved by conducting the following SI activities:

- ISWP Documentation: ISWPs will be developed to outline any supplemental research needs to evaluate the environmental setting and site conditions as well as the unique sampling strategy for each of the AFFF areas located at the 10 USAF BRAC installations. Based upon the results of SIs, an Installation-Specific Work Plan Addendum may be prepared to outline follow-on investigation and/or step-out sampling activities. Work plan and work plan addendums will be submitted to the appropriate regulatory agency for review and approval, as applicable.
- SI Activities: SI activities will include, but are not limited to, the collection of soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and drinking water samples; monitoring well installation; existing well rehabilitation; well development; stormwater evaluation; plume monitoring; supplemental research to determine the environmental setting; the update and evaluation of the conceptual site model, and IDW management.
- Follow-On SI Activities: Following initial SI activities, a conference call will be scheduled to review the results and determine if follow-on investigation activities are warranted based on the need to delineate locations where PFC concentrations exceed applicable criteria and update and evaluate the conceptual site model. In addition, fish tissue samples may be evaluated to assess whether there are PFCs in fish tissue that could potentially be consumed by recreational anglers fishing in surface water bodies within and downstream of AFFF areas to evaluate whether a fish consumption advisory is needed for recreational angling. Since PFOA and PFOS are the only PFCs with HAs, other PFCs will only be considered for potential follow-on activities if the state regulatory agency has threshold criteria, above which additional investigation is required.
- Private Well Survey and Sampling: Private well surveys will be conducted to identify properties located near the former base boundary that may be potential receptors of PFCs emanating from AFFF Areas. The surveys will determine the number and locations of private drinking water wells that potentially require sampling. Initial and follow-up sampling of private drinking water wells will be conducted to evaluate PFC presence and identify potential migration pathways. Coordination with private property owners (e.g., letters, telephone, results, etc.) will be conducted prior to and following well survey and sampling activities.
- Public Supply Sampling: Initial and follow-up sampling of public drinking water wells will be conducted to evaluate PFC presence within public drinking water sources and identify potential migration pathways. Coordination with public property owners (e.g., letters, telephone, results, etc.) will be conducted prior to and following well survey and sampling activities.
- Documentation: The results of SI field activities will be documented in 1) initial data transmittals, 2) Well Survey and Sampling Activity reports, and/or 3) Installation-Specific SI Reports. The results will include updated conceptual site models to aid in identifying exposure pathways and

potential receptors. SI Reports will be submitted to the appropriate regulatory agency for review and approval.

- Mitigation: Mitigation measures will be conducted at drinking water supplies when the presence of PFCs poses an imminent threat to human health. Mitigation measures may include, but are not limited to, the installation of ex-situ treatment systems (e.g., whole-house treatment systems), replacement of carbon within treatment systems, and the distribution of bottled water to affected property owners. Any mitigation activities conducted will be coordinated with the property owners and/or general public.

By achieving SI objectives, accurate and defensible SI reports will be prepared that will document whether PFCs are present at potential PFC release areas and whether PFCs are present at levels that require further action to assess potential risk to human health.

Table 1 provides a list of analytical suites that may be used during execution of TO 0218. The Statement of Work (SOW) identified a basic suite of 14 compounds (comprising the analytes listed for Method 537.1) that will likely be used for most of the SIs at the 10 installations. However, the analytical suite required at each installation will be based on applicable federal and state regulatory requirements, which are continuously evolving. For example, the Texas Commission on Environmental Quality (TCEQ), Texas Risk Reduction Program (TRRP) established protective concentrations for 16 PFC compounds. Samples collected at USAF installations located in Texas will be analyzed for these 16 compounds. Table 1 also includes two additional analytical suites (titled “UCMR 3” and “HAs- PFOS and PFOA”) as optional analytical suites, as applicable, based on regulatory requirements. Analyses for soil, sediment, surface water, influent/effluent, fish tissue, pore water, and groundwater sampling will be conducted using liquid chromatography and tandem mass spectrometry (LC-MS-MS). Analysis for drinking water samples will be conducted using Method 537.1.

The list below, using the list names presented on **Table 1**, provides our current understanding of the required analytical suite that will be required at each installation.

- Former Castle AFB – Method 537.1
- Former Chanute AFB – Method 537.1
- Former General Mitchell ARS – Method 537.1
- Former Griffiss AFB – Method 537.1
- Former Kelly AFB, Texas – TCEQ TRRP
- Former KI Sawyer AFB – Method 537.1
- Former Loring AFB – Loring List
- Former Plattsburgh AFB – Method 537.1
- Former Reese AFB – TCEQ TRRP
- Former Wurtsmith AFB – Method 537.1

Additional details regarding project tasks are included in UFP-QAPP Worksheets #14/16: Project Tasks and Schedule.

QAPP Worksheet #1 & 2: Title and Approval Page

Final Revision 1, Date: 8/17/2016

Project Name: Site Investigation of PFC Release Areas at Multiple BRAC Installations

Site Location: Nationwide

Contract Number: FA8903-08-D-8766, Delivery Order 0218

Lead Organization:

Air Force Civil Engineer Center
2261 Hughes Avenue, Suite 155
Joint Base San Antonio – Lackland, Texas 78236
TO 218 Functional Program Manager: Billy Claxton
billy.claxton@us.af.mil

Signature

Air Force Civil Engineer Center
8 Colorado Street, Suite 121
Plattsburgh, New York 12903
TO 218 Contracting Officer's Representative: David Farnsworth
david.farnsworth@us.af.mil

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DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USAF, cn=FARNSWORTH.DAVID.SCOTT.1011912580
Date: 2016.08.31 12:49:24 -04'00'

Signature

Preparer:

Amec Foster Wheeler Environment & Infrastructure, Inc.
2030 Falling Waters Rd., Suite 300
Knoxville, Tennessee 37922
Amec Foster Wheeler Project Manager: Melissa Helton
melissa.helton@amec.com

Melissa C. Helton

Signature

Relevant Plans and Reports:

AFCEE, 2009. Memorandum detailing the implementation of the UFP-QAPP on Air Force Restoration Projects. July.

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler), 2015. Draft Final Perfluorinated Compounds Preliminary Assessment, Former Castle Air Force Base, Merced County, California, November.

Amec Foster Wheeler, 2015. Draft Perfluorinated Compounds Preliminary Assessment, Former Chanute Air Force Base, Rantoul, Illinois, June.

Amec Foster Wheeler, 2015. Final Perfluorinated Compounds Preliminary Assessment, Former General Mitchell Air Reserve Station, Milwaukee, Wisconsin, September.

Amec Foster Wheeler, 2015. Final Perfluorinated Compounds Preliminary Assessment, Former Griffiss Air Force Base, Rome, New York, July.

Amec Foster Wheeler, 2015. Draft Perfluorinated Compounds Preliminary Assessment, Former Kelly Air Force Base, San Antonio, Texas, June.

Amec Foster Wheeler, 2015. Final Perfluorinated Compounds Preliminary Assessment, Former K.I. Sawyer Air Force Base, Gwinn, Michigan and Former Defense Fuel Supply Point, Wells Terminal Escanaba, Michigan, October.

Amec Foster Wheeler, 2015. Draft Final (Rev 01) Perfluorinated Compounds Preliminary Assessment, Former Loring Air Force Base, Limestone, Maine, October.

Amec Foster Wheeler, 2015. Final Perfluorinated Compounds Preliminary Assessment, Former Pease Air Force Base, Portsmouth, New Hampshire, December.

Amec Foster Wheeler, 2015. Final Perfluorinated Compounds Preliminary Assessment, Former Plattsburgh Air Force Base, Plattsburgh, New York, September.

Amec Foster Wheeler, 2015. Draft Final Perfluorinated Compounds Preliminary Assessment, Former Reese Air Force Base, Lubbock, Texas, October.

Amec Foster Wheeler, 2015. Draft Final Perfluorinated Compounds Preliminary Assessment, Former Wurtsmith Air Force Base, Oscoda, Michigan, November.

Department of Defense (DoD), 2009. Department of Defense Instruction 4715.18, Emerging Contaminants. Certified current through 11 June 2016.

Texas Commission on Environmental Quality, 2014. Texas Risk Reduction Program, Protective Concentrations Levels and Supporting Tables, November.

USAF, 2012. Interim USAF Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and Base Realignment and Closure Installations. August 27.

United States Environmental Protection Agency (USEPA), 2009. Provisional Health Advisories for Perfluorooctanoic Acid (PFOS) and Perfluorooctane Sulfonate (PFOS). January 27.

USEPA, 2012a. 2012 Edition of the drinking water Standards and Health Advisories. April.

USEPA, 2012b. USEPA Third Unregulated Contaminant Monitoring Rule, Promulgated May 16.

USEPA, 2016a. Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS). May 19.

USEPA, 2016b. Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA). May 19.

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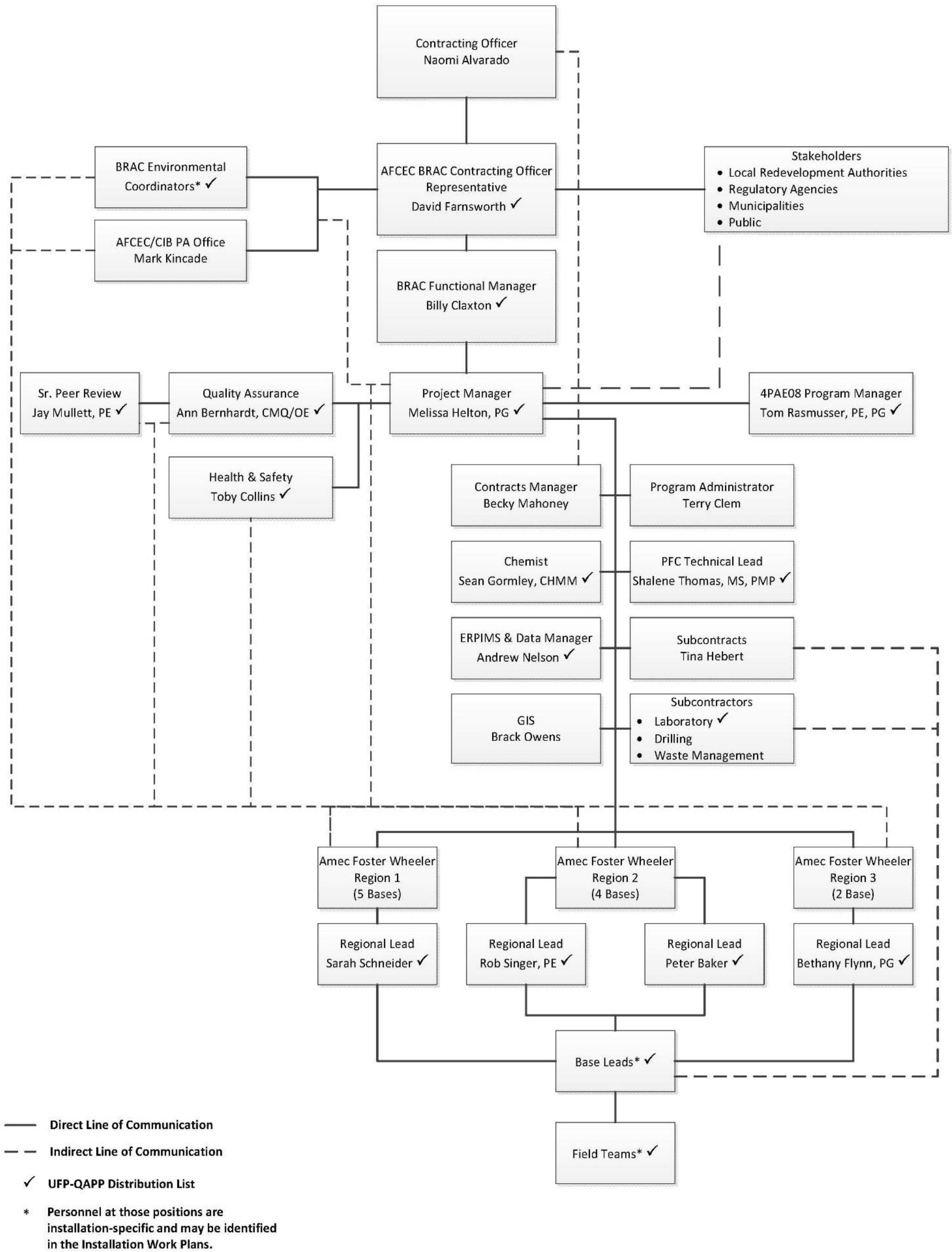
QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution

Final, Date: 3/21/2016



QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet

Final Revision 1, Date: 8/17/2016

Organization: Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler)

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/Date*
Melissa Helton	Project Manager	B.S. Geology/21 years	PG (TN)	Melissa C. Helton
Shalene Thomas	PFC Technical Lead	M.S. Environmental Science and Management/16 years	PMP	Shalene M. Thomas
Sean Gormley	Chemist	B.S. Chemistry/29 years	EAC, CHMM	Sean Gormley
Marie Bevier	Laboratory Coordinator	B.S. Chemistry/20 years	EAC, CHMM	[illegible]
Sarah Schneider	Region 1 Lead	B.A. Geology /13 years		Sarah Schneider
Rob Singer	Region 2 Lead	B.S. Civil Engineering/18 years	PE (MI, NH, KY)	[illegible]
Beth Flynn	Region 3 Lead	M.S. Geology/27 years	PG (CA)	Bethany P. Flynn
Ann Bernhardt	Quality Control Manager	B.S. Environmental Science/ 22 years	Certified Manager of Quality/Organizational Excellence, ASQ 14430	[illegible]

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet (continued)

Final Revision 1, Date: 8/17/2016

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/Date*
Peter Baker	Region 2 Lead	B.A. Geology/34 years	PG (ME)	Peter Baker

Notes: Signatures indicate personnel have read and agree to implement this QAPP and any future updates or addendum, as written. Signatures for Amec Foster Wheeler personnel not represented on this worksheet, but have read and agree to implement this QAPP as written (i.e., field staff) will be documented on the QPP/QAPP acknowledgement form located in **Appendix B** and retained in the Amec Foster Wheeler project file for each installation. Installation-specific personnel may be included in this worksheet within the Installation-Specific Work Plans.

PFC - perfluorinated compound
B.S. - Bachelor of Science
M.S. - Masters of Science
EAC – Environmental Analytical Chemist
PG – Professional Geologist
PE – Professional Engineer
PMP – Project Management Professional
CHMM – Certified Hazardous Materials Manager
NA – not applicable
QPP – Quality Program Plan
ASQ – American Society for Quality
TN – Tennessee
MI – Michigan
NH – New Hampshire
KY – Kentucky
CA – California
OH – Ohio
ERPIMS – Environmental Resources Program Information Management System
QAPP – Quality Assurance Project Plan

Organization: Analytical Laboratory – CT Laboratories, LLC (CT)

Subcontractor to Primary Analytical Laboratory – SGS Accutest Laboratories (SGS Accutest)

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/Date
Brett Szymanski	CT Project Manager	BA Business Administrative/HR Major, Chemistry Minor/10 years	NA	Brett Szymanski
Andrea Colby	SGS Accutest Project Manager	B.A. – Biology/26 years	NA	[illegible]

Notes: Signatures indicate personnel have read and agree to implement this QAPP and any future updates or addendum, as written.

B.A. – Bachelor of Art
NA – not applicable
PFC analysis will be conducted by SGS Accutest.
Waste characterization analysis will be conducted by CT.

Organization: Analytical Laboratory – Vista Analytical Laboratory (Vista)

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/Date
Martha Maier	Vista Laboratory Director	B.S. – Chemistry / 30 years	NA	Martha Maier 8/31/16
Andrew Patterson	Vista Technical Director	B.S. – Microbiology / 13 years	NA	[illegible] 8/31/16
Calvin Tanaka	Vista Acting Quality Assurance Manager	B.A. – Chemistry / 41 years	NA	[illegible] 8/31/16

Notes: Signatures indicate personnel have read and agree to implement this QAPP and any future updates or addendum, as written.
NA – not applicable
B.S. – Bachelor of Science
B.A. – Bachelor of Art
QAPP – Quality Assurance Project Plan

Organization: Analytical Laboratory – EMAX Laboratories Inc.
Subcontractor to Primary Analytical Laboratory – Maxxam Analytics International (Maxxam)

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Caspar Pang	President and Laboratory Director	B.A./10 years		[illegible] 8/31/2016
Melissa DiGrazia	Maxxam Project Manager	B.S./6 years	NA	M Di Grazia 16/08/31

Notes: Signatures indicate personnel have read and agree to implement this QAPP and any future updates or addendum, as written.
NA – not applicable
B.S. – Bachelor of Science
B.A. – Bachelor of Art
PFC analysis will be completed by Maxxam.

QAPP Worksheet #6: Communication Pathways

Final Revision 1, Date: 8/17/2016

Communication Driver	Responsible Organization	Responsible Person(s)	Phone Number	Responsible Party Communication Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	AFCEC	Billy Claxton TO 0128 Functional Manager	210-395-9475	The AFCEC Functional Manager will serve as the primary point of contact with regulatory agencies. Contact will be made by the AFCEC Functional Manager through telephone or electronic mail and a record will be retained detailing the correspondence.
Stop work due to safety issues	AFCEC, Amec Foster Wheeler, Subcontractors	On-site personnel	--	On-site personnel must notify the Amec Foster Wheeler Site Health and Safety Officer concerning health and safety issues. The Amec Foster Wheeler Health and Safety Officer will in turn notify the Amec Foster Wheeler Regional Lead* and the Amec Foster Wheeler Project Manager, who in turn will notify the AFCEC Functional Manager via telephone and/or electronic mail.
Stop work due to quality issues	AFCEC, Amec Foster Wheeler, Subcontractors	On-site personnel	--	On-site personnel must notify the Amec Foster Wheeler Field Manager**, who in turn will notify the Amec Foster Wheeler Quality Control (QC) Manager. The Amec Foster Wheeler QC manager will contact the Amec Foster Wheeler Regional Lead and the Amec Foster Wheeler Project Manager. The Amec Foster Wheeler Project Manager will then notify the AFCEC Functional Manager via telephone and/or electronic mail.
QPP changes prior to field work	Amec Foster Wheeler	Shalene Thomas PFC Technical Lead	612-252-3697	The Amec Foster Wheeler PFC Technical lead will notify the Amec Foster Wheeler Project Manager, who will notify the AFCEC Functional Manager via telephone and/or electronic mail.
QPP changes during project execution	Amec Foster Wheeler	Regional Leads	--	The Amec Foster Wheeler Regional lead will notify the Amec Foster Wheeler Project Manager who in turn will notify AFCEC.
Changes to investigative activities during or after initial field work is complete	Amec Foster Wheeler	Regional Leads	--	The Regional leads will prepare a memorandum describing changes to investigation activities and the rationale for the changes. Regional leads will arrange for and hold a conference call with stakeholders to brief them on changes in the SI program.

Communication Driver	Responsible Organization	Responsible Person(s)	Phone Number	Responsible Party Communication Procedure (timing, pathway, documentation, etc.)
Field corrective actions	Amec Foster Wheeler	Melissa Helton Project Manager	865-671-6774	Field corrective actions will be identified by the Amec Foster Wheeler Project Manager and Amec Foster Wheeler QC Manager within 24 hours and will be communicated to the Amec Foster Wheeler Regional Leads via telephone and/or electronic mail. The Amec Foster Wheeler Regional Leads will notify the Field Manager via telephone and/or electronic mail, who will directly communicate corrective actions to the field team. The field team will implement the corrective actions.
Sample receipt variances	CT Labs	Brett Szymanski CT Project Manager	608-356-2760	The laboratory will notify the Amec Foster Wheeler Laboratory Coordinator via telephone within 24 hours of sample receipt. The Amec Foster Wheeler Laboratory Coordinator will then notify the Amec Foster Wheeler Regional Lead and the Amec Foster Wheeler Project Manager via telephone and/or electronic mail.
	SGS Accutest (subcontractor to CT)	Andrea Colby SGS Accutest Project Manager	407-608-8062	
	Vista	Martha Maier Laboratory Director	906-673-1520	
	Maxxam (Subcontractor to EMAX)	Melissa DiGrazia Maxxam Project Manager	905-817-5712	
Laboratory quality control variances	CT Labs	Brett Szymanski CT Project Manager	608-356-2760	The laboratory will notify the Amec Foster Wheeler Laboratory Coordinator and Amec Foster Wheeler QC Manager via telephone within 24 hours of identified variance(s). If quality control variances contradict the minimum requirements of the DoD Quality Systems Manual, then the Amec Foster Wheeler QC Manager and the Amec Foster Wheeler Project Manager will contact the AFCEC Contracting Officer Representative (COR) and Functional Manager via telephone and/or electronic mail to discuss and receive approval for the variances within 7 days of notice of variance.
	SGS Accutest (Subcontractor to CT)	Andrea Colby SGS Accutest Project Manager	407-608-8062	
	Vista	Martha Maier Laboratory Director	906-673-1520	
	Maxxam (Subcontractor to EMAX)	Melissa DiGrazia Maxxam Project Manager	905-817-5712	
Analytical corrective actions	Amec Foster Wheeler	Ann Bernhardt QC Manager	503-639-3400	The Amec Foster Wheeler QC Manager will respond to laboratory issues with corrective action(s) via telephone and/or electronic mail (within 1 week of notification from the laboratory).
Data verification issues, e.g., incomplete records	Amec Foster Wheeler	Ann Bernhardt QC Manager	503-639-3400	The Amec Foster Wheeler QC Manager will resolve data verification issues with the contract laboratory within one week of issue being identified.

Communication Driver	Responsible Organization	Responsible Person(s)	Phone Number	Responsible Party Communication Procedure (timing, pathway, documentation, etc.)
Data validation issues, non-compliance with procedures	Amec Foster Wheeler	Ann Bernhardt QC Manager	503-639-3400	The Amec Foster Wheeler QC Manager will resolve data validation issues with the contract laboratory within one week of issue being identified.
Data review corrective actions	Amec Foster Wheeler	Ann Bernhardt QC Manager	503-639-3400	The Amec Foster Wheeler QC Manager will communicate necessary data review corrective actions with the contract laboratory via telephone and/or electronic mail within one week of corrective actions.

Notes:
* Since the Amec Foster Wheeler Regional Leads will be different for each installation, they will be identified in the Installation-Specific Work Plans (ISWPs).
**Since the Amec Foster Wheeler Field Managers will be different for each installation, they will be identified in the ISWPs.
TO – Task Order
AFCEC – Air Force Civil Engineering Center
Amec Foster Wheeler - Amec Foster Wheeler Environment & Infrastructure, Inc.
QC – quality control
PFC – perfluorinated compound
SI – site investigation
QPP – Quality Program Plan
CT – CT Laboratories, LLC
SGS Accutest – SGS Accutest Laboratories
Maxxam – Maxxam Analytics International
QAPP – Quality Assurance Project Plan
DoD – Department of Defense

QAPP Worksheet #9: Project Planning Session Summary

Final, Date: 3/21/2016

Date of planning session: 3 September 2015
Location: Teleconference
Purpose: Project Kickoff Meeting

Attendees:

David Farnsworth	(DF)	AFCEC CIBE, Contracting Officer Representative (COR)
Billy Claxton	(BC)	AFCEC CIBE, CIB Project Manager
Richard Compton	(RC)	772 ESS/PKC
Sean Eldredge	(SE)	CNTS
Melissa Helton	(MH)	Amec Foster Wheeler Project Manager
Tom Rasmussen	(TR)	Amec Foster Wheeler Program Manager
Becky Mahoney	(BM)	Amec Foster Wheeler Contracts Manager
Terry Clem	(TC)	Program Administrator

General Project Discussion:

- Introductions
    - Roles and Responsibilities – for Amec Foster Wheeler, attached organization chart and key personnel responsibilities was reviewed
    - Amec Foster Wheeler contact list is under development
    - AFCEC POCs contact list (attached)
    - Communications: will be conducted through the CPSMR, monthly project conference calls, installation-specific technical review calls/meetings, Project Management Review (PMR) meetings, SharePoint Site
        - Monthly conference calls – 3rd Wednesday of each month at 2:00 pm EST
        - First one scheduled for 16 Sept 2015
        - Joint call with TO 177. Undetermined in future monthly calls will be separate or combined.
- Project Overview
    - General overview/scope
      Dave Farnsworth described the Statement of Work.
    - TO 218 – Amec Foster Wheeler
        - POP: 14 Aug 2015 *thru* 14 Aug 2017
        - Primary POC: Melissa Helton, Project Manager
        - Primary Support Staff: Donna Sharp, Rob Singer, Peter Baker, Beth Flynn

- COR: Dave Farnsworth
- FPM: Billy Claxton
- CO: Naomi Alvarado

List of Installations in TO 218

Castle AFB, CA	Loring AFB, ME
Chanute AFB, IL	Pease AFB, NH
General Mitchell ARS, WI	Plattsburgh AFB, NY
Griffiss AFB, NY	Reese AFB, TX
Kelly AFB, TX	Wurtsmith AFB, MI
KI Sawyer AFB, MI	

- o Base POCs are familiar with SOW
- o Scoping visits are being conducted with Base POCs – expected to be completed by late Sept 2015
- o Project Schedule – to be updated based on meetings with Base POCs
  - Customer Goal: complete site investigations by Dec 2016
- o Discussion

- AFCEC Contracting comments – Richard Compton should be included on any communications to Naomi Alvarodo.
- AFCEC FPM comments – Billy Claxton did not have anything to add.
- Meeting adjournment

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QAPP Worksheet #10: Conceptual Site Model

Final, Date: 3/21/2016

A preliminary Conceptual Site Model (CSM) for each potential AFFF area will be developed and presented in the Installation-Specific Work Plans. The CSMs will include the following information presented in table format. In addition to the information that will be included in a table similar to the one below, data may also be presented as follows:

- Maps/figures to illustrate locations of sources, pathways, surface water features, and plume contours;
- Tabular data to support groundwater flow and contaminant distribution maps;
- Vertical profiles to document subsurface contamination, which will be supported by boring logs; and,
- Flow diagrams to illustrate the relationship between source areas to final receptors.

The information provided within each preliminary CSM will be revised based upon the information and data collected during the Sis, additional research, well surveys, and follow-on data.

Facility Profile	Physical Profile	Release Profile	Land Use and Exposure Profile	Ecological Profile
Installation Description: • Years of operation • Total area occupied by base (acres) • Description of historical activities on base • Installation mission **AFFF Area History**: • Location(s) on base • Years of operation • Frequency of operation	**AFFF Area Characteristics**: • Total area (acres) **Topography**: • General topography across base • Topography in vicinity of PFC release area • Approximate elevation of AFFF area **Vegetation**: • General overview of vegetation type(s) at AFFF area • Presence of stressed vegetation, as applicable **Surface Water**: • Presence of streams, lakes, playas, oceans, etc. • Drainage pathways **Soils**: • Primary soil makeup (e.g. sand, silt, clay, etc.) **Geology**: • Formation/lithologic unit description • Depth intervals **Hydrogeology**: • Hydrostratigraphic unit name(s) • Depth to groundwater • Saturated thickness • Confined, unconfined and/or perched groundwater zones • Groundwater flow direction in identified groundwater zones • Hydraulic gradient, hydraulic conductivity, and other aquifer parameters, if documented. **Meteorology:** • Average annual precipitation • Wet and dry seasons • Average temperature • Wind (prevailing direction, speed, etc.)	**Contaminants of Potential Concern**: • PFCs primary concern • Identify historical contaminants (e.g. chlorinated solvents, fuels, etc.) associated with AFFF areas **Media of Potential Concern**: • Soil, groundwater, surface water, sediment, pore water, influent/effluent, drinking water and fish tissue **Potential and Confirmed AFFF Releases**: • Areas identified in PA • Dates of AFFF release / use • Quantities of AFFF used (if known) **Contaminant Migration Pathways**: • Adsorption to soil matrix near source area • Infiltration into groundwater • Downgradient migration of dissolved PFCs in groundwater • Migration of dissolved PFCs from shallow to deeper groundwater zones • Direct discharge into surface water drainage systems including open drainage features and underground storm water sewer collection systems • Direct discharge into floor drains and sanitary sewer and industrial waste water lines • Discharge to surface water bodies (ditches, creeks) at treatment system or storm sewer outfall locations • **Secondary Pathways**: • Disposal of excavated soil	**Current Landowners**: • Owner(s) and lessees **Current Land Use**: • AFFF area specific land use Surrounding Land Use: • Land use of properties adjacent to former Base boundary **Future Land Use**: • Potential development • Land use restrictions **Potential Receptors**: • Surface water bodies • Municipal groundwater wells • Private groundwater wells • Humans • Biota	**Potential Ecological Receptors**: • High quality ecosystems – e.g., wetlands, rivers, streams, lakes, etc. • Inland and marine plant species, fish, birds, insects, soil invertebrates, and mammals that inhabit or migrate through the PFC release area(s) • Identified threatened and endangered species **Threatened and Endangered Species**: • Listed threatened and endangered species

Notes:
AFFF - aqueous firefighting foam
PA - Preliminary Assessment
PFC - perfluorinated compounds

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QAPP Worksheet #11: Project/Data Quality Objectives

Final Revision 1, Date: 8/17/2016

DQOs were developed using the Optimized UFP-QAPP Worksheets, March 2012, and USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* USEPA QA/G-4 (USEPA, 2006).

Step 1: State the Problem

PFCs are a large group of synthetic fluorinated compounds that are widely used to make everyday products more resistant to heat, stains, grease, and water and as components in firefighting foams, such as AFFF (NIEHS, 2012 and USAF, 2012). AFFF containing PFOS and/or PFOA was used by the United States (U.S.) military, including the USAF, for firefighting and firefighting training; and PFCs may be present at USAF installations where AFFF was stored, disposed, intentionally discharged, or spilled (USAF, 2012). The chemical structures of PFCs make them very resistant to breakdown in the environment. Due to their persistence, bioaccumulation potential, and toxicity, PFCs may potentially impact human health and the environment (USEPA, 2014). According to DoDI and subsequently under AFI 32-7020, PFCs (including PFOA/PFOS) are an emerging contaminant since they either do not have promulgated regulatory standards based on peer-reviewed science or they have promulgated standards but it is anticipated that such standards may change due to new science, detection capabilities, or pathways. As discussed in the Introduction, HAs have been established for PFOA and PFOS to protect humans from potential exposure risk to these PFCs, which are not legally enforceable federal standards and are subject to change as new information becomes available. Based on AFI 32-7020, the USAF is required to investigate and mitigate human exposure to PFCs as an emerging contaminant since there is a potential for the presence of an unacceptable risk.

Step 2: Identify the Goals of the Study

The objectives of this study are to:

(1) Conduct initial SIs at identified AFFF areas to determine the presence (concentrations greater than the laboratories' detection limits [DLs], defined as the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence) or absence of PFCs in sampled media. Sampled media will include, but is not limited to, soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and drinking water;

(2) Conduct follow-on investigation and step-out sampling at AFFF areas where PFCs are present at concentrations greater than USEPA HA values, or other applicable state or federal standards. The follow-on investigations will: a) further evaluate each area where PFCs have been identified at concentrations exceeding applicable criteria (including the extent of impacts from fire training areas [FTAs] and other identified AFFF areas), b) delineate downgradient groundwater plumes (as applicable), c) define the environmental setting including potential mechanisms for PFC

migration for each area that has a confirmed release of PFCs, and d) identify AFFF areas with potential impacts to down-stream and/or downgradient receptors;

(3) Conduct well surveys to assess the locations of downgradient drinking water supplies and determine potential exposure pathways that may be potential receptors;

(4) Perform initial and follow-up sampling of public/private drinking water wells to identify and verify where PFCs are present in drinking water at concentrations above USEPA HAs or state-specific standards and evaluate potential exposure pathways with immediate threats to human health; and,

(5) Apply mitigation measures to drinking water wells that present an imminent threat to human health from PFCs related to USAF activities at the 10 BRAC installations.

These objectives will be achieved by conducting the following SI activities:

- ISWP Documentation: ISWPs will be developed to outline any supplemental research needs to evaluate the environmental setting and site conditions as well as the unique sampling strategy for each of the AFFF areas located at the 10 USAF BRAC installations. Based upon the results of SIs, an Installation-Specific Work Plan Addendum may be prepared to outline follow-on investigation and/or step-out sampling activities. Each of the Installation-Specific Work Plans and Work Plan Addendums will include QAPP Worksheet #11 to reflect site-specific data requirements.
- SI Activities: SI activities will include, but are not limited to, the collection of soil, sediment, surface water, fish tissue, pore water, influent/effluent, and groundwater samples; monitoring well installation; existing well rehabilitation; well development; stormwater evaluation; plume monitoring; supplemental research to determine the environmental setting; the update and evaluation of the conceptual site model, and IDW management.
- Follow-On SI Activities: Following initial SI activities, a conference call will be scheduled to review the results and determine if follow-on investigation activities are warranted based on the need to delineate locations where PFC concentrations exceed applicable criteria (USEPA HAs and/or state-specific criteria) and update and evaluate the conceptual site model. In addition, fish tissue samples may be evaluated to assess whether there are PFCs in fish tissue that could potentially be consumed by recreational anglers fishing in surface water bodies within and downstream of AFFF areas to evaluate whether a fish consumption advisory is needed for recreational angling. Because PFOA and PFOS are the only PFCs with HAs, other PFCs will only be considered for potential follow-on activities if the state regulatory agency has threshold criteria, above which additional investigation is required.
- Additionally, if PFC standards established by states are exceeded at an applicable installation, further evaluation will be conducted based upon the need to delineate impacts.
- Private Well Survey and Sampling: Private well surveys will be conducted to identify properties located near the former base boundary that may be potential receptors of PFCs emanating from AFFF Areas. The surveys will determine the number and locations of private drinking water wells

that potentially require sampling. Initial and follow-up sampling of private drinking water wells will be conducted to evaluate PFC presence and identify potential migration pathways. Coordination with private property owners (e.g., letters, telephone, results, etc.) will be conducted prior to and following well survey and sampling activities.

- Public Supply Sampling: Initial and follow-up sampling of public drinking water wells will be conducted to evaluate PFC presence within public drinking water sources and identify potential migration pathways. Coordination with public property owners (e.g., letters, telephone, results, etc.) will be conducted prior to and following well survey and sampling activities.
- Documentation: The results of SI field activities will be documented in 1) initial data transmittals, 2) Well Survey and Sampling Activity reports, and/or 3) Installation-Specific SI Reports. The results will include updated conceptual site models to aid in identifying exposure pathways and potential receptors.
- Mitigation: Mitigation measures will be conducted at drinking water supplies when the presence of PFCs poses an imminent threat to human health. Mitigation measures may include, but are not limited to, the installation of ex-situ treatment systems (e.g., whole-house treatment systems), replacement of carbon within treatment systems, and the distribution of bottled water to affected property owners. Any mitigation activities conducted will be coordinated with the property owners and/or general public.

Additional details regarding project tasks are included in UFP-QAPP Worksheets #14/16: Project Tasks and Schedule.

Step 3: Identify Information Inputs

PFC guidance documents listed on **Worksheet #1 and #2** were used in the development of this QPP. In addition, PAs were prepared for each of the 10 BRAC installations to identify potential areas where AFFF may have been stored, used, or disposed. Information from the PAs and previous investigation reports will be used to develop sampling strategies that will be presented in subsequent ISWPs.

The following activities are anticipated to be performed to acquire the data and information required to achieve project goals as part of the SI program:

- Review background documentation including Installation-Specific PAs and other reports documenting previous investigation and monitoring programs as well as information collected during supplemental research to develop an understanding of environmental conditions at the identified AFFF areas;
- Visit identified AFFF areas at each of the 10 BRAC installations to assess current site conditions and areas potentially impacted by releases of PFCs from past use of AFFF;
- Develop an approach to the SIs based on the understanding of site conditions obtained through document review and site visits and develop a consensus on the investigation approach during conference calls attended by Amec Foster Wheeler and AFCEC project teams;

- Advance and lithologically log soil borings and install, develop, and gauge groundwater monitoring wells to further assess AFFF area-specific environmental conditions;
- Collect and analyze soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and drinking water samples using high-performance liquid chromatography LC-MS-MS to assess the presence and concentrations of PFCs at and downstream/downgradient of identified AFFF areas.
- PFC data contained in the UCMR3 reports from water purveyors at BRAC installations. UCMR3 PFC data can be used as baseline data when evaluating nature, extent, and relative levels of PFC detections at PFC investigation areas.
- Existing or planned PFC-related regulations at the state where the BRAC installation is located.
- Public awareness on PFCs at the BRAC installation location.
- If available, state-specific PFC action/cleanup levels.

Step 4: Define the Boundaries of Data Collection

The boundaries of the initial phase of investigation will be defined by 1) the timeframe of AFFF use, which has been documented to have occurred between 1970 and respective base closure dates, 2) areas where AFFF was used during this timeframe, and 3) alterations to AFFF areas (e.g., excavation and filling, demolition, etc.).

In general, the investigation will focus on the sampling of vadose zone soil, first encountered groundwater, sediment, surface water, and pore water in and downgradient/downstream of AFFF areas. Supplemental research may also be conducted to evaluate the environmental setting at specific AFFF areas. The collection and analysis of tissue from fish obtained from surface water bodies downstream of areas where PFCs have been identified at concentrations exceeding USEPA HAs and/or state-specific standards will be conducted to evaluate the bioaccumulation of PFCs in fish. Public and private well surveys and sampling may be conducted to determine the locations of water wells adjacent to the former Base, evaluate the presence of PFCs within potentially affected wells, and identify potential migration pathways.

The 14 PFC compound analytical suite that may be used during execution of TO 0218 is listed below.

- PFOS
- Perfluorohexanesulfonic acid (PFHxS)
- PFOA
- N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
- Perfluorodecanoic acid (PFDA)
- Perfluorododecanoic acid (PFDoA)
- Perfluorotridecanoic acid (PFTrDA)
- Perfluoroheptanoic acid (PFHPA)
- Perfluorononanoic acid (PFNA)
- Perfluorobutanesulfonic acid (PFBS)
- N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)

- Perfluorotetradecanoic acid (PFTA)
- Perfluorohexanoic acid (PFHxA)
- Perfluoroundecanoic acid (PFUnA)

Depending on the location of the installation and regulatory requirements, the following PFC compounds may also be analyzed:

- N-ethyl perfluorooctane sulfonamide (NEtFOSA)
- N-methyl perfluorooctane sulfonamide (NMeFOSA)
- 6:2 Fluorotelomer sulfonate (6:2 FTS)
- 8:2 Fluorotelomer sulfonate (8:2 FTS)
- N-ethyl perfluorooctane sulfonamidoethanol (NEtFOSE)
- N-methyl perfluorooctane sulfonamidoethanol (NMeFOSE)
- Perfluorobutanoic acid (PFBA)
- Perfluorodecanesulfonic acid (PFDS)
- Perfluoroheptanesulfonic acid (PFHpS)
- Perfluorooctane sulfonamide (PFOSA)
- Perfluoropentanoic acid (PFPeA)

Step 5: Develop the Analytical Approach

- Soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and/or drinking water samples will be collected to determine the presence or absence of PFCs in sampled media. For this SI program, PFC concentrations will be compared against USEPA HAs and/or state-specific regulations, as applicable. For most of the installations, it is expected that samples will be analyzed for the 14 PFCs listed for Method 537.1 in **Table 1**. However, the specific PFC compounds analyzed in samples collected at each BRAC installation will depend upon federal and state regulatory requirements applicable to the installation. LC-MS-MS methods will be used to analyze the samples. If PFCs are detected at concentrations exceeding USEPA HAs and/or concentrations established by state regulations, then the AFFF area will be further evaluated. In the absence of local standards and in accordance with the *Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and BRAC Installations* dated 27 Aug 2012 (USAF, 2012), further evaluation will be performed if the following HA levels are exceeded in groundwater and or surface water samples collected as part of SI programs at the 10 BRAC installations:
    - PFOS: 0.07 µg/L
    - PFOA: 0.07 µg/L
    - PFOS + PFOA : 0.07 µg/L

  For fish tissue sampling, PFC concentrations will be evaluated to assess whether there is a risk to recreational anglers fishing in surface water bodies within and downstream of AFFF areas. Working with appropriate agencies, the need for a fish consumption advisory will be determined.

- Follow-on investigation and step-out sampling will be conducted to evaluate the extent of PFC concentrations, delineate downgradient groundwater plumes (as applicable), further define the environmental setting, and identify AFFF areas with potential impacts to down-stream and/or downgradient receptors. If PFC concentrations exceed USEPA HAs and/or concentrations established by state regulations, then the USAF will be informed of the results of follow-on data collection to evaluate the need to conduct further investigation to delineate PFC concentrations, identify potential migration pathways, and identify down-stream and/or downgradient receptors.
- Well surveys will be conducted to assess the locations of downgradient drinking water supplies and determine potential exposure pathways that may be potential receptors. If PFCs are identified at concentrations exceeding USEPA HAs, and/or concentrations established by state regulations and a potential migration pathway is identified to downgradient drinking water supplies, then public/drinking water wells will be sampled.
- Initial and follow-up sampling of public/private drinking water wells will be conducted to identify and verify where PFCs are present in drinking water at concentrations above USEPA HAs, and/or state-specific standards and evaluate potential exposure pathways with immediate threats to human health. If PFCs are identified at concentrations exceeding USEPA HAs, and/or state-specific standards; then the USAF will be contacted to evaluate the mitigation measures that may be necessary.

Worksheet #15 identifies the method reporting limits that will be used to determine the presence of PFCs. If concentrations of PFCs are above the method reporting limits, the PFC constituent will be considered to be present at the specific AFFF area.

Step 6: Specify Performance or Acceptance Criteria

The following performance and acceptance criteria will be used during SI activities:

- Daily standardized PFC personal protective equipment (PPE) and field equipment checklist (provided in the PFC protocol SOP) will be completed by the Amec Foster Wheeler Field Manager for each installation. The Quality Assurance (QA) Manager will review and accept the final checklist.
- The Amec Foster Wheeler Field Manager will verify that field procedures described in the QPP and ISWP are followed on a daily basis during field work. The Amec Foster Wheeler QA Manager or designee will verify that field procedures are being followed by conducting field audits. Deviations from QPP procedures will be promptly addressed and documented by the Amec Foster Wheeler QA Manager and Field Manager.
- Laboratories analyzing SI samples will be accredited under the DoD Environmental Laboratory Accreditation Program (ELAP) for PFC analysis and will adhere to analytical method performance/acceptance criteria as specified in the DoD Quality Systems Manual (QSM) V5.0 and defined on **Worksheets #12a and 12b**.

- The Amec Foster Wheeler Project Chemist will conduct an audit of the laboratories prior to sampling to evaluate the laboratories' procedures, quality programs, and operations associated with the planned laboratory analysis. Findings or recommendations will be addressed by the laboratory prior to analysis of field samples collected as part of the SI program. Based on the findings of the laboratory audit, the QPP may be revised if deemed necessary by the Project Chemist.
- The LC-MS-MS method will provide acceptable DLs to confirm the exceedance of the USEPA HAs, or state-specific criteria at concentrations defined in Step 2 and **Worksheet #15**.
- USEPA Stage 2B data verification will be conducted on 100 percent of the data, and USEPA Stage IV data validation will be conducted on 10 percent of the analytical data by an experienced chemist to assess data usability. The data usability will then be evaluated by AFCEC for final approval. Data completeness of 90 percent usable data will be required for this SI program.
- All documents, including work plans, SI Reports, Well Survey Reports, and Well Sampling Reports will be reviewed and accepted by AFCEC.
- Sampling and laboratory analysis of PFOA and PFOS using the LC-MS-MS methodology will be used to verify that mitigation systems are reducing PFOA and PFOS concentrations to below USEPA HAs, and/or state-specific standards in drinking water.

Step 7: Develop the Detailed Plan for Obtaining Data

Prior to sampling activities, a scoping visit will be conducted at each installation to determine the number and locations of initial samples. Based on the results of the scoping visit and additional research, if applicable, a sampling approach will be developed that will be designed to determine whether PFCs are present at identified AFFF areas. Area-specific CSMs will be developed to identify the media and locations most likely to be impacted by releases of PFCs from past use of AFFF.

Based on the results of initial sampling, follow-on investigation and step-out sampling may be conducted to evaluate the extent of PFC concentrations, further evaluate the environmental setting, delineate groundwater plumes, and identify potential migration pathways and receptors.

Well surveys will be conducted to assess the locations of downgradient drinking water supplies and determine potential exposure pathways that may be potential receptors. Based upon the results of initial and follow-on sampling activities, private and public drinking water wells may be sampled to identify and verify where PFCs are present in drinking water at concentrations above USEPA HAs, and/or state-specific standards and evaluate potential exposure pathways with immediate threats to human health.

QAPP Worksheet #12a: Measurement Performance Criteria, Primary Laboratory - Maxxam (Subcontractor to EMAX)

Final, Date: 3/21/2016

Matrix: Soil, Water

Analytical Group or Method: USEPA Method 537.1 Modified (PFCs by LC-MS-MS)

Data Quality Indicator	Quality control sample	Measurement Performance Criteria
Sampling Bias	Field Blank/ Equipment Blank	<1/2 LOQ, <1/10 the concentration detected in an associated sample, or <1/10 the regulatory limit, whichever is highest
Sampling and Analytical Precision	Field Duplicate	≤30% RPD or the difference between analyte concentrations <LOQ
Analytical Bias	Method Blank	<1/2 LOQ, <1/10 the concentration detected in an associated sample, or <1/10 the regulatory limit, whichever is highest
Analytical Accuracy/Bias	Internal Standard	More conservative of laboratory-specified limits or areas within 50-150% of the average areas measured during initial calibration
Analytical Accuracy/Bias	Surrogate	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits
Analytical Accuracy	Laboratory Control Sample	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits
Analytical Accuracy and Precision	MS and MSD	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits, ≤30% RPD between MS and MSD results

Notes:
Measurement performance criteria comply with QSM 5.0
LOQ - limit of quantitation
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - relative percent difference
% - percent

QAPP Worksheet #12b: Measurement Performance Criteria, Secondary Laboratory – Vista

Final, Date: 3/21/2016

Matrix: Soil, Sediment, Surface Water, Fish Tissue, Pore Water, Influent/Effluent, Groundwater, and Drinking Water

Analytical Group or Method: USEPA Method 537.1 Modified (PFCs by LC-MS-MS)

Concentration Level: Low

Data Quality Indicator	Quality control sample or measurement performance activity	Measurement Performance Criteria
Sampling Bias	Field Blank/ Equipment Blank	<1/2 LOQ, <1/10 the concentration detected in an associated sample, or <1/10 the regulatory limit, whichever is highest
Sampling and Analytical Precision	Field Duplicate	≤30% RPD or the difference between analyte concentrations <LOQ
Analytical Bias	Method Blank	<1/2 LOQ, <1/10 the concentration detected in an associated sample, or <1/10 the regulatory limit, whichever is highest
Analytical Accuracy (laboratory)	Ongoing Precision & Recovery Sample	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits
Analytical Accuracy/Bias (laboratory)	Internal Standards	More conservative of laboratory-specified limits or areas within 50-150% of the average areas measured during initial calibration
Analytical Accuracy/Bias/Precision (matrix interference)	MS and MSD	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits, RPD ≤30%

Notes:
Measurement performance criteria comply with QSM 5.0
LOQ - limit of quantitation
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - relative percent difference
% - percent
QC - quality control

QAPP Worksheet #12c: Measurement Performance Criteria, Tertiary Laboratory – SGS Accutest

Final Revision 1, Date: 8/17/2016

Matrix: Soil, Sediment, Surface Water, Pore water, Influent/Effluent, Groundwater, and Drinking Water

Analytical Group or Method: USEPA Method 537.1 Modified (PFCs by LC-MS-MS)

Concentration Level: Low

Data Quality Indicator	Quality control sample	Measurement Performance Criteria
Sampling Bias	Field Blank/ Equipment Blank	<1/2 LOQ, <1/10 the concentration detected in an associated sample, or <1/10 the regulatory limit, whichever is highest
Sampling and Analytical Precision	Field Duplicate	≤30% RPD or the difference between analyte concentrations <LOQ
Analytical Bias	Method Blank	<1/2 LOQ, <1/10 the concentration detected in an associated sample, or <1/10 the regulatory limit, whichever is highest
Analytical Accuracy/Bias	Internal Standards	More conservative of laboratory-specified limits or areas within 50-150% of the average areas measured during initial calibration.
Analytical Accuracy/Bias	Surrogate	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits
Analytical Accuracy	LCS	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits
Analytical Accuracy and Precision	MS and MSD	Laboratory-specified limits or 70-130% recovery for analytes without laboratory-specified limits, ≤30% RPD between MS and MSD results

Notes:
Measurement performance criteria comply with QSM 5.0
LCS - laboratory control sample
LOQ - limit of quantitation
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - relative percent difference
% - percent

QAPP Worksheet #13: Secondary Data Uses and Limitations

Final, Date: 3/21/2016

This worksheet is used to identify sources of secondary data, which is defined as data generated for purposes other than this specific project or data pertinent to this project generated under a separate QAPP. This worksheet will be included in the Installation-Specific Work Plan to identify data used to develop each work plan (e.g., historic investigation results, aerial photographs, weather data, etc.)

Data Type	Source	Data Uses Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Preliminary Assessments	PFC Preliminary Assessment for: • Former Castle AFB • Former Chanute AFB • Former General Mitchell ARS • Former Griffiss AFB • Former Kelly AFB • Former KI Sawyer AFB • Former Loring AFB • Former Pease AFB • Former Plattsburgh AFB • Former Reese AFB • Former Wurtsmith AFB	Identification of potential PFC release areas as well as historic use and dates of operation.	Assessments were developed based upon reporting of others and/or interviews of former Base personnel.

QAPP Worksheet #14/16: Project Tasks & Schedule

Final Revision 1, Date: 8/17/2016

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Installation scoping visits	Amec Foster Wheeler	See schedule[1]	See schedule	Field notes (included in SI Report)	See schedule
General Quality Program Plan (UFP-QAPP)	Amec Foster Wheeler	See schedule*	See schedule	General QPP	See schedule
Installation-Specific Work Plans	Amec Foster Wheeler	See schedule*	See schedule	Installation-Specific Work Plans	See schedule
Mobilization/demobilization	Amec Foster Wheeler and subcontractors	See schedule*	See schedule	Field notes (included in SI Report)	See schedule
Utility clearance	Amec Foster Wheeler and subcontractor	NA[2]	NA[2]	Field notes (included in SI Report)	See schedule
Soil boring advancement/abandonment and surface and subsurface sample collection	Amec Foster Wheeler and subcontractors	See schedule*	See schedule	Field notes and boring logs (included in SI Report)	See schedule
Monitoring well installation, development, and sampling	Amec Foster Wheeler and subcontractors	See schedule*	See schedule	Field notes, monitoring well diagrams, and field measurements (included in SI Report)	See schedule
Monitoring well surveying	Amec Foster Wheeler and subcontractors	NA[3]	NA[3]	Survey Report (included in SI Report)	See schedule
Redevelopment of existing wells and sample collection - groundwater from existing monitoring wells	Amec Foster Wheeler and subcontractors	See schedule*	See schedule	Field notes, and field measurements (included in SI Report)	See schedule
Sediment and surface water sampling	Amec Foster Wheeler	See schedule*	See schedule	Field notes, and field measurements (included in SI Report)	See schedule
Well survey and private well sampling	Amec Foster Wheeler	See schedule*	See schedule	Well Survey and Sampling Activity Report	See schedule
Public supply sampling	Amec Foster Wheeler	See schedule*	See schedule	Well Survey and Sampling Activity Report	See schedule
Fish Tissue Sampling	Amec Foster Wheeler	See schedule*	See schedule	Field notes, and field measurements (included in SI Report)	See schedule

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Pore Water Sampling	Amec Foster Wheeler	See schedule*	See schedule	Field notes, and field measurements (included in SI Report)	See schedule
Stormwater Evaluation	Amec Foster Wheeler	See schedule*	See schedule	Field notes, and field measurements (included in SI Report)	See schedule
Plume and receptor pathway investigation	Amec Foster Wheeler	See schedule*	See schedule	Field notes, and field measurements (included in SI Report)	See schedule
Sample Analyses	Maxxam (Subcontractor to EMAX), CT Labs, SGS Accutest (Subcontractor to CT), and Vista	See schedule	See schedule	Report of analyses/Data package (included in SI Report)	See schedule
Analytical Data Validation	Amec Foster Wheeler	See schedule	See schedule	Validation Summary (included in SI Report)	See schedule
Environmental Resources Program Information Management System (ERPIMS) Data Submittal	Amec Foster Wheeler	See schedule*	90 days after Sampling Completed	Successful submittal of ERPIMS data for each installation and receipt of AFCEC ERPIMS Data Loading Notification	90 days after Sampling Completed
Investigation Derived Waste Characterization, Profiling, and Disposal	Amec Foster Wheeler	See schedule*	See schedule	SI Report	See schedule

Initial data transmittals	Amec Foster Wheeler	See schedule*	See schedule	Initial data transmittals	See schedule
SI Report	Amec Foster Wheeler	See schedule*	See schedule	SI Report	See schedule
Mitigation Measures[4]	Amec Foster Wheeler	TBD	TBD	TBD	TBD

Notes:

[1]The project schedule is provided as **Appendix B**. Updated project schedules will be included in the Installation-Specific Work Plans.

[2] Part of utility clearance includes contacting a "Call Before You Dig" service that coordinates utility locate and markout services. Since Amec Foster Wheeler does not coordinate these activities, utility locate activities are not included in the schedules.

[3] Monitoring well surveying will be conducted during SI activities, but is dependent upon the date when well installation and completion are completed and the availability of the surveyor once installation activities are complete; therefore, this activity is not included in the schedule.

[4] Based upon the results of investigations conducted under this TO, mitigation measures may be conducted at or downgradient of AFFF areas. The scope and schedule of these measures will be determined based upon the investigation results, and will be outlined when determined necessary.

Amec Foster Wheeler - Amec Foster Wheeler Environment & Infrastructure, Inc.
UFP-QAPP - Uniform Federal Policy – Quality Assurance Project Plan
SI - site investigation
QPP - Quality Program Plan
NA - not available

CT - CT Laboratories, LLC
SGs Accutest – SGS Accutest Laboratories
Maxxam - Maxxam Analytics International
Vista - Vista Analytical Laboratory
TBD - to be determined

SITE INVESTIGATION OF AFFF AREAS

To meet the project goals defined in **Worksheet #11**, SIs will be initiated at 10 BRAC installations. SIs will be conducted in accordance with the Statement of Work outlined under TO 0218 with AFCEC. It should be noted that any additional data required under CERLA Federal Facilities SI Guidance will be collected as part of future investigative activities, as necessary. The SIs will include site reconnaissance (as needed to refine the scope of sampling activities) as well as collection of soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and drinking water samples to determine the presence of PFCs at identified AFFF areas. The specific sampling and analytical procedures for implementing the SIs will be described in 10 ISWPs. Based on the scope of work in TO 0218, the SIs will include the activities identified in **Worksheet #14/16** and described below. It is expected the scope of work identified in Worksheet #14/16 of this QPP will be modified based on the scoping visits and review of pertinent background documentation for each BRAC installation. The final SI scope will be described in detail in ISWPs that will be reviewed by AFCEC and the appropriate regulatory agency, as applicable, for review and approval prior to the commencement of field activities. Fieldwork will be conducted in accordance with the SOPs provided in **Appendix D**.

Installation Scoping Visits

Installation scoping visits will be conducted at each of the 10 BRAC installations scheduled for fieldwork to collect installation and area-specific information necessary to refine the scope of work at each identified AFFF area. Information to be collected during scoping visits include the following:

- Areas where AFFF may have been released based on past USAF practices;
- Locations of existing monitoring wells and monitoring well conditions at and downgradient of AFFF areas;
- Access routes to sample locations;
- Current site conditions to include supplemental research to determine the environmental setting;
- Conditions affecting types and locations of samples (e.g., utilities, structures, etc.);
- Equipment and personnel requirements for anticipated investigation activities;
- Access requirements (e.g., escorts, badging, flight line training, etc.);
- Permit requirements (e.g., dig permit, hot work, Federal Aviation Administration [FAA] permit, etc.);
- Consensus decisions made regarding project activities and action items;
- Existing land use controls and/or 5-year reviews over the targeted investigation areas;
- Traffic considerations (e.g., the need for traffic control at planned sample locations);
- Well construction requirements based on installation geologic conditions;
- Area restoration based on installation requirements;
- U.S. Fish and Wildlife Services (USFWS) consultation requirements, where applicable based on sensitive species and habitats at and in the vicinity of AFFF areas.

Pre-Mobilization

Prior to site mobilization, it will be necessary to complete several pre-mobilization activities including coordinating with the point of contact (POC) for each installation and obtaining utility clearances and dig permits.

- Installation-Specific Regulations – Fieldwork conducted under this TO will be performed at installations where land use varies, including use as an active airport. Personnel must become familiar with and comply with installation-specific regulations and procedures. Prior to start of fieldwork, all required badges, passes, and vehicle permits will be acquired and followed with proper authority, as required by each installation.
- Site Access – Installation POCs, land development authorities (LDAs), and property owners/managers will be contacted and access issues resolved to obtain access to AFFF areas prior to the start of fieldwork.
- Utility Clearances and Dig Permits – Prior to the commencement of drilling activities, underground utility lines will be located and protected. Drilling operations will not begin until all underground hazards have been located. To assist with utility location, utility maps will be requested from the POC showing the locations of utilities and other infrastructure features at each AFFF area.
- FAA Notification – A *Form 7460-1 Notice of Proposed Construction or Alteration* will be filed with the FAA if the installation has a public use airport listed in the Airport/Facility Director and the equipment height extends above an imaginary surface extending outward and upward at a slope of 100:1 for a horizontal distance of 20,000 feet (ft) from the nearest point of the closest runway surface to the planned sample location.

After pre-mobilization activities are complete, permits obtained, a determination letter from the FAA obtained (as applicable), and site access coordinated with the AFCEC and the current landowners, Amec Foster Wheeler will mobilize to the installations. Demobilization will occur once SI activities are completed and the investigation areas have been restored to original conditions.

Environmental Sampling

To confirm releases of PFCs, soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and/or drinking water samples (as applicable) will be collected at identified AFFF areas located at each of the 10 BRAC installations. The goal of site-specific sampling is to determine the presence or absence of PFCs within media of concern. Investigation requirements at each installation will vary based upon current site ownership, site layout and access, in-place remedies, and other unforeseen factors that will be identified during site reconnaissance and detailed within ISWPs. SOPs (**Appendix D**) applicable to each installation/AFFF area will be reviewed prior to implementation of field activities; the SOPs consist of:

- SOP AFW-01: *Field Sampling Protocols to Avoid Cross-Contamination of PFCs;*
- SOP AFW-02: *Soil Sampling*;
- SOP AFW-03: *Groundwater Sampling*;
- SOP AFW-04: *Monitoring Well Installation*;
- SOP AFW-05: *Monitoring Well Development*;
- SOP AFW-06: *Borehole Abandonment;*
- SOP AFW-07: *Sediment Sampling*;
- SOP AFW-08: *Surface Water Sampling*;
- SOP AFW-09: *Influent and Effluent Water Sampling*;
- SOP AFW-10: *Drilling, Development, and Heavy Equipment Decontamination*;
- SOP AFW-11: *Sampling Handling and Custody;*
- SOP AFW-12: *Protocol to Provide Water Free of Perfluorinated Compounds for Collection of Field Blanks and Equipment Blanks*;
- SOP AFW-13: *Groundwater Sampling from Private and Public Supply Wells*;
- SOP AFW-14: *Slug Testing*;
- SOP AFW-15: *Fish Sampling*;
- SOP AFW-16: *Pore Water Sampling;* and,
- SOP AFW-17: *Response to PFC Testing of Private Water Supplies*.

A summary of the proposed field sampling activities identified in TO 0218 is provided in **Table 2,** and are described in the following sections. It should be noted that the scope of field activities may be revised following the site reconnaissance based upon Amec Foster Wheeler's understanding of past AFFF use at each area, potential release locations, potential contaminant migration pathways, and site conditions (e.g., presence of pavement, structures, drainage features, existing monitoring wells, etc.). **Table 2** is based on a conceptual scope of work for each BRAC installation, and the actual number of AFFF areas investigated, monitoring wells, soil borings, and samples for each media will be identified in the ISWPs.

PFC Sampling Considerations

Given the low DLs associated with PFC analysis and the many potential sources of trace levels of PFCs, field personnel are advised to strictly follow protocols to help mitigate the potential for false detections of PFCs. A list of prohibited and acceptable clothing/equipment for sampling at PFC sites is provided in **Table 3**. Specific details and procedures related to sampling for analysis of PFCs can be found in SOP AFW-01 (**Appendix D**). In addition, a *Protocol to Provide Water Free of Perfluorinated Compounds for Collection of Field Blanks and Equipment Blanks* has also been included as SOP AFW-12.

Soil Boring Advancement/Abandonment and Soil Sample Collection

To identify the presence or absence of PFCs at identified AFFF areas and to characterize subsurface conditions, soil borings will be advanced to the top of the water table and the borings will be lithologically logged and soil samples collected for chemical analysis. The number of borings to be advanced at each installation are listed in **Table 2** based on the scope of work in TO 0218. Soil boring locations will be selected based on site reconnaissance and will be biased toward potential source(s) areas, known spill locations, and locations that are downgradient or downstream of contaminant migration pathways. Proposed soil boring locations will be presented in ISWPs.

Soil cores will be collected continuously, visually screened for evidence of chemical impact (e.g., discoloring or staining), and logged by a qualified and under the supervision of a licensed professional, as applicable for the state, professional in accordance with the Unified Soil Classification System (USCS). At the completion of soil boring advancement, up to three discrete soil samples distributed throughout the vadose zone soil column will be selected for laboratory analysis. All samples collected will be placed in laboratory-supplied containers, stored on ice, and shipped to the analytical laboratory for analysis.

Soil samples will be collected in accordance with SOP AFW-02, *Soil Sampling* (**Appendix D**). Borings that are not completed as monitoring wells will be abandoned in accordance with the state-specific regulatory requirements and SOP AFW-06, *Borehole Abandonment* (**Appendix D**). Soil samples and lithologic descriptions will be recorded on drilling logs (**Appendix E**). If soil samples are collected, the information will be recorded in Soil Sample Collection Forms. A summary of proposed soil samples (e.g., number, locations, equipment to be used, and depths) will be provided in ISWPs.

Sediment Sampling

Sediment samples will be collected, as applicable, to determine the presence or absence of PFCs within sediment at and adjacent to AFFF areas and in downstream surface water bodies. Sediment samples will also be collocated where surface water and fish tissue samples are collected. A sample will be considered a sediment sample if it is collected within a surface water body; otherwise it will be considered a soil sample. For the purposes of this investigation, a surface water body will be defined as those bodies of water that support one or more of the following designated uses:

- Supports aquatic life;
- Supports recreational use; and,
- Supplies water for agricultural, industrial, or domestic use.

Sediment samples will be collected in accordance with SOP AFW-07, *Sediment Sampling* (**Appendix D**) and will be analyzed for the suite of PFC analytes required based on federal and state regulatory requirements for the specific installation. Sample collection information will be recorded in field logs and on sample collection forms (**Appendix E**). Proposed sediment sample locations and specific equipment to be used during sample collection will be described in ISWPs.

Surface Water Sampling

Surface water samples will be collected, as applicable, to determine the presence or absence of PFCs within surface water bodies. Surface water samples may be collected from any flowing or free-standing water present at, adjacent to, or downstream of the AFFF areas. Surface water will be analyzed for the suite of PFC analytes required for each BRAC installation. Surface water samples will be collected in accordance with SOP AFW-08, *Surface Water Sampling* (**Appendix D**). Sample collection information will be recorded in field logs and on sample collection forms (**Appendix E**). A summary of proposed surface water samples (e.g., number, locations, equipment to be used, and depths) will be provided in ISWPs.

Pore Water Sampling

Pore-water sampling may be conducted to evaluate groundwater migration pathways at or near surface water discharge areas. Pore water samples will be collected from drive points, or equivalent, along the up-gradient side of surface water bodies for PFC analysis. Pore water samples will be collected in accordance with SOP AFW-16, *Pore Water Sampling* (**Appendix D**). Sample collection information will be recorded in field logs and on sample collection forms (**Appendix E**). A summary of proposed pore water samples (e.g., number, locations, equipment to be used, and depths) will be provided in ISWPs.

Monitoring Well Rehabilitation, Installation, Development and Sampling

Existing monitoring wells at each installation may require repair and/or redevelopment. Actual locations and the types of well repairs and need for redevelopment will be based upon actual damage identified during the site reconnaissance and the presence of dedicated sampling equipment (e.g., pumps and passive diffusion bags that are likely to contain PFCs). Repairs may include reconstruction of the concrete pad around the monitoring well, installation/replacement of locks and lids, replacement of monuments, etc. Proposed monitoring well repairs will be described in ISWPs. If dedicated sampling equipment are present in the monitoring wells, the equipment will be removed and the wells redeveloped.

Groundwater monitoring wells will be installed as necessary to collect groundwater samples at and downgradient of AFFF areas. Monitoring well locations will be determined based on observations during the site reconnaissance, soil sample analytical results, and review of installation-specific data or reports showing potentiometric surface elevations and calculated groundwater flow directions and gradients. Likely monitoring well locations will include source areas, downgradient migration pathways, areas where soils have been impacted by PFCs, and along other identified preferential pathways. The monitoring wells will be installed by state licensed drilling contractors in accordance with state-specific requirements and SOP AFW-04, *Monitoring Well Installation* (**Appendix D**). Where site conditions and state regulations allow, monitoring wells will be installed using a direct-push drill rig. As applicable, a hollow stem auger, air rotary casing hammer, or sonic rig will be used to drill and install monitoring wells. Drilling equipment will be decontaminated between drilling, installing, and re-developing each monitoring well following the SOP AFW-10, *Drilling, Development, and Heavy Equipment Decontamination* (**Appendix D**). Proposed monitoring well locations and existing wells proposed for redevelopment and sampling will be presented in ISWPs.

Monitoring wells will be constructed with 2-inch, inside-diameter PVC casing that will be flush-threaded and will have a threaded bottom cap installed. Well screens will be constructed of 2-inch inside diameter factory-cut slotted pipe that will contain appropriate slot size based upon site-specific conditions at each AFFF area. Filter pack mesh size will also be determined on an area-specific basis to prevent the intrusion of fines. Filter pack sand will be consist of commercially available, clean silica sand with uniform sorting, or similar size compatible with the well slot size, that will be installed in the annulus around the well screen to a minimum of 2 ft above the top of the screen. The auger/rotary drilling rods may be used as a tremie for filter pack placement. An annular seal will be placed above the filter pack to prevent grout intrusion, and will consist of a minimum of 2 ft of very fine, clean silica sand or granular bentonite that is hydrated. Above the grout barrier, the well annulus will be filled with granular bentonite that is hydrated during placement using the drilling rods as a tremie, or flowable grout (e.g., neat cement grout) that is placed from the bottom upward using a side-discharge, small-diameter tremie pipe. The remaining annular space will be filled with a bentonite/grout mixture also placed by tremie pipe. The bentonite/grout mixture will set for a minimum of 24 hours prior to surface completion of the well. The top of each well casing will be fitted with a water-tight locking cap. Each monitoring well will be completed with a 2-ft by 2-ft concrete pad that is a minimum of 4 inch thick and a flush mount water-tight well cover. At specific AFFF areas, the wells may be completed above grade within an above-grade steel monument. In those cases, three bollards will be installed in concrete around the boring. Actual construction details (e.g., screen lengths, screen slot size, total well depth, and filter pack sizing) will be specified in ISWPs and adjusted as necessary in the field based on area-specific conditions. Boring logs and monitoring well completion diagrams will be generated for each well on forms provided in **Appendix E**.

A minimum of 24 hours following monitoring well installation and surface completion activities, each monitoring well will be developed to remove sediment from the well in accordance with SOP AFW-05, *Monitoring Well Development* (**Appendix D**). Existing monitoring wells that are proposed to be sampled will also be redeveloped as necessary based on the presence of dedicated sampling equipment. Wells will be developed until water quality parameters (temperature, specific conductance, pH, dissolved oxygen, and oxidation-reduction potential [ORP]) have stabilized and turbidity has stabilized or is below 10 nephelometric turbidity units (NTUs). Development water will be containerized in Department of Transportation (DOT)-approved 55-gallon drums pending characterization and offsite transportation and disposal. Following completion of well development, the wells will be allowed to stabilize prior to purging and sampling.

Prior to initiating groundwater sampling activities, static water levels will be measured in existing and newly installed monitoring wells at each AFFF area to evaluate the direction of groundwater flow. Water level measurements will be measured from the top of well casing to an accuracy of 0.01 ft using an electronic water level indicator. Wells in which water levels are measured will be identified in ISWPs.

Groundwater samples will be collected from existing and newly installed monitoring wells to determine the presence or absence of PFCs within groundwater at the AFFF areas. Wells will be purged and sampled using low flow purge sampling techniques in accordance with SOP AFW-03, *Groundwater Sampling* (**Appendix D**). During the purging process, water quality parameters (pH, specific conductance, temperature, ORP, and turbidity) will be measured using water quality meter(s). Well purging will be considered complete when water quality parameters are stabilized, as specified in SOP AMEC-03. After water quality parameters have stabilized, the appropriate sample containers will be directly filled. For slowly recharging wells, parameters may not stabilize before the well casing is emptied. In this case, groundwater sampling will be conducted in accordance with Section 4.2.2.11 of SOP AFW-03, *Groundwater Sampling* (**Appendix D**). Groundwater samples will be analyzed for the suite of PFC analytes required based on the federal and state regulatory requirements for each BRAC installation. Purge records, water quality parameters, and sampling details will be recorded on groundwater sample forms (**Appendix E**). Proposed groundwater sample locations and specific sampling equipment to be used will be presented in the ISWPs.

Well Survey and Private Well Sampling

A well survey will be conducted to identify potentially affected properties located near the BRAC installation boundary. The survey will be conducted in two phases. The first phase will consist of a desktop review of available records (e.g., GIS databases, municipality records, parcel records, etc.) of properties within a 1-mile radius. The second phase will consist of identifying target properties for further additional outreach. Additional information will be obtained by mailing a survey form to the property owners and/or phone and door-to-door surveys, as necessary. Coordination with private and public property owners (e.g., letters, telephone, results, etc.) will be conducted prior to and following well survey and sampling activities.

Once it is determined that the need to evaluate private water wells is necessary, Private Well Sampling Letter Work Plans will be developed. The letter work plans will include the sampling approach, locations, number of samples, analyte list, and procedures/methodology to be used during sampling activities. The letter work plans will provide a means to expedite the development and review process to ensure a relatively quick turnaround from identification to sample collection and analysis. Samples collected from private wells will be conducted in accordance with SOP AFW-13, *Groundwater Sampling from Private and Public Supply Wells* (**Appendix D**). Up to three samples will be collected from each well location: one from the raw feed from the well, one from a kitchen faucet, and one blank (i.e., PFC free water) that will be collected at the residence at the time of sampling. At locations where a tap is not present at the raw feed or where residences do not want sampling performed (e.g., inside the home), samples will be collected at locations that are accessible and approved by the residence. Samples will be placed in laboratory-supplied sample containers, stored on ice, and shipped to the analytical laboratory for PFC analysis. Field blank samples shipped to the laboratory will be placed on hold pending the results of samples collected from the raw feed or kitchen faucet. If analytical results indicate that PFC concentrations exceed USEPA HAs or state-specific criteria, then the field blank will be analyzed. Proposed private well sample locations and specific sampling equipment to be used will be presented in the Private Well Sampling Letter Work Plans. The procedures for coordinating with the USAF, private well owners, and applicable regulatory agencies are included in SOP AFW-17, *Response to PFC Testing of Private Water Supplies*, which is included in **Appendix D**.

<u>Public Well Sampling</u>

Samples will be collected from public supply wells in accordance with SOP AFW-13, *Groundwater Sampling from Private and Public Supply Wells* (**Appendix D**). A grab sample will be collected at the source well or at a location where a representative water sample for the distribution system can be collected.

<u>Fish Tissue Sampling</u>

The objective of fish tissue analysis is to evaluate the presence and concentrations of PFCs in fish as part of an evaluation of potential human exposure to PFCs from consumption of fish derived from water bodies potentially impacted by historic USAF activities. Fish tissue samples will be collected in accordance with SOP AFW-15, *Fish Sampling* (**Appendix D**). Fish tissue samples (two samples at each installation) will be collected for PFC analysis from background locations (upstream of installation) and at appropriate locations within surface water bodies downstream of AFFF areas. Fish will be collected using methods determined to be effective, including rod and reel (hook and line) and back-pack electro-fishing. If necessary, boat electro-shocking, gill nets, or seine nets may be used to collect fish samples. A fish sample collection record form will be filled out for each of the fish samples collected, and samples will be analyzed for the installation-specific PFC suite of analytes. Each field sample will comprise 3 to 5 fish. Field samples from each sampling location will be identified with a field sample identification that identifies the location and type of sample. Samples submitted to the laboratory will comprise the edible portions of the fish (e.g., fillets). To prepare fish fillets, the head, innards, tail, and fins will be removed. The remaining body (skin, backbone and flesh) will comprise the fillet.

If possible, entire fish fillets from each individual fish will be combined to prepare a single composite laboratory sample. If necessary due to sample volume, the laboratory can select approximately equal portions of fillet tissue from each individual fish and combine the tissue into a single composite that is processed (ground and mixed). After the fillets are thoroughly homogenized, an aliquot of tissue will be obtained for sample extraction and analysis.

The processed samples will not be allowed to come into contact with plastics or other materials that may contain PFCs. Samples will be cut and handled using stainless steel, titanium, or anodized aluminum blades and forceps; borosilicate glass forceps may also be used. A rough-surfaced glass or stainless steel cutting board will be used to process fish samples. Cutting implements and cutting blades will be decontaminated between filleting/cutting and homogenizing each fish sample. A summary of proposed fish tissue sampling (e.g., number, locations, equipment to be used, and methodology) will be provided in ISWPs.

<u>Stormwater Evaluation</u>

Evaluations of stormwater systems will be conducted to investigate potential pathways of PFCs into groundwater and surface water bodies. System evaluations will be conducted at installations where potential PFC releases occurred and likely entered into the stormwater systems. Stormwater system evaluation activities may include review of stormwater construction drawings, site reconnaissance, collection of sediment and surface water samples within the stormwater system, and collection of sediment and surface water samples at the discharge location(s). Sediment and surface water samples will be collected in accordance with SOP AFW-07, *Sediment Sampling*, and SOP AFW-08, *Surface Water Sampling*, respectively (**Appendix D**). A summary of proposed stormwater system activities will be provided in ISWPs.

Plume Monitoring

For groundwater impacted with PFCs that has private or public drinking water wells located downgradient, a monitoring program will be established to investigate the extent of the plume, seasonal influence, and evaluate potential receptor pathways. Sampling of monitoring, private drinking water, and public water supply wells may be included in the program. The specific details regarding sample collection for plume monitoring will be included in Installation-Specific Work Plan Addendums.

Private Well Mitigation System

Drinking water mitigation systems (whole-home treatment systems) may be installed at residential properties to remove PFCs from the domestic water supply. The systems will likely include the following:

- A three valve treatment loop tying into the existing domestic water supply line;
- A cartridge style particulate pre-filter;
- Two 3-cubic ft granular activated carbon (GAC) vessels in series;
- A third 3-cubic ft filter installed in series and dedicated for the kitchen water line only;
- Labeled sample taps before and after each filter stage; and,
- A flow totalizer to measure the total water used in gallons throughout the system.

At least two annual follow-on sampling events of the drinking water systems will be performed to assess the mitigation system's performance. Approximately two samples will be collected during each event. Samples will be collected in accordance with SOP AFW-13, *Groundwater Sampling from Private and Public Supply Wells* (**Appendix D**). Coordination with private landowners as well as government agencies when mitigation measures are deemed necessary will be conducted in accordance with SOP AFW-17, *Response to PFC Testing of Private Water Supplies* (**Appendix D**).

Public Well Mitigation System

When drinking water sample results from public water supply wells exceed USEPA HAs and/or state-specific regulations, Amec Foster Wheeler will notify the USAF to determine the proper response activities. Specific response activities will be determined on a case-by-case basis and in coordination with well owners and the appropriate government agencies.

Quality Control (QC) Samples

One duplicate sample will be collected at a rate of 10 percent (one for each 10 samples) for each media sampled. In addition, duplicate sample volume will be collected at a rate of 5 percent (one for each 20 samples) for matrix spike/matrix spike duplicate analysis. In addition, due to the ubiquitous presence of

PFCs in many everyday items, equipment rinsate blanks will play an important role during sampling. One rinsate sample will be collected for each day that samples are collected. Additionally, one field blank per lot of laboratory-provided "PFC-free" deionized water will be collected and analyzed for PFCs.

Surveying

Initial surveying conducted during scoping visits and utility clearance work will be performed by Amec Foster Wheeler personnel with handheld global positioning system (GPS) units. After well installation and sampling activities are completed, newly installed monitoring wells and existing wells (if needed) that are part of the PFC sampling program will be surveyed by licensed land surveyors. Wells will be surveyed to enable accurate placement of well locations on a map and to provide data sufficient to calculate groundwater elevations. Horizontal coordinates will be surveyed to the nearest 0.1 ft and referenced to the relevant State Plane Coordinate System using the North American Datum (NAD) of 1983, as adjusted in 1991. Elevation measurements will be made both at ground surface and at a casing measurement point at each of the wells. Elevations will be surveyed to the nearest 0.01 ft and referenced to the North American Vertical Datum (NAVD) of 1988. The survey reference point on the monitoring well casing will be marked for future reference by the surveyor.

Investigation-Derived Waste Management

Investigation-derived waste (IDW) will consist of soil cuttings from monitoring well installation, soil boring advancement, decontamination water, disposable PPE, and other trash. PPE and other trash will be placed in plastic bags and placed into sanitary trash containers and disposed of at a sanitary landfill. Soil and water IDW will be containerized in DOT-approved 55-gallon drums pending characterization. The volume of IDW is expected to be one drum per 15 ft of auger boring, one drum per 250 ft of geoprobe boring, an average of one drum per monitoring well for well development, and one drum for every two sites for decontamination rinsate.

Based upon characterization results, IDW will be profiled and transported offsite and disposed at a facility permitted to receive the waste. IDW characterization analyses will be based upon specific state and disposal facility requirements and will be identified in ISWPs. Based on past sampling results as part of FTA PFC investigations, it is assumed that all IDW will be handled and disposed as non-hazardous waste. Profiles and manifests will be signed by an Air Force representative or by authorize Amec Foster Wheeler personnel. The USAF will issue "Authorization to Sign Waste Classification Letters" to authorize Amec Foster Wheeler personnel to sign profiles and manifests "on behalf of the USAF." Once the waste profiles and draft manifests are approved, Amec Foster Wheeler will return to the site to meet the disposal vendor for waste pickup and sign the non-hazardous manifest "as agent for the USAF."

Field Documentation

A field logbook will be maintained for documentation of pertinent field activities from each activity conducted during the SIs (e.g., utility clearance, sampling, and surveying). Field logs and other forms to be used to document pertinent information associated with the field activities are presented in

Appendix E. In addition, digital photographs will be taken to document significant observations during activities. Field documentation including field notes, photographs, and other forms (e.g., sampling forms, etc.) will be included in Installation-Specific Site Investigation and Release Determination Reports.

Health and Safety

Fieldwork conducted during the SI will be conducted in accordance with the general Health and Safety Plan (HSP) (**Appendix A**) and installation-specific HSPs that will be developed and included as attachments to the ISWPs.

Data Management

The purpose of data management is to ensure that all of the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The analytical results will be provided by the laboratory in the Environmental Resources Program Information Management System (ERPIMS) lab submittal electronic data deliverable (EDD) format. Laboratory EDDs will be loaded to the ERPToolsX software where it will be checked and supplemented with field-derived data. Final ERPIMS submittal will be complete after all data in ERPToolsX have been loaded, checked, and final review performed by Amec Foster Wheeler ERPIMS staff.

Data Validation

Data validation will be conducted in accordance with QAPP Worksheet #36: Data Validation Procedures. The results of data validation will be presented in a Data Validation Report that will be included as an appendix in the SI Report.

Reporting

Reporting of investigation findings/results will occur within one of three deliverable types, including (1) Initial Data Transmittals, (2) Site Investigation Reports, and (3) Well Survey and Sampling Activity Report.

Initial Data Transmittals will document the results of initial site investigation activities and will include data (presented in text, tables, and figures), results, and recommendations. The results will be discussed on a conference call to determine if follow-on investigation activities are necessary. If follow-on investigation is needed, an ISWPA will be developed.

A total of 10 Installation-Specific Site Investigation Reports (ISSIRs) will be developed to document the results of SI activities. Each report will provide defensible rationale for the determination of whether a PFC release has occurred in environmental media at each area. The ISSIRs will include revised area-specific CSMs to facilitate the identification of exposure pathways by which receptors may be exposed to PFCs.

Well survey activities and the results of private and public water supply sampling will be documented in a Well Survey and Sampling Activity Report. This report will include a summary of the sampling approach, the scope of activities conducted during the investigation, and analytical data that will be used to determine if mitigation activities are necessary. If mitigation measures are implemented based upon the results of private and public water supply sampling, these measures will be documented in an Interim Mitigation Action Completion Report.

QAPP Worksheet #15a: Action Limits and Laboratory-Specific Detection/Quantitation Limits

Vista

Final Revision 1, Date: 8/17/2016

Matrix: Aqueous

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC-MS-MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/L)	Project Quantitation Limit Goal (µg/L)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/L)	Limit of Detection (µg/L)	Detection Limit (µg/L)
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	NA	0.00800	0.00400	0.00200
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	NA	0.00800	0.00400	0.00206
N-Ethyl perfluorooctane sulfonamide	EtFOSA	4151-50-2	NA	NA	0.0400	0.0200	0.00511
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	0.00800	0.00400	0.00137
N-Ethyl perfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2	NA	NA	0.0400	0.0200	0.0944
N-Methyl perfluorooctane sulfonamide	MeFOSA	31056-32-8	NA	NA	0.0400	0.0100	0.00383
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	0.00800	0.00400	0.00165
N-Methyl perfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	0.0400	0.0200	0.00607
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	0.00800	0.00400	0.00179
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	0.00800	0.00200	0.000729
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	0.00800	0.00400	0.00123
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	0.00800	0.00200	0.000937
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	0.00800	0.00200	0.000591
Perfluorohexane sulfonic acid	PFHxS	355-46-4	NA	NA	0.00800	0.00200	0.000947
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	0.00800	0.00400	0.00218
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	0.00800	0.00200	0.000810
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	0.00800	0.00400	0.00177
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	0.00800	0.00400	0.00128
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	0.00800	0.00200	0.000755
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	0.00800	0.00100	0.000494
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	0.00800	0.00400	0.00105
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	0.00800	0.00400	0.00149
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	0.00800	0.00200	0.000792
Perfluorooctanoic acid	PFOA	335-67-1	0.07	0.0007	0.00800	0.00200	0.000651

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/L)	Project Quantitation Limit Goal (µg/L)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/L)	Limit of Detection (µg/L)	Detection Limit (µg/L)
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.07	0.007	0.00100	0.000750	0.000305
Perfluorooctanesulfonic acid *and* Perfluorooctanoic acid	PFOS *and* PFOA	1763-23-1 335-67-1	0.07	0.007	0.00800	0.00200	0.000651

Notes:

[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.

[2] USEPA Drinking Water Health Advisories (HAs) for PFOA (USEPA, May 2016b) and PFOS (USEPA, May 2016a). The HAs will be used as the action criteria unless state-specific regulations are applicable.

Detection Limit (DL) - The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.

Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate (Type II error) is 1 percent.

Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For Department of Defense (DoD) projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard.

LODs and Detection Limits (DLs) are subject to change based on the results of the most current DL and LOD studies.

Health Advisory (HA) – Concentration of a contaminant in drinking water at which adverse health effects are not anticipated to occur over specific exposure durations. Potential for human health and environmental risk will be evaluated.

Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project Data Quality Objective (DQO).

CAS - Chemical Abstract Service

µg/L - micrograms per liter

DL - Detection Limit

NA - not available

QAPP Worksheet #15b: Action Limits and Laboratory-Specific Detection/Quantitation Limits

Vista

Final Revision 1, Date: 8/17/2016

Matrix: Solid

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC/MS/MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	NA	2.00	0.500	0.229
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	NA	2.00	0.500	0.285
N-Ethyl perfluorooctane sulfonamide	EtFOSA	4151-50-2	NA	NA	10.0	5.00	01.34
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	2.00	0.250	0.0667
N-Ethyl perfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2	NA	NA	10.0	2.50	1.01
N-Methyl perfluorooctane sulfonamide	MeFOSA	31056-32-8	NA	NA	10.0	2.50	0.943
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	2.00	0.250	0.0814
N-Methyl perfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	10.0	5.00	1.95
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	2.00	0.500	0.237
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	2.00	0.500	0.140
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	2.00	0.500	0.201
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	2.00	0.500	0.170
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	2.00	0.250	0.107
Perfluorohexane sulfonic acid	PFHxS	355-46-4	NA	NA	2.00	0.500	0.242
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	2.00	0.500	0.191
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	2.00	0.250	0.0992
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	2.00	0.500	0.227
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	2.00	0.500	0.202
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	2.00	0.250	0.0883
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	2.00	0.250	0.0990
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	2.00	0.250	0.0736
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	2.00	0.500	0.136
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	2.00	0.250	0.115

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
Perfluorooctanoic acid	PFOA	335-67-1	12,000	1,200	2.00	0.125	0.0605
Perfluorooctanesulfonic acid	PFOS	1763-23-1	5,000	500	0.750	0.500	0.151

Notes:

[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.

[2] Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and Base Realignment and Closure (BRAC) Installations (USAF, 2012).

Detection Limit – The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.

Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate (Type II error) is 1 percent.

Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For Department of Defense (DoD) projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard.

LODs and Detection Limits (DLs) are subject to change based on the results of the most current DL and LOD studies.

Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project Data Quality Objective (DQO).

CAS - Chemical Abstract Service

µg/kg - micrograms per kilogram

DL - Detection Limit

NA - not available

QAPP Worksheet #15c: Action Limits and Laboratory-Specific -Detection/Quantitation Limits

Vista

Final Revision 1, Date: 8/17/2016

Matrix: Fish Tissue

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC/MS/MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal[1] (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	NA	2.00	0.500	0.152
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	NA	2.00	0.250	0.0981
N-Ethyl perfluorooctane sulfonamide	EtFOSA	4151-50-2	NA	NA	10.0	5.00	1.84
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	2.00	0.250	0.0777
N-Ethyl perfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2	NA	NA	10.0	5.00	1.71
N-Methyl perfluorooctane sulfonamide	MeFOSA	31056-32-8	NA	NA	10.0	2.5	0.885
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	2.00	0.500	0.134
N-Methyl perfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	10.0	5.00	1.83
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	2.00	0.500	0.330
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	2.00	0.500	0.058
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	2.00	0.500	0.254
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	2.00	0.500	0.138
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	2.00	0.250	0.0860
Perfluorohexane sulfonic acid	PFHxS	355-46-4	NA	NA	2.00	0.500	0.215
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	2.00	0.500	0.180
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	2.00	0.125	0.0555
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	2.00	0.500	0.168
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	2.00	0.500	0.196
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	2.00	0.250	0.0782
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	2.00	0.500	0.130
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	2.00	0.250	0.0813
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	2.00	0.500	0.129
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	2.00	0.250	0.0727

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal[1] (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
Perfluorooctanoic acid	PFOA	335-67-1	3.2	0.32	2.00	0.250	0.0909
Perfluorooctanesulfonic acid	PFOS	1763-23-1	42	4.2	0.750	0.250	0.112

Notes:

[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.

[2] Based on screening levels for subsistence fishers. Maine Center for Disease Control and Prevention.

Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project DQO.

Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the limit of quantitation shall be set at or above the concentration of the lowest initial calibration standard.

Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the limit of detection, the false negative rate (Type II error) is 1 percent.

Detection Limit (DL) - The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.

CAS - Chemical Abstract Service

µg/kg - micrograms per kilogram

DL - Detection Limit

NA - not available

QAPP Worksheet #15d: Action Limits and Laboratory-Specific Detection/Quantitation Limits

Maxxam (Subcontractor to EMAX)

Final Revision 1, Date: 8/17/2016

Matrix: Aqueous

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC/MS/MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/L)	Project Quantitation Limit Goal (µg/L)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/L)	Limit of Detection (µg/L)	Detection Limit (µg/L)
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	0.02	0.014	0.0066
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	0.02	0.010	0.0036
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	0.02	0.010	0.0046
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	0.02	0.010	0.0047
Perfluorooctanoic acid	PFOA	335-67-1	0.07	0.007	0.02	0.014	0.0053
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	0.02	0.010	0.0046
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	0.02	0.014	0.0066
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	0.02	0.010	0.0037
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	0.02	0.014	0.0057
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	0.02	0.010	0.0034
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	0.02	0.014	0.0052
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	0.02	0.007	0.0019
Perfluorohexanesulfonic acid	PFHxS	355-46-4	NA	NA	0.02	0.010	0.0040
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	0.02	0.010	0.0036
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.07	0.007	0.02	0.010	0.0033
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	0.02	0.010	0.0043
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	0.02	0.014	0.0058
N-methylperfluorooctanesulfonamide	MeFOSA	31506-32-8	NA	NA	0.02	0.010	0.0040
N-ethylperfluorooctanesulfonamide	EtFOSA	4151-50-2	NA	NA	0.02	0.010	0.0053
N-methylperfluorooctanesulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	0.02	0.014	0.0055
N-ethylperfluorooctanesulfonamideoethanol	EtFOSE	1691-99-2	NA	NA	0.02	0.010	0.0049
N-methylperfluorooctane sulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	0.02	0.010	0.0043
N-ethylperfluorooctane sulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	0.02	0.010	0.0040
6:2 Fluorotelomersulfonate	6:2-FTS	27619-97-2	NA	NA	0.02	0.014	0.0065

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/L)	Project Quantitation Limit Goal (µg/L)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/L)	Limit of Detection (µg/L)	Detection Limit (µg/L)
8:2 Fluorotelomersulfonate	8:2-FTS	39108-34-4	NA	NA	0.02	0.014	0.0055
Perfluorooctanesulfonic acid *and* Perfluorooctanoic acid	PFOS *and* PFOA	1763-23-1 335-67-1	0.07	0.007	0.02	0.014	0.0053

Notes:

[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.

[2] USEPA Drinking Water Health Advisories for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) (May, 2016). The HA will be used as the action criteria unless state-specific regulations are applicable.

Maxxam is unable to report DLs, LODs, and LOQs due to limits with its data system. Maxxam's LOQ is listed as a reportable detection limit (RDL) on the analytical report. Instead of reporting nondetected results to the LOD per QSM 5.0 reporting conventions, nondetected results are reported at the DL and for the purposes of data validation the LOD is considered to be the same number as the DL.

Detection Limit (DL) - The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.

Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the limit of detection, the false negative rate (Type II error) is 1 percent.

Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the limit of quantitation shall be set at or above the concentration of the lowest initial calibration standard.

LODs and DLs are subject to change based on the results of the most current DL and LOD studies.

Health Advisory (HA) – Concentration of contaminant in drinking water at which adverse health effects are not anticipated to occur over specific exposure durations. Potential for human health and environmental risk will be evaluated.

Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project Data Quality Objective (DQO).

CAS - Chemical Abstract Service

µg/L - micrograms per liter

NA - not available

QAPP Worksheet #15e: Action Limits and Laboratory-Specific Detection/Quantitation Limits

Maxxam (Subcontractor to EMAX)

Final Revision 1, Date: 8/17/2016

Matrix: Soil

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC/MS/MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	1.0	0.4	0.11
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	1.0	0.4	0.13
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	1.0	0.4	0.11
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	1.0	0.4	0.14
Perfluoro-n-octanoic acid	PFOA	335-67-1	12,000	1,200	1.0	0.2	0.060
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	1.0	0.2	0.084
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	1.0	0.4	0.14
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	1.0	0.4	0.13
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	1.0	0.4	0.13
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	1.0	0.4	0.20
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	1.0	0.4	0.18
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	1.0	0.4	0.17
Perfluorohexanesulfonic acid	PFHxS	355-46-4	NA	NA	1.0	0.4	0.13
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	1.0	0.4	0.20
Perfluorooctanesulfonic acid	PFOS	1763-23-1	5,000	500	1.0	0.4	0.12
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	1.0	0.4	0.17
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	1.0	0.4	0.12
N-methylperfluorooctanesulfonamide	MeFOSA	31506-32-8	NA	NA	1.0	0.9	0.29
N-ethylperfluorooctanesulfonamide	EtFOSA	4151-50-2	NA	NA	1.0	0.9	0.58
N-methylperfluorooctanesulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	1.0	0.4	0.16
N-ethylperfluorooctanesulfonamideoethanol	EtFOSE	1691-99-2	NA	NA	1.0	0.9	0.34
N-methylperfluorooctane sulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	1.0	0.4	0.12
N-ethylperfluorooctane sulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	1.0	0.4	0.12

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
6:2 Fluorotelomersulfonate	6:2-FTS	27619-97-2	NA	NA	1.0	0.4	0.16
8:2 Fluorotelomersulfonate	8:2-FTS	39108-34-4	NA	NA	1.0	0.4	0.18

Notes:
[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.
[2] Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and Base Realignment and Closure (BRAC) Installations (USAF, 2012).
Maxxam is unable to report DLs, LODs, and LOQs due to limits with its data system. Maxxam's LOQ is listed as a reportable detection limit (RDL) on the analytical report. Instead of reporting nondetected results to the LOD per QSM 5.0 reporting conventions, nondetected results are reported at the DL and for the purposes of data validation the LOD is considered to be the same number as the DL.
Detection Limit (DL) - The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.
Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the limit of detection, the false negative rate (Type II error) is 1 percent.
Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the limit of quantitation shall be set at or above the concentration of the lowest initial calibration standard.
LODs and DLs are subject to change based on the results of the most current DL and LOD studies.
Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project Data Quality Objective (DQO).
CAS - Chemical Abstract Service
µg/L - micrograms per liter
TBD - to be determined
NA - not available

QAPP Worksheet #15f: Action Limits and Laboratory-Specific Detection/Quantitation Limits

Maxxam (Subcontractor to EMAX)

Final Revision 1, Date: 8/17/2016

Matrix: Fish Tissue

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC/MS/MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	1.0	0.9	0.38
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	1.0	0.6	0.22
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	1.0	0.1	0.10
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	1.0	0.6	0.21
Perfluorooctanoic acid	PFOA	335-67-1	3.2	0.32	1.0	0.6	0.16
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	1.0	0.6	0.16
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	1.0	0.4	0.14
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	1.0	0.4	0.14
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	1.0	0.6	0.15
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	1.0	0.4	0.10
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	1.0	0.6	0.15
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	1.0	0.6	0.27
Perfluorohexanesulfonic acid	PFHxS	355-46-4	NA	NA	1.0	0.6	0.18
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	1.0	0.6	0.19
Perfluorooctanesulfonic acid	PFOS	1763-23-1	42	4.2	1.0	0.4	0.11
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	1.0	0.6	0.18
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	1.0	0.6	0.20
N-methylperfluorooctanesulfoamide	MeFOSA	31506-32-8	NA	NA	1.0	0.9	0.45
N-ethylperfluorooctanesulfonamide	EtFOSA	4151-50-2	NA	NA	1.0	0.9	0.38
N-methylperfluorooctanesulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	1.0	0.9	0.29
N-ethylperfluorooctanesulfonamidoethanol	EtFOSE	1691-99-2	NA	NA	1.0	0.9	0.38
6:2 Fluorotelomersulfonate	6:2-FTS	27619-97-2	NA	NA	1.0	0.6	0.18
8:2 Fluorotelomersulfonate	8:2-FTS	39108-34-4	NA	NA	1.0	0.6	0.22
N-methylperfluorooctane sulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	TBD	TBD	TBD

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
N-ethylperfluorooctane sulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	TBD	TBD	TBD

Notes:

[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.

[2] Based on screening levels for subsistence fishers. Maine Center for Disease Control and Prevention.

Detection Limit (DL) - The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.

Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the limit of detection, the false negative rate (Type II error) is 1 percent.

Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the limit of quantitation shall be set at or above the concentration of the lowest initial calibration standard.

Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project Data Quality Objective (DQO).

CAS - Chemical Abstract Service

µg/L - milligrams per liter

TBD - to be determined

NA - not available

QAPP Worksheet #15g: Action Limits and Laboratory-Specific Detection/Quantitation Limits

SGS Accutest (Subcontractor to CT)

Final Revision 1, Date: 8/17/2016

Matrix: Aqueous

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC/MS/MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/L)	Project Quantitation Limit Goal (µg/L)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/L)	Limit of Detection (µg/L)	Detection Limit (µg/L)
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	NA	0.040	0.032	0.016
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	NA	0.040	0.032	0.016
N-Ethyl perfluorooctane sulfonamide	EtFOSA	4151-50-2	NA	NA	0.500	0.400	0.200
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	0.040	0.032	0.016
N-Ethyl perfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2	NA	NA	0.500	0.400	0.200
N-Methyl perfluorooctane sulfonamide	MeFOSA	31056-32-8	NA	NA	0.200	0.160	0.080
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	0.040	0.032	0.016
N-Methyl perfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	0.500	0.400	0.200
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	0.020	0.0128	0.008
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	0.020	0.016	0.008
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	0.020	0.0128	0.008
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	0.020	0.0128	0.008
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	0.020	0.0128	0.008
Perfluorohexane sulfonic acid	PFHxS	355-46-4	NA	NA	0.020	0.0128	0.008
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	0.020	0.0128	0.008
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	0.020	0.0064	0.004
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	0.020	0.016	0.008
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	0.020	0.0128	0.008
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	0.020	0.0128	0.008
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	0.020	0.0128	0.008
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	0.020	0.0128	0.008
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	0.020	0.0128	0.008
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	0.020	0.0128	0.008
Perfluorooctanoic acid	PFOA	335-67-1	0.07	0.007	0.020	0.0064	0.004

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/L)	Project Quantitation Limit Goal (µg/L)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/L)	Limit of Detection (µg/L)	Detection Limit (µg/L)
Perfluorooctanesulfonic acid	PFOS	1763-23-1	0.07	0.007	0.020	0.0064	0.004
Perfluorooctanesulfonic acid *and* Perfluorooctanoic acid	PFOS *and* PFOA	1763-23-1 335-67-1	0.07	0.007	0.020	0.0064	0.004

Notes:

[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.

[2] USEPA Drinking Water Health Advisories for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) (May, 2016). The HA will be used as the action criteria unless state-specific regulations are applicable.

Detection Limit (DL) - The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.

Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the limit of detection, the false negative rate (Type II error) is 1 percent.

Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the limit of quantitation shall be set at or above the concentration of the lowest initial calibration standard.

LODs and Detection Limits (DLs) are subject to change based on the results of the most current DL and LOD studies.

Health Advisory (HA) – Concentration of a contaminant in drinking water at which adverse health effects are not anticipated to occur over specific exposure durations. Potential for human health and environmental risk will be evaluated.

Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project Data Quality Objective (DQO).

CAS - Chemical Abstract Service

µg/L - micrograms per liter

TBD - to be determined

NA - not available

QAPP Worksheet #15h: Action Limits and Laboratory-Specific Detection/Quantitation Limits

SGS Accutest (Subcontractor to CT)

Final Revision 1, Date: 8/17/2016

Matrix: Soil

Analytical Method: USEPA Method 537.1 Modified (PFCs by LC/MS/MS)

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	NA	NA	25	20	10
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	NA	NA	25	20	10
N-Ethyl perfluorooctane sulfonamide	EtFOSA	4151-50-2	NA	NA	62.5	50	25
N-Ethyl perfluorooctanesulfonamidoacetic acid	EtFOSAA	2991-50-6	NA	NA	25	20	10
N-Ethyl perfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2	NA	NA	62.5	50	25
N-Methyl perfluorooctane sulfonamide	MeFOSA	31056-32-8	NA	NA	25	20	10
N-Methyl perfluorooctanesulfonamidoacetic acid	MeFOSAA	2355-31-9	NA	NA	25	20	10
N-Methyl perfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7	NA	NA	62.5	50	25
Perfluorobutanesulfonic acid	PFBS	375-73-5	NA	NA	12.5	10	5.0
Perfluorobutanoic acid	PFBA	375-22-4	NA	NA	12.5	10	5.0
Perfluorodecanesulfonic acid	PFDS	335-77-3	NA	NA	12.5	10	5.0
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	NA	NA	12.5	10	5.0
Perfluoroheptanoic acid	PFHpA	375-85-9	NA	NA	12.5	10	5.0
Perfluorohexane sulfonic acid	PFHxS	355-46-4	NA	NA	12.5	10	5.0
Perfluorohexanoic acid	PFHxA	307-24-4	NA	NA	12.5	10	5.0
Perfluorononanoic acid	PFNA	375-95-1	NA	NA	12.5	10	5.0
Perfluorooctane sulfonamide	PFOSA	754-91-6	NA	NA	12.5	10	5.0
Perfluoropentanoic acid	PFPeA	2706-90-3	NA	NA	12.5	10	5.0
Perfluorotetradecanoic acid	PFTeDA	376-06-7	NA	NA	12.5	10	5.0
Perfluorotridecanoic acid	PFTrDA	72629-94-8	NA	NA	12.5	10	5.0
Perfluoroundecanoic acid	PFUnA	2058-94-8	NA	NA	12.5	10	5.0
Perfluorodecanoic acid	PFDA	335-76-2	NA	NA	12.5	10	5.0
Perfluorododecanoic acid	PFDoA	307-55-1	NA	NA	12.5	10	5.0
Perfluorooctanoic acid	PFOA	335-67-1	12,000	1,200	12.5	10	5.0

Analyte[1]	Acronym	CAS Number	Project Action Limit[2] (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Achievable Laboratory Limits		
					Limit of Quantitation (µg/kg)	Limit of Detection (µg/kg)	Detection Limit (µg/kg)
Perfluorooctanesulfonic acid	PFOS	1763-23-1	5,000	500	12.5	10	5.0

Notes:

[1] This analyte list represents the Perfluorinated Compounds (PFCs) that may be included within the Installation-Specific Work Plans.

[2] Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and Base Realignment and Closure (BRAC) Installations (USAF, 2012).

Detection Limit (DL) - The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the detection limit, the false positive rate (Type I error) is 1 percent.

Limit of Detection (LOD) - The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the limit of detection, the false negative rate (Type II error) is 1 percent.

Limit of Quantitation (LOQ) - The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the limit of quantitation shall be set at or above the concentration of the lowest initial calibration standard.

LODs and Detection Limits (DLs) are subject to change based on the results of the most current DL and LOD studies.

Project Quantitation Limit Goal - The lowest concentration of a target analyte the laboratory must be able to achieve, as determined by the project Data Quality Objective (DQO).

CAS - Chemical Abstract Service

µg/kg - micrograms per kilograms

NA - not available

QAPP Worksheet #17: Sampling Design and Rationale

Final, Date: 3/21/2016

Soil, sediment, surface water, fish tissue, pore water, influent/effluent, groundwater, and drinking water samples will be collected, as applicable, at identified AFFF areas at each of the 10 BRAC installations to determine the presence or absence of PFCs in environmental media. The sampling approach, number of samples to be collected, and frequency of sampling will be determined during each installation-specific scoping session. The following chemicals will be analyzed in environmental samples collected under this TO:

Chemical Name	Chemical Abstract Service (CAS) Number
• 6:2 Fluorotelomer sulfonate (6:2 FTS)	27619-97-2
• 8:2 Fluorotelomer sulfonate (8:2 FTS	39108-34-4
• N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2
• N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)	2991-50-6
• N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2
• N-Methyl perfluorooctane sulfonamide (MeFOSA)	31056-32-8
• N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)	2355-31-9
• N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7
• Perfluorobutanesulfonic acid (PFBS)	375-73-5
• Perfluorobutanoic acid (PFBA)	375-22-4
• Perfluorodecanesulfonic acid (PFDS)	335-77-3
• Perfluoroheptanesulfonic acid (PFHpS)	375-92-8
• Perfluoroheptanoic acid (PFHpA)	375-85-9
• Perfluorohexanesulfonic acid (PFHxS)	355-46-4
• Perfluorohexanoic acid (PFHxA)	307-24-4
• Perfluorononanoic acid (PFNA)	375-95-1
• Perfluorooctane sulfonamide (PFOSA)	754-91-6
• Perfluoropentanoic acid (PFPeA)	2706-90-3
• Perfluorotetradecanoic acid (PFTeDA)	376-06-7
• Perfluorotridecanoic acid (PFTrDA)	72629-94-8
• Perfluoroundecanoic acid (PFUnA)	2058-94-8
• Perfluorodecanoic acid (PFDA)	335-76-2
• Perfluorododecanoic acid (PFDoA)	307-55-1
• Perfluorooctanoic acid (PFOA)	335-67-1
• Perfluorooctanesulfonic acid (PFOS)	1763-23-1

Information from the preliminary CSM (**Worksheet #10**) of the ISWP, which will include information from the scoping visit and any supplemental research, will be the basis for sample design at each AFFF area. Samples will be collected at locations where AFFF may have been released or transported from identified AFFF areas based on Amec Foster Wheeler’s understanding of past use of the AFFF area and local environmental conditions (e.g., presence and locations of floor drains, pavement, surface water features, etc.). Details of AFFF area-specific sampling design and rationale will be presented in the Installation-Specific Work Plans.

QAPP Worksheet #18: Sampling Locations and Methods

Final, Date: 3/21/2016

Sampling locations and methods will be presented in the ISWPs. As discussed on **Worksheet #14/16**, sample methodologies will strictly follow the protocols SOP AMEC-01 (**Appendix D**) to help mitigate the potential for false detections of PFCs. A list of prohibited and acceptable clothing/equipment for sampling at PFC sites is included in **Table 5** in **Worksheet #14/16**.

QAPP Worksheet #19a & 30a: Sample Containers, Preservation, and Hold Times

Primary Laboratory – SGS Accutest (Subcontractor to CT)

Final Revision 1, Date: 8/17/2016

Laboratory for PFC Analysis: SGS Accutest Laboratories Southeast, Inc., 4405 Vineland Rd, Ste C-15, Orlando, FL 32811, 407-425-6700

List any required accreditations/certifications: DoD ELAP; International Organization for Standardization (ISO) 17025; FDOH (TNI)

Back-up Laboratory for PFC Analysis: Vista Analytical Laboratory, Maxxam

Sample Delivery Method: EDDs (analytical data packages, electronic data)

Analyte/ Analyte Group	Matrix	Method/ SOP[1]	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package TAT
Perfluorinated Alkyl Acids	Soil	PFC by LC/MS/MS, SOP# MS014[2]; OP063	15 December 2018	125 ml polyethylene wide mouth bottle with unlined cap	<10°C during the first 48 hours after collection. <6°C from the time of receipt until extraction	14 days	28 days	28 days
Perfluorinated Alkyl Acids	Groundwater	PFC by LC/MS/MS, SOP# MS014; OP058[3]	15 December 2018	2- 125 ml polyethylene bottles with polyethylene screw top.	<10°C during the first 48 hours after collection. <6°C from the time of receipt until extraction	14 days	28 days	28 days

Analyte/ Analyte Group	Matrix	Method/ SOP[1]	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package TAT
Perfluorinated Alkyl Acids	Drinking Water	EPA 537/ SOP# MS017[2]	15 December 2018	2- 125 ml polyethylene bottles with polyethylene screw top.	Trizma if the sample is collected from a chlorinated water source. <10°C during the first 48 hours after collection. <6°C from the time of receipt until extraction	14 days	28 days	28 days
Total Sulfide	Solid	SM4500S=F-11Mod, GN140	15 December 2018	250 ml bottle	<4°C	Analysis completed within 7 days		10 business days
Toxicity characteristic leaching procedure (TCLP) Herbicides	Solid	SW-846 8151A, GC031	15 December 2018	300 ml glass jar with Teflon lined cap	Protected from light and <6°C	14 days for leaching, 7 days for extraction	40 days	10 business days
Herbicides	Groundwater	SW-846 8151A, OP037, OP037RV	15 December 2018	1 L amber glass bottle with Teflon lined cap. For RV, 250 ml amber glass bottle with Teflon lined cap	Protected from light and <6°C	7 days	40 days	10 business days

Notes:

[1] SOPs from SGS Accutest Laboratories Southeast, Inc. will be forwarded to the government upon request.

[2] SOPs# MS014 and MS017 are titled *Analysis of Perfluorinated Alkyl Acids by LC/MS/MS.*

[3] SOP# OP058 is titled *Extraction of Perfluorinated Alkyl Acids for analysis by LC/MS/MS*.

DoD - United States Department of Defense
ELAP - Environmental Laboratory Approval Program
TAT - turnaround time
LC/MS/MS - Liquid Chromatography and Tandem Mass Spectrometry
PFC - perfluorinated compound
SOP - standard operating procedure
ml - milliliter
°C - degrees Celsius

QAPP Worksheet #19b & 30b: Sample Containers, Preservation, and Hold Times

Primary Laboratory – Vista

Final Revision 1, Date: 8/17/2016

Laboratory for PFC Analysis: Vista Analytical Laboratory, 1104 Windfield Way, El Dorado Hills, CA 95762, Martha Maier, mmaier@vista-analytical.com, (916) 673-1520

List any required accreditations/certifications: DoD ELAP; ISO 17025; FDOH (TNI)

Back-up Laboratory for PFC Analysis: SGS Accutest (Subcontractor to CT), Maxxam

Sample Delivery Method: EDDs (analytical data packages, electronic data)

Analyte/ Analyte Group	Matrix	Method/ SOP[1]	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
PFCs	Solid (Soil, Sediment)	PFC by LC/MS/MS, SOP 49, rev5[2]	30 Sept. 2017	125 ml HDPE bottles and jars	≤10°C for up to 48 hours after sampling, then ≤6°	14 days	28 days	10 business days
PFCs	Aqueous (Groundwater, Surface Water, Pore Water, Drinking Water)	PFC by LC/MS/MS, SOP 49, rev5	30 Sept. 2017	2 x 125 ml HDPE bottles and jars	Trizma if the sample is collected from a chlorinated water source. ≤10°C for up to 48 hours after sampling, then ≤6°	14 days	28 days	10 business days
PFCs	Tissue	PFC by LC/MS/MS, SOP 49, rev5	Not applicable	Wrap fish in foil, shiny side away from body and place in zipper bag	Freeze to ≤0°C	60 days	30 days	10 business days

Notes:

[1] SOPs from Vista Analytical Laboratory will be forwarded to the government upon request.

[2] SOP 49 is titled *Preparation and Analysis of Perfluorinated Compounds*.

PFCs - perfluorinated compounds
SOP - standard operating procedure
mL – milliliters
LC/MS/MS - Liquid Chromatography and Tandem Mass Spectrometry
°C - degrees Celcius
PFC - perfluorinated compound
HDPE – high-density polyethylene

QAPP Worksheet #19c & 30c: Sample Containers, Preservation, and Hold Times

Waste Characterization Laboratory – CT Labs

Final Revision 1, Date: 8/17/2016

Laboratory for Waste Characterization Analysis: CT Laboratories, 1230 Lange Ct., Baraboo, WI, 53913, Brett Szymanski, BSzymanski@ctlaboratories.com, (608) 356-2760

List any required accreditations/certifications: DoD ELAP; ISO 17025; NELAP (LA DEQ)

Sample Delivery Method: EDDs (analytical data packages, electronic data)

Analyte/ Analyte Group	Matrix	Method/ SOP[1]	Accreditation Expiration Date	Container(s) (number, size & type per sample)[2,3]	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Mercury	Solid	7471A	4/30/2018	4-oz PL cup	$\leq$6°C	28 days	28 days	15 business days
Mercury	Aqueous	7470A	4/30/2018	250-ml PL	$\leq$6°C , HNO_3	28 days	28 days	15 business days
TAL Metals	Solid	6010C	4/30/2018	4-oz PL cup	$\leq$ 6°C	6 months	6 months	15 business days
TAL Metals	Aqueous	6010C	4/30/2018	250-ml PL	HNO_3	6 months	6 months	15 business days
VOCs	Solid	8260C	4/30/2018	2 x 40-ml VOCs vials or 4-oz GL no headspace	$\leq$6°C	n/a	14 days	15 business days
VOCs	Aqueous	8260C	4/30/2018	3 x 40-mL VOC vials	$\leq$6°C, HCl	n/a	14 days	15 business days
SVOCs	Solid	8270D	4/30/2018	4-oz Amber GL	$\leq$6°C	14 days	40 days	15 business days
SVOCs	Aqueous	8270D	4/30/2018	2 x 1-L Amber GL	$\leq$6°C	7 days	40 days	15 business days
PCBs	Solid	8082A	4/30/2018	4-oz Amber GL	$\leq$6°C	14 days	40 days	15 business days
PCBs	Aqueous	8082A	4/30/2018	2 x 1-L Amber GL	$\leq$6°C	7 days	40 days	15 business days
Pesticides	Solid	8081B	4/30/2018	4-oz Amber GL	$\leq$ 6°C	14 days	40 days	15 business days
Pesticides	Aqueous	8081B	4/30/2018	2 x 1-L Amber GL	$\leq$ 6°C	7 days	40 days	15 business days
DRO/ORO	Solid	8015C	4/30/2018	4-oz GL	$\leq$ 6°C	14 days	40 days	15 business days
DRO/ORO	Aqueous	8015C	4/30/2018	2 x 1-L Amber GL	$\leq$6°C	7 days	40 days	15 business days
GRO	Solid	8015C	4/30/2018	2 x 40-mL VOCs vials or 4-oz GL no headspace	$\leq$ 6°C, MeOH	n/a	14 days	15 business days
GRO	Aqueous	8015C	4/30/2018	2 x 40-mL VOCs vials	$\leq$ 6°C, HCl	n/a	14 days	15 business days

Analyte/ Analyte Group	Matrix	Method/ SOP[1]	Accreditation Expiration Date	Container(s) (number, size & type per sample)[2,3]	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Sulfide	Aqueous	9034/ ASTM 4978	4/30/2018	250-mL PL	$\leq$ 6°C, ZnAc + NaOH	n/a	7 days	15 business days
Cyanide	Solid	9012/ ASTM 5049	4/30/2018	4-oz GL	$\leq$6°C	n/a	14 days	15 business days
Cyanide	Aqueous	9012/ ASTM 5049	4/30/2018	500-mL PL	$\leq$6°C	n/a	14 days	15 business days
pH	Solid	9045D	4/30/2018	4-oz GL	$\leq$6°C	n/a	ASAP	15 business days
pH	Aqueous	9040C/ SM4500H	4/30/2018	500-mL PL	$\leq$6°C	n/a	ASAP	15 business days
Flash Point	Solid	1010/ SM2330	4/30/2018	4-oz PL cup	$\leq$6°C	n/a	10 days	15 business days
Flash Point	Aqueous	1010	4/30/2018	250-mL PL	$\leq$6°C	n/a	10 days	15 business days

Notes:

[1] SOPs from CT will be forwarded to the government upon request.

[2] Multiple analyses may be performed from the same container as long as preservation requirements are identical and there is sufficient sample volume or mass available.

[3] Size and number of sample containers may change at the discretion of the laboratory. However, Amec Foster Wheeler approval is needed to implement a change to the container size.

TAL - Target Analyte List
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
PCBs - polychlorinated biphenyls
DRO - diesel range organics
ORO - oil range organics
GRO - gasoline range organics
SOP - standard operating procedure
oz - ounce
PL - plastic
GL - glass

HNO_3 - nitric acid
HCL - hydrochloric acid
MeOH - methanol
ZnAc - zinc acetate
NAOH - sodium hydroxide
ASAP - as soon as possible
n/a - not applicable
°C - degrees Celsius
L - liter
ml - milliliter

QAPP Worksheet #19d & 30d: Sample Containers, Preservation, and Hold Times

Primary Laboratory – Maxxam (Subcontractor to EMAX)

Final Revision 1, Date: 8/17/2016

Laboratory for PFC Analysis: Maxxam Analytics International Corp, 6740 Campobello Road, Mississauga, ON L5N 2L8, Canada, 905-817-5712

List any required accreditations/certifications: DoD ELAP

Back-up Laboratory for PFC Analysis: Vista Analytical Laboratories, SGS Accutest Laboratories (Subcontractor toCT)

Sample Delivery Method: EDDs (analytical data packages, electronic data)

Analyte/ Analyte Group	Matrix	Method/ SOP[1]	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Perfluorinated Alkyl Acids	Solid (Soil, Sediment)	CAM SOP-00894 [2]	31 May 2017	(1) 250 ml polyethelne bottle unlined plastic cap[3]	≤10°C for up to 48 hours after sampling, then ≤6°	28 days	14 days	28 days
Perfluorinated Alkyl Acids	Aqueous (Groundwater, Surface Water, Pore Water, Drinking Water)	CAM SOP-00894 [2]	31 May 2017	(1) 250 ml HDPE bottle with HDPE lined cap [3]	≤10°C for up to 48 hours after sampling, then ≤6°	28 days	45 days	28 days
PFCs	Tissue	CAM SOP-00894 [2]	Not applicable	Wrap fish in foil, shiny side away from body and place in zipper bag	Freeze to ≤ 0°C	60 days	30 days	10 business days

Notes:

[1] SOPs from Maxxam Analytics International Corp will be forwarded to the government upon request.

[2] Compliance Assurance Monitoring (CAM) SOP-00894 is titled United States Environmental Protection Agency 537.1 (modified).

[3] Size and number of sample containers may change at the discretion of the laboratory. However, Amec Foster Wheeler approval is needed to implement a change to the container size.

°C - Celsius
CAM - Compliance Assurance Monitoring
HDPE - high density polyethylene
mL - milliliter
SOP - Standard Operating Procedure
PFCs - perfluorinated compounds

QAPP Worksheet #20: Field QC Summary

Final, Date: 3/21/2016

The following QC samples (and collection frequencies) will be collected during field activities:

- Field Duplicate (1:10 or 10%);
- Equipment Rinsates (1 sample per day for each piece of non-dedicated sampling equipment);
- Field Blank per lot of laboratory-provided “PFC-free” deionized water; and,
- MS/MSDs (1:20 or 5%).

The Field QC summary will be presented in each of the 10 ISWPs.

QAPP Worksheet #21: Field SOPs

Final, Date: 3/21/2016

SOP # or reference[1]	Title, Revision, Date, and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
AFW-01	Field Sampling Protocols to Avoid Cross-Contamination of PFCs	Amec Foster Wheeler	n/a	N	n/a
AFW-02	Soil Sampling	Amec Foster Wheeler	Core sampler, split-spoon sampler, Shelby Tube sampler	Y	Incorporates PFC protocols.
AFW-03	Groundwater Sampling	Amec Foster Wheeler	Bladder Pump, Peristaltic Pump, Electric Submersible Pump, Bailer	Y	Incorporates PFC protocols.
AFW-04	Monitoring Well Installation	Amec Foster Wheeler	Direct push technology (DPT), Hollow stem auger (HSA), rotary, dual-tube percussion	Y	Incorporates PFC protocols.
AFW-05	Monitoring Well Development	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-06	Borehole Abandonment	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-07	Sediment Sampling	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-08	Surface Water Sampling	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-09	Influent and Effluent Sampling	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-10	Drilling, Development, and Heavy Equipment Decontamination	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-11	Sample Handling and Custody	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-12	Protocol to Provide Water Free of Perfluorinated Compounds for Collection of Field Blanks and Equipment Blanks	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-13	Groundwater Sampling from Private and Public Supply Wells	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.
AFW-14	Slug Testing	Amec Foster Wheeler	n/a	Y	Incorporates PFC protocols.

SOP # or reference[1]	Title, Revision, Date, and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
AFW-15	Fish Sampling	Amec Foster Wheeler	Rod/reel, electrofishing, gill and seine net	N	Incorporates PFC protocols.
AFW-16	Pore Water Sampling	Amec Foster Wheeler	n/a	N	Incorporates PFC protocols.

Notes:
[1] Amec Foster Wheeler SOPs included as Appendix D.
Amec Foster Wheeler – Amec Foster Wheeler Environment & Infrastructure, Inc.
n/a - not applicable
Y - yes
N - no

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Final, Date: 3/21/2016

Field Equipment	Activity	SOP Reference	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
Water Quality Meter (DO, temperature, pH, ORP, and specific conductivity meter)	Calibration, Testing, and Inspection	Manufacturer's User Guide	Environmental Field Team Lead	Daily, before groundwater monitoring	Most units: Verification of calibration passes if result is within ±20% certified/ expected value	Troubleshoot problem(s), repeat calibration. If check fails again, obtain new unit and calibrate new unit for use. Document in field logbook.
Turbidity Meter	Calibration, Testing, and Inspection	Manufacturer's User Guide	Field Manager	Daily, before groundwater monitoring	Most units: Verification of calibration passes if result is within +20% certified/ expected value	Troubleshoot problem(s), repeat calibration. If check fails again, obtain new unit and calibrate new unit for use. Document in field logbook.

Notes:
DO - dissolved oxygen
ORP - oxidation reduction potential
Field quality audits will be conducted on a subset of the sites and will include inspection of the field equipment calibration records.
% - percent

QAPP Worksheet #23a: SGS Accutest (Subcontractor to CT) Analytical SOPs

Final Revision 1, Date: 8/17/2016

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	‡Modified for Project? Y/N
MS014	Analysis of Perfluorinated Alkyl Acids by LC/MS/MS	Definitive	Aqueous/Solid	Agilent 1200 LC/MS/MS	N
MS17	Analysis of Perfluorinated Alkyl Acids by LC/MS/MS	Definitive	Potable Water	Agilent 1200 LC/MS/MS	N
OP058	Extraction of Perfluorinated Alkyl Acids for analysis by LC/MS/MS	Definitive	Aqueous	Solid Phase Extractor	N
GN140	Total Sulfide	Definitive	Solid, Aqueous	Microburette	N
GC031	Analysis of Chlorinated Herbicides by GC/ECD	Definitive	Solid, Aqueous	Agilent GC/ECD	N
OP037	Extraction of Chlorinated Herbicides for Analysis by GC/ECD	Definitive	Aqueous	Agilent GC/ECD	N

Notes:
SOPs from SGS Accutest Laboratories Southeast, Inc. will be forwarded to the government upon request.
LC/MS/MS - Liquid Chromatography and Mass Spectrometry
GC/ECD - Gas Chromatography with Electron Capture Detector
SOP - standard operating procedure
Y - yes
N - no

QAPP Worksheet #23b: Vista Analytical SOPs

Final Revision 1, Date: 8/17/2016

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	‡Modified for Project? Y/N
49	Preparation and Analysis of Per and Poly- Fluorinated Compounds, 07/29/2015 – rev.5	Definitive	Aqueous/Solid/Tissue/PFCs	LC/MS/MS	Y (Sample preparation procedure for water with high particulates)

Notes:

SOPs from Vista Analytical Laboratory will be forwarded to the government upon request.

LC/MS/MS - Liquid Chromatography and Mass Spectrometry

PFCs - Perfluorinated Compounds

SOP - standard operating procedure

Y - yes

N - no

QAPP Worksheet #23c: CT Analytical SOPs

Final, Date: 3/21/2016

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	‡Modified for Project? Y/N
WC001 Rev 0	Reactive Cyanide Screen	Definitive	Solids & Water/Inorganics	Colorimetric	N
WC002 Rev 0	Reactive Cyanide Distillation	Definitive	Solids & Water/Inorganics	Distillation	N
WC003 Rev 8	Cyanide, Total & Amenable to Chlorination	Definitive	Solids & Water/Inorganics	Lachat	N
WC020 Rev 3	pH- Liquids	Definitive	Water/Inorganics	Probe	N
WC021 Rev 4	pH- Soils and Waste	Definitive	Solids/Inorganics	Probe	N
WC022 Rev 3	Free Liquids (Paint Filter)	Definitive	Solids & Water/Inorganics	Filter	N
WC028 Rev 5	Reactive Sulfide Screen	Definitive	Solids & Water/Inorganics	Colorimetric	N
WC029 Rev 0	Reactive Sulfide Distillation	Definitive	Solids & Water/Inorganics	Distillation	N
WC030 Rev 5	Sulfide	Definitive	Water/Inorganics	Titrimetric	N
WC034 Rev 2	Flash-Point by Pensky-Martens Closed Cup Tester	Definitive	Solids & Water/Inorganics	Flash Point Tester	N
WC044 Rev 0	Cyanide Automated Colorimetric In-Line Distillation	Definitive	Water/Inorganics	Lachat	N
PR002 Rev 2	TCLP / SPLP Extraction, Volatile Fraction (ZHE)	Definitive	TCLP	Extraction Vessel	N
MT003 Rev 5	Acid Digestion of Waters for Dissolved or Total Recoverable Metals by ICP & GFAA	Definitive	Water/Metals Prep	ICP/GFAA	N
MT004 Rev 8	Acid Digestion of Waters for Total Metals by ICP	Definitive	Water/Metals Prep	ICP	N
MT009 Rev 2	Inductively Coupled Plasma (ICP) Emission – ICP-OES	Definitive	Solids & Water/Metals	ICP	N
MT012 Rev 8	Mercury Cold Vapor Atomic Absorption (CV)	Definitive	Solids & Water/Metals	CetacM-6000A Mercury Analyzer	N
SV001 Rev 10	Diesel Range Organics by GC	Definitive	Solids & Water/Organics	GC	N
SV002 Rev 9	Organochlorine Pesticide by GC w/extended list	Definitive	Solids & Water/Organics	GC	N
SV004 Rev 11	Polychlorinated biphenyls (PCBs) as Aroclors by GC	Definitive	Solids & Water/Organics	GC	N
SV006 Rev 0	Semivolatile Organic Compounds by 8270D	Definitive	Solids & Water/Organics	GC-MS	N
VO005 Rev 4	BTEX and Gasoline Range Organics by GC	Definitive	Solids & Water/Organics	GC	N
VO004 Rev0	Volatile Organic Compounds by GC/MS 8260C	Definitive	Solids & Water/Organics	GC-MS	N

Notes: Standard Operating Procedures (SOPs) from CT will be forwarded to the government upon request.

GC - gas chromatograph
MS - mass spectrometer
TCLP - Toxicity Characteristic Leaching procedure
N - no
GFAA - graphite furnace atomic absorption
OES - optical emission spectrometry
SOP - Standard Operating Procedure
Y - yes
ICP - inductively-coupled plasma
SPLP - Synthetic Precipitation Leaching Procedure
BTEX - Benzene, Toluene, Ethylbenzene, and Xylenes

QAPP Worksheet #23d: Maxxam (Subcontractor to EMAX) SOPs

Final, Date: 3/21/2016

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	‡Modified for Project? Y/N
CAM SOP-00894	Determination of Perfluorinated Compounds in Water and Soil by LC/MS/MS, August 18, 2015	Definitive	Organics	AB Sciex 5500 Qtrap LC/MS/MS	N

Notes:
Standard Operating Procedures (SOPs) from Maxxam will be forwarded to the government upon request.
GC - gas chromatograph
GFAA - graphite furnace atomic absorption
ICP - inductively-coupled plasma
MS - mass spectrometer
OES - optical emission spectrometry
SPLP - Synthetic Precipitation Leaching Procedure
TCLP - Toxicity Characteristic Leaching procedure
SOP - Standard Operating Procedure
LC/MS/MS - Liquid Chromatography and Mass Spectrometry
N - no
Y - yes

QAPP Worksheet #24a: SGS Accutest (Subcontractor to CT) Analytical Instrument Calibration

Final Revision 1, Date: 8/17/2016

Instrument	Calibration Procedure	Calibration Range	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible For Corrective Action	SOP Reference
Agilent 1200 series LC/MS/MS (Electrospray detector)	PFOS/PFOA, 5 points minimum, 6 points preferred to maximize calibration range	1 – 25 ppb on-column	Major maintenance (per method) or second consecutive failure of opening CCV warrants recalibration	Correlation coefficient R>0.995. Individual calibration points drift <25%, low standard <30%. ICV and CCV %D <25%;	Instrument maintenance, standard inspection, recalibration	Laboratory Analyst	MS014, MS017
GC-ECD	Calibration verification (CCV)	Various	Every 10 samples and at the end of the run	All analytes within ± 20% of expected value	Remake standard, recalibrate if necessary.	Analyst, Supervisor	GC031, OP037
GC-ECD	Minimum five-point initial calibration for all analytes (ICAL)	Various	Initial calibration prior to sample analysis	Average RPD <20%	Repeat calibration if criterion is not met	Analyst, Supervisor	GC031, OP037
GC-ECD	Second source calibration verification	Various	Once after each initial calibration	All analytes within ± 20% of expected value	Remake standard, recalibrate if necessary.	Analyst, Supervisor	GC031, OP037
GC-ECD	Evaluation of retention time windows	NA	Prior to sample analysis	Established over 72 hours	CCV fails, perform column maintenance, and leak checks	Analyst, Supervisor	GC031, OP037
GC-ECD	LOD/LOQ verification	Various	Quarterly	LOD meets method qualitative requirements or is at least 3X higher than noise; LOQ is within LCS/LCSD criteria.	Perform instrument maintenance and repeat failed LOD or LOQ study passing two consecutive tests or perform new DL study.	Analyst, Supervisor	GC031, OP037

Notes: Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria.
SOPs from SGS Accutest Laboratories Southeast, Inc. will be forwarded to the government upon request.

LC/MS/MS - Liquid Chromatography and Mass Spectrometry
GC/ECD - Gas Chromatography with Electron Capture Detector
PFOS/PFOA – PFOA - Perfluorooctanesulfonic Acid/Perfluorooctanoic Acid
LOD/LOQ – Limit of Detection/Limit of Quantification
LCS/LCSD – laboratory control sample/laboratory control sample duplicate

SOP – standard operating procedure
DL – detection limit
%D – percent difference
% - percent

QAPP Worksheet #24b: Vista Analytical Instrument Calibration

Final, Date: 3/21/2016

Instrument	Calibration Procedure	Calibration Range	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
Quattro Premier XE	NaICs calibration	22 – 1,500 amu	Annually or after major repairs	Internal (instrument) software acceptance	Clean sample/gas cones and repeat	Technical Director	SOP 54, rev0
Quattro Premier XE	Compound tuning	Within 22 – 1,500 amu	Before analysis of ICAL	+/- 0.3 amu from theoretical	Recalibrate with NaICs	Analyst	SOP 54, rev0
Quattro Premier XE	Initial Calibration (ICAL)	NA	After prep. of standards	Linear, ≤20% RSD	Clean sample/gas cones and repeat	Analyst	SOP 49, rev2
Quattro Premier XE	Continuing Calibration Verification (CCV)	NA	Before and after analytical sequence and every 10 samples	70 to 130% for target analytes	Clean sample/gas cones and repeat	Analyst	SOP 49, rev2

Notes:

Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria.
SOPs from Vista Analytical Laboratory will be forwarded to the government upon request.
amu - atomic mass unit
NA - not applicable
SOP - Standard Operating Procedure
RSD - Relative Standard Deviation
% - percent
RSD - relative standard deviation

QAPP Worksheet #24c: CT Analytical Instrument Calibration

Final, Date: 3/21/2016

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
ICP / 6010C	Initial calibration (ICAL)	Daily prior to sample analysis. Minimum one high standard and a calibration blank.	Linear regression - correlation coefficient $\geq$0.995	Correct problem, repeat ICAL	Analyst / Supervisor	MT009
ICP / 6010C	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Percent recovery 90 to 110%	Correct problem. Rerun ICV. If rerun fails, repeat ICAL.	Analyst / Supervisor	MT009
ICP / 6010C	Continuing Calibration Verification (CCV)	After every 10 sample injections and at the end of the run	Within ±10% of true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst / Supervisor	MT009
ICP / 6010C	Low-level Calibration Check Standard (Low-level ICV)	Daily.	All reported analytes within ±20% of true value.	Correct problem and repeat ICAL.	Analyst / Supervisor	MT009
ICP / 6010C	Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at the end of the analysis sequence.	No analytes detected >LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Analyst / Supervisor	MT009

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
ICP / 6010C	Interference Check Solutions (ICS)	After ICAL and prior to sample analysis.	ICS-A: Absolute value of concentration for all non-spiked project analytes <LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	Analyst / Supervisor	MT009
CVAA / 7470A/7471 A	Initial calibration (ICAL)	Daily prior to sample analysis. Minimum 5 standards and a calibration blank.	Linear regression - correlation coefficient ≥0.995	Correct problem, repeat ICAL	Analyst / Supervisor	MT012
CVAA / 7470A/7471 A	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of the true value.	Correct problem. Rerun ICV. If rerun fails, repeat ICAL.	Analyst / Supervisor	MT012
CVAA / 7470A/7471 A	Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst / Supervisor	MT012

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
CVAA / 7470A/7471 A	Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample rune, after every 10 field samples, and at the end of the analysis sequence.	No analytes detected >LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Analyst / Supervisor	MT012
GC / 8015C(GRO/ DRO)/ 8082A/8081 B	Breakdown check (Endrin/DDT Method 8081 only)	Before sample analysis and at the beginning of each 12-hour shift.	Degradation of DDT and Endrin must each be ≤15%.	Correct problem, then repeat breakdown checks. No samples shall be run until degradation of DDT and Endrin is each ≤ 15%.	Analyst / Supervisor	SV002
GC / 8015C(GRO/ DRO)/ 8082A/8081 B	Initial Calibration (ICAL) for all analytes (including surrogates)	At instrument set-up and after ICV or CCV failure, prior to sample analysis. Minimum 5 levels for linear and 6 levels for quadratic. Quantitation for multi-component analytes such as chlordane, toxaphene, and Aroclors performed using a 5-point calibration. Results may not be quantitated using single point.	ICAL must meet one of the three options below: <u>Option 1</u>: RSD for each analyte ≤20%; <u>Option 2</u>: linear least squares regression for each analyte: r^2 ≥0.99; <u>Option 3</u>: non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$.	Correct problem then repeat ICAL. No samples shall be analyzed until ICAL has passed.	Analyst / Supervisor	SV001, SV002, SV004, VO005

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
GC / 8015C(GRO/ DRO)/ 8082A/8081 B	Retention Time window position establishment	Once per ICAL and at the beginning of the analytical sequence. Calculate for each analyte and surrogate.	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.	Analyst / Supervisor	SV001, SV002, SV004, VO005
GC / 8015C(GRO/ DRO)/ 8082A/8081 B	Retention Time (RT) window width	At method set-up and after major maintenance (e.g., column change). Calculate for each analyte and surrogate.	RT width is ±3 times standard deviation for each analyte RT from the 72-hour study.	N/A.	Analyst / Supervisor	SV001, SV002, SV004, VO005
GC / 8015C(GRO/ DRO)/ 8082A/8081 B	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within established RT windows. All reported analytes within ± 20% of true value.	Correct problem, rerun ICV. If that fails, repeat ICAL. No samples shall be analyzed until calibration has been verified with a second source.	Analyst / Supervisor	SV001, SV002, SV004, VO005
GC / 8015C(GRO/ DRO)/ 8082A/8081 B	Continuing Calibration Verification (CCV)	Before sample analysis, after every 10 field samples, and at the end of the analysis sequence with the exception of CCVs for Pesticides multi-component analytes (i.e. Toxaphene, Chlordane), which are only required before sample analysis.	All reported analytes and surrogates within established RT windows. All reported analytes and surrogates within ±20% of true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst / Supervisor	SV001, SV002, SV004, VO005

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
GC/MS / 8260C/8270 D	Tune Check	Prior to ICAL and prior to each 12-hour period of sample analysis.	Specific ion abundance criteria of BFB or DFTPP from method.	Retune instrument and verify. No samples shall be analyzed without a valid tune.	Analyst / Supervisor	SV006, SV007, VO004
GC/MS / 8260C/8270 D	Performance Check (Method 8270 only)	At the beginning of each 12-hour period, prior to analysis of samples.	Degradation ≤20% for DDT. Benzidine and pentachlorophenol shall be present at their normal responses, and shall not exceed a tailing factor of 2.	Correct problem, then repeat performance checks.	Analyst / Supervisor	SV006
GC/MS / 8260C/8270 D	Initial Calibration (ICAL) for all analytes (including surrogates)	At instrument set-up, prior to sample analysis. Minimum 5 levels for linear and 6 levels for quadratic.	Each analyte must meet 1 option below: Option1: RSD for each analyte ≤15%; Option 2: linear least squares regression for each analyte: $r^2 \geq 0.99$; Option 3: non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$. *If specific version of a method requires addition evaluation (e.g., RFs or low calibration standard analysis and recovery criteria) these additional requirements must also be met.	Correct problem then repeat ICAL. No samples shall be analyzed until ICAL has passed.	Analyst / Supervisor	SV006, SV007, VO004,

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
GC/MS / 8260C/8270 D	Retention Time window position establishment	Once per ICAL and at the beginning of the analytical sequence.	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.	Analyst / Supervisor	SV006, SV007, VO004,
GC/MS / 8260C/8270 D	Evaluation of Relative Retention Times (RRT)	With each sample. RRTs may be updated based on the daily CCV.	RRT of each reported analyte within ± 0.06 RRT units. RRTs shall be compared with the most recently updated RRTs.	Correct problem, then rerun ICAL.	Analyst / Supervisor	SV006, SV007, VO004,
GC/MS / 8260C/8270 D	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 20% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL. No samples shall be analyzed until calibration has been verified with a second source.	Analyst / Supervisor	SV006, SV007, VO004
GC/MS / 8260C/8270 D	Continuing Calibration Verification (CCV)	Daily before sample analysis; after every 12 hours of analysis time; and at the end of the analytical batch run.	All reported analytes and surrogates within ±20% of true value. All reported analytes and surrogates within ±50% for end of analytical batch CCV. *If the specific version of a method requires additional evaluation (e.g., average RFs) these additional requirements must also be met.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst / Supervisor	SV006, SV007, VO004,

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
GC/MS / 8260C/8270 D	Internal Standards (IS)	Every field sample, standard, and QC sample.	Retention time within ±10 seconds from retention time of the midpoint standard in the ICAL; IS area within – 50% to ±100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions and correct problem. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	Analyst / Supervisor	SV006, SV007, VO004,
Lachat (Cyanide) / 9012A/335.4	Initial Calibration (ICAL)	Daily ICAL prior to sample analysis.	>r2 > 0.99.	Correct problem, then repeat ICAL.	Analyst / Supervisor	WC044, WC003
Lachat (Cyanide) / 9012A/335.4	Distillation Verification	Once after each ICAL, with 2 distilled ICAL standards; prior to sample analysis. Not required if all ICAL standards are distilled.	Within ±10% of non-distilled standard value.	Correct problem, rerun distilled standards or repeat ICAL	Analyst / Supervisor	WC044, WC003
Lachat (Cyanide) / 9012A/335.4	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of second source standard prior to sample analysis.	Within ±10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Analyst / Supervisor	WC044, WC003
Lachat (Cyanide) / 9012A/335.4	Continuing Calibration Verification (CCV)	After every 10 field samples and at end of the analysis sequence.	Within ±10% of true value.	Recalibrate and reanalyze all affected samples since last acceptable CCV; or Immediately analyze 2 additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since last acceptable CCV.	Analyst / Supervisor	WC044, WC003

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
Lachat (Cyanide) / 9012A/335.4	Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run; After every 10 field samples; At end of the analysis sequence (after ICV and each CCV).	No cyanide detected >LOD.	Correct problem and reanalyze all samples analyzed since last acceptable calibration blank.	Analyst / Supervisor	WC044, WC003

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria.
Standard Operating Procedures (SOPs) from CT will be forwarded to the government upon request.
CCB - continuing calibration blank
CCV - continuing calibration verification
DRO - diesel-range organics
GC - gas chromatograph
GC/MS - gas chromatograph/mass spectrometer
GRO - gasoline-range organics
ICAL - initial calibration
ICP - inductively coupled plasma
ICS - interference check solution
ICV - initial calibration verification
RRT - relative retention time
RT - retention time
% - percent
LOD - Limit of Detection
SOP - standard operating procedure
CVAA - Cold Vapor Atomic Absorption
GC - gas chromatography
DDT - dichlorodiphenyltrichloroethane
RSD - relative standard deviation

QAPP Worksheet #24d: Maxxam (Subcontractor to EMAX) Analytical Instrument Calibration

Final, Date: 3/21/2016

Instrument	Calibration Procedure	Calibration Range	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
LC/MS/MS	5 points minimum	low	5 pt. daily	Unlabeled analytes ≤25% from target (lowest standard ≤30%) Analyte retention time is ≤2% from internal Signal to noise 5	Instrument Maintenance Instrument parameters adjusted (re-optimization) Standards reanalyzed	Instrument Operator	CAM SOP-00894

Notes:

Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria.
Standard Operating Procedures (SOPs) from Maxxam will be forwarded to the government upon request.
LC/MS/MS - Liquid Chromatography and Mass Spectrometry
SOP - Standard Operating Procedure
CAM - Compliance Assurance Monitoring
pt. - point
% - percent

QAPP Worksheet #25a: SGS Accutest (Subcontractor to CT) Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Final Revision 1, Date: 8/17/2016

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	SOP Reference
Agilent 1200 series LC/MS/MS	Spray chamber, Clean capillary	Perfluorinated Alkyl Acids and Sulfonates	Check Tune Leak checks Pressure check Mobile phase filters Needle inspection	Need for maintenance determined by passing calibration– see MS014	Passing calibration	Check LC column Run Autotune Check calculations Re-run affected samples	Laboratory Analyst	MS014; MS017
HP5890, HP6890, Dual ECD	Injector port, column maintenance	SW-846 8151A, 8081B	Leak test, column and injector port inspection	Need for maintenance determined by passing calibration– see GC031, GC015	Passing CCV	Column clipping, seals and liners replacement, recalibrate and reanalyze affected samples	Laboratory Analyst	GC031; OP037

Notes:
Standard Operating Procedures (SOPs) from SGS Accutest Laboratories Southeast, Inc. will be forwarded to the government upon request.
LC/MS/MS - Liquid Chromatography and Mass Spectrometry
CCV - Continuing Calibration Verification
ECD - Electron Capture Detector
SOP - standard operating procedure

QAPP Worksheet #25b: Vista Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Final, Date: 3/21/2016

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	SOP Reference
Quattro Premier XE	Source cleaning	Sample/gas cone cleaning	Visual	As needed	NA	NA	Analyst	SOP 54, rev0
Aquity UPLC	Needle replacement	Contamination Bent needle	Visual	As needed	Leak test in software	Repeat if leak test fails	Analyst	SOP 54, rev0
Quattro Premier XE	Source heater	Source not at 150 degrees	Low readback	As needed	Source maintains 150 degrees	Repeat with new heater if source does not heat	Analyst	SOP 54, rev0

Notes:
Standard Operating Procedures (SOPs) from Vista Analytical Laboratory will be forwarded to the government upon request.
NA - not applicable
SOP - standard operating procedure

QAPP Worksheet #25c: CT Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Final, Date: 3/21/2016

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	SOP Reference
GC/MS	Replace septa, clean injection port, clip column, clip or replace pre-column check auto sampler, clean source	SVOC	Detector, injection port, column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	SV006
GC/MS	Replace septa, clean injection port, clip column, check auto sampler, clean source	VOC	Detector, injection port, column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	VO004
GC	Replace septa, clean injection port, clip column, clip or replace pre-column, check auto sampler	Pesticides / PCBs DRO/TPH	Detector, injection port, column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	SV002, SV004, SV001
GC	Replace septa, clean injection port, clip column, clip or replace pre-column, check auto sampler	PVOC / GRO Dissolved Gases	Detector, injection port, column, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	VO005, VO001

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	SOP Reference
ICP-AES	Clean torch assembly, nebulizer, and spray chamber as needed. Check argon gas, vacuum, waste container, and reagent water levels daily. Replace pump tubing as needed.	Metals	Torch, nebulizer chamber, pump and pump tubing, vacuum source, waste container	Daily prior to calibration	Acceptable calibration	Correct problem and recalibrate	Analyst / Supervisor	MT009
CVAA	Check lamp voltage, check autosampler, and make necessary pump tube changes.	Metals	Autosampler, gases, pump tubing.	Daily prior to calibration	Acceptable calibration	Correct problem and recalibrate	Analyst / Supervisor	MT0012
Lachat	Replace pump tubing and o-rings. Clean out instrument lines.	Inorganics	Detector, flow rate, autosampler	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Lab Section Supervisor	WC013, WC014, WC015, WC016, WC017

Notes:

Standard Operating Procedures (SOPs) from CT Labs will be forwarded to the government upon request.

GC/MS - Gas Chromatograph/Mass Spectrometer
GC - Gas Chromatography
SVOC - Semi-Volatile Organic Compound
VOC - Volatile Organic Compound
DRO/TPH - Diesel Range Organics/Total Petroleum Hydrocarbons
PVOC/GRO - Petroleum Volatile Organic Compounds/Gasoline Range Organics
ICP-AES - Inductively Coupled Plasma Atomic Emission Spectroscopy
SOP - standard operating procedure
PCBs - polychlorinated biphenyls
CVAA - Cold Vapor Atomic Absorption

QAPP Worksheet #25d: Maxxam (Subcontractor to EMAX) Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Final Revision 1, Date: 8/17/2016

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	SOP Reference
LC/MS/MS	• Ion source • Injector Column • UHPLC Pump	USEPA 537.1 (modified)	• Leaks • LC column performance • MS Sensitivity/Selectivity	Daily	Passing ICAL	• Recalibrate • Re-inject affected samples • Reanalyze affected samples	Laboratory Analyst	CAM SOP-00894
	Planned Maintenance (PM)		• Tuning • Mass Calibration/Resolution • Replace Consumables	Mass Spectrometer (Bi-annually) UHPLC Pump (Annually)	Meets original manufacturers performance specifications	NA	Contracted third party service provider	

Notes:
Standard Operating Procedures (SOPs) from Maxxam will be forwarded to the government upon request.
CAM - Compliance Assurance Monitoring
ICAL - Initial Calibration
LC/MS/MS - Liquid Chromatography and Mass Spectrometry
LC - Liquid Chromatography
MS - Mass Spectrometry
UHPLC - Ultra High Performance Liquid Chromatography
USEPA - United States Environmental Protection Agency
NA - not applicable
SOP - standard operating procedure

QAPP Worksheet #26a & 27a: Sample Handling, Custody, and Disposal

Final Revision 1, Date: 8/17/2016

Sampling Organization: Amec Foster Wheeler

Laboratory: SGS Accutest (Subcontractor to CT)

Method of sample delivery (shipper/carrier): FedEx

Number of days from reporting until sample disposal: 60 days from receipt

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	Amec Foster Wheeler – Field Manager	AFW-11
Chain-of-custody form completion	Amec Foster Wheeler – Field Manager	AFW-11
Packaging	Amec Foster Wheeler – Field Manager	AFW-11
Shipping coordination	Amec Foster Wheeler – Field Manager	AFW-11
Shipping coordination	SGS Accutest Laboratories Southeast Project Manager and Amec Foster Wheeler Field Manager	SAM102
Sample receipt, inspection, & log-in	SGS Accutest Laboratories Southeast Sample Management	SAM101
Sample custody and storage	SGS Accutest Laboratories Southeast Sample Management	SAM101, QA048
Sample disposal	SGS Accutest Laboratories Southeast Sample Management	SAM101

Notes:
Amec Foster Wheeler - Amec Foster Wheeler Environment & Infrastructure, Inc.
SOP - standard operating procedure

QAPP Worksheet #26b & 27b: Sample Handling, Custody, and Disposal

Final, Date: 3/21/2016

Sampling Organization: Amec Foster Wheeler

Laboratory: Vista

Method of sample delivery (shipper/carrier): FedEx

Number of days from reporting until sample disposal: 60 days from receipt

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	Amec Foster Wheeler – Field Manager	AFW-11
Chain-of-custody form completion	Amec Foster Wheeler – Field Manager	AFW-11
Packaging	Amec Foster Wheeler – Field Manager	AFW-11
Shipping coordination	Amec Foster Wheeler – Field Manager	AFW-10
Shipping coordination	Vista Analytical Laboratory/Sample Custodian	SOP 12, rev 9
Sample receipt, inspection, & log-in	Vista Analytical Laboratory/Sample Custodian	SOP 12, rev 9
Sample custody and storage	Vista Analytical Laboratory/Sample Custodian	SOP 12, rev 9
Sample disposal	Vista Analytical Laboratory/Sample Custodian	SOP 12, rev 9

Notes:

Amec Foster Wheeler – Amec Foster Wheeler Environment & Infrastructure, Inc.

SOP - standard operating procedure

QAPP Worksheet #26c &27c: Sampling Handling, Custody, and Disposal

Final, Date: 3/21/2016

Sampling Organization: Amec Foster Wheeler

Laboratory: CT Labs

Method of sample delivery (shipper/carrier): FedEx

Number of days from reporting until sample disposal: 60 days from receipt

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	Amec Foster Wheeler – Field Manager	AFW-11
Chain-of-custody form completion	Amec Foster Wheeler – Field Manager	AFW-11
Packaging	Amec Foster Wheeler – Field Manager	AFW-11
Shipping coordination	Amec Foster Wheeler – Field Manager	AFw-11
Shipping coordination	CTL – PM, Login Supervisor	CTL – PM 006 Project Coordination
Sample receipt, inspection, & log-in	CTL – PM, Login Supervisor	CTL – PM 003 Sample Receiving and Processing
Sample custody and storage	CTL – PM, Login Supervisor	CTL – PM 003 Sample Receiving and Processing
Sample disposal	CTL – PM, Login Supervisor	CTL – WS 001 Laboratory Waste Disposal

Notes:
Amec Foster Wheeler – Amec Foster Wheeler Environment & Infrastructure, Inc.
SOP - Standard Operating Procedure
PM - Project Manager
CTL – CT Laboratories, LLC

QAPP Worksheet #26d & 27d: Sample Handling, Custody, and Disposal

Final, Date: 3/21/2016

Sampling Organization: Amec Foster Wheeler

Laboratory: Maxxam (Subcontractor to EMAX)

Method of sample delivery (shipper/carrier): FedEx

Number of days from reporting until sample disposal: 60 days from receipt

Activity	Organization and title or position of person responsible for the activity	SOP Reference
Sample labeling	Amec Foster Wheeler – Field Manager	AFW-11
Chain-of-custody form completion	Amec Foster Wheeler – Field Manager	AFW-11
Packaging	Amec Foster Wheeler – Field Manager	AFW-11
Shipping coordination	Amec Foster Wheeler – Field Manager	AFW-11
Shipping coordination	Maxxam Project Manager and Amec Foster Wheeler Field Manager	None
Sample receipt, inspection, & log-in	Maxxam Sample Management	CAM-WI-00405
Sample custody and storage	Maxxam Sample Management	CAM-WI-00405
Sample disposal	Maxxam Sample Management	CAM WI-CAM SOP-00105

Notes:

Amec Foster Wheeler – Amec Foster Wheeler Environment & Infrastructure, Inc.
Maxxam - Maxxam - Maxxam Analytics International
SOP - Standard Operating Procedures
CAM - Compliance Assurance Monitoring

QAPP Worksheet #28a: SGS Accutest (Subcontractor to CT) Analytical Quality Control and Corrective Action

Final Revision 1, Date: 8/17/2016

Matrix: Soil/Aqueous

Analytical Group: Organics

Analytical Method/SOP: PFC by LC/MS/MS

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	1 per prep. batch of up to 20 samples.	No analytes detected > ½ reporting limit (RL)	Reprep and reanalyze the method blank and all samples processed with the contaminated blank. If problem persists, call project manager (PM).	Bench Analyst	All analytes in the method blank must be less than ½ the RL or 1/5 of the HAs on WS#15, whichever is greater
Laboratory Control Sample (LCS) containing all analytes	One per preparatory batch of up to 20 samples.	70% to 130% for mid- to high-concentration spikes or 50% to 150% for low-level spikes	Correct problem, reprep and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call PM.	Bench Analyst	All analytes in samples with concentrations within 20% of the HAs on WS#15 must pass method/SOP criteria.
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	Use LCS control limits	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. When appropriate, re-prep if sufficient sample is available.	Bench Analyst	Use LCS control limits
Matrix Spike Duplicate (MSD)	One per preparatory batch of up to 20 samples.	Use LCS control limits; Relative Percent Difference (%RPD) <30	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. When appropriate, re-prep if sufficient sample is available.	Bench Analyst	Use LCS control limits; %RPD <30
Internal Standards (IS)	Every standard and sample	70% to 130% and area must be within 50% of the average areas measured during Initial Calibration (ICAL)	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Failed QC samples must be reanalyzed with all associated failed field samples.	Bench Analyst	70% to 130% and area must be within 50% of the average areas measured during ICAL

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Surrogate Spike	Every sample	70% to 130%	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Failed QC sample – correct analytical problem and reanalyze all failed samples.	Bench Analyst	70% to 130%

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
% - percent
RL - Reporting Limit
HAs - Health Advisory
SOP - standard operating procedure

QAPP Worksheet #28b: Vista Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: PFCs

Analytical Method/SOP: PFC by LC/MS/MS

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	1 per prep. batch of up to 20 samples.	No analytes detected > 1/3 the reporting limit (RL) or the regulatory limit, whichever is greater.	Reprep and reanalyze the method blank and all samples processed with the contaminated blank. If problem persists, call project manager (PM).	Analyst / Laboratory Quality Assurance Officer	All analytes in the method blank must be less than ½ the LOQ or 1/5 of the HA's on **Worksheet #15**, whichever is greater
Laboratory Control Sample (LCS) containing all analytes	One per preparatory batch of up to 20 samples.	Laboratory-specified limits	Correct problem, reprep and reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, call PM.	Analyst / Laboratory Quality Assurance Officer	All analytes in samples with concentrations within 20% of the HAs on **Worksheet #15** must pass method/SOP criteria.
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	Use LCS control limits	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. When appropriate, re-prep if sufficient sample is available.	Bench Analyst	Use LCS control limits
Matrix Spike Duplicate (MSD)	One per preparatory batch of up to 20 samples.	Use LCS control limits; Relative Percent Difference (%RPD) <30	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. When appropriate, re-prep if sufficient sample is available.	Bench Analyst	Use LCS control limits; %RPD <30
Internal Standards (IS)	Every standard and sample	Laboratory-specified limits	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Failed quality control (QC) samples must be reanalyzed with all associated failed field samples	Bench Analyst	Laboratory-specified limits

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Surrogate Spike	NA	NA	NA	NA	NA

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
LOQ - Limit of Quantification
HAs - Health Advisories
SOP - standard operating procedure
NA - not applicable

QAPP Worksheet #28c: Maxxam (Subcontractor to EMAX) Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: PFCs

Analytical Method/SOP: PFC by LC/MS/MS

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank (MB)	1 per prep. batch of up to 20 samples.	No analytes detected > 1/3 the reporting limit (RL) or the regulatory limit, whichever is greater.	The source of the contamination is investigated and eliminated before proceeding with further analysis. If required, re-prep and re-analyze MB and all samples processed with contaminated blank.	Analyst/Prep Analyst	All analytes in the method blank must be less than ½ the LOQ or 1/5 of the HA's on **Worksheet #15**, whichever is greater
Laboratory Control Sample (LCS) containing all analytes	One per preparatory batch of up to 20 samples.	%Recovery = (Calculated Value/True Value) *100% Native analyte recoveries 70-130%	Source of poor recovery is investigated and eliminated before proceeding with further analysis. If necessary, re-prep and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes.	Analyst/Prep Analyst	All analytes in samples with concentrations within 20% of the HAs on **Worksheet #15** must pass method/SOP criteria.
Matrix Spike (MS)	One per preparatory batch of up to 20 samples.	Use LCS control limits	If the recoveries indicate that the problem is procedure related, re-extraction and re-analysis is required. If the recoveries indicate that the failures are matrix-related, refer to Blank Spike as measure of method performance in clean matrix. The project Chemist will be contacted and a decision will be made to either report the data as is with a notation in the analytical narrative or if the samples should be re-extract and re-analyzed.	Analyst/Prep Analyst	Use LCS control limits
Matrix Spike Duplicate (MSD)	One per preparatory batch of up to 20 samples.	Use LCS control limits; Relative Percent Difference (%RPD) <30	Source of poor RPD is investigated and eliminated before proceeding with further analysis. Check for heterogeneity in samples.	Bench Analyst	Use LCS control limits; %RPD <30

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Internal Standards (IS)	Every standard and sample	Laboratory-specified limits	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Failed quality control (QC) samples must be reanalyzed with all associated failed field samples	Bench Analyst	Laboratory-specified limits
Surrogate Spike	Every standard and sample	Laboratory-specified limits	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Failed quality control (QC) samples must be reanalyzed with all associated failed field samples	Bench Analyst	Laboratory-specified limits

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
% - percent
LOQ - Limit of Quantification
HAs - Health Advisories
SOP - standard operating procedure

QAPP Worksheet #28d: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous/Toxicity Characteristic Leaching Procedure (TCLP)

Analytical Group: VOCs

Analytical Method/SOP: SW8260C / VO004, PR002 Rev. 2

QC Sample	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/ Group Leader	Bias/ Contamination	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.0 LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/ Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.0 LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).	Analyst/ Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.

QC Sample	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.0 LCS limits used for a MSD, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 20% (between MS and MSD or sample and MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/ Group Leader	Analytical Accuracy/Bias/ Precision	Same as QC Acceptance Limits.
Internal Standards (IS)	Every field samples, standard and QC sample.	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL; IS areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions and correct problem. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	Analyst/ Group Leader	Accuracy	Same as QC Acceptance Limits.
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.0 limits are used.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/ Group Leader	Accuracy/Bias	Same as QC Acceptance Limits.

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
LOQ - Limit of Quantification
DoD - United States Department of Defense
QSM - Quality Systems Manual
QC - quality control
RPD - relative percent difference
ICAL - initial calibration
IS - internal standard

QAPP Worksheet #28e: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous/TCLP

Analytical Group: SVOCs

Analytical Method/SOP: SW8270D / SV006, SV007, PR003

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Bias/ Contamination	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.0. In-house control limits may not be >±3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM Version 5.0 LCS limits are used for a MSD, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤20% (between MS and MSD or sample and MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Analytical Accuracy/Bias/ Precision	Same as QC Acceptance Limits.
Internal Standards (IS)	Every field samples, standard and QC sample.	Retention time within ±10 seconds from retention time of the midpoint standard in the ICAL; IS areas within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions and correct problem. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	Analyst/Group Leader	Accuracy	Same as QC Acceptance Limits.

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.0 limits are used.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/Group Leader	Accuracy/Bias	Same as QC Acceptance Limits.

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
LOQ - Limit of Quantification
DoD - United States Department of Defense
QSM - Quality Systems Manual
QC - quality control
RPD - relative percent difference
ICAL - initial calibration
IS - internal standard

QAPP Worksheet #28f: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous/TCLP

Analytical Group: Metals

Analytical Method/SOP: 6010C/7470A/7471B/ MT009 Rev. 2, MT012 Rev. 8, PR003

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Supervisor	Analytical Accuracy/Bias	Same as QC Acceptance Limits

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits are used, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Supervisor	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits are used for a MSD, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 20% (between MS & MSD or sample & MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Supervisor	Analytical Accuracy/Bias/ Precision	Same as QC Acceptance Limits.
Dilution Test (Serial Dilution)	One per preparatory batch of 20 or fewer samples of similar matrix if MS or MSD fails.	Five-fold dilution must agree within ± 10% of the original measurement. Only applicable for samples with concentrations > 50 x LOQ (prior to dilution).	No specific CA, unless required by the project.	Analyst/Supervisor	Analytical Accuracy/Bias	Same as QC Acceptance Limits.

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Post-Digestion Spike (PDS) Addition	Perform if MS/MSD fails. One per preparatory batch (using the same sample as used for the MS/MSD if possible) of 20 or fewer samples of similar matrix.	Recovery within 80-120%.	No specific CA, unless required by the project.	Analyst/Supervisor	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Method of Standard Additions (MSA)	When dilution test or post digestion spike fails and if required by project.	N/A.	N/A.	Analyst/Supervisor	N/A.	Document use of MSA in the case narrative.

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
LOQ - Limit of Quantification
DoD - United States Department of Defense
QSM - Quality Systems Manual
QC - quality control
RPD - relative percent difference
ICAL - initial calibration
IS - internal standard

QAPP Worksheet #28g: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: TPH GRO/DRO/ORO

Analytical Method/SOP: SW8015C / VO005 Rev. 4, SV001 Rev. 10

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Bias/ Contamination	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits are used for MSD, if available. Otherwise, in-house control limits are used for any compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD of all analytes ≤ 30% (between MS & MSD or sample & MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Analytical Accuracy/Bias/ Precision	Same as QC Acceptance Limits.

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Surrogates	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise DoD QSM Version 5.0 limits are used.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Analyst/Group Leader	Accuracy/Bias	Same as QC Acceptance Limits.

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
LOQ - Limit of Quantification
DoD - United States Department of Defense
QSM - Quality Systems Manual
QC - quality control
RPD - relative percent difference
ICAL - initial calibration
IS - internal standard

QAPP Worksheet #28h: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: Cyanide

Analytical Method/SOP: 9012A/335.4 / WC003 Rev. 8, WC044

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Bias/ Contamination	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	DoD QSM V 5.0 LCS limits used if available. Otherwise, in-house control limits used for compounds not specified in QSM 5.0. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery. MSD or MD: RPD ≤ 20% (between MS & MSD or between the sample & the MD).	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Analytical Accuracy/Bias/ Precision	Same as QC Acceptance Limits.

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
LOQ - Limit of Quantification
DoD - United States Department of Defense
QSM - Quality Systems Manual
QC - quality control
RPD - relative percent difference
ICAL - initial calibration
IS - internal standard

QAPP Worksheet #28i: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: General Chemistry

Analytical Method/SOP: 9034/ASTM D4978/ASTM D5049/WC030 Rev. 5, WC029, WC002

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Method Blank (MB)	One per preparatory batch of 20 or fewer samples of similar matrix.	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	Analyst/Group Leader	Bias/ Contamination	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	In-house control limits are used. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Matrix Spike (MS)	One per preparatory batch of 20 or fewer samples of similar matrix.	In-house control limits are used. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside limits, the data shall be evaluated to determine the source(s) of difference (i.e., matrix effect or analytical error).	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Matrix Spike Duplicate (MSD) and/or Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	In-house control limits are used. In-house control limits may not be > ± 3 times the standard deviation of the mean LCS recovery.	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Analytical Accuracy/Bias/ Precision	Same as QC Acceptance Limits.

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
LOQ - Limit of Quantification
QC - quality control

QAPP Worksheet #28j: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: pH

Analytical Method/SOP: USEPA 9040C, 9045D / WC020 Rev. 3, WC021 Rev. 4

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	RPD within ± 1 S.U.	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Precision	Same as QC Acceptance Limits.

Notes:

Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria

QC - quality control

SOP - standard operating procedure

RPD - relative percent difference

QAPP Worksheet #28k: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: Flashpoint

Analytical Method/SOP: USEPA 1010 / WC034 Rev. 2

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	Recovery: 90 – 110%	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst/Group Leader	Analytical Accuracy/Bias	Same as QC Acceptance Limits.
Matrix Duplicate (MD)	One per preparatory batch of 20 or fewer samples of similar matrix.	RPD = 5%	Examine the project-specified requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of difference.	Analyst/Group Leader	Analytical Accuracy/Bias/ Precision	Same as QC Acceptance Limits.

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
QC - quality control
SOP - standard operating procedure
% - percent

QAPP Worksheet #28l: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: GRO

Analytical Method/SOP: Gasoline range organics by 8015, O-TPH Gasoline Rev 4

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Initial Calibration (ICAL)	Each time instrument is set up	Correlation coefficient (r) ≥ 0.995 for linear Coefficient of Determination (r2) ≥.99 for non-linear 2nd (minimum 6pts) order and 3rd (minimum 7 pts) order curves or program/project specific.	Correct system and recalibrate.	Analyst/Group Leader	NA
Initial Calibration Verification (ICV)	After each calibration curve	80-120%	Correct system and recalibrate.	Analyst/Group Leader	NA
Continuing Calibration Verification (CCV)	At the beginning of a sequence shift and every 12 hours thereafter, then one at the end of sequence shift	80-120%	Correct problem and reanalyze affected samples. If recoveries after reanalysis still exceed limits, recalibrate instrument and reanalyze samples.	Analyst/Group Leader	NA

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Internal Standards (ISTD)	Added to all blanks, standards, and samples	Peak area within -50 to +100% of area in associated CCV.	Inspect instrument for malfunctions. Correct problems and reanalyze samples. If no instrument malfunction is apparent, proceed as follows: • Reanalyze samples • If recoveries after reanalysis still exceed criteria, data should be flagged (S).	Analyst/Group Leader	NA
Method Blank (MB)	One per medium per 20 samples per matrix	No analytes detected > ½ RL, or >5% of the regulatory limit for that analyte, or >5% of the measured concentration in the sample; whichever is highest.	Reanalyze to determine if instrument contamination was the cause. If the MB is still non-compliant, reprep and reanalyze blank and samples. If reanalysis of blank still shows contamination above specified limits, affected data should be qualified (B) and noted in the case narrative included with the data package (if applicable).	Analyst/Group Leader	NA
Laboratory Control Sample (LCS)	One per medium per 20 samples per matrix	70-130%	If LCS recoveries fall outside limits, reanalyze LCS. If reanalysis recoveries are still outside limits, reprep and reanalyze samples with a new LCS. If LCS recovery is high with no associated detects in samples, no further action is needed. If data is reported with failures on associated LCS results should be qualified (Q) and explained in the case narrative included with the data package (if applicable).	Analyst/Group Leader	NA

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One per medium per 20 samples per matrix	70-130% RPD <30%	If LCS is acceptable and MS/MSD recoveries fall outside of acceptance limits, report probable matrix interference. Qualify data if the recoveries are low (M). If recoveries are high and there are no detects in the unspiked sample then that data does not require flagging. Qualify data for RPD failures (Y) when there are any precision failures between the MS and MSD. Explain qualified data in the case narrative (if applicable).	Analyst/Group Leader	NA
Surrogate Standard (SSTD)	All blanks, standards, and samples	70-130%	If recovery is not within limits: • Check to be sure that there are no errors in calculation, surrogate solutions, or internal standards. Also, verify instrument performance. If no problem is found, reprep and reanalyze samples. • If surrogate level falls within limits after reanalysis, report reanalysis. If surrogate level is still outside limits data should be qualified (S) and noted in the case narrative (if applicable).	Analyst/Group Leader	NA

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
% - percent
QC – quality control
NA – not applicable
RL – Reporting Limit
RPD – relative percent difference

QAPP Worksheet #28m: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous

Analytical Group: Polychlorinated Byphenyls (PCBs)

Analytical Method/SOP: Polychlorinated Byphenyls (PCBs) as Aroclors by GC, SV004 Rev 11

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Initial Calibration (ICAL) Aroclor 1016/1260 or client specified aroclor(s)	Initial calibration prior to sampling analysis	1. RSD for each analyte < 20% 2. Linear – least squares regression r > 0.995. 3. Non-linear regression r2 > 0.99. (6 points shall be used for second order)	For aroclor analysis, a mixture of aroclors 1016/1260 is normally used to establish detector calibration linearity, unless project specific arolclor(s) is required. Linearity must fit one of acceptance criteria. Correct the problem and repeat ICAL. Single level CFs for the remaining arolcors must be established with each initial calibration.	Analyst, Supervisor, QA Manager	Same as SOP
Initial Calibration Verification (ICV)	Immediately following ICAL	Difference ≤20% From a second source (different lot or manufacturer)	If ICV falls outside QC criteria, reanalysis must take place. If ICV still fails, it will be necessary to correct to problem, or it will be appropriate to repeat the initial calibration curve or to qualify the analyte with "Z". QSM: No samples will be analyzed until the problem has been corrected	Analyst, Supervisor, QA Manager	Same as SOP
Continuing Calibration Verification (CCV)	Every twelve hours or every twenty samples (which one comes first) QSM: Every ten samples, Prior to sample analysis, after every 10 field	Difference ≤20%	If CCV falls outside QC criteria, reanalysis must take place. If CCV still fails, it will be necessary to correct to problem, or it will be appropriate to repeat the initial calibration curve or to qualify the analyte with "Z". Exception to the above, if the acceptance limits are exceedingly high and the analyte is not detected in the sample the verification standard has passed (analyte would have been detected if present).	Analyst, Supervisor, QA Manager	Same as SOP

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
	samples, and at the end of the analysis sequence.		QSM: No samples will be analyzed until the problem has been corrected. Flagging is only appropriate in cases where the sample cannot be reanalyzed		
Retention Time Window (RTW)	Retention times will be set using the midpoint standard in the ICAL or the RT in the CCV run at the beginning of each analytical shift.	Shift less than within ± 3 times the absolute Standard Deviation from the 72 hour RTW study, with a minimum width of 0.03 minutes		Analyst, Supervisor, QA Manager	Same as SOP
Method Reporting Limit (MRL) Level Verification Check standard at Reporting Limit. (Louisville Chemistry Guidance [LCG] only)	Beginning and end of 12 hour sequence or program specified.	70-130%	Note failures in case narrative. If Detection Limit (DL) check was run at the end and acceptable, do not reject data.	Analyst, Supervisor, QA Manager	Same as SOP
Method Blank (MB)	1 per sample batch ≤ 20 samples of the same matrix	Analytes must not be higher than the highest of the following: ½ MRL, or 5% of the regulatory limit, or 5% of the associated sample concentration. Quality Systems Manual (QSM) = ½ MRL	If sample is available and within holding times, sample associated with method blank needs to be reprepped. If no sample is available, qualify the data with a "B" to all associated positives when less than 5X blank concentration. QSM: Apply "B" to all results for the specific analytes in all samples in the associated preparatory batch.	Analyst, Supervisor, QA Manager	Same as SOP

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Laboratory Control Sample (LCS)	1 per sample batch ≤ 20 samples of the same matrix	• Client specified limits • QSM – use LCS criteria • In-house limits	If LCS fails percent recoveries, correct problem and re-analyze the LCS. If LCS recoveries are still outside QC control limits, and if there is sample remaining, the sample batch must be reprepped. If there is not sample available for reanalysis, qualify the failing analytes with a "Q".	Analyst, Supervisor, QA Manager	Same as SOP
Matrix Spike (MS)	1 per sample batch ≤ 20 samples of the same matrix	• Client specified limits • QSM – use LCS criteria • In-house limits	No action is taken based on MSD results alone, use of professional judgement. If Relative Percent Difference (RPD) is outside QC criteria, then qualify the out-lying analyte(s) in the parent sample with "Y".	Analyst, Supervisor, QA Manager	Same as SOP
Matrix Spike Duplicate (MSD)		• Client specified limits • QSM RPD < 30% • In-house limits	No action is taken based on MSD results alone, use of professional judgement. If RPD is outside QC criteria, then qualify the out-lying analyte(s) in the parent sample with "Y".	Analyst, Supervisor, QA Manager	Same as SOP
Surrogates	Every sample and QC	• Client specified limits • QSM – use LCS criteria • In-house limits	Rerun sample. If no apparent matrix interference noticed re-extract sample. If no sample is available, qualify the surrogate with "S". QSM: For QC and field samples; correct problem, reprep, and re-analyze all failed samples or failed surrogates in the associated batch, if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Same as SOP

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Target Analyte Confirmation	Whenever a positive is detected, check agreement between primary and secondary columns	RPD ≤ 40% QSM: Discuss in case narrative about qualified data.	Report from primary column unless it can be scientifically excluded **If present and RPD >40%** Flag with "P" qualifier and discuss in case narrative if appropriate.	Analyst, Supervisor, QA Manager	Same as SOP

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
% - percent
CFs - calibration factors
QA - quality assurance
QC - quality control
SOP - standard operating procedure
RT - retention time
RPD - relative percent difference

QAPP Worksheet #28n: CT Analytical Quality Control and Corrective Action

Final, Date: 3/21/2016

Matrix: Soil/Aqueous/Tissue

Analytical Group: Pesticides

Analytical Method/SOP: Organochlorine Pesticides by GC with Extended List, SV002 Rev. 9

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Initial Calibration (ICAL)	Initial calibration prior to sample analysis	1. RSD for each analyte < 20% 2. Linear – least squares regression r > 0.995. 3. Non-linear regression r^2 > 0.99. (6 points shall be used for second order)	Linearity must fit one of the acceptance criteria. Correct the problem and repeat ICAL.	Analyst, Supervisor, QA Manager	Same as SOP
Initial Calibration Verification (ICV)	Immediately following the ICAL	Difference ≤20% From a second source (different lot or manufacturer)	If ICV falls outside QC criteria, reanalysis must take place. If ICV still fails, it will be necessary to correct to problem, or it will be appropriate to repeat the initial calibration curve or to qualify the analyte with "Z". QSM: No samples will be analyzed until the problem has been corrected.	Analyst, Supervisor, QA Manager	Same as SOP

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Continuing Calibration Verification (CCV)	Every 12 hours or every 20 samples (whichever comes first) QSM: Every 10 samples. Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	Difference ≤20%	If CCV falls outside QC criteria, reanalysis must take place. If CCV still fails, it will be necessary to correct to problem, or it will be appropriate to repeat the initial calibration curve or to qualify the analyte with "Z". Exception to the above, if the acceptance limits are exceeded high and the analyte is not detected in the sample the verification standard has passed (analyte would have been detected if present). QSM: No samples will be analyzed until the problem has been corrected. Flagging is only appropriate in cases where the sample cannot be reanalyzed.	Analyst, Supervisor, QA Manager	Same as SOP
Retention Time Window (RTW)	Retention times will be set using the midpoint standard in the ICAL or the RT in the CCV run at the beginning of each analytical shift.	Shift less than within ± 3 times the absolute Standard Deviation from the 72 hour RTW study, with a minimum width of 0.03 minutes		Analyst, Supervisor, QA Manager	Same as SOP
MRL Level Verification Check standard at Reporting Limit (Louisville Chemistry Guidance [LCG] only)	Beginning and end of 12 hour sequence or program specified	70-130%	Note failures in case narrative. If DL check was run at the end and acceptable, do not reject data.	Analyst, Supervisor, QA Manager	Same as SOP

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Evaluation Standard	Beginning of an analytical sequence and every 12 hours.	Breakdown for Endrin and 4,4'-DDT must be ≤15%	Correct problem and repeat.	Analyst, Supervisor, QA Manager	Same as SOP
Method Blank (MB)	1 per sample batch ≤ 20 samples of the same matrix	Analytes must not be higher than the highest of the following: 1/2 MRL, or 5% of the regulatory limit, or 5% of the associated sample concentration. QSM = ½ MRL	If sample is available and within holding times, sample associated with method blank needs to be reprepped. If no sample is available, qualify the data with a "B" to all associated positives when less than 5X blank concentration. QSM: Apply "B" to all results for the specific analytes in all samples in the associated preparatory batch.	Analyst, Supervisor, QA Manager	Same as SOP
Laboratory Control Sample (LCS)	1 per sample batch ≤ 20 samples of the same matrix	• Client specified limits • QSM – use LCS criteria • In-house limits	If LCS fails percent recoveries, correct problem and re-analyze the LCS. If LCS recoveries are still outside QC control limits, and if there is sample remaining, the sample batch must be reprepped. If there is not sample available for reanalysis, qualify the failing analytes with a "Q."	Analyst, Supervisor, QA Manager	Same as SOP
Matrix Spike (MS)	1 per sample batch ≤ 20 samples of the same matrix	• Client specified limits • QSM – use LCS criteria • In-house limits	No action is taken based on MS recovery alone, use of professional judgement. For recoveries outside QC criteria, qualify out-lying analyte(s) in the parent sample with "M."	Analyst, Supervisor, QA Manager	Same as SOP
Matrix Spike Duplicate (MSD)	1 per sample batch ≤ 20 samples of the same matrix	• Client specified limits • QSM RPD < 30% • In-house limits	No action is taken based on MSD results alone, use of professional judgement. If RPD is outside QC criteria, then qualify the out-lying analyte(s) in the parent sample with "Y."	Analyst, Supervisor, QA Manager	Same as SOP

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Surrogates	Every sample and QC	• Client specified limits • QSM – use LCS criteria • In-house limits	Rerun sample. If no apparent matrix interference noticed re-extract sample. If no sample is available, qualify the surrogate with "S". QSM: For QC and field samples; correct problem, reprep, and re-analyze all failed samples or failed surrogates in the associated batch, if sufficient sample material is available	Analyst, Supervisor, QA Manager	Same as SOP
Target Analyte Confirmation	Whenever a positive is detected, check agreement between primary and secondary columns	RPD ≤ 40% QSM: Discuss in case narrative about qualified data.	Report from primary column unless it can be scientifically excluded **If present and RPD ≤ 40%** Flag result with "P" and discuss in case narrative if appropriate.	Analyst, Supervisor, QA Manager	Same as SOP

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
QC - quality control
% - percent
RSD - relative standard deviation
QA - quality assurance
SOP - standard operating procedure
RT - retention time
MRL - Method Reporting Limit
DL - Detection Limit
DDT - dichlorodiphenyltrichloroethane
QSM - Quality Systems Manual
RPD - relative percent difference

QAPP Worksheet #28o: SGS Accutest (Subcontractor to CT) Analytical Quality Control and Corrective Action

Final Revision 1, Date: 8/17/2016

Matrix: Soil/Aqueous

Analytical Group: Sulfides

Analytical Method/SOP: Standard Method (SM) 4500S=F-11Mod, GN140

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank	1 per batch; maximum of 20 samples	No analytes detected > ½ LOQ.	Reanalyze, and/or stop the run and determine the source of contamination, or document why the data are acceptable.	Analyst, Supervisor, QA Manager	Same as SOP
Laboratory Control Sample (LCS)	1 per batch; maximum of 20 samples	80-120%	Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable.	Analyst, Supervisor, QA Manager	Same as SOP
Matrix Spike or Matrix Spike Duplicate (MS/MSD)	10% of matrix	75-125%	Determine and correct the problem, or document why data are acceptable.	Analyst, Supervisor, QA Manager	Same as SOP
Matrix Spike Duplicate (MSD)	10% of matrix	RPD ≤ 20%	Determine and correct cause of the poor reproducibility	Analyst, Supervisor, QA Manager	Same as SOP

Notes:
Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria
QC - quality control
LOQ -Limit of Quantification
% - percent
QA - quality assurance
SOP - standard operating procedure

QAPP Worksheet #28p: SGS Accutest (Subcontractor to CT) Analytical Quality Control and Corrective Action

Final Revision 1, Date: 8/17/2016

Matrix: Leachate

Analytical Group: Chlorinated Herbicides

Analytical Method/SOP: SW-846 8151A/GC031

QC Sample	Number/ Frequency	Method/SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Project-Specific Measurement Performance Criteria
Method Blank	1 per batch; maximum of 20 samples	No analytes detected > ½ LOQ. For common laboratory contaminants, no analytes detected > LOQ.	Correct problem; reanalyze any sample associated with a blank that fails criteria, except when the sample analysis resulted in a non-detect.	Analyst, Supervisor, QA Manager	Same as SOP
Laboratory Control Sample (LCS)	1 per batch; maximum of 20 samples	QC acceptance criteria specified in QSM 4.2 Table G-8 and G-9 if available or laboratory limits.	Reanalyze all associated samples unless recoveries are high with no detection of analytes. If no sample available for analysis – qualify data.	Analyst, Supervisor, QA Manager	Same as SOP
Matrix Spike or Matrix Spike Duplicate (MS/MSD)	One pair per batch or as specified by client request	For matrix evaluation, use LCS recovery and RPD acceptance criteria	Evaluate data to determine if failure is due to matrix effects or laboratory error. Reanalyze if sufficient sample is available when appropriate; include narrative with the data.	Analyst, Supervisor, QA Manager	Same as SOP
Surrogates	In all field samples, calibrations and QC standards	QC acceptance criteria specified in QSM 4.2 Table G-3 if available or laboratory limits.	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Reanalyze if sufficient sample is available when appropriate; include narrative with the data	Analyst, Supervisor, QA Manager	Same as SOP

Notes:

Data will be evaluated using the more stringent of QSM 5.0 or laboratory-specified criteria

QC - quality control

LOQ - Limit of Quantification

QSM - Quality Systems Manual

SOP - standard operating procedure

QA - quality assurance

QAPP Worksheet #29: Project Documents and Records

Final, Date: 3/21/2016

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
• Field logbooks • Chain-of-custody forms • Sample labels • Shipping records • Variance Request Forms • Sample Location Coordinates	• Field logbooks • Chain-of-custody forms • Variance Request Forms	• Laboratory sample receipt logs • Chain-of-custody form • Standard traceability logs • Instrument calibration logs • Instrument maintenance logs • Sample preparation worksheets/logs • Sample analysis worksheets/run logs • Chromatograms/raw data/instrument printouts • Sample results/Form Is • QC sample results • Telephone/email logs • Corrective action documentation	• Laboratory data review checklists • Corrective action documentation • Data validation report • ERPIMS Error Logs	• Telephone/email logs • Corrective action documentation

Notes:
ERPIMS - Environmental Resources Program Information Management System
QC - Quality Control

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action

Final Revision 1, Date: 8/17/2016

Assessments:

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Field Quality Control Audit	Once	Internal	Amec Foster Wheeler	Amec Foster Wheeler Quality Control Manager or Designee	Amec Foster Wheeler Field Manager	Amec Foster Wheeler Field Manager	Amec Foster Wheeler QC Manager
Analytical Quality Control Audit	Once	Internal	Amec Foster Wheeler	Amec Foster Wheeler Quality Control Manager or Designee	Laboratory Project Manager	Laboratory Project Manager	Amec Foster Wheeler QC Manager

Notes:
Amec Foster Wheeler - Amec Foster Wheeler Environment & Infrastructure, Inc.
QC - quality control

Assessment Findings and Corrective Action:

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response
Field Quality Control Audit: Operational Readiness Review	Checklist or logbook entry	Amec Foster Wheeler Field Manager	Immediately to within 24 hours of review	Checklist or logbook entry	Amec Foster Wheeler Regional Lead
Field Quality Control Audit: Deviations from QPP	Logbook or Field Change Request	Amec Foster Wheeler Project Manager and Regional Lead	Immediately to within 24 hours of deviation	Logbook or Field Change Request	Amec Foster Wheeler Project Manager and Regional Lead
Analytical Quality Control Audit: Laboratory Technical Systems/Performance	E-mail followed by deficiency report	Amec Foster Wheeler Project Manager, Amec Foster Wheeler Chemist, SGS Accutest Project Manager, Maxxam Project Manager, and/or Vista Project Manager	Immediately to within 24 hours of deviation	Corrective Action Report	Amec Foster Wheeler Project Manager and Amec Foster Wheeler Chemist

Notes:
Amec Foster Wheeler - Amec Foster Wheeler Environment & Infrastructure, Inc.
SGS Accutest – SGS Accutest Laboratories
Maxxam – Maxxam Laboratories International
Vista – Vista Analytical Laboratory

Quality Control Management Reports Table:

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Quality Control Audit	Once	January 2016	Amec Foster Wheeler Quality Control Manager or Designee	Amec Foster Wheeler Project Manager and Amec Foster Wheeler Regional Lead
Data validation report	As performed	Up to 15 business days after receipt of data package	Amec Foster Wheeler	Contents summarized in Installation-Specific Investigation Report
Laboratory Technical Systems/ Performance Audits	As per QSM V 5.0	Per certification requirements	SGS Accutest, Maxxam, and Vista	Amec Foster Wheeler Project Manager and Laboratory Coordinator
Laboratory DoD ELAP Re-Certification*	Per certification or every two years.	December 2018 (SGS Accutest) July 2016 (CT) May 2017 (Maxxam) September 2017 (Vista)	CT Labs, Vista, Maxxam (Subcontractor to EMAX), and SGS Accutest (Subcontractor to CT)	Amec Foster Wheeler Project Manager and Laboratory Coordinator
Variance Request Form	As required per variance/field change	Prior to field change if feasible	Amec Foster Wheeler	AFCEC Project Manager

Notes:
*****Each laboratory was accredited for the United States Environmental Protection Agency (USEPA) Method 537.1 (Modified for non-potable water and soil) as a part of their DoD ELAP accreditation. This is equivalent to the LC/MS/MS method.
DoD - United States Department of Defense
ELAP - Environmental Laboratory Approval Program
QSM - Quality Systems Manual
SGS Accutest – SGS Accutest Laboratories
CT - CT Laboratories, LLC
Maxxam - Maxxam Laboratories International
Vista - Vista Analytical Laboratory
Amec Foster Wheeler - Amec Foster Wheeler Environment & Infrastructure, Inc.
AFCEC - Air Force Civil Engineering Center

QAPP Worksheet #34: Data Verification and Validation Inputs

Final, Date: 3/21/2016

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QPP	**X**	**X**
2	Contract	**X**	**X**
3	Field SOPs	**X**	**X**
4	Laboratory SOPs	**X**	
Field Records			
5	Field logbooks	**X**	**X**
6	Equipment calibration records	**X**	**X**
7	Chain-of-Custody Forms	**X**	**X**
8	Sampling diagrams/surveys	**X**	**X**
9	Drilling logs	**X**	**X**
10	Relevant Correspondence	**X**	**X**
11	Change orders/deviations	**X**	**X**
12	Field audit reports	**X**	**X**
13	Field corrective action reports	**X**	**X**
Analytical Data Package			
14	Cover sheet (laboratory identifying information)	**X**	**X**
15	Case narrative	**X**	**X**
16	Internal laboratory chain-of-custody	**X**	**X**
17	Sample receipt records	**X**	**X**
18	Sample chronology (i.e. dates and times of receipt, preparation, & analysis)	**X**	**X**
19	Communication records	**X**	**X**
20	Project-specific PT sample results	**X**	**X**
21	LOD/LOQ establishment and verification	**X**	**X**
22	Standards Traceability	**X**	**X**
23	Instrument calibration records	**X**	**X**
24	Definition of laboratory qualifiers	**X**	**X**
25	Results reporting forms	**X**	**X**
26	QC sample results	**X**	**X**
27	Corrective action reports	**X**	**X**
28	Raw data	**X**	**X**
29	Electronic data deliverable	**X**	**X**

Notes:
QPP - Quality Program Plan
SOP - standard operating procedure
LOD/LOQ - Limit of Detection/Limit of Quantification
QC - quality control

QAPP Worksheet #35: Data Verification Procedures

Final Revision 1, Date: 8/17/2016

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Field logbooks	Field notes will be reviewed periodically to determine completeness, appropriateness, ease of understanding, etc., of information recorded. Upon completion of field work, logbooks will be placed in the project files.	Internal	Amec Foster Wheeler Project Manager or designee
Chain-of-custody forms	Chain-of-custody forms will be reviewed against the samples packed in the specific cooler prior to shipment. Original chain-of-custody forms will be sent with the samples to the laboratory, while a copy is retained for the project files.	Internal	Amec Foster Wheeler Field Manager or designee
Sample receipt and log-ins	Sample receipt and log-in summaries will be reviewed to determine potential receipt issues that may impact data quality and for consistency with the chain-of-custody forms.	Internal and External	Amec Foster Wheeler; CT Labs, Vista, Maxxam (Subcontractor to EMAX), or SGS Accutest (Subcontractor to CT) Project Manager (or designee)
Laboratory analytical data package prior to release	Data packages will be reviewed/verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	External	CT Labs, Vista, Maxxam (Subcontractor to EMAX), or SGS Accutest (Subcontractor to CT)
Laboratory analytical data package	Data packages will be reviewed by the project chemist. The data will undergo Level 2B/IV validation protocol.	Internal	Amec Foster Wheeler Project Chemist or designee
Data validation report	Data validation reports will be reviewed by the Amec Foster Wheeler Project Manager and the Quality Control Specialist.	Internal	Amec Foster Wheeler Project Manager or designee
Electronic data	Electronic laboratory data and field data will be reviewed for consistency with the hardcopy information.	Internal	Amec Foster Wheeler Database Manager or designee

Notes:

Amec Foster Wheeler – Amec Foster Wheeler Environment & Infrastructure, Inc.
CT – CT Laboratories, LLC
Vista – Vista Analytical Laboratory
Maxxam – Maxxam Laboratories International
SGS Accutest – SGS Accutest Laboratories

QAPP Worksheet #36: Data Validation Procedures

Final Revision 1, Date: 8/17/2016

Data Validator: Amec Foster Wheeler

Analytical Group/Method:	PFCs by USEPA Method 527
Data deliverable requirements:	Level III/IV data package, ERPIMS deliverable
Analytical specifications:	QSM 5.0
Measurement performance criteria:	Worksheet 12
Laboratory quality control criteria:	Worksheet 28
Percent of data packages to be validated:	100%
Percent of raw data reviewed:	10%
Percent of results to be recalculated:	10%
Validation procedure:	Amec Foster Wheeler data validation SOP
Validation code (*see attached table):	S2BVM (90%) S4VM (10%)

Notes:
Amec Foster Wheeler - Amec Foster Wheeler Environment & Infrastructure, Inc.
QSM – Quality Systems Manual
SOP – standard operating procedure
USEPA – United States Environmental Protection Agency

Validation Code	Validation Label	Description/Reference
S2BVM	Stage 2B Validation Manual	USEPA 540-R-08-005
S4VM	Stage 4 Validation Manual	USEPA 540-R-08-005
NV	Not Validated	USEPA 540-R-08-005

Notes:
USEPA – United States Environmental Protection Agency

Amec Foster Wheeler chemists will perform validation on the data associated with samples collected and analyzed under TO 0218. With the exception of IDW samples, data will be validated 90% Stage 2B, manual (S2BVM) and 10% Stage 4, manual (S4VM). Data validation will be performed in accordance with the DoD QSM and QC criteria specified in this document.

S2BVM and S4VM data validation follow Amec Foster Wheeler data validation protocols. These protocols apply to full data packages that include raw data (e.g., instrument spectra and chromatograms), backup documentation for calibration standards, analysis run logs, and dilution factors. Data and QC summary forms are reviewed for compliance with method-specified QC criteria. For data that undergo S4VM validation, analyte identification and reported concentrations are also checked. To assure that detection limits and data values meet project requirements; instrument performance, methods of calibration, and calibration standards are evaluated.

Analytical data may be qualified based on findings from data validation review. Qualifiers will provide data users with an estimate of the level of uncertainty associated with the qualified results.

Data validation results will be evaluated with respect to the qualifiers listed below to assess the usability of the data:

B – analyte was detected in the associated blank at a concentrations greater than 1/10 the concentration detected in the sample
J – estimated concentration
Q – analyte was both B and J qualified
UJ – not detected and sample detection limit is estimated
R – rejected

The following data validation guidelines will be followed for sample reporting and blank detections:

- The general reporting convention will be to report non-detected results at the limit of detection (LOD), with detections reported down to the detection limit (DL). All detections less than the limit of quantitation (LOQ) will be reported by the laboratory with J qualifiers.
- If the sample concentration is between the DL and LOQ and less than ten times the concentration detected in the blank or rinsate sample, then the qualifier will be changed from the laboratory's J qualifier to B during data validation.
- If the sample concentration is greater than the LOQ and less than five times the concentration detected in the blank or rinsate sample, then the sample concentration will be B-flagged during data validation.

The data validation criteria will not adhere to National Functional Guidelines (NFG) but will be based on method-specific criteria for preservation, holding times, instrument tuning, calibration, instrument performance checks, internal standard responses, serial dilutions, and target compound identification; laboratory-specified criteria for surrogate, laboratory control samples, laboratory duplicates, and matrix spikes; and the validator's professional judgment.

QAPP Worksheet #37: Data Usability Assessment

Final Revision 1, Date: 8/17/2016

The quality and usability of data obtained during the project will be determined by reviewing and inspecting field logbooks, sampling forms, chain of custody forms, laboratory data packages, and data validation reports; and verifying that the sampling procedures and analytical results were obtained following the applicable protocols such that they will satisfy project requirements and can be relied upon for evaluating the data with respect to project DQOs. The data usability assessment will identify possible effects on data usage resulting from project requirement failures (i.e., data quality), and the adequacy of the data in meeting project-specific QA/QC requirements (i.e., data usability).

Efforts to evaluate and verify attainment of project requirements will enable data users to understand usability limitations associated with project data. Procedures used to assess QA/QC objectives will be in accordance with the analytical methods, which were selected based on the method's ability to meet project goals.

The data quality/usability and reconciliation evaluations will be performed by personnel with the appropriate training and/or experience to perform these reviews/evaluations. The results of the data quality/usability evaluation and project goal reconciliation will be presented in the Installation Specific Site Investigation and Release Determination Report.

The objective of this program is presence/absence evaluation of PFCs, and no statistical evaluation of the data is planned, but a data quality assessment (DQA) will be conducted to evaluate usability of the data for defined project objectives. In this DQA, data will be evaluated using a 5-step process consisting of:

1. Review of data collection documentation to assess compliance with site-specific work plans.
2. Review data validation reports to assess overall data quality as defined by this QPP.
3. Compare analytical results, including detection limits, to potentially applicable screening values.
4. Based on the above, determine whether the data meet project data quality objectives.
5. Draw conclusions from the data, and evaluate against existing CSM and project approach to determine if the CSM or project approach needs to be adjusted, or if additional evaluation of the data are required to address questions.

Amec Foster Wheeler will assess the following data quality indicators during data validation and/or data quality assessment:

<u>Precision</u>

Results of all laboratory duplicates will be presented in tabular format in the applicable data validation report. For each duplicate pair, the relative percent difference (RPD) will be calculated for each analyte that was detected in at least one of the duplicate samples. The RPDs will be checked against measurement performance criteria presented on **Worksheet #12**. The RPDs exceeding these criteria will be identified on the tables. The data quality assessment will include a summary of evaluation of laboratory precision based on meeting RPD criteria. Limitations on the use of the data based on precision criteria will be identified.**Accuracy/Bias**

Results for all laboratory method blanks and instrument blanks will be assessed in the applicable data validation reports. The blank results for each analyte will be checked against the measurement performance criteria presented on **Worksheet #12**. Results for analytes that exceed these criteria will be identified in the data validation reports. The data quality assessment will include a summary of results of the evaluation laboratory accuracy/bias based on meeting method and instrument blank criteria. Limitations on the use of the data based on method/instrument accuracy and bias will be identified.

Completeness

Completeness is defined as the percentage of laboratory measurements judged to be valid on a method-by-method basis. In addition to valid results (data not rejected); broken and/or spilled samples and other problems that may compromise sample representativeness are included in the assessment of completeness. Valid data are defined as all data and/or qualified data considered to meet the DQOs for this project. Data completeness is expressed as percent complete and should be ≥ 90 percent and the goal for meeting analytical holding times is 100 percent. At completion of each sampling event and after receipt of final laboratory data packages, the completeness of the data will be assessed. If data omissions are identified, the associated sample may be re-sampled and/or reanalyzed, if feasible. Laboratory results will be reviewed as they become available to assess laboratory performance and its effect on data completeness requirements.

Comparability

Comparability expresses the confidence with which data from one sample, sampling round, site, laboratory, or project can be compared to those from another similar data source. Comparability during sampling is dependent upon sampling program design. Comparability during analysis is dependent upon analytical methods, detection limits, laboratories, units of measure, and sample preparation procedures. Comparability is determined on a qualitative rather than quantitative basis. For this project, comparability of data collected will be ensured by adherence to standard sample collection procedures, standard field measurement procedures, and standard reporting methods, including consistent units. For example, concentrations will be reported in a manner consistent with general industry practice (e.g., soil data will be reported on a dry-weight basis). In addition, to support the comparability of fixed-base laboratory analytical results with those obtained from previous or future testing, all samples will be analyzed by USEPA-approved methods, when applicable. The USEPA-recommended maximum permissible sample holding times (**Worksheet #19**) for organic parameters will not be exceeded. All analytical standards will be traceable to standard reference materials. Instrument calibrations will be performed in accordance with USEPA method specifications and will be checked at the frequency specified for the methods. The results of these analyses can then be compared to analyses by other laboratories and/or to analyses for other sites addressed under this project.**Representativeness**

Representativeness expresses the extent to which collected data characterize the presence or absence of contaminants at a given location. Sample collection, handling, preservation, and analytical procedures are designed to obtain the most representative sample possible. Representative samples will be achieved by the following:

- Collection of samples from locations representing site conditions;
- Use of appropriate sample preservation techniques;
- Use of appropriate sampling procedures, including proper equipment;
- Use of appropriate analytical methods for the required parameters; and,
- Analysis of samples within the required holding times.

Sample representativeness is also affected by the portion of each sample chosen for analysis. The laboratory will adequately homogenize all samples prior to taking aliquots for analysis to ensure that the reported results are representative of the sample received.

Sensitivity

The concentration of any one target compound that can be detected and/or quantified is a measure of sensitivity for that compound. Sensitivity is instrument-, compound-, method-, and matrix-specific. The subcontract laboratory will flag (as an estimate, "J" flag) and report target compounds detected below the LOQ down to the DL in an effort to meet project DQOs.

Raw data collected in the field will be verified and included in the final report. Data verification and validation procedures employed during this project will ensure data collected meet project DQOs and assure a reasonable basis for decision making.

Inter-laboratory Comparison

Split samples may be collected, analyzed, and evaluated for inter-laboratory differences as a part of the overall PFC study at multiple facilities. Appendix F, *Final Inter-Laboratory Comparison Report*, presents a detailed evaluation of more than a year's worth of data from laboratories providing PFC analytical support for this project (the Final QPP will be amended once the Final Inter-Laboratory Comparison Report is completed). As part of the inter-laboratory comparison, laboratory quality control sample data and surrogate data, per laboratory, were evaluated to assess trends in the data, with QC data presented in charts along with a narrative providing context and assessment of the trends. This initial demonstration of inter-laboratory data comparability showed that the data generated by different laboratories and method modifications are comparable against common, established QC criteria presented in the QPP. Ongoing review of the QC data will be performed as part of the data validation step. Ongoing verification of data comparability will be measured by split samples.

Split Samples

Inter-laboratory split samples will be incorporated at a rate of one per month per matrix when sampling is active at multiple contract laboratories. One soil, sediment, and water matrix (either surface water or groundwater) will be collected and sent to laboratories for analysis. If no sampling is performed, or a type of sample is not collected, (e.g. sediments) or all work is handled at the primary laboratory, no split sample analysis will be performed. If a split sample is not analyzed in a month that a split sample should have been analyzed in (e.g. split sample was not collected or lost in transit to the laboratory), the missing split sample will be collected as soon as possible after the non-compliance is noted. If it is not possible to collect the missing split until the following month, it will be collected along with any split samples required for the current month's sampling. Split sample results will be evaluated against the following limits: ≤50% RPD for aqueous samples, ≤50% RPD for solid samples, or the difference between analyte concentrations should be less than twice the higher of the two LOQs. If split samples show trends that suggest significant inter-laboratory differences, further controls through use of laboratory performance evaluation samples or laboratory corrective action may be required. AFCEC will be contacted for confirmation of any program change.

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TABLES

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Table 1. PFC Analytical Suites

Analyte Name	Acronym	CAS #	Full List	Texas Commission on Environmental Quality - TRRP	Loring List	Method 537.1	UCMR 3	HAs - PFOA and PFOS
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2	x		x			
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4	x		x			
N-Ethyl perfluorooctane	EtFOSA	4151-50-2	x					
N-Ethyl	EtFOSAA	2991-50-6			x	x		
N-Ethyl perfluorooctane	EtFOSE	1691-99-2	x					
N-Methyl perfluorooctane	MeFOSA	31056-32-8	x					
N-Methyl	MeFOSAA	2355-31-9			x	x		
N-Methyl perfluorooctane	MeFOSE	24448-09-7	x					
Perfluorobutanesulfonic acid	PFBS	375-73-5	x	x	x	x	x	
Perfluorobutanoic acid	PFBA	375-22-4	x	x	x			
Perfluorodecanesulfonic acid	PFDS	335-77-3	x	x				
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	x					
Perfluoroheptanoic acid	PFHpA	375-85-9	x	x	x	x	x	
Perfluorohexane sulfonic acid	PFHxS	355-46-4	x	x	x	x	x	
Perfluorohexanoic acid	PFHxA	307-24-4	x	x	x	x		
Perfluorononanoic acid	PFNA	375-95-1	x	x	x	x	x	
Perfluorooctane sulfonamide	PFOSA	754-91-6	x	x				
Perfluoropentanoic acid	PFPeA	2706-90-3	x	x	x			
Perfluorotetradecanoic acid	PFTeDA	376-06-7	x	x	x	x		
Perfluorotridecanoic acid	PFTrDA	72629-94-8	x	x	x	x		
Perfluoroundecanoic acid	PFUnA	2058-94-8	x	x	x	x		
Perfluorodecanoic acid	PFDA	335-76-2	x	x	x	x		
Perfluorododecanoic acid	PFDoA	307-55-1	x	x	x	x		
Perfluorooctanoic acid	PFOA	335-67-1	x	x	x	x	x	x
Perfluorooctanesulfonic acid	PFOS	1763-23-1	x	x	x	x	x	x

Notes:
CAS # - Chemical Abstract Service Number
HA - United States Environmental Protection Agency (USEPA) Health Advisory for PFOS and PFOA
TRRP - Texas Risk Reduction Program, Protective Concentration Levels, September 2014
UCMR 3 - USEPA Third Unregulated Contaminant Monitoring Rule, Promulgated May 16, 2012

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Table 2. Preliminary Summary of Field Sampling Activities

Installation	Number of AFFF Areas	Initial Site Investigation Sampling Activities						Follow-On Site Investigation & Delineation						
		Advance 4 soil borings per area	Install 2 new GW monitoring wells per area	Number of existing wells per installation (4 per area)	Collect & analyze 3 subsurface soil samples from each boring	Collect & analyze 1 groundwater sample from 3 existing wells per area	Collect & analyze 1 groundwater sample from 2 new wells per area	20% of areas require follow-on	Advance 3 soil borings per area	Install 2 new GW monitoring wells per area (5 new for PB)	Number of existing wells per installation (5 per area)	Collect & analyze 3 subsurface soil samples from each boring	Collect & analyze 1 groundwater sample from 5 existing wells per area	Collect & analyze 1 groundwater sample from 2 new wells per area (5 new for PB)
Castle AFB, CA	12	48	24	48	144	36	24	3	9	6	15	27	15	6
Chanute AFB, IL	9	36	18	36	108	27	18	2	6	4	10	18	10	4
General Mitchell ARS, WI	11	44	22	44	132	33	22	3	9	6	15	27	15	6
Griffiss AFB, NY	17	68	34	68	204	51	34	4	12	8	20	36	20	8
Kelly AFB, TX	26	104	52	104	312	78	52	6	18	12	30	54	30	12
KI Sawyer AFB, MI	19	76	38	76	228	57	38	4	12	8	20	36	20	8
Loring AFB, ME	14	56	28	56	168	42	28	3	9	6	15	27	15	6
Pease AFB, NH	14	56	28	56	168	42	28	3	9	6	15	27	15	6
Plattsburgh (PB) AFB, NY	8	32	16	32	96	24	16	2	6	10	10	18	10	10
Reese AFB, TX	13	52	26	52	156	39	26	3	9	6	15	27	15	6
Wurtsmith AFB, MI	14	56	28	56	168	42	28	3	9	6	15	27	15	6
Totals	157	628	314	628	1,884	471	314	36	108	78	180	324	180	78

Total Borings	736
Total new wells install & sample	392
Total existing wells sample	651
Redevelop 15% of existing wells	98

Groundwater Samples from Monitoring Wells	1,043
Soil Samples	2,208
Sediment Samples	56
Surface Water Samples	56
Fish Samples	126
Pore Water Samples	120
Drinking Water Samples	436

Table 2. Preliminary Summary of Field Sampling Activities (Continued)

		Plume & Receptor Pathway												
Installation	**Number of AFFF Areas**	**Number of Plumes per Installation**	**For 6 of the plumes, collect 3 initial samples from 2 water supply wells**	**For 6 of the plumes, collect 3 initial samples from 15 private wells**	**For 6 of the plumes, collect 3 samples from 5 private wells for verification**	**For 14 of the 22 plumes, collect 1 surface water samples from 4 locations**	**For 14 of the 22 plumes, collect 1 sediment samples from 4 locations**	**For 6 of the 22 plumes, collect 2 fish tissue samples at 4 locations**	**For 6 of the 22 plumes, collect 2 fish tissue samples for background**	**Daylight investigation for 5 of the 22 plumes (2 SW bodies per plume)**	**2 rounds of 12 drive points (baseline & secondary) along upgradient side of SW bodies**	**Collect 1 pore water samples at each location during each round**	**Regular monitoring of 10 whole house treatment systems (associated with 11 plumes)**	**Performance monitoring at 10 households; 1 influent & 1 effluent sample; 1 X year for 2 years**
Castle AFB, CA	12	2	12	90	30	0	0	0	0	--	--	--	--	--
Chanute AFB, IL	9	2	0	0	0	8	8	16	2	--	--	--	--	--
General Mitchell ARS, WI	11	2	0	0	0	0	0	0	0	--	--	--	--	--
Griffiss AFB, NY	17	2	0	0	0	8	8	16	2	1	24	24	--	--
Kelly AFB, TX	26	2	0	0	0	8	8	16	2	1	24	24	--	--
KI Sawyer AFB, MI	19	2	0	0	0	0	0	0	0	1	24	24	2	8
Loring AFB, ME	14	2	0	0	0	8	8	16	2	--	--	--	2	8
Pease AFB, NH	14	2	12	90	30	8	8	16	2	1	24	24	2	8
Plattsburgh AFB, NY	8	2	0	0	0	8	8	16	2	1	24	24	2	8
Reese AFB, TX	13	2	0	0	0	0	0	0	0	--	--	--	--	--
Wurtsmith AFB, MI	14	2	12	90	30	8	8	16	2	--	--	--	2	8
Totals	157	22	36	270	90	56	56	112	14	5	120	120	10	40

Total Borings	736
Total new wells install & sample	392
Total existing wells sample	651
Redevelop 15% of existing wells	98

Groundwater Samples from Monitoring Wells	1,043
Soil Samples	2,208
Sediment Samples	56
Surface Water Samples	56
Fish Samples	126
Pore Water Samples	120
Drinking Water Samples	436

Table 3. Summary of Prohibited and Acceptable Items for Sampling of PFCs

Prohibited Items	Acceptable Items
Field Equipment	
Teflon® containing materials	High-density polyethylene (HDPE) and Low density polyethylene (LDPE) materials
Storage of samples in containers made of LDPE materials	Acetate liners
Teflon® tubing	Silicon tubing
Waterproof field books not manufactured by Rite in the Rain	Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
	Sharpies®, pens
Post-It Notes	
Chemical (blue) ice packs	Regular ice
Excel Purity Paste TFW Multipurpose Thread Sealant Vibra-Tite Thread Sealant	Gasoils NT Non-PTFE Thread Sealant Bentonite
Equipment with Viton Components (need to be evaluated on a case by case basis, Viton contains PTFE, but may be acceptable if used in gaskets or O-rings that are sealed away and will not come into contact with sample or sampling equipment.)	
Field Clothing and PPE	
New clothing or water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of synthetic or natural fibers (preferable cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™	Boots made with polyurethane and PVC
	Reflective safety vests, Tyvek®, Cotton Clothing, synthetic under clothing, body braces
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	**Sunscreens** - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are "free" or "natural" **Insect Repellents** - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics **Sunscreen and insect repellant -** Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion
Sample Containers	
LDPE or glass containers	HDPE or polypropylene
Teflon®-lined caps	Lined or unlined HDPE or polypropylene caps

Prohibited Items	Acceptable Items
Rain Events	
Waterproof or resistant rain gear	Polyurethane, vinyl, wax or rubber-coated rain gear. Gazebo tent that is only touched or moved prior to and following sampling activities
Equipment Decontamination	
Decon 90	Alconox® and/or Liquinox®
Water from an on-site well	Potable water from municipal drinking water supply
Food Considerations	
All food and drink, with exceptions noted on the right	Bottled water and hydration drinks (i.e. Gatorade® and Powerade®) to be brought and consumed only in the staging area

APPENDIX A

General Health and Safety Plan

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GENERAL HEALTH AND SAFETY PLAN
FOR
SITE INVESTIGATION OF PERFLUORINATED COMPOUND (PFC) RELEASE AREAS AT MULTIPLE BRAC INSTALLATIONS

Prepared for:
Air Force Civil Engineer Center
Joint Base San Antonio – Lackland, Texas

Prepared by:

amec
foster
wheeler

Amec Foster Wheeler Environment & Infrastructure, Inc.

Contract FA8903-08-D-8766
Task Order 0218

April 2016

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General Health and Safety Plan

Site Investigation of Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations

General Information

Project Name:	Site Investigation of Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations
Location:	Multiple Former Air Force Installations
Client:	Air Force Civil Engineer Center
Plan Prepared By:	
Plan Reviewed By:	
Plan Approved By:	

Emergency Contacts

Ambulance	911	
Fire	911	
Police	911	
Poison Control Center	1-800-222-1222	
Hospital	See Site Specific HSP	
HAZMAT	1-800-424-8802	
Amec Foster Wheeler Health and Safety Officer	Toby Collins:	Office: (615) 333-0630x7103 Mobile: (615) 305-6598
Amec Foster Wheeler Project Manager	Melissa Helton:	Office: (865) 218-1062 Mobile: (865) 607-4829
Amec Foster Wheeler Central Group's HSE Manager	John Mazur, CIH, CHMM	Office: (910) 452-1185 Mobile: (910) 431-2330
Air Force Contracting Officer Representative	Dave Farnsworth:	Office: (518) 563-2871 Mobile: (518) 420-2179

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
ANSI	American National Standards Institute
BRAC	Base Realignment and Closure
CFR	Code of Federal Regulations
CIH	certified industrial hygienist
CO_2	carbon dioxide
CPR	cardiopulmonary resuscitation
dBA	decibels on A-weighted scale
DoD	Department of Defense
DRI	direct reading instrument
°F	degrees Fahrenheit
FM	Field Manager
ft/sec	feet per second
GFCI	ground fault circuit interrupter
HSP	Health and Safety Plan
HAZCOM	hazardous communication
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSE	Health, Safety, and Environment
IDW	investigation derived waste
JHA	job hazard analysis
kV	kilovolt
LEL	lower explosive limit
mph	miles per hour
NIOSH	National Institute for Occupational Safety and Health
NRR	noise reduction rating
NWS	National Weather Service
OSHA	Occupational Safety and Health Administration

PEL	permissible exposure limit
PFC	perfluorinated compounds
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
SAP	Sampling and Analysis Plan
SCBA	self-contained breathing apparatus
SDS	safety data sheet
SHSO	Site Health and Safety Officer
TLV	threshold limit value
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance

1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) has prepared this general Health and Safety Plan (HSP) for safety and health requirements concerning potential chemical exposures and other hazards that may be encountered during implementation of the Site Investigation of Perfluorinated Compounds (PFCs) Release Areas at 11 Base Realignment and Closure (BRAC) Installations. Installation-specific health and safety information will be included in the Installation-Specific Work Plan Addendums prior to beginning fieldwork.

1.1 Purpose and Policy

The purpose of this HSP is to present the general health and safety policies, responsibilities, procedures, and controls that will be implemented during field activities at each of the 11 installations. This HSP presents the minimum requirements for health and safety that must be met by Amec Foster Wheeler and other contractor personnel. Field and contractor personnel shall read, understand, and comply with the requirements of this HSP and the installation-specific HSP for each installation. Visitors shall also be required to review, sign, and comply with this HSP to gain site entry.

This HSP is in compliance with applicable federal, state, and local health and safety requirements. Specific references consulted in assembling the HSP include:

- 29 Code of Federal Regulations (CFR) 1910 and 1926 (Occupational Safety and Health Administration [OSHA] General Industry and Construction Standards, respectively); and,
- Amec Foster Wheeler Health, Safety, and Environment (HSE) program and field operating procedures.

1.2 Applicability

This HSP is structured to assign responsibilities, establish personal protection standards and mandatory safety procedures, and provide for contingencies that might arise while project-related operations are being conducted at the Site. The provisions of the plan are mandatory for on-site employees engaged in hazardous material management activities, including but not limited to, hydrogeologic and soil investigation, construction activities; installation of monitoring wells; development of monitoring wells; collection of soil, sediment, surface water, fish tissue, and groundwater samples; management of investigation derived waste (IDW); mobilization; project operations; and demobilization.

1.2.1 Modification Plan

Changing and/or unanticipated site conditions might require modification of this plan to maintain a safe and healthy work environment. Any proposed change must be reviewed by the Project Manager (PM) and HSE Group Manager prior to implementation of the change. Under no circumstances will modifications to this plan conflict with federal, state, or local health and safety regulations.

1.2.2 Subcontractor Responsibilities

Team members or subcontractors who perform work for Amec Foster Wheeler under this HSP are responsible for the health and safety of their employees. Each teaming partner and/or subcontractor is responsible for compliance with applicable federal, state, local, and Amec Foster Wheeler safety requirements, including but not limited to:

- 29 CFR 1910.120 (OSHA) guidelines regarding 40-hour Hazardous Waste Operations and/or 24-hour awareness training;
- Medical monitoring, medical examination for fitness to work including respirator use pursuant to 29 CFR 1910.134, if required;
- Supplying personal protective equipment (PPE) (coveralls, respirators, boots, gloves, etc.) as required by site conditions; and,
- 29 CFR 1926 (OSHA Construction Standard).

Copies documenting the above training and programs will be kept on-site by all individual contractors.

1.3 Site Location

Work conducted under this HSP will be performed at 11 installations, listed in the table below. Additional installations may be added for evaluation and/or sampling beyond the 11 currently specified; however, the work tasks addressed in this HSP will remain the same.

Table 1-1. Installations Included in this Task Order

Installation	Location
Castle AFB	California
Chanute AFB	Illinois
General Mitchell ARS	Wisconsin
Griffiss AFB	New York
Kelly AFB	Texas
K.I. Sawyer AFB (includes Escanaba DFSP - GSU of KI)	Michigan
Loring AFB	Maine
Pease AFB	New Hampshire
Plattsburgh AFB	New York
Reese AFB	Texas
Wurtsmith AFB	Michigan

Notes:
AFB – Air Force Base
ARS – Air Reserve Station
DFSP - GSU – Defense Fuels Supply Point – General Support Unit

1.4 Scope of Work

The scope of work to be conducted under this HSP is based upon the technical approach presented in the general environmental Sampling and Analysis Plan (SAP) and 11 Installation–Specific Work Plans. Planned site activities include the following:

- Soil sample collection;
- Monitoring well installation;
- Monitoring well development and rehabilitation of existing wells;
- Groundwater sample collection;
- Confined space entry into an extraction well vault to collect groundwater samples;
- Sediment and surface water sample collection;
- Fish tissue sample collection;
- Construction activities; and,
- Management of IDW.

1.5 Health and Safety Planning

Identifying and evaluating potential health and safety hazards prior to beginning and during field activities are an integral part of HSP development. A formal site characterization must be completed by the Site Health and Safety Officer (SHSO) per OSHA standard for hazardous waste sites in 29 CFR 1910.120. The SHSO will perform a hazard assessment at each of the sites to collect information concerning the types and degrees of hazards and risks that may be present. Based upon the information collected, the project team can assess additional hazards and identify additional safety requirements not initially addressed in this HSP or in the installation-specific HSP. The hazard assessment will allow the project team to verify that the proper hazard control measures such as PPE, training requirements, permits, procedures, and engineering controls are being used.

1.6 Project Organization and Responsibilities

Personnel shall be aware of the site organization and the responsibilities and qualifications of each organization member. The general responsibilities of each are discussed below. Refer to page iii for emergency contact information.

1.6.1 Project Manager

The PM has overall health and safety responsibility for the work performed at the Base. The PM is responsible for regulatory compliance and the health and safety of employees working on the project. The PM has the authority to direct response operations, if necessary.

1.6.2 Field Manager

The Field Manager (FM) is responsible for ensuring that field operations are performed in accordance with the SAP and this HSP as well as protecting the health and safety of the workers and the public. The FM may delegate responsibilities for health and safety to the SHSO or other appropriate team personnel. The

FM is also responsible for reviewing field reports, and interfacing with the Project's Certified Industrial Hygienist (CIH) and/or the SHSO regarding resolution of health and safety problems/concerns. The FM reports to the PM who has the authority to make the appropriate changes or cease work.

1.6.3 Health, Safety, and Environment Group Manager

The Amec Foster Wheeler HSE Group Manager will be a primary point of contact for any incidents that arise during work activities.

1.6.4 Site Health and Safety Officer

One SHSO will be assigned to each field team. The SHSO reports to the FM and is responsible for implementing this HSP plan in the field. The SHSO advises both the FM and PM on all aspects of on-site health and safety and advises the FM of conditions that may require work to be ceased or of any changes in operations in the event that worker or public health or safety is threatened. The SHSO will control visitor access to the work zone. The SHSO will conduct daily tailgate safety meetings and is responsible for updating the HSP (field changes) to ensure it adequately identifies all tasks and significant hazards at the Site and notifying project personnel, the FM, and PM of changes. The FM may serve as the SHSO.

1.6.5 Project Field Team

The Project Field Team is responsible for the completion of various site tasks, complying with the HSP, notifying the SHSO of suspected unsafe conditions, and reporting any accidents or injuries through the appropriate chain of command.

1.7 Subcontractor's Safety Representative

Team members or subcontractor's safety representative will oversee the field activities of his/her employees and is responsible for enforcing the field requirements of this HSP.

2.0 TRAINING

2.1 General Training

The FM and SHSO are responsible for informing site personnel and visitors of the contents of this HSP and ensuring that each person signs the Health and Safety Plan Acceptance Form (included at the end of this plan) prior to working on site. Training documentation will be reviewed by the SHSO and filed on site.

Authorized visitors shall receive a safety briefing from the designated SHSO prior to accessing the site. The safety briefing will inform visitors of the potential hazards and installation-specific procedures appropriate to site areas they intend to visit. The briefing shall also include emergency action plan procedures.

2.2 Safety Meetings

Personnel shall be provided continuous health and safety training, as appropriate, to ensure that work is being performed in a safe manner. The SHSO shall conduct a daily safety meeting to discuss health and safety considerations for each day's activities, pertinent aspects of Job Hazard Analyses (JHAs), necessary PPE, problems encountered during the previous day, and new operations. Attendance records and meeting notes will be maintained for each day's meeting and will be filed on site.

2.3 Installation-Specific Training

Prior to beginning fieldwork, personnel (e.g., field personnel, subcontractors, authorized visitors, etc.) shall attend the pre-entry briefing covering the contents of this HSP and the appropriate installation-specific HSP. The briefing shall be conducted by the SHSO or designated representative. Attendance shall be documented on the Health and Safety Plan Acceptance Form. By signing the acceptance form, personnel acknowledge that they have attended the briefing, understand the potential safety and health hazards as described in this HSP, and agree to perform work according to the requirements outlined in this HSP and the installation-specific HSP. During the HSP review, the FM/SHSO will discuss specific tasks to be performed and the objectives of the project. This initial review will be supplemented, as needed, with daily, pre-task reviews, which will include the review of pertinent JHAs (**Appendix B**); Safety Data Sheets (SDSs) (**Appendix C**), and other applicable documents with intended task participants. The following topics will be addressed during the briefing:

- Names of the SHSO and the designated alternate;
- Safety, health, and other potential hazards;
- Task activities to be performed;
- Hazardous chemicals that may be encountered;
- Monitoring instrumentation;
- Hazard Communication (HAZCOM) Program;
- Physical hazards that may be encountered;
- PPE requirements;
- Proper use of assigned PPE, including respiratory protection if required;

- Action levels requiring upgrades/downgrades;
- Site controls and safety rules;
- Special training requirements and safe work practices;
- Emergency communication signals, codes, and location of telephone numbers;
- Emergency procedures for injuries, fires, and hazardous materials incidents; and,
- Emergency routes.

2.4 Hazard Communication

Employees working with hazardous materials shall receive training in accordance with the HAZCOM Standard, 29 CFR 1926.59. The HAZCOM program elements are addressed in Section 5.7 of this HSP.

2.5 First Aid and Cardiopulmonary Resuscitation

At least two field personnel at each installation will be currently certified in both basic first aid and cardiopulmonary resuscitation (CPR) by the American Red Cross, American Heart Association, or recognized equivalent organization. The designated first aid/CPR-trained personnel will also have the required blood-borne pathogen training.

2.6 Confined Space Training

Personnel responsible for supervising, planning, entering, or participating in confined space entry and rescue shall be adequately trained and demonstrate proficiency in their functional duties prior to any confined space entry. Training shall be provided before the employee is assigned their functional duties or whenever there is a change in operations or procedures. The training shall be certified by the employer, and the certification shall be documented and maintained on site. The training shall include:

- An explanation of the general hazards associated with confined spaces;
- A discussion of specific confined space hazards associated with the facility location;
- The reason for, proper use and limitations of PPE, and other safety equipment required for entry into confined spaces;
- An explanation of the permit system and other procedural requirements for conducting confined space entry;
- How to respond to emergencies;
- Duties and responsibilities as a member of the confined space entry team; and,
- A description of how to recognize probable air contaminant over-exposure and/or oxygen deficiency symptoms in themselves and their coworkers, and methods for alerting attendants.

2.6.1 Training for Entry Supervisor

The supervisor authorizing or in charge of entry shall receive the training in Section 2.6 above, and additional training on:

- Recognizing the effects of exposure to chemical hazards known to be in the confined space;
- The use of air monitoring equipment and the interpretation of results; and,
- The use and selection of PPE.

2.6.2 Training for the Authorized Attendants

Authorized attendants shall receive the training in Section 2.6.1, and additional training on:

- Practical exercises;
- Special rescue equipment;
- Radio operations;
- Lifelines and safety harnesses;
- Procedures for summoning rescue service;
- First aid; and,
- Cardiopulmonary resuscitation.

2.6.3 Authorized Entrants

Authorized entrants shall receive the training in Section 2.6.1, and additional training on:

- Respiratory fit-test for each type of respirator they will wear in a confined space;
- Detection of a prohibited condition;
- Proper exit techniques during evacuation;
- The requirements of the confined space entry permit; and,
- Communication techniques and equipment.

2.7 Mandatory Training and Certifications

In addition to the training and certification detailed above, the following will also be required:

- Personnel operating motor vehicles shall hold a valid operator's license from the state in which they reside.
- Following the completion of the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training, all personnel are required to complete an annual 8-hour HAZWOPER refresher training. Copies of personnel training certificates shall be provided to the SHSO for inclusion and retention in the project's records.
- In addition to the initial 40-hour HAZWOPER training, the PM and SHSO will have completed the 8-hour Supervisor/Manager HAZWOPER training. The course provides managers with specific safety and health responsibilities in accordance with the requirements of 29 CFR 1910.120(e)(4).

2.8 Other Training

Since work may be conducted within areas used by commercial and/or Department of Defense (DoD) aircraft, personnel should determine whether special training is required in areas adjacent to and near aprons, taxiways, and runways. This instruction (e.g., Flightline Training) establishes the responsibilities, procedures, and training requirements for the safe control of vehicles and pedestrians on and near airfield operations. Training requirements should be determined prior to work plan development and fieldwork activities and will be followed by all personnel working in areas where required.

3.0 SAFETY AND HEALTH RISK ANALYSIS

Personnel shall be made aware of chemical and physical hazards of concern associated with the project. The potential hazards for tasks associated with this project are discussed below. Protective measures and proper PPE are discussed in Section 4.2.

3.1 Chemical Hazards

Field activities conducted under this HSP are associated with site investigations for releases of PFCs at 11 installations. Personnel shall be aware of site control measures designed to minimize potential exposure from any PFC found during the assessment and characterization activities.

The chemical toxicological properties and permissible exposure limits (PELs) for constituents that may be encountered during sampling and drilling activities are shown in **Table 3-1**. Other potential hazards include Liquinox® or equivalent, isobutylene gas (equipment calibration), and methanol and nitric acid (sample preservatives). SDS information including Liquinox® is included in **Appendix C**.

Table 3-1. Toxicity Assessment

Constituent	IDLH Level	PEL/REL	Acute Toxicological Symptoms for Relevant Exposure Pathway (oral, dermal, inhalation)
Gasoline	Carcinogen	See Benzene	Irritant to the eyes, skin, and mucous membrane; dermatitis; fatigue; blurred vision; dizziness; slurred speech; confusion; convulsion; chemical pneumonia; possible liver and kidney damage
Petroleum Products (diesel fuel)	1,100 ppm (LEL)	REL TWA 350 mg/m^3 REL-C 1800 mg/m^{3*} *15-min	Irritant to the eyes, nose, and throat; dizziness; drowsiness; headache; nausea; dry cracked skin; chemical pneumonia
Benzene	Carcinogen (500 ppm)	TWA 0.5 ppm STEL 2.5 ppm	Irritation to the eyes, skin, nose, respiratory system; dizziness; headache; nausea; staggered gait; anorexia; lassitude (weakness, exhaustion); dermatitis; bone marrow depression

Notes:
* Information obtained from *ACGIH Guide to Occupational Exposure Values, 2013 and NIOSH Publications*
IDLH – immediately dangerous to life or health
LEL – lower explosive limit
mg/m^3 – milligrams per cubic meter
min – minute
PEL – Occupational Safety and Health Administration permissible exposure limits
ppm – parts per million
REL – National Institute for Occupational Safety and Health recommended exposure limits
TWA – time-weighted average (8-hour workday, 40-hour work week)
STEL – short-term exposure limit (15-minute time-weighted average)
REL-C – ceiling level concentration that should not be exceeded during any part of the working exposure

3.2 Physical Hazards

Potential physical hazards anticipated for this project include, but are not limited to:

- Uneven terrain and slips/trips/falls;
- Crushing injuries from unstable equipment;
- Injuries from the use of hand and power tools;
- Elevated noise levels;
- Exposure to the sun/sunburn;
- Sharp objects such as nails, broken glass, etc.;
- Weather related (heat/cold stress, inclement weather/electrical storms);
- Underground and aboveground utilities;
- Heavy equipment operation (including drill rigs); and,
- Vehicle and/or airport related traffic.

Control or protective measures for these physical hazards will be addressed during initial review of this HSP, during mandatory daily job safety meetings, and through the use of engineering controls (where applicable). Communications with other contractors shall be established and maintained during site activities. This will ensure that all contractors are provided with the appropriate hazard information. A telephone or cellular phone shall be available and easily accessible to site personnel.

Prior to beginning any intrusive activities the proper authorities will be contacted to provide a utility mark-out. All known utilities will be located, marked and avoided during intrusive activities. In addition, a review of all available utility maps will be conducted for the vicinity of the proposed sampling locations and proper dig permits will be acquired as applicable. In the event that any of the planned sampling locations are found to interfere with buried utilities or are located in an area subject to frequent flooding, the locations will be relocated as closely as practical to the original location. Relocated drilling locations will be approved by the FM. In the event that gas, water, or sewer utilities are damaged during field activities, Amec Foster Wheeler will immediately contact the appropriate authorities to coordinate response/repair activities.

3.2.1 Slips, Trips, and Falls

Slips, trips, and falls are the primary physical hazard that site personnel may encounter. Therefore, personnel shall adhere to the following preventative measures. Supervisors will remind personnel and subcontractors to maintain sure footing on all surfaces. Sure footing includes safety boots with treaded soles to minimize slipping on surfaces. The supervisor and/or the SHSO will inspect all work areas prior to the start of work to look for hazards.

3.2.2 Falling Objects

Falling or overhead objects are a potential hazard during all activities with heavy equipment. Personnel should be aware of overhead hazards, especially with heavy equipment. Personnel will be required to wear hard hats during activities involving heavy equipment and any other activities where falling or overhead objects are a hazard. Hard hats meeting American National Standards Institute (ANSI) Z89.1 standard will be provided.

3.2.3 Use of Tools and Machinery

The use of hand and power tools is anticipated during field activities. Personnel should be familiar with each piece of equipment that they intend to use and be familiar with manufacturer's instructions and recommendations for the use and maintenance of each piece of equipment.

3.2.4 Noise Hazards

Noise hazards at the sites may include the use of heavy equipment and power tools as well as airplanes arriving at and departing from nearby runways. Personnel within 25 feet of operating equipment shall wear hearing protection. The FM or SHSO will determine and enforce any other noise protection requirements if necessary.

3.2.5 Construction Hazards and Heavy Equipment

While working on site, employees must be aware of other physical hazards that might exist from drilling and sampling activities, including risk of injury while working in or around heavy equipment such as drill rigs. Care will be exercised in the use of and while working near equipment. Heavy equipment will be inspected and documented throughout environmental service activities. Operators of equipment shall be qualified and licensed to operate the specific heavy equipment. Before equipment is placed into use, it will be inspected by the operator to ensure that it is in safe operating condition. Construction activity will vary among sites, so site-specific hazards and safety protocols will be included in site-specific HSPs.

3.2.6 Traffic Hazards

Driving a vehicle and working in areas of vehicle and/or aircraft traffic both present hazards to employees. Safe driving rules and speed limits must be followed at all times, both on base and off base. When working or driving in an area shared by aircraft, personnel should obtain and follow area-specific driving and work regulations/instructions (e.g., Flightline Training) prior to entering and working in the area. Cell phone use is prohibited while driving at all times. High visibility traffic vests must be worn if working in areas with vehicle and/or aircraft traffic or heavy equipment operation.

3.2.7 Fire/Explosions

The primary fire hazards at the project consist of fueling operations, storage of fuels, and other flammable liquids at the project site. The significant ignition sources at the project include smoking materials, vehicle/equipment exhaust, catalytic converters, and engine block surfaces. Personnel shall also be alert for other ignition sources such as static electricity, lightning, and electrical equipment.

3.2.8 Oxygen-Deficient Atmospheres

During on-site activities, no confined spaces will be entered; therefore, oxygen-deficient atmospheres will not be encountered during sampling activities.

3.2.9 Heat/Cold-Related Stress/Illness

Field activities conducted at the Site in either the winter or summer months may present a potential hazard to personnel for heat/cold stress injuries.

The potential for a heat stress injury rises considerably when workers are required to perform physical activities in impermeable PPE and outdoor temperatures are above 70 degrees Fahrenheit (°F), particularly in humid weather. This type of exposure can result in health effects ranging from heat fatigue to serious illness or death. Signs and symptoms of heat related injuries include the following:

- Heat cramps – muscle spasms during or after work shift;
- Heat exhaustion – fatigue, clammy skin, nausea, profuse sweating; and,
- Heat stroke – confusion, hot and dry skin, absence of sweating (life threatening).

The potential for cold stress injury rises when workers are exposed to extreme cold or work in cold environments. Extreme cold weather is a dangerous situation that can bring on health emergencies in susceptible people, such as those without shelter, outdoor workers, and those who work in an area that is poorly insulated or without heat. What constitutes cold stress and its effects can vary across different areas of the country. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered factors for "cold stress." Whenever temperatures drop decidedly below normal, heat can more rapidly leave your body, especially as the wind speed increases. These weather-related conditions may lead to serious health problems.

- Hypothermia
  – Early symptoms: shivering, fatigue, confusion and disorientation;
  – Late symptoms: no shivering, blue skin, dilated pupils, slowed pulse and breathing, loss of consciousness; and,
- Frostbite – reduced blood flow to hands and feet, numbness, tingling, bluish or pale waxy skin.

3.2.10 Working on Private Property

The scope of work for this task order may include the collection of groundwater samples on private property. Many private property owners do not like strangers on their property; therefore, the following practices should be followed when conducting work on private property:

- Contact the property owner prior to field activities to (1) discuss the scope of work, (2) obtain permission to conduct the activities and (3) schedule a date and time that suites the property owner to perform the work;
- Contact the property owner the day before conducting the work to confirm the activities;
- When arriving at the property inform the property owner that you are on site; and,
- Prior to commencing activities, perform a hazard analysis by walking the areas where you will be working to evaluate the presence of potential safety hazards (e.g., slip, trip, falls; dogs; etc.).

3.2.11 Boating

Collection of fish tissue samples may require the use of boats during fishing activities, which presents a series of hazards to personnel. The following practices must be followed when using a boat:

- Care will be taken attaching and detaching the boat from the trailer during transport;
- A life jacket must be worn by each person at all times while boating;
- A safe speed must be observed at all times while traveling in the boat to avoid debris and other water traffic;
- Proper distribution of the load in the boat must be ensured to avoid tipping; and,
- A proper anchor must be included in the boat for stabilization at the sampling location.

3.2.12 Electrofishing

Collection of fish tissue may include the use of electrofishing. Operators of the electroshock unit must have appropriate training in equipment operation, as well as prevention and treatment of electric shock. Rubber gloves with the proper voltage resistance will be worn at all times. While working in streams, follow the "rule of 10":

- If a stream is 1 foot deep and flowing at 10 feet per second (ft/sec), it is too hazardous to wade.
- If a stream is 2 feet deep and flowing at 5 ft/sec, it is too hazardous to wade.
- If you do enter a stream and discover that it is too dangerous to wade, back out using your wading pole for balance.

3.3 Biological Hazards

Working outdoors presents many potential biological hazards. These include, but are not limited to insect bites or stings, contact with poisonous plants or the oil from these plants, and encounters with animals. Biological hazards endemic to certain geographic areas will be described in detail in the site-specific HASPs.

3.4 Confined Space Entry

A confined space is defined as a space that has one or more of the following characteristics (29 CFR 1910.146):

- Contains or has a potential to contain a hazardous atmosphere;
- Contains a material that has the potential for engulfing an entrant;
- Is configured such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a small cross section; and,
- Contains any other recognized serious safety hazard.

Due to the nature of confined spaces, they can be further classified as Permit Required Confined Spaces if they meet one of the following conditions:

- Contains or has a potential to contain a hazardous atmosphere;
- Contains a material that has the potential for engulfing an entrant;
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or,
- Contains any other recognized serious safety or health hazard.

Before personnel may enter a confined space, the SHSO or designee must survey the premises and perform a job task analysis to identify chemical and physical hazards and evaluate whether the confined space is a Permit Required Confined Space. In identifying possible hazards, the SHSO or designee will evaluate if:

- Atmospheres that are oxygen-deficient or -enriched, flammable, or toxic for single or multigas environments;

> **NOTE:** When testing for atmospheric hazards, note the O_2 reading first. Low O_2 readings (<16%) can cause inaccuracies in detecting the concentrations of combustible gases and vapors, and toxic gases and vapors.

- Possible physical, mechanical, electrical, or biological hazards;
- The possibility of liquids, gases, or solids being admitted during occupancy;
- Past and current uses of the confined space that may have adversely affected the atmosphere of the confined space;
- Any hazards that might be created by the physical characteristics, configuration, and location of the confined space; and,
- Activities or facilities in the area (particularly in interconnected spaces) that could adversely affect the confined space, such as traffic, running vehicles (exhaust fumes), gas lines, sewers, fuel or chemical tank vents

The presence of one or more or the following conditions would indicate that the confined space contains a high hazard(s); thus, would represent a Permit Required Confined Space:

- Atmospheric oxygen concentration below 19.5% or above 23.5%;
- Flammable atmosphere greater than 10% of the lower explosive limit (LEL);
- Atmospheric hydrogen sulfide concentration above 10 parts per million (ppm);
- Atmospheric CO concentration above 25 ppm;
- Atmospheric carbon dioxide (CO_2) concentration above 5,000 ppm;
- Atmospheric concentration of any toxic substance above the OSHA PEL or the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) (whichever is lower);
- Any atmospheric or physical condition recognized as dangerous;
- Conditions that limit access or egress; or,
- Mechanical energy.

If a site is determined to be a Permit Required Confined Space, a Confined Space Entry Permit must be completed (**Appendix D**).

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4.0 PERSONNEL PROTECTION AND MONITORING

Initial safety and health indoctrination, visitor safety and health awareness, and any additional training shall be the responsibility of the SHSO. The SHSO shall maintain a record of training attendance in the Safety and Health Logbook.

Employees working on-site (such as but not limited to equipment operators, general laborers, and others) potentially exposed to hazardous substances, health hazards, or safety hazards shall be trained in accordance with the requirements of 29 CFR 1910.120 (HAZWOPER) and 29 CFR 1910.1200 (HAZCOM). Personnel shall provide written certification to the SHSO that the required training has been received prior to engaging in on-site activities. Documentation of training will be maintained on site and managed by the SHSO. Specific training requirements are discussed below.

4.1 Medical Surveillance

Personnel requiring access to controlled work areas will have a baseline medical examination and a periodic (usually annual) update examination prior to assignment, in accordance with OSHA 29 CFR 1910.120(f). The exam must be performed by an Occupational Health Physician, who will provide written clearance for hazardous waste site work and respirator usage. Protocols for the baseline, periodic, and exit exams must be at least as stringent as those defined in the Amec Foster Wheeler Medical Surveillance Program, Volume II of Amec Foster Wheeler’s Corporate Health and Safety Manual.

4.2 Personal Protective Equipment and Action Levels

During field activities, controls will be implemented using the OSHA hierarchy of controls (e.g., engineering, administrative, and PPE, as the last resort). When engineering and administrative controls are not feasible or additional controls are needed, the use of PPE is implemented. The use of PPE shall be in compliance with 29 CFR 1910 Subpart I.

Prior to commencement of field activities, site personnel will be trained in the use of PPE. Standard minimum PPE for this project will consist of modified Level D protection, which includes the following:

- Cotton Coveralls
- Hardhat;
- ANSI Z87.1 approved safety glasses;
- Long Pants;
- Nitrile gloves;
- Steel-toed boots (ANSI Z41 approved);
- Hearing protection, as needed; and,
- Class II High Visibility Work Vest.

Given the low detection limits associated with PFC analysis and the many potential sources of trace levels of PFCs, field personnel are advised to err on the side of caution by strictly following protocols to help mitigate the potential for false detections of PFCs. The following table lists the acceptable and unacceptable PPE for this project:

Table 4-1. Summary of Prohibited and Acceptable Items for Sampling of PFCs

Prohibited Items	Acceptable Items
Field Clothing and Personal Protective Equipment (PPE)	
New cotton clothing or synthetic water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of natural fibers (preferable cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™	Boots made with polyurethane and polyvinyl chloride (PVC)
Tyvek®	Cotton Clothing
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	**Sunscreens** - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are "free" or "natural" **Insect Repellents** - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics **Sunscreen and insect repellant -** Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion

4.2.1 Work Practices

Good personal hygiene shall be practiced by all site personnel. This includes:

- No eating, drinking, chewing of gum or tobacco, application of cosmetics, or smoking on site.
- Washing hands frequently, prior to eating or drinking, and at the end of each day's activities.

4.3 Monitoring Requirements

4.3.1 Exposure/Air Monitoring

The SHSO or designee shall test for hazardous atmospheres in the confined space before the entry supervisor will authorize entry into the space. The sequence of testing will be oxygen, flammability, toxicity. Preliminary tests shall be conducted before and after ventilation of the confined space. Testing should be conducted for at least 15 minutes before employees enter the space and continuously while they occupy it. If a permanent monitor is installed in the space, it must operate continuously while the confined space is occupied.

During occupancy, the frequency of testing shall be as stated in the Confined Space Entry Permit, (as previously determined by the Corporate HSE Director or local HSE designee). In cases that require continuous atmospheric testing, the results will be recorded on the Confined Space Entry Permit at an interval no longer than every 30 minutes. Testing shall be conducted throughout the entire space occupied by using direct reading instruments (DRIs) worn by entrants.

The required atmospheric test equipment shall be listed on the Confined Space Entry Permit (Attachment 1).

The atmosphere of a confined space shall be considered within acceptable limits whenever the following conditions are maintained:

- Oxygen between 19.5% and 23.5%;
- Flammability less than 10% of the LEL;
- Hydrogen sulfide concentration less than 10 ppm;
- CO concentration less than 25 ppm;
- CO_2 concentration less than 5,000 ppm; and,
- Toxicity concentrations less than one-half the OSHA PEL or ACGIH TLV (whichever is lower).

4.3.2 Routine Monitoring for Explosive Environments

Explosive environments are not anticipated for the fieldwork to be conducted during the investigations. In the unlikely event that unexploded ordnance is discovered during site investigation activities, the field team will cease working and contact the project manager and the Amec Foster Wheeler unexploded ordnance (UXO) Program Manager.

4.4 Physical Monitoring

During extreme temperatures, heat or cold stress monitoring will be implemented. The State of California Department of Industrial Relations updated their Heat and Illness Prevention Regulation Amendments on May 14, 2015, and the new code of regulations can be found in **Appendix E**.

4.4.1 Heat Stress Monitoring

Heat stress monitoring will be conducted at times of elevated ambient temperatures, moderate to heavy workloads, and/or when impermeable protective clothing are being used. Heat stress monitoring will be implemented when impermeable protective clothing is in use and ambient temperatures exceed 70°F. The frequency of monitoring will increase as the ambient temperature increases or if slow recovery rates are indicated. When ambient temperatures exceed 80°F, monitoring will be accomplished after each work period.

The heat stress monitoring program will be managed on site by the SHSO. **Table 4-2** provides a summary of the types of heat-related illnesses that are possible when working in hot temperature extremes. Monitoring will increase with temperature extremes.

Table 4-2. Summary of Heat-Related Illnesses

Heat Related Illness	Signs and symptoms	Emergency Care
Heat Rash	Red skin rash and reduced sweating	Keep the skin clean, change all clothing daily, cover affected areas with powder containing corn starch or regular corn starch
Heat Cramps	Severe muscle cramps, exhaustion, sometimes with dizziness or periods of faintness	Move the patient to a nearby cool place; give the patient half-strength electrolyte fluids; if cramps persist, or if more serious signs develop, seek medical attention

Table 4-2. Summary of Heat-Related Illnesses (continued)

Heat Related Illness	Signs and symptoms	Emergency Care
Heat Exhaustion	Rapid breathing, weak pulse, cold and clammy skin, heavy perspiration, total body weakness, dizziness that sometimes leads to unconsciousness	Move the patient to a nearby cool place; keep the patient at rest, give the patient half-strength electrolyte fluids, treat for shock, seek medical attention. **DO NOT TRY TO ADMINISTER FLUIDS TO AN UNCONSCIOUS PATIENT**
Heat Stroke	Deep breaths, then shallow breathing; rapid, strong pulse, then rapid, weak pulse; dry, hot skin; dilated pupils, loss of consciousness (possible coma); seizures or muscular twitching may be seen	Cool the patient rapidly; treat for shock; if cold packs or ice bags are available, wrap them and place one bag or pack under each armpit, behind each knee, one in the groin, one on each wrist and ankle, and one on each side of the neck; seek medical attention as rapidly as possible; monitor the patient's vital signs constantly. **DO NOT ADMINISTER FLUIDS OF ANY KIND**

Of particular importance is heat stress resulting when protective clothing decreases natural body ventilation. One or more of the following steps will help reduce heat stress:

- Drinking water and/or electrolyte solution will be made available to the workers in such a way that they are stimulated to frequently drink small amounts (i.e., two or more cups at every break period). The fluid will be kept reasonably cool (55 to 60°F) and shall be placed close to the workplace so that the worker can reach it without abandoning the work area
- Lightweight clothing acts as a wick to help absorb moisture and to protect the skin from direct contact with heat-absorbing protective clothing.
- When determined to be necessary/applicable, the installation of mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.
- In extremely hot weather, conduct non-emergency response operations in the evening.
- In hot weather, rotate shifts for workers wearing impervious clothing.

4.4.2 Cold Stress Monitoring

Evaluating a work environment to determine the degree of cold stress involves measuring air temperature, wind speed, and the amount of energy expended by the workers. **Table 4-3** provides a summary of the types of cold-related illnesses that are possible when working in cold temperature extremes. Monitoring will increase with temperature extremes.

Work place monitoring for cold related stress is required as follows:

- Suitable temperature measurements should be conducted at any workplace where the environment temperature is 60.8°F so that overall compliance with the requirements of the TLV can be maintained.
- Whenever the air temperature at a workplace falls below 30.2°F, the dry bulb temperature should be measured and recorded at least every 4 hours.

- The wind speed should also be recorded at least every 4 hours whenever the rate of air movement exceeds 2 meters per second (5 miles per hour). Contact the local meteorological station (e.g., local airport) for wind speed and direction data.
- In outdoor work situations, the wind speed should be measured and recorded together with the air temperature whenever the air temperature is below 30.2°F.

Table 4-3. Summary of Cold-Related Illnesses

Cold Related Illness	Symptoms	Possible Underlying Causes	Treatment
Hypothermia	• Pain in the extremities • Uncomfortable shivering and the sensation of cold • Reduction of body core temperature • Cool skin • Rigid muscles • Slowing of heart rate • Weakening of pulse • Low blood pressure • Irritability of heart muscle • Sometimes heart beating abnormally in respect to strength and rhythm • Slow irregular breathing • Memory lapses • Vague slow slurred speech • Drowsiness • Incoherence • Diminished reaction time • Diminished coordination • Diminished dexterity	• Exposure to low air temperatures, high wind, inadequate clothing or water immersion • Underlying disease, such as heart or blood vessel disease • Old age • Allergies • Alcoholism • Recent alcohol consumption • Smoking • Medications that affect the temperature-regulation mechanism • Exhaustion • Sedative drugs • Dehydration	• Get the victim out of the wind, snow, or rain • Keep use of energy to a minimum • Keep person awake • Victim should be handled on a stretcher if movement is necessary • Strip off all wet clothes • Get person into dry clothes • Wrap blanket around victim • In conscious victims, body should be packed with heat packs or wet towels no warmer than 105˚F, behind the neck, groin, and armpits • Do not rewarm extremities and the core at the same time • Provide lifesaving actions as necessary - mouth-to-mouth resuscitation or cardiopulmonary resuscitation (CPR), if trained • If blankets, sleeping bag, newspapers, heat packs, or wet towels are not available, rewarm victim with body heat • Give sweet warm drinks to conscious victims • Do not immerse victim in a warm water bath • Take victim to the hospital by calling an ambulance and telling them that a cold illness emergency exists
Raynaud's Syndrome	• Fingers turn white and stiff • Intermittent blanching and reddening of the fingers and toes • Affected area tingles and becomes very red or reddish purple	• Exposure to low air temperature, high winds • Inadequate clothing • Underlying disease such as blood vessel disease	• Remove to warmer area • Consult physician

Cold Related Illness	Symptoms	Possible Underlying Causes	Treatment
Acrocyanosis	• Hands and feet are cold, blue, and sweaty	• Exposure to cold • Inadequate clothing • Underlying disease such as blood vessel disease	• Remove to warmer area • Loosen tight clothing • Consult physician
Frostnip	• Skin turns white	• Exposure to cold	• Remove to warmer area • Refer to treatment for frostbite
Chilblain	• Recurrent localized itching, swelling, and painful inflammation of the fingers, toes, or ears • Severe spasms	• Inadequate clothing • Exposure to cold and moisture • Underlying disease such as blood vessel disease	• Remove to warmer area • Consult physician
Frostbite	• Skin changes color to white or grayish yellow, progresses to reddish violet, and ultimately turns black • Burns at first • Blisters • Affected part cold, numb, and tingling	• Exposure to cold • Lack of acclimatization • Age (very young or old) • Physically disabled or mentally impaired • Underlying diseases, such as heart and blood vessel disease	• Cover the frozen part • Provide extra clothing and blankets • Bring victim indoors as soon as possible • Place the frozen part in warm water at a temperature of 102°F to 105°F or re-warm with warm packs • If affected part has been thawed and refrozen, do not use water, re-warm at room temperature • If no water is available, wrap gently in a sheet and blanket • Discontinue warming the victim as soon as the affected part becomes flushed and swelling develops after thawing • Exercise part after re-warming, but do not allow victim to walk after the affected part thaws • Place dry sterile gauze between affected fingers and toes, do not apply other dressings unless victim is to be transported for medical aid • If travel is necessary, warm affected parts with sterile or clean cloths during transportation • Elevate the frostbitten parts and protect them from contact with bedclothes • Give sweet, warm fluid if victim is conscious and not vomiting; no alcoholic or caffeine beverages • In absence of warm water, frostbitten fingers should be placed uncovered under the armpits next to skin • If the toes or heels are affected, footwear should be covered with dry socks • If above measures for feet are not possible, place bare frostbitten feet against the belly of a companion or under clothing

Cold Related Illness	Symptoms	Possible Underlying Causes	Treatment
			• If the cheeks are frostbitten, cover the affected areas with warm hands until the pain returns • Following re-warming, wounds should be treated in open and sterile manner; bandages hamper the circulation • Deep frostbite should not be thawed in the field • Do not rub the part with anything (including snow and ice), apply heat lamp or hot water bottles, place injured part near a hot stove, or break blisters • Obtain medical assistance as soon as possible

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5.0 SITE CONTROLS, MEASURES, ACCIDENT PREVENTION, AND CONTINGENCY PLAN

5.1 Site Control Measures

The SHSO and/or FM will be responsible for establishing the site control zones, as necessary, around areas that present physical and/or chemical hazards. Unauthorized personnel shall be kept out of work zones.

5.2 Work Zone

The work area shall be established to provide for protection of personnel during investigation activities. These work areas will be dynamic and will change as the work proceeds from one area of the site to another and will be identified in the installation-specific HSP. The work area is defined as the overall boundary where field activities will be performed. Activities that will occur in the work area include equipment and material staging, drilling, soil, sediment, surface water and groundwater sampling. Site personnel, including visitors such as client or regulatory agency personnel, will be properly briefed on the HSP prior to entering any designated work area. Work areas will be clearly identified using barricade fencing, hazard tape, or adequate signage.

5.3 Safe Work Practices

Project personnel must have adequate training and understanding of this HSP and the appropriate installation-specific HSP. The SHSO will review safe work practices during daily tailgate meetings. Examples of safe work practices include, but are not limited to, the following:

- Unauthorized personnel are not allowed in the work area.
- Work groups will always consist of at least two team members.
- A high standard of personal hygiene will be observed. Smoking, eating, drinking, and chewing gum or tobacco will not be permitted within the work area.
- Personnel under the obvious influence of alcohol or controlled substances will not be allowed on-site; those taking medications must notify the SHSO.
- Site personnel will familiarize themselves with these practices and the emergency procedures during daily tailgate and pre-work safety meetings.
- Workers who are drivers or passengers of vehicles will wear their seat belts any time the vehicle is in motion.
- Cell phone use is prohibited while driving at all times.
- Personnel will avoid contact with contamination or potentially contaminated media. If such contact occurs, the affected areas should be washed thoroughly with soap and water.
- Personnel will discard and replace any damaged or heavily soiled protective clothing. Discarded PPE will be containerized or drummed at the end of each day.
- Personnel should notify the SHSO of any defective monitoring, emergency, or other protective/safety equipment.

- For cold weather work, shelter away from rain, snow, or wind will be provided for breaks. Employees will be encouraged to increase fluid intake to prevent dehydration, and to drink warm, sweet, caffeine-free, nonalcoholic drinks periodically.
- If working in hot weather conditions, employees should work at a slow even pace, take frequent rest breaks away from direct sunlight, and drink plenty of electrolyte-containing liquids. Use of the buddy system to monitor co-workers and watch for signs of heat stress will be implemented.
- A supply of potable water, electrolyte replacement solutions, shaded break area, and sufficient lighting will be maintained on site; and sanitary facilities will be accessible to personnel.

5.4 Health and Safety Equipment Checklist

Prior to beginning work on-site, the SHSO will make sure necessary safety equipment and PPE are accessible and in good condition.

Subcontractors will be responsible for checking their equipment, such as drill rigs, prior to the start of field activities.

A key element of the Project Specific Safety and Health Program is the implementation of an accident prevention program. It is essential that the contents of this HSP are communicated to all personnel who work on the site. The following actions will be used to prevent accidents at the Site:

- **Educate personnel** as to the requirements of the HSP;
- **Eliminate unsafe conditions.** Efforts must be initiated to identify conditions that can contribute to an accident and to remove exposure to these conditions;
- **Reduce unsafe acts.** Personnel shall make a conscious effort to work safely; and
- **Inspect frequently.** Regular safety inspections of the work site, material, equipment, and operations by qualified persons (i.e., SHSO) will help with early detection of unsafe conditions. Safety and health deficiencies shall be corrected as soon as possible, or site activities shall be suspended.

Adherence to Safe Work Practices and procedures outlined in this HSP will assist with accident prevention. JHA forms are included in **Appendix B**.

5.5 Accident Prevention

Slips, Trips, and Falls

The following preventive measures will reduce the potential for these hazards:

- Personnel will keep working areas clean. Tools, equipment, and materials will be used and stored in a fashion to minimize tripping hazards. Small, loose items such as tools, materials, and other small objects and debris will not be left lying around, particularly in areas where personnel walk.
- Walkways will be kept free of obstacles. Openings in walkways will be repaired, if possible. If not immediately repaired, the section must be roped off or closed until repairs can be made.

- Personnel will not walk or climb on piping, valves, fittings, or any other equipment not designed as walking surface. Walking and working surfaces will be properly maintained during inclement weather.
- Electrical extension cords and electrical wiring must be kept clear of walking and working areas and/or covered, buried, or otherwise secured.
- Personnel will maintain a three-point contact when mounting or dismounting heavy equipment or ladders.
- Running is prohibited on job sites unless under emergency conditions.
- Spills will be cleaned up immediately.
- Personnel will take extra precautions, such as establishing firm hand holds, footwear, and walking slowly when walking or working during wet, snowy, or icy weather.

5.5.1 Use of Tools and Machinery

Tools and machinery use safety procedures include:

- Tools and machinery will be inspected and properly maintained in accordance with the manufacturer's instructions and recommendations. Hand tools and machinery should be inspected daily or before each use for defects. Tools that are burred, broomed, mushroomed, have split or loose handles, worn or sprung jaws, or are generally unsafe should be turned in to the FM or SHSO and immediately taken out of service.
- Defective or unsafe machinery must be tagged with “Do Not Use” or “Defective Do Not Use” tags until repaired or otherwise made acceptable. Defective or unsafe equipment must be removed to a secure place to prevent inadvertent use until repaired. Repaired items must be re-inspected by the SHSO before being placed back into service.
- Tools and machinery must be used only for the purpose for which it was designed (do not use a wrench for a hammer, screwdriver for a chisel, pliers for a wrench, pipe or stilson wrenches as a substitute for other wrenches, a pipe handle-extension or a “cheater” on a wrench). All modifications, extensions, replacement parts, or repairs of equipment must maintain at least the same factor of safety as the original equipment.
- Machinery containing liquid systems (e.g., fuel, hydraulic, lubrication) will be inspected daily to ensure that liquid-containing systems (e.g., hoses, tubing, hydraulic lines) are in good operating condition and that plugs, stoppers, valves, etc., are properly seated.
- Machinery must not be operated without proper training and special permission unless it is a regularly assigned duty.
- Loose or frayed clothing, dangling ties, rings, etc., must not be worn around moving machinery or other mechanical sources of entanglement.
- Air hoses should not be disconnected from compressors until the air within the hoses has been bled off.

* Pressure reducers will be in place for air hoses used to blow off debris or clothing. Gauges will be used to ensure that air used to blow off debris or clothes will be no more than 30 pounds per square inch.
* Personnel shall not use air hoses to blow off potentially contaminated clothing.
* Electrical power tools, lighting equipment, etc. to be used must be properly grounded by using three-wire receptacles and extension cords rated for the amperage required. Ground fault circuit interrupters (GFCIs) should be used with temporary electrical systems or other proper grounding system.
* Portable electric tools must not be lifted or lowered by means of a power cord. Electrical equipment cords should be kept coiled when not in use. When electrical equipment is in use, cords should be protected and positioned to avoid being run over by vehicles or equipment.
* Machinery must not be repaired or adjusted while in operation. Oiling of moving parts must not be attempted except on equipment that is designed or fitted with safeguards to protect the person performing the work.
* Personnel using hand and mechanical tools will position themselves properly and anticipate what could happen if a tool slips or moves suddenly.

5.5.2 Noise

Personnel shall use protective devices per the following guidelines:

* The direction of the FM/SHSO; and,
* When working within 25 feet of operating equipment.

A noise reduction rating (NRR) value of 33 decibels on the A-weighted scale (dBA) is the minimal acceptable value for hearing protection. Protective devices will have an NRR appropriate to reduce the sound levels below 85 dBA while not affecting the worker's ability to communicate, hear alarms, or hear nearby moving equipment. Moreover, project staff will be trained on how to properly use hearing protection. Finally, the use of hearing protection devices will be monitored by the FM and SHSO.

5.5.3 Severe Weather

Personnel will receive information regarding severe weather during Tailgate Safety Meetings. The following are examples of typical weather alerts:

* Lightning Watch – Lightning is possible within 5 miles of the site (or within approximately 30 minutes). Work may continue but personnel should be prepared to stop work operations.
* Lightning Warning – Lightning is imminent or occurring on within the immediate area. Personnel visually see lightning strikes. Operations must cease and personnel must seek cover (e.g., vehicle or field office) and wait 15 minutes after the final lightning strike.
* Tornado Watch – Issued by the National Weather Service (NWS) when conditions are favorable for the development of tornadoes in and close to the Tornado Watch area. Duration for watch is usually 4 to 8 hours.

- Tornado Warning – The NWS reports where the tornado was located and what towns will be in its path. Personnel are to take cover immediately if within or near the path. Seek low-lying areas if out in an open field. Cover head area with hands and arms, and lay still.
- Hurricane Watch (where applicable) – Issued by the NWS whenever a hurricane becomes a threat to coastal areas. Everyone in the area covered by the “watch” should listen for further advisories and be prepared to act promptly if a hurricane warning is issued.
- Hurricane Warning (where applicable) – Issued by the NWS when hurricane winds of 74 miles per hour (mph) or higher, or a combination of dangerously high water and very rough seas, are expected in a specific coastal area within 24 hours. Precautionary actions should begin immediately.

5.5.4 Heavy Equipment

The following guidelines will be adhered to while operating heavy construction equipment:

- Hard hats, steel-toed boots, safety glasses or goggles, and high visibility vest shall be worn at all times when personnel are around heavy equipment. The JHA shall specify any additional PPE requirements.
- Equipment will not be operated in a manner that will endanger persons or property nor will the safe operating speeds or loads be exceeded.
- Getting off or on any equipment while it is in motion is prohibited.
- Operators will maintain a “three-point” contact while mounting or dismounting equipment (i.e. two hands and one foot contact on stable equipment surface).
- Equipment will be operated in accordance with the manufacturer's instructions and recommendations.
- Drill platforms and immediate work areas must be kept clear. Oil, grease, or excessive mud will not be allowed to accumulate in these areas. Open boreholes will be backfilled immediately, or capped and flagged.
- Machinery or equipment will be shut down and positive means taken to prevent its operation while repairs or manual lubrications are being done. Equipment designed to running is exempt from this requirement.
- No guard, safety appliance, or device will be removed from machinery or equipment, or made ineffective except for making immediate repairs, lubrications, or adjustments, and then only after the power has been shut off. All guards and devices will be replaced immediately after completion of repairs and adjustments and before power is turned on.
- Mechanized equipment will be shut down prior to and during fueling operations. Closed systems, with automatic shut off that prevent spillage if connections are broken, may be used to fuel diesel-powered equipment left running.
- Each piece of heavy equipment and other similar equipment shall be equipped with at least one dry chemical or carbon dioxide fire extinguisher with a minimum rating of 10 pounds B:C.

- Spotters for tight areas, overhead and underground utilities, excavation, etc. and sample collectors will be the only personnel allowed near heavy equipment. Spotters and sample collection personnel will stay out of the boom radius. Personnel needing to approach heavy equipment while it is in operation will observe the following protocols:
  - Never walk directly behind or to the side of heavy equipment without the operator's knowledge.
  - Make eye contact with the operator (and spotter).
  - Signal the operator to cease heavy equipment activity.
  - Approach the equipment only after the operator has given a signal to do so.

5.5.5 Utilities

The minimum clearance from overhead power lines, up to 50 kilovolts (kVs), is 10 feet. For voltages over 50 kV, add 4 inches per 10 kV to obtain the minimum clearance distance to obtain safe distance between equipment and power lines (**see Table 5-1**, Minimum Clearance from Energized Overhead Electrical Lines). If voltage is unknown, remain at least 20 feet from overhead power lines.

If activities occur where equipment needs to be closer to overhead power lines than the minimum distance shown in **Table 5-1**, the power to the overhead lines will need to be shut off and locked out, unless it can be confirmed that the power lines are not operational.

Table 5-1. Minimum Clearance from Energized Overhead Electrical Lines

Nominal System Voltage (kV)	Minimum Rated Clearance (ft)
0-50	9.8
51-200	14.7
201-300	19.7
301-500	24.6
501-750	34.4
751-1000	44.3

Notes:
kV – kilovolt
ft – foot or feet

If for any reason there is a need to either shut-off or turn-on a utility (e.g., steam, water, or electrical), the FM will contact proper authorities prior to this action. In addition, only hand digging is permitted within 3 feet of underground high voltage, product or gas lines. Once the line is exposed, heavy equipment can be used but must remain at least 3 feet from the exposed line.

5.5.6 Boating

The following guidelines will be adhered to when operating a boat:

- Any employee assigned to operate a boat on behalf of Amec Foster Wheeler shall be thoroughly trained in the proper operation of the boat and outboard motor.

- Be sure to wear work gloves when working with trailer hitches to reduce pinching fingers and hands.
- Fueling the boat should be done with extreme caution to avoid static sparks and spills. Don't overfill the tank.
- Make sure a fire extinguisher and first aid kit are on the boat.
- Watch your wake and the wake of other boats.
- An appropriate Coast Guard approved personal floatation device shall be worn by each individual on board to protect against drowning.
- A throwable floatation device (ring) shall also be onboard during boat operation.
- Carry extra engine parts and fluids in the event of engine problems.
- A two-way or marine radio shall be maintained on board the boat at all times.

5.6 Site Security

Workers and visitors in the work area will be monitored by the FM and SHSO and required to sign the daily tailgate meeting form and HSP acceptance form.

5.7 Communication

On-site personnel will be trained on the physical and health hazards associated with hazardous materials planned for use during the project in compliance with OSHA standards 29 CFR 1910.1200 and 29 CFR 1926.59.

The HAZCOM Program formulates the basis for chemical safety found in the aforementioned OSHA standards. These standards provide the basis for workers to know the physical and health hazards involved with the chemicals used on site. The implementation of an effective HAZCOM Program reduces the potential for workers to be exposed to hazardous chemicals. This program encompasses chemicals workers use in their daily activities. The elements of a HAZCOM Program include:

- Written workplace program;
- Chemical inventory (**Appendix A**);
- SDSs (**Appendix C**);
- Training workers on the physical and health hazards, and methods and observations to detect the release or presence of hazardous chemicals; and,
- Labeling system.

The SHSO will maintain a Chemical Inventory Form (**Appendix A**) and copies of SDSs (**Appendix C**) for hazardous chemicals that are to be used on-site during project work. The SHSO will maintain a binder with contents of the OSHA standard (29 CFR 1910.1200 or 29 CFR 1926.59), written program, chemical inventory, and corresponding SDSs in the Amec Foster Wheeler site office. The SHSO will provide copies of applicable SDSs to emergency service personnel as needed or requested.

Subcontractors shall provide a complete chemical inventory of chemicals intended for use on-site prior to mobilization. The Amec Foster Wheeler Site Chemical Inventory Form (**Appendix A**) can be used to document chemicals brought on site. In addition, corresponding SDSs for each chemical listed will be provided with the inventory for inclusion into the site HAZCOM binder. The SHSO will in turn inform subcontractors of the location of the project HAZCOM binder. The SHSO will provide copies of applicable SDSs to subcontractor personnel as needed or requested. Site personnel will be informed of the hazardous substances that they will be working with through HAZCOM training at the time of SHSO review and at safety meetings.

Primary containers (i.e., manufacturer's label) will include the product identity, hazard warnings, and manufacturer's name and address. If the label is defaced, an alternate label with the product identity and hazard warnings is required. Secondary containers package hazardous substances transferred from an original container to another container. These containers require labeling at the time that they are filled. The label shall include the identity of the product and any hazard warnings found on the original container (e.g., flammable, corrosive). The precautions described under each JHA in **Appendix B** shall ensure that potential exposure to chemicals brought on-site is minimized.

Subcontractors are responsible for providing HAZCOM training for their personnel. SDSs for the site-related contaminants such as lead, gasoline, diesel fuel are included in this HSP (**Appendix C**). These SDSs are provided for informational purpose only. They are not part of the HAZCOM program. SDSs provide information such as health effects that can result from exposure, flammability, and reactivity hazards associated with handling these materials. The SHSO will ensure the HAZCOM binder is appropriately supplemented with additional SDSs as required during performance of field activities, that the Chemical Inventory is maintained accurately on-site, that site personnel review appropriate SDSs prior to using or handling these substances, and that SDSs are maintained with this HSP in an area accessible to all site personnel.

Personnel will observe all of the requirements and restrictions specified on the product SDS (e.g., PPE, first aid, disposal, incompatibilities, etc.). The SHSO will determine respiratory protection requirements based on air monitoring results. Persons using a substance and who are unfamiliar with the hazards conveyed by the substance or the necessary control measures must first review the SDS, and have an opportunity to ask the SHSO any questions. The SHSO is responsible for ensuring that persons using or handling the substances have been trained in HAZCOM (e.g., how to read and understand an SDS, chemical labeling, etc.).

5.8 Contingency Plan

Project personnel shall be familiar with the various contingency measures should an accident occur. Emergency telephone numbers and other emergency provisions for the Site are listed on the cover page of the installation-specific HSP. A hospital map is provided in the installation-specific HSP**.**

5.8.1 Fire

In case of a fire, personnel shall exit the site by the nearest means of egress, find the nearest telephone and call/dial 911. Once contact is made, witnessing personnel shall stay on the telephone to provide the responding elements with additional data. In no case shall witnessing personnel attempt to fight a major fire.

Once off the site, personnel shall assemble at a location designated by the FM or SHSO and be counted. Any missing personnel shall be brought to the attention of the emergency response personnel.

5.8.2 Chemical Exposure

Chemical exposures are not anticipated during installation investigations; however, if a member of the field crew demonstrates symptoms of chemical exposure, the procedures outlined below should be followed:

- Another team member (buddy) will remove the individual from the immediate area of contamination, if safe to do so. The buddy will communicate to the field team of the chemical exposure. The FM will contact the appropriate emergency response agency.
- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individuals clothing, the chemical will be neutralized or removed if it is safe to do so.
- In the case of eye contact, an emergency eye wash will be used. Eyes will be washed for at least 15 minutes.
- Chemical exposure incidents must be reported in writing to the Health, Safety, and Environment Program Manager.

5.8.3 Spill or Hazardous Materials Release

In the event of a spill or release, the SHSO or FM should be notified immediately. After taking precautions for personal safety, Amec Foster Wheeler or the subcontractor will contain the spill if possible with on-site equipment, to the extent that the responder's training and capability allows. If necessary, the SHSO will evacuate personnel and visitors to the refuge area. Contained materials must be properly drummed and handled as hazardous waste. The FM will notify the client to contact the United States Environmental Protection Agency (USEPA) within 24 hours after occurrence, provided the spill is greater than the reportable quantity.

5.8.4 Confined Space Emergency Response

The authorized attendant shall call the authorized entrants out of the confined space if any of the following occurs:

- An emergency signal or alarm is sounded;

- The attendant cannot effectively or safely perform all the duties required, or has to leave the area without transferring responsibility;
- The attendant detects or suspects the presence of any substance that could endanger the entrants;
- The attendant detects or suspects any atmospheric hazard at or above the prohibited levels;
- Any of the required air monitoring equipment malfunctions;
- There is a breakdown in communication with the entrants;
- The attendant detects the behavioral effects of a hazard exposure in an entrant; or,
- The attendant detects a situation outside the confined space that could endanger the entrants.

When rescue becomes necessary, the authorized attendant shall:

- Notify the entry supervisor of an emergency and, if possible, describe the nature of the emergency, the extent of injuries if any, and the exact location;
- Tell the entry supervisor to contact rescue services and other emergency services;
- Initiate rescue operations from outside the confined space by using the winch(es) and retrieval line(s) attached to the authorized entrant(s);
- Prohibit unauthorized personnel from attempting rescue;

> **NOTE:** An injured, ill, or incapacitated person should not be pulled from a confined space by the lifeline without a trained and properly outfitted rescuer inside the confined space guiding them to ensure that there will be no further injury by supports or protruding objects.

- Provide first aid or CPR as necessary; and,
- Give the rescue service a situation report immediately upon their arrival on site.

If the entrants are still within the confined space, the rescue service will enter the space wearing the same PPE as the attendant and an self-contained breathing apparatus (SCBA) or airline (if space permits) and fully equipped life-support equipment.

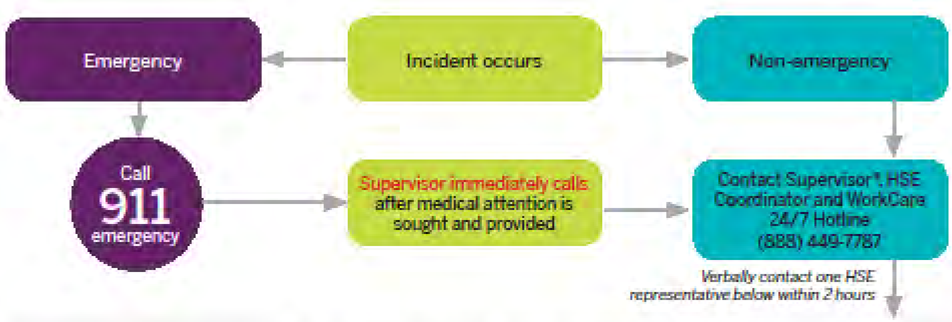
Any injured person will receive emergency treatment at the site and then, if necessary, will be transported to the nearest medical facility, as specified in the Confined Space Entry Permit.

> **NOTE:** Communication shall be established between the confined space location and the rescue service prior to personnel entry into the confined space.

5.8.5 Incident Reporting Procedures

Incident flow chart

Call immediately



E&I Corporate HSE department contact list

Name/email	Office location	Contact information
Bruce Voss bruce.voss@amecfw.com	Cathedral City, CA	760.202.3737 (office) 951.897.6381 (cell)
Chad Barnes chad.barnes@amecfw.com	Phoenix, AZ	602.733.6000 (office) 480.495.9846 (cell)
Cindy Sundquist cynthia.sundquist@amecfw.com	Portland, ME	207.828.3309 (office) 207.650.7593 (cell) 207.892.4402 (home)
Gabe Sandholm gabe.sandholm@amecfw.com	Minneapolis, MN	612.252.3785 (office) 206.683.9190 (cell)
John Mazur john.mazur@amecfw.com	Wilmington, NC	910.444.2978 (office) 910.431.2330 (cell) 910.681.0538 (home)
Lori Dowling lori.dowling@amecfw.com	Prince George, BC	250.564.3243 (office)
Philip Neville philip.neville@amecfw.com	Thorold, ON	905.687.6616 (office) 905.380.4465 (cell)
Tim Kihn tim.kihn@amecfw.com	Edmonton, AB	780.944.6363 (office) 780.717.5058 (cell)
Vladimir Ivensky (can call 24/7) vladimir.ivensky@amecfw.com	Plymouth Meeting, PA	610.877.6144 (office) 484.919.5175 (cell) 215.947.0393 (home)
Kirby Lastinger kirby.lastinger@amecfw.com	Lakeland, FL	836-667-2345 x207 (office) 863-272-4775 (cell)

High potential near misses, subcontractor incidents, regulatory inspections, spills, and property damage should be reported within 60 minutes to one of the above HSE Representatives.

***Supervisor Responsible For:**

- **D&A Testing Coordination as per client and AmecFW requirements, Local/Client Notifications, and Completing Initial IAR within 24 hours and forwarding to Corporate HSE.**

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5.8.6 Evacuation Procedures

Site personnel shall be made aware of the provisions of the emergency response plan. This awareness training shall be conducted by the FM or SHSO prior to the commencement of site activities. This will be conducted in conjunction with the mandatory daily job safety briefing.

Prior to the commencement of site activities, the FM or SHSO shall select a location at an appropriate distance from the site where personnel can gather in the event of an emergency requiring evacuation of the site. This location shall be pointed out to site personnel during the mandatory daily job safety briefing. This refuge site may change depending on weather and activity. The SHSO shall ensure that all personnel are made aware of any changes. Workers will pay special note to the wind direction and evacuate the work area upwind during an emergency. During accidents involving a fire or spill of potentially explosive materials, site personnel shall turn off any operating equipment and evacuate the site by the nearest means of egress.

Personnel shall exit the site by the nearest means of egress during accidents requiring site evacuation. Once off the site, personnel shall assemble at a location designated by the FM or SHSO and be counted. If any person is determined to be missing, it shall be brought to the attention of the emergency response personnel.

If an operation shutdown is necessary, the steps below shall be followed:

- Personnel are to leave the work location (upwind) and assemble at a designated assembly point (if safe) after detecting the emergency signal for evacuation;
- If an emergency situation is of concern to local site personnel, they will notify the SHSO who will notify the appropriate individuals;
- If appropriate and safe, the SHSO and a “buddy” are to remain at or near the location after it has been evacuated to assist local responders and advise them of the nature and location of the incident; and,
- The FM is to account for field team members at the assembly point.

Evacuation routes and assembly points will be documented by the SHSO or FM during the employee health and safety briefing and daily tailgate meetings. Such locations shall minimize the spread of contamination.

5.9 Recordkeeping

The SHSO will establish and maintain documents regarding health and safety records; reports; and information concerning individual training, medical surveillance, etc. Sections in this filing system will include:

- Personnel Records – Certificates for training required under 29 CFR 120, medical examination summary letters or certificates, monitoring results, etc.
- Incident Analysis Reports – Reports on any medical, vehicle, property damage, near miss incidents, first aid, etc.

- Training – Sign-in sheets for on-site training with topics and dates.
- Visitor Logs – Sign-in sheets for site visitors.
- Inspection reports – Reports of daily inspections by the SHSO and others concerning health and safety issues.
- Accident Prevention – Copies of hazard analyses performed on new tasks or activities. Copies of any accident/incident reports and follow-up reports. Other pertinent correspondence.
- PPE – Records of periodic inspection, testing, and maintenance performed on PPE.

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6.0 REFERENCES

Code of Federal Regulation (CFR); Title 29 – *Labor*; Subtitle B – *Regulations Relating to Labor*; Chapter XVII – *Occupational Safety and Health Administration, Department of Labor*; Part 1910 – *Occupational Safety and Health Standards*.

CFR, Title 29 – *Labor*; Subtitle B – *Regulations Relating to Labor*; Chapter XVII – *Occupational Safety and Health Administration, Department of Labor*; Part 1926 – *Safety and Health Regulations for Construction*.

National Institute for Occupational Safety and Health (NIOSH), 2005. *NIOSH Guide to Chemical Hazards*. September.

United States Environmental Protection Agency (USEPA), 1984. *Standard Operating Safety Guides*. November.

Health and Safety Plan Acceptance

I have had the opportunity to read and ask questions regarding the information presented in this HSP. I understand the procedures, equipment, and restrictions of this plan and agree to abide by them. Be signing below, personnel are indicating they have received and are current with their medical surveillance and training certification; in accordance with 29 CFR 1910.120 and AMEC corporate health and safety policies.

Signature	Printed Name	Company	Date

APPENDIX A

HEALTH AND SAFETY FIELD FORMS

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Completed by: ____________________

Date: ____________________

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Chemical Inventory Form - Hazard Communication

Job Number: ____________________ **Project:** ____________________ **Date:** ____________________

Chemical Name	Quantity	Is it labeled?	Do you have the MSDS?

Hazard Assessment and PPE Selection

Task: ______

Department: ______

HAZARDS IDENTIFIED:
Seriousness of Injury?

Impact (Explain): ______
None ☐ Lo ☐ Med ☐ Hi ☐

Penetration: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Compression: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Chemical: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Heat, Hot Surfaces: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Harmful Dust: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Light Radiation: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Falling Objects: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Sharp Objects: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Rolling or Pinching Objects: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Electrical Hazards: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Ergonomic/Lifting: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Other: ______
None ☐ Lo ☐ Med ☐ Hi ☐

Can the task be modified to reduce/eliminate the hazard? Yes __No __If yes, how? ______

MSDS PPE RECOMMENDATIONS:

☐ **Gloves, Type:** ______

☐ **Safety-toe Boots**

☐ **Boot Covers**

☐ **Hard Hats**

☐ **Other** ______

☐ **Coveralls, Type:** ______

☐ **Apron**

☐ **Safety Glasses, Goggles, or Faceshield**
Type: ______

☐ **Respirator**
Type: ______

PPE REQUIRED FOR THE TASK:

☐ **Gloves, Type:** ______

☐ **Safety-toe Boots**

☐ **Boot Covers**

☐ **Hard Hats**

☐ **Other** ______

☐ **Coveralls, Type:** ______

☐ **Apron**

☐ **Safety Glasses, Goggles, or Faceshield**
Type: ______

☐ **Respirator**
Type: ______

Training Required for Task: ______

POST THIS FORM IN THE WORK AREA WHERE THE TASK IS ROUTINELY PERFORMED.

Record of Change
Site-Specific Health and Safety Plan

GENERAL SITE INFORMATION

Site Name: ______________________________ Date: __________

Project Number: ______________________________

Site Health and Safety Coordinator: ______________________________

Project Manager: ____________________ Field Manager: ____________________

DESCRIPTION OF AND JUSTIFICATION FOR CHANGE

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SHSC Signature: ______________________________ Date: __________

Authorization: ____________________ Title: ____________________ Date: __________

Tailgate Safety Meeting Report

Check One:

❑ Initial Kickoff Safety Meeting ❑ Regular/Daily Tailgate Safety Meeting ❑ Unscheduled Tailgate Safety Meeting

Date: ________________________ Site: ____

Field Manager: ______________________________ Site Health and Safety Coordinator: ____________________________
(print) *(print)*

Order of Business

Topics Discussed (check all that apply):

❑ Site History/Site Layout
❑ Scope of Work
❑ Personnel Responsibilities
❑ Medical Surveillance Requirements
❑ Training Requirements
❑ Safe Work Practices
❑ Logs, Reports, Recordkeeping
❑ Sanitation and Illumination
❑ Air Surveillance Type and Frequency
❑ Monitoring Instruments and Personal Monitoring
❑ Action Levels
❑ Accident Reporting Procedures
❑ Site Control (visitor access, buddy system, work zones, security, communications)
❑ Discussion of previous "near misses" including work crew suggestions to correct work practices to avoid similar occurrences

❑ Engineering Controls
❑ PPE Required/PPE Used
❑ Define PPE Levels, Donning, Doffing Procedures
❑ Physical Hazards and Controls (e.g., overhead utility lines)
❑ Decontamination Procedures for Personnel and Equipment
❑ General Emergency Procedures (e.g., locations of air horns and what 1 or 2 blasts indicate)
❑ Site/Regional Emergency Procedures (e.g., earthquake response, typhoon response, etc.)
❑ Medical Emergency Response Procedures (e.g., exposure control precautions, location of first aid kit, etc.)
❑ Hazardous Materials Spill Procedures
❑ Applicable SOPs (e.g., Hearing Conservation Program, Safe Driving, etc.)
❑ Injury/Illness Reporting Procedures
❑ Route to Hospital and Medical Care Provider Visit Guidelines
❑ Hazard Analysis of Work Tasks (chemical, physical, biological and energy health hazards and effects)

Safety suggestions by site workers: ____

____

____

Action taken on previous suggestions: ____

____

____

Injuries/accidents/personnel changes since previous meeting: ______________________________

____

____

Tailgate Safety Meeting Report *(continued)*

Observations of unsafe work practices/conditions that have developed since previous meeting: __________

____

____

Location of (or changes in the locations of) evacuation routes/safe refuge areas: ______________________________________

____

____

Additional comments: ____

____

____

Attendee signatures below indicate acknowledgment of the information and willingness to abide by the procedures discussed during this safety meeting.

Name (print)	Company	Signature

Meeting conducted by: ______________________________________ Title: ____________________
(print)

Signature: ____ Time: ____________________

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APPENDIX B

JOB HAZARD Analysis

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JOB HAZARD ANALYSIS (JHA)
FOR DRILLING/BORING AND ASSOCIATED SOIL SAMPLING

Risk Assessment Code (RAC) Table						
		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

E = Extremely High Risk; H = High Risk; M = Moderate Risk; L = Low Risk
Noted in “Potential Hazard” Column

PREREQUISITES		
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
Standard PPE: ANSI Z89.1 approved hard hat (Class C), steel-toe boots (ANSI Z41), ANSI Z87.1 approved safety glasses, hearing protection, and reflective safety vest. Contact with potentially contaminated soil: Standard PPE plus one layer of nitrile rubber gloves, and cotton coveralls. Eye wash station capable of providing 15 minutes of continuous service.	Inspect PPE equipment prior to donning and doffing equipment. Inspect eye wash station at least weekly. Prior to equipment demobilization, equipment used in exclusion zone areas shall be wash down in decontamination wash down station area.	Only trained and qualified personnel will be allowed to work within exclusion zone. Only trained and qualified personnel will be allowed to operate equipment. All personnel trained on the physical and health hazards associate with chemicals used on site. Source documents will be MSDSs from supplier of items.

WORK	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
All Drilling/ Boring Activities	Slips, trips, and falls	• Use caution when walking around the site, look out for uneven terrain and slipper surface after increment weather conditions (e.g. rain, ice, snow). • Personnel shall wear protective foot wear. Foot wear shall have adequate sole and tread to reduce the potential for slipping or falling on slick surfaces. • Practice good housekeeping to keep the site clear of obstructions, materials, equipment and other tripping hazards. Maintain work area clear and in good order. • ALWAYS PLACE TRASH INTO PLASTIC BAGS and dispose of bags in proper waste receptacles.

amec foster wheeler	**JOB HAZARD ANALYSIS (JHA)** **FOR DRILLING/BORING AND ASSOCIATED SOIL SAMPLING**

WORK	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
All Drilling/ Boring Activities	Heat/Cold Stress	• Take breaks if feeling faint or overexerted • Consume adequate food/beverages (water, sports drinks) • If possible, adjust work schedule to avoid temperature extremes.
	Biological Hazards: Insects, Snakes, Wildlife, Vegetation	• Inspect work areas when arrive at site to identify hazard(s) • Open enclosures slowly • Survey site for presence of biological hazards and maintain safe distance • Wear appropriate PPE including leather gloves, long sleeves and pants, and snake chaps as warranted by site conditions
	Traffic (including pedestrian)	• Notify attendant or site owner/manager of work activities and location • Use cones, signs, flags or other traffic control devices as necessary to establish work area • Wear appropriate PPE including high visibility clothing such as reflective vest • Inspect area behind vehicle prior to backing and use spotter
	Fire/ Explosion	• Post No Smoking signs around work area • Establish designated smoking area away from work area • Ensure type ABC, 20-lb, fully charged fire extinguisher on-site and within inspection period • As site conditions/activities warrant, establish Hot Work Permit • Stop work if hazardous conditions (explosive atmosphere) are identified
Concrete Coring	Ignition Sources	• Ensure electrical equipment properly grounded • Apply water as necessary to address surface sparking potential
	High Noise Levels	• Hearing protection required when working around operating equipment if levels are suspected to be >85 dBA (if have to yell to person at a distance of 3 ft to be heard, likely exceeding 85 dBA).
	Airborne Particulates and Debris	• Use water as necessary to control dust in area • Wear appropriate PPE including face shield or safety glasses with side shields, dust mask, leather gloves and long sleeves
	Sharp Rough Materials	• Wear appropriate PPE including leather gloves, long sleeves and pants, and steel-toed boots
	Impact to Subsurface Lines	• Ensure all underground features have been identified in area prior to start of activities

	JOB HAZARD ANALYSIS (JHA) **FOR DRILLING/BORING AND ASSOCIATED SOIL SAMPLING**

WORK	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Drill Rig Set-Up	Rig Roll Over	• Do not move rig with mast raised • Cross all hills and obstructions head on • Set riggers prior to raising mast • If soil appears unstable, the soil should be assessed by a qualified professional engineer to ensure safe conditions with implementation of design control measures prior to start of work
	Contact with Electric Lines and Other Overhead Obstacles	• Position rig to avoid overhead utility lines by distance defined by voltage and local regulations • Use a spotter when raising mast to confirm clearance of overhead lines and other obstructions
	Rig Movement	• Heavy equipment should be equipped with back-up alarm or use horn when backing - use spotter when available • Stay clear of operating equipment and rig when moving
	Heavy Equipment Lifting/Carrying	• Use at least 2 people to lift and carry sections, use mechanical lift devices whenever possible, bend and lift with legs and arms, not back
	Sharp or Elevated Equipment	• Wear appropriate PPE including steel-toed safety boots, leather gloves and hard hat • Establish communication system between workers involved in moving/attaching sections
Ground Disturbance: Auger/Boring Advancement	Faulty or Inappropriate Equipment	• Qualified driller must inspect drill rig prior to use, if faulty or inappropriate, do not proceed until repaired or replaced • Inspect all hand tools prior to use, if faulty or inappropriate, do not proceed until repaired or replaced
	Moving Equipment	• Clear area of obstructions and communicate with all workers involved that drilling is beginning • Do not exceed manufacturer's recommended speed, force, torque, or other specifications. and penetrate the ground slowly with hands on the controls for at least the first foot of soil to minimize chance of auger kick-out • Stay clear of rotating auger • Use long-handled shovel to clear away cuttings when auger has stopped • Do not wear loose clothing • Wear appropriate PPE including leather gloves and steel-toed boots
	Suspended Loads	• Do not walk under suspended loads • When possible, remove overhead hazards promptly • Wear appropriate PPE including hard hat and steel-toed boots
	High Noise Levels	• Use hearing protection if within 20 feet of active drill rig

WORK	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Ground Disturbance: Auger/Boring Advancement (cont.)	Impact to Subsurface Lines/Tanks	• Only drill in areas where underground features have been identified and if hole has to be moved, clear new location first • Wear appropriate PPE including insulating gloves or stand on an insulating mat when in contact with drill rig • Ensure first aid responders are trained to deal with electric shock and flash burns
Ground Intrusion: Split Spoon	Faulty Equipment	• Inspect rope/cable/rod for wear, fraying, oils and moisture prior to use, do not use if faulty until repaired or replaced • Inspect cathead for rust and rope grooves prior to use, do not use if faulty until repaired or replaced
	Moving Equipment	• Do not wrap rope around any part of the hand or body • Maintain distance of at least 18-inches from in-running points on running/reciprocating equipment • Eliminate excess rope • Do not wear loose clothing • Wear appropriate PPE including leather gloves
Soil Sampling	Sharp Sampling Tools	• Use correct tools for opening sleeves • When opening sleeve, cut away from body • Place soil core on sturdy surface prior to cutting • Wear appropriate PPE including respirator if conditions warrant • Double-check sample labels to ensure accuracy and adhesion to containers
	Heavy Materials and Containers Lifting/ Moving	• Position hands/fingers to avoid pinching/smashing/crushing when closing drum rings • Do not lift or move heavy containers without assistance • Use proper bending/lifting techniques by lifting with arms and legs and not with back • Take breaks if feeling faint or overexerted • Wear appropriate PPE including leather gloves and steel-toed boots
General safety during this activity	Severe Weather (RAC: L)	• Prior to work, check the weather forecast for the day. Take cover in a building/vehicle if lightning is spotted. • Wear appropriate clothing for weather conditions.
	Sunburn (RAC: L)	• Shade should be utilized when available and/or shade provided when feasible. If feasible, avoid sunlight during the hours of 10 am and 2 pm when the sunlight is most intense. • Wear hats and other protective garments to provide shade.

amec foster wheeler	**JOB HAZARD ANALYSIS (JHA)** **FOR GROUNDWATER SAMPLING ACTIVITIES**

Risk Assessment Code (RAC) Table						
		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

E = Extremely High Risk; H = High Risk; M = Moderate Risk; L = Low Risk
Noted in “Potential Hazard” Column

PREREQUISITES		
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
Standard PPE: ANSI Z89.1 approved hard hat (Class C), steel-toe boots (ANSI Z41), ANSI Z87.1 approved safety glasses, and reflective safety vest. Contact with groundwater: Standard PPE plus nitrile gloves and cotton coveralls. Eye wash station capable of providing 15 minutes of continuous service.	Inspect PPE equipment prior to donning and doffing equipment. Inspect eye wash station at least weekly. Prior to equipment demobilization, equipment used in work areas shall be decontaminated appropriately.	Only trained and qualified personnel will be allowed to work within work area Only trained and qualified personnel will be allowed to operate equipment. All personnel trained on the physical and health hazards associate with chemicals used on site. Source documents will be MSDSs from supplier of items.

WORK ACTIVITY	**POTENTIAL HAZARD**	**REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE**
Set up decontamination area and groundwater sample collection equipment	Slips, trips, and falls (RAC: M)	• Use caution when walking around the site, look out for uneven terrain and slipper surface after increment weather conditions (e.g. rain, ice, snow). • Personnel shall wear protective foot wear. Foot wear shall have adequate sole and tread to reduce the potential for slipping or falling on slick surfaces. • Practice good housekeeping to keep the site clear of obstructions, materials, equipment and other tripping hazards. Maintain work area clear and in good order. • ALWAYS PLACE TRASH INTO PLASTIC BAGS and dispose of bags in proper waste receptacles.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Set up decontamination area and groundwater sample collection equipment (cont.)	Heavy lifting, muscle strains and sprains involved with handling pumps, polyethylene lining rolls, and generator equipment.(RAC: L)	• No individual employee is permitted to lift any object that weighs over 50 lbs. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50 lb. limit. • Use proper lifting techniques: - Lift with your legs, not your back, bend your knees, move as close to the load as possible, and ensure good handholds are available. - Minimize the horizontal distance to the center of the lift to your center of gravity. - Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. - Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. • Other considerations defining lifting hazards - Area available to maneuver the lift. - Area of the lift – workplace clutter, slippery surfaces. - Overall physical condition.
	Use of sharp edge hand tools to cut tubing (RAC: M)	• Insure handles are in good construction (no cracks, splinters, loose heads/cutting apparatus). • Insure all cutting tools are maintained properly. Blades shall be sharp without knicks and gouges in the blade. • All hand tools (brush hooks, machetes, etc.) with cutting blades shall be provided with a sheath to protect individuals, when not in use. • ALWAYS USE A CUTTING MOTION MOVING AWAY FROM YOU. Never cut towards your body. • All personnel will maintain a 10-foot perimeter around persons clearing brush.
	Struck by hazard (RAC: L)	• Personnel shall wear protective head gear (e.g. hard hats) to reduce risk of hazard. • Personnel shall not position themselves between trucks, and equipment or structures. • Site workers on the ground will remain in the line of sight of personnel operating trucks and use high visibility reflective vest or highly-visible colored apparel.
Collecting purge water from wells using submersible pump connected to 110 W generator	Portable energized sources (RAC: M)	• Perform all service and maintenance work with the generator engine off and the positive battery cable disconnected. Moving parts can cause severe personal injury or death, and live wires could cause fatal electrocution. • Keep the exhaust and air intake free from obstructions such as clothing, furniture or other material. • Always operate the generator in an area where the wind will carry away the exhaust fumes. • Do not overload the generator. • Use the right power cords with your portable power generators such as heavy duty, outdoor rated cords with a wire gauge adequate for the equipment load. Overloaded cords can cause fires or equipment damage. You must also not use extension cords with exposed wires or worn shielding. • Fuels and other flammable liquids should be stored away from exhaust. In addition, the container of flammable or combustible liquids shall an approved safety can.

	JOB HAZARD ANALYSIS (JHA) **FOR GROUNDWATER SAMPLING ACTIVITIES**

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Collecting purge water from wells using submersible pump connected to 110 W generator (cont.)	Noise hazard (RAC: M)	• Equipment producing sound level measurements in excess of 85 dB A-weighted may require the use of hearing protection depending on duration of exposure to the equipment. Rule of thumb, if personnel must shout to be heard at arms distance, hearing protection is required. • Personnel within 15 feet of operating generator shall wear hearing protection. Hearing protection with noise reduction statistic range between 21-32 (noise reduction rating 30) is adequate for protecting workers. • Position generator at least 20 feet way from sample collection area.
Collecting purge water from wells using submersible pump connected to 110 W generator (cont.)	Potential inhalation hazard from contaminants of concern in groundwater (RAC: L) The primary contaminants of concern (COC) include PFCs.	• It is not anticipated that potential contaminant concentrations at outdoor sample locations will present an inhalation hazard. • Personnel shall receive training on the elements of each of the identified COCs.
	Potential contact and ingestion hazards from COCs in groundwater (RAC: M)	• Personnel shall wear nitrile rubber gloves during contact with groundwater. • Personnel shall not perform any hand to mouth contact until gloves are removed and hands thoroughly washed.
Collecting purge water from wells using submersible pump connected to 110 W generator (cont.)	Transfer of contamination into clean areas (RAC: M)	• Decontaminate all equipment and supplies if they become contaminated, between locations and prior to leaving the site. • Dispose of all supplies in direct contact with groundwater into heavy duty plastic liners with 6 mm thickness. (e.g. tubing, disposable PPE). • Minor decontamination of equipment requires the use of Citranox®, “PFC-free” water, and methanol. These items are placed in secondary container spray bottles (normally 32 fl oz). • Personnel shall ensure spray bottles are properly label in accordance with Hazard Communication requirements. • Ensure all transport containers (e.g. polyethylene tanks) are not filled to the top. Secure transport container lids when in transit. • All transport containers shall be label with “Non Potable Water” stickers or hand written. • Transport containers shall have camlock fittings and ball valve to control flow of water.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Collecting samples for groundwater analysis (cont.)	Repetitive movements while using bailers to collect samples from wells (RAC: M)	• Bailers are used to collect groundwater. Personnel use a 3/8 inch breaded nylon rope or nylon masonry string to lower bailers into well screen. The following measures should reduce repetitive trauma to arms and hands: - Wear two layers of nitrile rubber gloves to minimize contact with contaminated material. - Rotate team members between sampling events. - Maintain a good posture position when lifting bailer out of the well casing.
Transporting purge water from transport containers into frac tank	Potential contact and ingestion hazards from COCs in groundwater (RAC: M)	• Personnel shall wear two layers of nitrile rubber gloves during contact with groundwater. • Personnel shall not perform any hand to mouth contact until gloves are removed and hands thoroughly washed. • Due to the greater potential for splash during transfer of purge water into the frac tank, personnel shall don a full face shield.
	Transfer of contamination into clean areas (RAC: M)	• Personnel shall adequately secure hose to frac tank. • Ensure cam locks are secure. • Frac containers shall be label with “Non Potable Water” stickers or hand written. • Maintain a small spill kit to handle incidental spill of purge water at the storage lay down area.
	Fall hazard (RAC: M)	• Inspect hand railing of frac tank regularly to ensure pins are secured and integrity of railing. • If railing is bent, cracked, or heavily rust, report to SM or SSO. • Always utilize a “three-point” contact when climbing railing. Do not jump off railing at anytime.
	Noise hazard while using trash pump during transfer from container to frac tank (RAC: M)	• Equipment producing sound level measurements in excess of 85 dBA-weighted may require the use of hearing protection depending on duration of exposure to the equipment. Rule of thumb, if personnel must shout to be heard at arms distance, hearing protection is required. • Personnel within 15 feet of operating generator shall wear hearing protection. Hearing protection with noise reduction statistic range between 21-32 (noise reduction rating 30) is adequate for protecting workers. • Position trash pump at least 20 feet way from railing.

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WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
General safety during this activity	Severe Weather (RAC: L)	• Prior to work, check the weather forecast for the day. Take cover in a building/vehicle if lightning is spotted. • Wear appropriate clothing for weather conditions.
	Sunburn (RAC: L)	• Shade should be utilized when available and/or shade provided when feasible. If feasible, avoid sunlight during the hours of 10 am and 2 pm when the sunlight is most intense. • Wear hats and other protective garments to provide shade.
	Heat/Cold Stress (RAC: L)	• Drink plenty of fluids to keep your body hydrated. • Heat stress and cold related injuries will be monitored and controls will be implemented as necessary. • An adequate supply of drinking water shall be provided in all places of employment. Frequent rest breaks shall be taken as needed to insure proper hydration during weather extremes.
	Struck by hazards (RAC: M)	• Personnel shall wear protective head gear (e.g. hard hats) to reduce risk of hazard. • Personnel shall not position themselves between support materials and equipment or structures. • Personnel shall not stand next to vehicles being loaded or unloaded. • Site workers on the ground will remain in the line of sight of personnel operating equipment and use high visibility reflective vest or highly-visible colored apparel.
	Insects, Spiders, and Ticks (RAC: L)	• Personnel will be instructed to be cautious of insects, spiders, and ticks, especially when opening well covers. • Wear clothing that covers potentially affected body parts. • Seal pants legs against contact with plants and to prevent access by organisms (examples – ticks & chiggers).
	Hypersensitivity or Allergic Reactions (RAC: L)	• Personnel who are knowingly hypersensitive or allergic to insects or plants will be identified using Medical Data Sheet and precautions taken.
	Personnel Injury (RAC: L)	• Wear appropriate PPE. • Inspect the work area for hazards, including tripping hazards, prior to the start of survey efforts. • Keep non-essential personnel out of the work zone. Barricade as necessary.

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Risk Assessment Code (RAC) Table							
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Severity	Catastrophic	E	E	H	H	M	E = Extremely High Risk; H = High Risk; M = Moderate Risk; L = Low Risk
	Critical	E	H	H	M	L	Noted in "Potential Hazard" Column
	Marginal	H	M	M	L	L	
	Negligible	M	L	L	L	L	

PREREQUISITES		
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
Standard PPE: ANSI Z89.1 approved hard hat (Class C), steel-toe boots (ANSI Z41), ANSI Z87.1 approved safety glasses, and reflective safety vest. Eye wash station capable of providing 15 minutes of continuous service when corrosive materials are used on site.	Inspect PPE equipment prior to donning and doffing equipment. Inspect eye wash station at least weekly. Completion of Equipment Inspection Form before subsequent daily use.	Only trained and qualified personnel will be allowed to work within work area. Only trained and qualified personnel will be allowed to operate equipment. All personnel trained on the physical and health hazards associate with chemicals used on site. Source documents will be MSDSs from supplier of items.

WORK ACTIVITY	**POTENTIAL HAZARD**	**REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE**
Collect and confirm required worker training and medical compliance documentation.	Acceptable worker knowledge and fit-for-duty status (RAC: M)	• All personnel participating in field activities shall be current on HAZWOPER training requirements listed in 29 CFR 1910.120 (e) as well as medical surveillance requirements in 29 CFR 1910.120 (f). • Visitors not meeting the above requirements shall be escorted throughout their visit by an AMEC representative.
Perform site survey and initial inspections of intended work areas	Slips, trips, and falls (RAC: M)	• Use caution when walking around the site, look out for uneven terrain and slipper surface after increment weather conditions (e.g. rain, ice, snow). • Personnel shall wear protective foot wear. Foot wear shall have adequate sole and tread to reduce the potential for slipping or falling on slick surfaces. • Maintain work area clear and in good order.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Perform site survey and initial inspections of intended work areas (cont.)	Traffic safety (RAC: M)	• Stay clear of the designated contractor's route, use signals, horns, etc. when entering site where workers are present. • Post "Men at Work" signage to notify vehicular traffic of activity being performed adjacent to roadway. • Use traffic cones to demarcate work zone entrance near roadway. • Designated traffic pattern shall be used to ensure safe movement of trucks in and out of loading zone. • Use escort vehicles with flashing lights to warn and control local traffic when moving large equipment to support area. • A spotter shall guide drivers when backing up into congested and narrow path areas.
	Struck by hazard (RAC: L)	• Personnel shall wear protective head gear (e.g. hard hats) to reduce risk of hazard. • Personnel shall not position themselves between trucks and equipment or structures. • Site workers on the ground will remain in the line of sight of personnel operating trucks and use high visibility reflective vest or highly-visible colored apparel.
Perform inspections of vehicles and equipment arriving/preparing to depart the site	Operating vehicles and heavy equipment unsafely (RAC: M)	• Prior to operating a vehicle, the driver shall perform daily inspections using the Safety Inspection Form. • Prior to operating equipment, operator shall perform daily inspection using Safety Inspection Form. • Personnel working near heavy equipment shall wear high visibility vests. • The equipment operators and on-site supervisors are responsible for ensuring that the Safety Inspection Forms have been reviewed and completed, and that all moving parts are guarded if such parts are exposed. • Equipment operators shall operate equipment in a safe manner at all times and wear seatbelts while operating heavy equipment. • Check/test all emergency stop controls. Personnel shall only operate equipment that is in good condition and safe to operate. • Equipment found to be in need of repair, defective, or unsafe in any way, shall be tagged and taken out of service. Equipment shall not be operated with damaged windshield or glass. Equipment shall not be placed back into service until repaired and inspected and authorized to do so by SHSO. • Loads shall be lowered and power shut off when equipment is left unattended. Heavy equipment shall be equipped with backup alarms. • Equipment shall have properly functioning: brake system, brake lights, audible horn, and all other safety systems specified in the operator's manual. • Fire extinguishers shall be mounted on diesel and propane powered mobile equipment. • Equipment shall be shut-off prior to refueling. • No smoking or spark sources shall be allowed near refueling or battery maintenance areas.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Limited Site Clearing including brush removal using heavy equipment, chain saws, and other similar equipment	Rotating/cutting machinery and light equipment operation (RAC: M)	• Equipment shall be inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600,.601,.602), and manufacturers design. • Only manufacturer-approved parts may be used in repair of site equipment. • An equipment inspection checklist will be completed prior to the use of project vehicles, machinery and equipment. • Equipment shall be operated by knowledgeable ground crew. • Establish safe zones and routes of approach to the operation (personnel should remain cognizant that this is a multi-task operation with many activities engaged in simultaneously). • Restrictions at the operation (All personnel not directly supporting this clearance activity will remain at least 50-100 feet from the point of this operation). • Hand signals with the light equipment operator will be established prior to the commencement of activities. • Work areas will be kept clear of clutter. • Secure all loose articles to avoid possible entanglement. • Self-propelled equipment shall be equipped with movement warning systems. • Personnel will be instructed in the location and operations of the emergency shut-off device(s). This device will be tested initially (and then periodically) to insure its operational status. • Damaged or questionable equipment shall not be used and labeled with “Do Not Use”.
	Noise hazard (RAC: M)	• Equipment producing sound level measurements in excess of 85 dB A-weighted may require the use of hearing protection depending on duration of exposure to the equipment. Rule of thumb, if personnel must shout to be heard at arms distance, hearing protection is required. • Due to expected high elevated noise levels from machinery and equipment, excessive noise control will be facilitated through the use of hearing protection. Hearing protection with noise reduction statistic range between 21-32 (noise reduction rating 30) is adequate for protecting workers.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Limited Site Clearing including brush removal using heavy equipment, chain saws, and other similar equipment (cont.)	Flying projectiles/falling tree limbs (RAC: M)	• Inspect the chainsaw prior to each use. Insure the blade is adjusted and sharp, and all parts are lubricated per the manufacturer's instruction. Test all safety devices initially and then periodically to insure operational status. • When starting, place the chainsaw on the ground or some other firm surface. Place your foot in the hand guard at the rear of the saw, grip the top handle of the saw with one hand, pull the start cord with the free hand. Never attempt to start the saw free hand or by placing on your knee. • Never cut with tip of the chain saw blade. • Plan the cut. Know where the tree will fall. Have a clear escape plan when dropping trees greater than 2 inches in diameter. • Preview the tree to be dropped. Often, red wasps will nest in hollowed out trunks and in tree tops. Do not stand between falling trees and branches and fixed items or other trees. • Do not cut over your head. • Do not cut materials other than wood with the chain saw. • Wear prescribed safety equipment (hard hat with mesh face shield, chainsaw chaps, etc.). • Monitor, the condition of the saw during use, make adjustments as necessary. • When limbing a tree, to the extent possible cut from the other side of the trunk, which will serve as a shield. • Be attentive as to which way the trunk may move when removing limbs, place yourself out of the anticipated pathway when cutting. • Be attentive to movement of the trunk as an indication of the stability of the tree and brush pile. • Keep the work area free from clutter to avoid potential slip, trip, and fall hazards.
Set up material and equipment lay-down areas	Injuries from hand and power tools (RAC: L)	• All hand and power tools shall be used in accordance with the HASP. • Keep any machine guarding in place. • Avoid any moving parts and secure loose clothing, jewelry or long hair that could become entangled. Inspect tools prior to use. Damaged tools shall be removed immediately. Tools shall be used for its designed purpose.
	Crushing injuries from unstable loads (RAC: M)	• Inspect staging areas prior to placing materials. • Utilize traffic cones to demarcate loading/unloading zone for delivery of support materials • Prior to the initiation of work, personnel will be informed of potential hazards and required precautions. Equipment shall be properly leveled/stabilized and checked to insure that it will not move once in place. All rigging equipment shall be inspected prior to use. Only rigging equipment with the load capacity stamped or labeled on the equipment shall be used. • Rigging equipment rating to load ratio shall be 4 to 1 as a minimum. Ensures stability of load during transport. • No load shall be transported above any individual. Maintain load as close to the ground when transporting from one location to the other. • Personnel shall not stand underneath loads handled by lifting or digging equipment. • Damaged, unrated, or questionable rigging equipment shall not be used and labeled with "Do Not Use".

	Noise hazard (RAC: L)	• Equipment producing sound level measurements in excess of 85 dBA-weighted may require the use of hearing protection depending on duration of exposure to the equipment. Utilize hearing protection with Noise Reduction Rating of at least 33 dB. Rule of thumb, if personnel must shout to be heard at arms distance, hearing protection is required.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Set up material and equipment lay-down areas (cont.)	Pinch point hazards (RAC: L)	• Wear leather work gloves when handling support materials. • Never place hands into bind spots of equipment.
	Heavy Lifting, Strains, Sprains (RAC: L)	• No individual employee is permitted to lift any object that weighs over 50 lbs. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50 lb. limit. Use proper lifting techniques: - Lift with your legs, not your back, bend your knees, move as close to the load as possible, and ensure good handholds are available. - Minimize the horizontal distance to the center of the lift to your center of gravity. - Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. - Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. • Other considerations defining lifting hazards - Area available to maneuver the lift. - Area of the lift – workplace clutter, slippery surfaces. - Overall physical condition.
	Chemical hazards from chemicals utilized on site (RAC: L)	• The on-site Hazard Communication Program will be followed. All chemicals brought onto the site by AMEC and subcontractor personnel will be inventoried and have an MSDS on-site, on file. This effort shall include: - Maintain an accurate chemical inventory list (entries will match chemicals brought on-site, as the names appear on the MSDS) - MSDSs will be maintained in a central location, accessible to all personnel. • All containers will have labels specifying the following information: - Chemical Identity (As it appears on the label, MSDS, and Chemical Inventory List) - Appropriate Warning (i.e., eye and skin irritation, flammable, etc.) - Manufacturer's Name, Address, and Phone Number • It will be the SM and/or the SSO's responsibility to insure this is completed.
Establish excavation locations and arrange for utility clearances prior to intrusive activities. Secure permits from	Potential to strike existing utility lines (RAC: H)	• Pre-inspect vehicle moving lanes noting overhead utilities. • Do not approach within 10' of any overhead electric line of 50 kV or less. Additional clearance distance is required for lines of > 50kV. Reference Section 5.8.2. • Pre-survey the height of equipment and height of utility lines to determine which lines must be removed or raised. • Pre-plan the move with the local utility companies if utility lines must be moved.

appropriate authorities	Electrocution or penetration of buried utilities from equipment coming into contact with power, gas, water or sewer lines (RAC: H)	• Contact appropriate installation to mark locations of utilities prior to intrusive activities. • All underground and above utilities will be located prior to the initiation of work. Only qualified personnel shall install temporary utilities. • The locations of all underground utilities will be identified and marked in the field prior to subsurface investigation.

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WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
General safety during this activity	Severe Weather (RAC: L)	• Prior to work, check the weather forecast for the day. Take cover in a building/vehicle if lightning is spotted. • Wear appropriate clothing for weather conditions.
	Sunburn (RAC: L)	• Shade should be utilized when available and/or shade provided when feasible. If feasible, avoid sunlight during the hours of 10 am and 2 pm when the sunlight is most intense. • Wear hats and other protective garments to provide shade.
	Heat/Cold Stress (RAC: L)	• Drink plenty of fluids to keep your body hydrated. • Heat stress and cold related injuries will be monitored and controls will be implemented as necessary. • An adequate supply of drinking water shall be provided in all places of employment. Frequent rest break shall be taken as needed to insure proper hydration during weather extremes.

Risk Assessment Code (RAC) Table						
		Probability				
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	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

E = Extremely High Risk; H = High Risk; M = Moderate Risk; L = Low Risk
Noted in "Potential Hazard" Column

PREREQUISITES		
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
Standard PPE: ANSI Z89.1 approved hard hat (Class C), steel-toe boots (ANSI Z41), ANSI Z87.1 approved safety glasses, and reflective safety vest. Contact with potentially contaminated soil: Standard PPE plus one layer of nitrile rubber gloves, and cotton coveralls. Eye wash station capable of providing 15 minutes of continuous service.	Inspect PPE equipment prior to donning and doffing equipment. Inspect eye wash station at least weekly.	Only trained and qualified personnel will be allowed to work within work area. Only trained and qualified personnel will be allowed to operate equipment. All personnel trained on the physical and health hazards associate with chemicals used on site. Source documents will be MSDSs from supplier of items.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Set up work area.	Slips, trips, and falls (RAC: M)	• Use caution when walking around the site, look out for uneven terrain and slipper surface after increment weather conditions (e.g. rain, ice, snow). • Personnel shall wear protective foot wear. Foot wear shall have adequate sole and tread to reduce the potential for slipping or falling on slick surfaces. • Practice good housekeeping to keep the site clear of obstructions, materials, equipment and other tripping hazards. Maintain work area clear and in good order. • ALWAYS PLACE TRASH INTO PLASTIC BAGS and dispose of bags in proper waste receptacles.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Set up work area. (cont.)	Heavy lifting, muscle strains and sprains involved with handling drums, polyethylene lining rolls, and generator equipment. (RAC: M)	• No individual employee is permitted to lift any object that weighs over 50 lbs. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50 lb. limit. • Use proper lifting techniques: - Lift with your legs, not your back, bend your knees, move as close to the load as possible, and ensure good handholds are available. - Minimize the horizontal distance to the center of the lift to your center of gravity. - Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. - Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. • Other considerations defining lifting hazards - Area available to maneuver the lift. - Area of the lift – workplace clutter, slippery surfaces. - Overall physical condition.
	Use of sharp edge hand tools to cut material (e.g. heavy duty liner, boxes) (RAC: M)	• Wear cut-resistant gloves when handling items with sharp or rough edges. • Insure handles are in good construction (no cracks, splinters, loose heads/cutting apparatus). • Insure all cutting tools are maintained properly. Blades shall be sharp without knicks and gouges in the blade. • All hand tools (brush hooks, machetes, etc.) with cutting blades shall be provided with a sheath to protect individuals, when not in use. • ALWAYS USE A CUTTING MOTION MOVING AWAY FROM YOU. Never cut towards your body. • All personnel will maintain a 10-foot perimeter around persons clearing brush.
	Traffic safety (RAC: M)	• Designated traffic pattern shall be used to ensure safe movement of trucks in and out of support zone. • A spotter shall guide drivers when backing up into congested and narrow path areas. • If driver's line of sight is block when moving backwards, the vehicle should have back-up alarm and a spotter assigned to lead the driver.
	Struck by hazard (RAC: L)	• Personnel shall wear protective head gear (e.g. hard hats) to reduce risk of hazard. • Personnel shall not position themselves between trucks, and equipment or structures. • Site workers on the ground will remain in the line of sight of personnel operating trucks and use high visibility reflective vest or highly-visible colored apparel.
Personal decontamination	Cross contamination while doffing personal protective equipment (PPE) (RAC:H)	• Personnel shall be trained on the proper procedures for doffing PPE. The first PPE item removed shall be the cotton coveralls. Then the Nitrile gloves. • Place all disposable PPE items into commercial heavy duty plastic liners.

amec foster wheeler	**JOB HAZARD ANALYSIS (JHA)** **FOR PERSONAL AND EQUIPMENT DECONTAMINATION ACTIVITIES**

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Decontamination of heavy equipment using pressure washer	Slips, trips, and falls (RAC: M)	• Personnel shall wear protective foot wear. Foot wear shall have adequate sole and tread to reduce the potential for slipping or falling on slick surfaces. • Clear debris from work area prior to commencing work in the area. Maintain work area clear and in good order.
	Injuries from hand and power tools (RAC: L)	• All hand and power tools shall be used in accordance with the HASP. • Keep any machine guarding in place. • Avoid any moving parts and secure loose clothing, jewelry or long hair that could become entangled. Damaged tools shall be removed immediately. Tools shall be used for its designed purpose.
	Injury due to misuse or accidental contact (system is operating at pressures up to 3000 psi) (RAC: M)	• **Caution!** This equipment operates at high pressure. Accidental contact with pressurized water could cause serious injury. The spray nozzle should never be directed towards personnel. • Equipment operating pressure should never exceed that which is necessary to accomplish the job. Inspect hoses, cords and connections for deformities, cuts, leaks and other damage prior to startup. • Hoses and fittings should be supported to prevent excessive sway, vibration or stress on end connections. Hoses should be protected to prevent kinking or excessive wear. Install whip-checks on hose. • Protect hoses and cords from traffic. Do NOT allow machinery or equipment to drive over them. • At a minimum, PPE shall include requirements specified in JHA. In areas where respiratory protection is not necessary, eye and face protection (safety goggles and face-shield) and rubber gloves shall be worn. • When necessary, liquid proof coveralls (rain gear or other similar material) shall be worn. Foot wear shall include steel toe boots w/metatarsal protection; shin guards. • When not in use and when making repairs, the system shall be depressurized (both air and water). Ensure that equipment guards/covers removed for adjustments or repairs are properly installed before restarting. • Never leave the system unattended while pressurized. Only non-sparking tools shall be used in locations where sources of ignition may cause fire or explosion. • Fuel powered tools (generators, tamps, pumps, etc.) shall be turned off during refueling.
	Electric Shock (RAC: M)	• Electric tools with missing ground prongs or cut or frayed cords shall be removed from service and tagged. • Electric tools used in highly conductive locations, such as where the employee may contact water, shall be approved for use in those locations. • Power for portable electric tools shall be supplied from a GFCI receptacle. • Electric tools must be grounded, except tools, which are equipped with double insulation. • Electric tools shall not be used in hazardous locations such as flammable or explosive atmospheres unless they are approved for such locations.
	Injury to unqualified operators/on-lookers (RAC: M)	• Only trained and qualified personnel shall operate this equipment • Non-essential personnel shall remain a safe distance (at least 25 feet) from pressure washing activities. Barricade areas.

	JOB HAZARD ANALYSIS (JHA) **FOR PERSONAL AND EQUIPMENT DECONTAMINATION ACTIVITIES**

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
Decontamination of heavy equipment using pressure washer (cont.)	Portable energized sources (RAC: M)	• Perform all service and maintenance work with the generator engine off and the positive battery cable disconnected. Moving parts can cause severe personal injury or death, and live wires could cause fatal electrocution. • Keep the exhaust and air intake free from obstructions such as clothing, furniture or other material. • Always operate the generator in an area where the wind will carry away the exhaust fumes. • Do not overload the generator. • Use the right power cords with your portable power generators such as heavy duty, outdoor rated cords with a wire gauge adequate for the equipment load. Overloaded cords can cause fires or equipment damage. You must also not use extension cords with exposed wires or worn shielding. • Fuels and other flammable liquids should be stored away from exhaust. In addition, the container of flammable or combustible liquids shall an approved safety can.
	Noise hazard (RAC: M)	• Equipment producing sound level measurements in excess of 85 dBA-weighted may require the use of hearing protection depending on duration of exposure to the equipment. Rule of thumb, if personnel must shout to be heard at arms distance, hearing protection is required. • Place hazardous noise warning signs at least 15 feet from generators.
	Struck by hazard (RAC: L)	• Personnel shall wear protective head gear (e.g. hard hats) and faceshield to reduce risk of hazard. • Personnel shall not position themselves between trucks, and equipment or structures. • Site workers on the ground will remain in the line of sight of personnel operating equipment and use high visibility reflective vest or highly-visible colored apparel. • Personnel shall wear PPE for pressure washing activities.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
	Use of sharp edge hand tools to cut material (e.g. stainless steel augers and) (RAC: M)	• Wear cut-resistant gloves when handling items with sharp or rough edges. • Insure handles are in good construction (no cracks, splinters, loose heads/cutting apparatus). • Insure all cutting tools are maintained properly. Blades shall be sharp without knicks and gouges in the blade. • All hand tools (brush hooks, machetes, etc.) with cutting blades shall be provided with a sheath to protect individuals, when not in use. • ALWAYS USE A CUTTING MOTION MOVING AWAY FROM YOU. Never cut towards your body. If possible, place liners on a table or elevated platform at waist height. Use a device to secure the liners when performing cutting actions (e.g. clamps).
	Potential contact and ingestion hazards from COCs in potentially contaminated soils (RAC: M)	• Personnel shall wear two layers of nitrile rubber gloves during contact with groundwater. • Personnel shall not perform any hand to mouth contact until gloves are removed and hands thoroughly washed.
	Cross-contamination personnel or clean areas (RAC: M)	• Decontamination tools using the following procedures: - Wash with Citraonox - Rinse with “PFC-free” water - Rinse with methanol - Final rinse with “PFC-free” water - Air dry
General safety during this activity	Severe Weather (RAC: L)	• Prior to work, check the weather forecast for the day. Take cover in a building/vehicle if lightning is spotted. • Wear appropriate clothing for weather conditions.
	Sunburn (RAC: L)	• Shade should be utilized when available and/or shade provided when feasible. If feasible, avoid sunlight during the hours of 10 am and 2 pm when the sunlight is most intense. • Wear hats and other protective garments to provide shade.
	Heat/Cold Stress (RAC: L)	• Drink plenty of fluids to keep your body hydrated. • Heat stress and cold related injuries will be monitored and controls will be implemented as necessary. • An adequate supply of drinking water shall be provided in all places of employment. Frequent rest breaks shall be taken as needed to insure proper hydration during weather extremes.
	Struck by hazards (RAC: M)	• Personnel shall wear protective head gear (e.g. hard hats) to reduce risk of hazard. • Personnel shall not position themselves between support materials and equipment or structures. Personnel shall not stand next to vehicles being loaded or unloaded. • Site workers on the ground will remain in the line of sight of personnel operating equipment and use high visibility reflective vest or highly-visible colored apparel.

WORK ACTIVITY	POTENTIAL HAZARD	REQUIRED ACTIONS, CONTROLS, OR METHODS OF COMPLIANCE
General safety during this activity (cont.)	Insects, Spiders, and Ticks (RAC: L)	• Personnel will be instructed to be cautious of insects, spiders, and ticks, especially when opening well covers. Wear clothing that covers potentially affected body parts. Seal pants legs against contact with plants and to prevent access by organisms (examples – ticks & chiggers). Check body thoroughly after work to detect ticks and chiggers. Take hot shower after field work and wash thoroughly. • Avoid nesting areas. • Report any insect bite to the SHSO.
	Hypersensitivity or Allergic Reactions (RAC: L)	• Personnel who are knowingly hypersensitive or allergic to insects or plants will be identified using Medical Data Sheet and precautions taken.
	Personnel Injury (RAC: L)	• Wear appropriate PPE. • Inspect the work area for hazards, including tripping hazards, prior to the start of survey efforts. • Keep non-essential personnel out of the work zone. Barricade as necessary.

APPENDIX C

SAFETY DATA SHEETS

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Safety Data Sheet

Material Name: Diesel Fuel, All Types

SDS No. 9909
US GHS

Synonyms: Ultra Low Sulfur Diesel; Low Sulfur Diesel; No. 2 Diesel; Motor Vehicle Diesel Fuel; Non-Road Diesel Fuel; Locomotive/Marine Diesel Fuel

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

Phone: 732-750-6000 Corporate EHS
Emergency # 800-424-9300 CHEMTREC
www.hess.com (Environment, Health, Safety Internet Website)

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Flammable Liquids - Category 3
Skin Corrosion/Irritation – Category 2
Germ Cell Mutagenicity – Category 2
Carcinogenicity - Category 2
Specific Target Organ Toxicity (Single Exposure) - Category 3 (respiratory irritation, narcosis)
Aspiration Hazard – Category 1
Hazardous to the Aquatic Environment, Acute Hazard – Category 3

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

DANGER

Hazard Statements

Flammable liquid and vapor.
Causes skin irritation.
Suspected of causing genetic defects.
Suspected of causing cancer.
May cause respiratory irritation.
May cause drowsiness or dizziness.
May be fatal if swallowed and enters airways.
Harmful to aquatic life.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed.
Ground/bond container and receiving equipment.

Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Wear protective gloves/protective clothing/eye protection/face protection.
Wash hands and forearms thoroughly after handling.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Avoid breathing fume/mist/vapours/spray.

Response
In case of fire: Use water spray, fog or foam to extinguish.
IF ON SKIN (or hair): Wash with plenty of soap and water. Remove/Take off immediately all contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention.
IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a poison center/doctor if you feel unwell.
If swallowed: Immediately call a poison center or doctor. Do NOT induce vomiting.
IF exposed or concerned: Get medical advice/attention.

Storage
Store in a well-ventilated place. Keep cool.
Keep container tightly closed.
Store locked up.

Disposal
Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
68476-34-6	Fuels, diesel, no. 2	100
91-20-3	Naphthalene	<0.1

A complex mixture of hydrocarbons with carbon numbers in the range C9 and higher.

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

First Aid: Skin
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or with waterless hand cleanser. Obtain medical attention if irritation or redness develops. Thermal burns require immediate medical attention depending on the severity and the area of the body burned.

First Aid: Ingestion
DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, and other gaseous agents.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment. Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution, flammable vapors may accumulate in closed containers.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

Handle as a combustible liquid. Keep away from heat, sparks, excessive temperatures and open flame! No smoking or open flame in storage, use or handling areas. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks."

Incompatibilities

Keep away from strong oxidizers.

* * * Section 8 - Exposure Controls / Personal Protection * * *

Component Exposure Limits

Fuels, diesel, no. 2 (68476-34-6)

ACGIH: 100 mg/m3 TWA (inhalable fraction and vapor, as total hydrocarbons, listed under Diesel fuel)
Skin - potential significant contribution to overall exposure by the cutaneous route (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH:	10 ppm TWA
	15 ppm STEL
	Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA:	10 ppm TWA; 50 mg/m3 TWA
NIOSH:	10 ppm TWA; 50 mg/m3 TWA
	15 ppm STEL; 75 mg/m3 STEL

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile, neoprene, or PVC are recommended.

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Clear, straw-yellow.	**Odor:**	Mild, petroleum distillate odor
Physical State:	Liquid	**pH:**	ND
Vapor Pressure:	0.009 psia @ 70 °F (21 °C)	**Vapor Density:**	>1.0
Boiling Point:	320 to 690 °F (160 to 366 °C)	**Melting Point:**	ND
Solubility (H2O):	Negligible	**Specific Gravity:**	0.83-0.876 @ 60°F (16°C)
Evaporation Rate:	Slow; varies with conditions	**VOC:**	ND
Percent Volatile:	100%	**Octanol/H2O Coeff.:**	ND
Flash Point:	>125 °F (>52 °C) minimum	**Flash Point Method:**	PMCC
Upper Flammability Limit (UFL):	7.5	**Lower Flammability Limit (LFL):**	0.6
Burning Rate:	ND	**Auto Ignition:**	494°F (257°C)

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

Incompatible Products

Keep away from strong oxidizers.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

* * * Section 11 - Toxicological Information * * *

Acute Toxicity

A: General Product Information

Harmful if swallowed.

B: Component Analysis - LD50/LC50

Naphthalene (91-20-3)

Inhalation LC50 Rat >340 mg/m3 1 h; Oral LD50 Rat 490 mg/kg; Dermal LD50 Rat >2500 mg/kg; Dermal LD50 Rabbit >20 g/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

Contact with eyes may cause mild irritation.

Potential Health Effects: Ingestion

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Potential Health Effects: Inhalation

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This material has been positive in a mutagenicity study.

Carcinogenicity

A: General Product Information

Suspected of causing cancer.

Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.

B: Component Carcinogenicity

Fuels, diesel, no. 2 (68476-34-6)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
NTP: Reasonably Anticipated To Be A Human Carcinogen (Possible Select Carcinogen)
IARC: Monograph 82 [2002] (Group 2B (possibly carcinogenic to humans))

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

This product is not reported to have any specific target organ general toxicity repeat exposure effects.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

Fuels, diesel, no. 2 (68476-34-6)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	35 mg/L [flow-through]	

Naphthalene (91-20-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	5.74-6.44 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	1.6 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	0.91-2.82 mg/L [static]	
96 Hr LC50 Pimephales promelas	1.99 mg/L [static]	

96 Hr LC50 Lepomis macrochirus	31.0265 mg/L [static]
72 Hr EC50 Skeletonema costatum	0.4 mg/L
48 Hr LC50 Daphnia magna	2.16 mg/L
48 Hr EC50 Daphnia magna	1.96 mg/L [Flow through]
48 Hr EC50 Daphnia magna	1.09 - 3.4 mg/L [Static]

Persistence/Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

DOT Information

Shipping Name: Diesel Fuel

NA #: 1993 **Hazard Class:** 3 **Packing Group:** III

Placard:

* * * Section 15 - Regulatory Information * * *

Regulatory Information

Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Naphthalene (91-20-3)

CERCLA: 100 lb final RQ; 45.4 kg final RQ

SARA Section 311/312 – Hazard Classes

Acute Health	Chronic Health	Fire	Sudden Release of Pressure	Reactive
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product may contain listed chemicals below the de minimis levels which therefore are not subject to the supplier notification requirements of Section 313 of the Emergency Planning and Community Right- To-Know Act (EPCRA) of 1986 and of 40 CFR 372. If you may be required to report releases of chemicals listed in 40 CFR 372.28, you may contact Hess Corporate Safety if you require additional information regarding this product.

State Regulations

Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA	RI
Fuels, diesel, no. 2	68476-34-6	No	No	No	Yes	No	No
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	Yes	No

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.

Component Analysis - WHMIS IDL

No components are listed in the WHMIS IDL.

Additional Regulatory Information

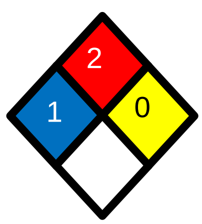
Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
Fuels, diesel, no. 2	68476-34-6	Yes	DSL	EINECS
Naphthalene	91-20-3	Yes	DSL	EINECS

* * * Section 16 - Other Information * * *

NFPA® Hazard Rating

Health	1	
Fire	2	
Reactivity	0	



HMIS® Hazard Rating

Health	1*	Slight
Fire	2	Moderate
Physical	0	Minimal
		*Chronic

Key/Legend

ACGIH = American Conference of Governmental Industrial Hygienists; ADG = Australian Code for the Transport of Dangerous Goods by Road and Rail; ADR/RID = European Agreement of Dangerous Goods by Road/Rail; AS = Standards Australia; DFG = Deutsche Forschungsgemeinschaft; DOT = Department of Transportation; DSL = Domestic Substances List; EEC = European Economic Community; EINECS = European Inventory of Existing Commercial Chemical Substances; ELINCS = European List of Notified Chemical Substances; EU = European Union; HMIS = Hazardous Materials Identification System; IARC = International Agency for Research on Cancer; IMO = International Maritime Organization; IATA = International Air Transport Association; MAK = Maximum Concentration Value in the Workplace; NDSL = Non-Domestic Substances List; NFPA = National Fire Protection Association; NOHSC = National Occupational Health & Safety Commission; NTP = National Toxicology Program; STEL = Short-term Exposure Limit; TDG = Transportation of Dangerous Goods; TLV = Threshold Limit Value; TSCA = Toxic Substances Control Act; TWA = Time Weighted Average

Literature References

None

Other Information

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

End of Sheet

Safety Data Sheet

Material Name: Gasoline All Grades **SDS No. 9950**
US GHS

Synonyms: Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

Phone: 732-750-6000 Corporate EHS
Emergency # 800-424-9300 CHEMTREC
www.hess.com (Environment, Health, Safety Internet Website)

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Flammable Liquid - Category 2
Skin Corrosion/Irritation - Category 2
Germ Cell Mutagenicity - Category 1B
Carcinogenicity - Category 1B
Toxic to Reproduction - Category 1A
Specific Target Organ Toxicity (Single Exposure) - Category 3 (respiratory irritation, narcosis)
Specific Target Organ Toxicity (Repeat Exposure) - Category 1 (liver, kidneys, bladder, blood, bone marrow, nervous system)
Aspiration Hazard - Category 1
Hazardous to the Aquatic Environment – Acute Hazard - Category 3

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

DANGER

Hazard Statements

Highly flammable liquid and vapour.
Causes skin irritation.
May cause genetic defects.
May cause cancer.
May damage fertility or the unborn child.
May cause respiratory irritation.
May cause drowsiness or dizziness.
Causes damage to organs (liver, kidneys, bladder, blood, bone marrow, nervous system) through prolonged or repeated exposure.
May be fatal if swallowed and enters airways.
Harmful to aquatic life.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed.
Ground/bond container and receiving equipment.
Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Wear protective gloves/protective clothing/eye protection/face protection.
Wash hands and forearms thoroughly after handling.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Do not breathe mist/vapours/spray.
Use only outdoors or in well-ventilated area.
Do not eat, drink or smoke when using this product.
Avoid release to the environment.

Response

In case of fire: Use water spray, fog, dry chemical fire extinguishers or hand held fire extinguisher.
IF ON SKIN (or hair): Wash with plenty of soap and water. Remove/Take off immediately all contaminated clothing and wash before reuse. If skin irritation occurs, get medical advice/attention.
IF exposed or concerned: Get medical advice/attention.
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a poison center or doctor/physician if you feel unwell.
Get medical advice/attention if you feel unwell.
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. Do not induce vomiting.

Storage

Store in a well-ventilated place.
Keep cool. Keep container tightly closed.
Store locked up.

Disposal

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
86290-81-5	Gasoline, motor fuel	100
108-88-3	Toluene	1-25
106-97-8	Butane	<10
1330-20-7	Xylenes (o-, m-, p- isomers)	1-15
95-63-6	Benzene, 1,2,4-trimethyl-	<6
64-17-5	Ethyl alcohol	0-10
100-41-4	Ethylbenzene	<3
71-43-2	Benzene	0.1-4.9

110-54-3	Hexane	0.5-4

A complex blend of petroleum-derived normal and branched-chain alkane, cycloalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol). Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

First Aid: Skin

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or with waterless hand cleanser. Obtain medical attention if irritation or redness develops.

First Aid: Ingestion

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.
Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or gaseous extinguishing agent.
LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment. Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution, flammable vapors may accumulate in closed containers.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

USE ONLY AS A MOTOR FUEL.
DO NOT SIPHON BY MOUTH

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

Incompatibilities

Keep away from strong oxidizers.

* * * Section 8 - Exposure Controls / Personal Protection * * *

Component Exposure Limits

Gasoline, motor fuel (86290-81-5)

ACGIH:	300 ppm TWA
	500 ppm STEL

Toluene (108-88-3)

ACGIH:	20 ppm TWA
OSHA:	200 ppm TWA; 375 mg/m3 TWA
	150 ppm STEL; 560 mg/m3 STEL
NIOSH:	100 ppm TWA; 375 mg/m3 TWA
	150 ppm STEL; 560 mg/m3 STEL

Butane (106-97-8)

ACGIH:	1000 ppm TWA (listed under Aliphatic hydrocarbon gases: Alkane C1-4)
OSHA:	800 ppm TWA; 1900 mg/m3 TWA
NIOSH:	800 ppm TWA; 1900 mg/m3 TWA

Xylenes (o-, m-, p- isomers) (1330-20-7)

ACGIH:	100 ppm TWA
	150 ppm STEL
OSHA:	100 ppm TWA; 435 mg/m3 TWA
	150 ppm STEL; 655 mg/m3 STEL

Benzene, 1,2,4-trimethyl- (95-63-6)

NIOSH:	25 ppm TWA; 125 mg/m3 TWA

Ethyl alcohol (64-17-5)

ACGIH:	1000 ppm STEL
OSHA:	1000 ppm TWA; 1900 mg/m3 TWA
NIOSH:	1000 ppm TWA; 1900 mg/m3 TWA

Ethylbenzene (100-41-4)

ACGIH:	20 ppm TWA
OSHA:	100 ppm TWA; 435 mg/m3 TWA 125 ppm STEL; 545 mg/m3 STEL
NIOSH:	100 ppm TWA; 435 mg/m3 TWA 125 ppm STEL; 545 mg/m3 STEL

Benzene (71-43-2)

ACGIH:	0.5 ppm TWA 2.5 ppm STEL Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA:	5 ppm STEL (Cancer hazard, Flammable, See 29 CFR 1910.1028, 15 min); 0.5 ppm Action Level; 1 ppm TWA
NIOSH:	0.1 ppm TWA 1 ppm STEL

Hexane (110-54-3)

ACGIH:	50 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA:	500 ppm TWA; 1800 mg/m3 TWA
NIOSH:	50 ppm TWA; 180 mg/m3 TWA

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile, neoprene, or PVC are recommended.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Translucent, straw-colored or light yellow	**Odor:**	Strong, characteristic aromatic hydrocarbon odor. Sweet-ether like
Physical State:	Liquid	**pH:**	ND
Vapor Pressure:	6.4 - 15 RVP @ 100 °F (38 °C) (275-475 mm Hg @ 68 °F (20 °C)	**Vapor Density:**	AP 3-4
Boiling Point:	85-437 °F (39-200 °C)	**Melting Point:**	ND
Solubility (H2O):	Negligible to Slight	**Specific Gravity:**	0.70-0.78
Evaporation Rate:	10-11	**VOC:**	ND
Percent Volatile:	100%	**Octanol/H2O Coeff.:**	ND
Flash Point:	-45 °F (-43 °C)	**Flash Point Method:**	PMCC
Upper Flammability Limit (UFL):	7.6%	**Lower Flammability Limit (LFL):**	1.4%
Burning Rate:	ND	**Auto Ignition:**	>530°F (>280°C)

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Chemical Stability
This is a stable material.

Hazardous Reaction Potential
Will not occur.

Conditions to Avoid
Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

Incompatible Products
Keep away from strong oxidizers.

Hazardous Decomposition Products
Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

* * * Section 11 - Toxicological Information * * *

Acute Toxicity

A: General Product Information
Harmful if swallowed.

B: Component Analysis - LD50/LC50

Gasoline, motor fuel (86290-81-5)
Inhalation LC50 Rat >5.2 mg/L 4 h; Oral LD50 Rat 14000 mg/kg; Dermal LD50 Rabbit >2000 mg/kg

Toluene (108-88-3)
Inhalation LC50 Rat 12.5 mg/L 4 h; Inhalation LC50 Rat >26700 ppm 1 h; Oral LD50 Rat 636 mg/kg; Dermal LD50 Rabbit 8390 mg/kg; Dermal LD50 Rat 12124 mg/kg

Butane (106-97-8)
Inhalation LC50 Rat 658 mg/L 4 h

Xylenes (o-, m-, p- isomers) (1330-20-7)
Inhalation LC50 Rat 5000 ppm 4 h; Inhalation LC50 Rat 47635 mg/L 4 h; Oral LD50 Rat 4300 mg/kg; Dermal LD50 Rabbit >1700 mg/kg

Benzene, 1,2,4-trimethyl- (95-63-6)
Inhalation LC50 Rat 18 g/m3 4 h; Oral LD50 Rat 3400 mg/kg; Dermal LD50 Rabbit >3160 mg/kg

Ethyl alcohol (64-17-5)
Oral LD50 Rat 7060 mg/kg; Inhalation LC50 Rat 124.7 mg/L 4 h

Ethylbenzene (100-41-4)
Inhalation LC50 Rat 17.2 mg/L 4 h; Oral LD50 Rat 3500 mg/kg; Dermal LD50 Rabbit 15354 mg/kg

Benzene (71-43-2)
Inhalation LC50 Rat 13050-14380 ppm 4 h; Oral LD50 Rat 1800 mg/kg

Hexane (110-54-3)
Inhalation LC50 Rat 48000 ppm 4 h; Oral LD50 Rat 25 g/kg; Dermal LD50 Rabbit 3000 mg/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

Moderate irritant. Contact with liquid or vapor may cause irritation.

Potential Health Effects: Ingestion

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Potential Health Effects: Inhalation

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This product may cause genetic defects.

Carcinogenicity

A: General Product Information

May cause cancer.

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

B: Component Carcinogenicity

Gasoline, motor fuel (86290-81-5)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans

Toluene (108-88-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999]; Monograph 47 [1989] (Group 3 (not classifiable))

Xylenes (o-, m-, p- isomers) (1330-20-7)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999]; Monograph 47 [1989] (Group 3 (not classifiable))

Ethyl alcohol (64-17-5)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
IARC: Monograph 100E [in preparation] (in alcoholic beverages); Monograph 96 [2010] (in alcoholic beverages) (Group 1 (carcinogenic to humans))

Ethylbenzene (100-41-4)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
IARC: Monograph 77 [2000] (Group 2B (possibly carcinogenic to humans))

Benzene (71-43-2)

ACGIH: A1 - Confirmed Human Carcinogen
OSHA: 5 ppm STEL (Cancer hazard, Flammable, See 29 CFR 1910.1028, 15 min); 0.5 ppm Action Level; 1 ppm TWA
NIOSH: potential occupational carcinogen
NTP: Known Human Carcinogen (Select Carcinogen)
IARC: Monograph 100F [in preparation]; Supplement 7 [1987]; Monograph 29 [1982] (Group 1 (carcinogenic to humans))

Reproductive Toxicity

This product is suspected of damaging fertility or the unborn child.

Specified Target Organ General Toxicity: Single Exposure

This product may cause drowsiness or dizziness.

Specified Target Organ General Toxicity: Repeated Exposure

This product causes damage to organs through prolonged or repeated exposure.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Very toxic to aquatic life with long lasting effects. Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

Gasoline, motor fuel (86290-81-5)

Test & Species		Conditions
96 Hr LC50 Alburnus alburnus	119 mg/L [static]	
96 Hr LC50 Cyprinodon variegatus	82 mg/L [static]	
72 Hr EC50 Pseudokirchneriella subcapitata	56 mg/L	
24 Hr EC50 Daphnia magna	170 mg/L	

Toluene (108-88-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	15.22-19.05 mg/L [flow-through]	1 day old
96 Hr LC50 Pimephales promelas	12.6 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	5.89-7.81 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	14.1-17.16 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	5.8 mg/L [semi-static]	
96 Hr LC50 Lepomis macrochirus	11.0-15.0 mg/L [static]	
96 Hr LC50 Oryzias latipes	54 mg/L [static]	
96 Hr LC50 Poecilia reticulata	28.2 mg/L [semi-static]	
96 Hr LC50 Poecilia reticulata	50.87-70.34 mg/L [static]	
96 Hr EC50 Pseudokirchneriella subcapitata	>433 mg/L	
72 Hr EC50 Pseudokirchneriella subcapitata	12.5 mg/L [static]	
48 Hr EC50 Daphnia magna	5.46 - 9.83 mg/L [Static]	
48 Hr EC50 Daphnia magna	11.5 mg/L	

Xylenes (o-, m-, p- isomers) (1330-20-7)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	13.4 mg/L [flow-through]	

96 Hr LC50 Oncorhynchus mykiss	2.661-4.093 mg/L [static]
96 Hr LC50 Oncorhynchus mykiss	13.5-17.3 mg/L
96 Hr LC50 Lepomis macrochirus	13.1-16.5 mg/L [flow-through]
96 Hr LC50 Lepomis macrochirus	19 mg/L
96 Hr LC50 Lepomis macrochirus	7.711-9.591 mg/L [static]
96 Hr LC50 Pimephales promelas	23.53-29.97 mg/L [static]
96 Hr LC50 Cyprinus carpio	780 mg/L [semi-static]
96 Hr LC50 Cyprinus carpio	>780 mg/L
96 Hr LC50 Poecilia reticulata	30.26-40.75 mg/L [static]
48 Hr EC50 water flea	3.82 mg/L
48 Hr LC50 Gammarus lacustris	0.6 mg/L

Benzene, 1,2,4-trimethyl- (95-63-6)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	7.19-8.28 mg/L [flow-through]	
48 Hr EC50 Daphnia magna	6.14 mg/L	

Ethyl alcohol (64-17-5)

Test & Species		Conditions
96 Hr LC50 Oncorhynchus mykiss	12.0 - 16.0 mL/L [static]	
96 Hr LC50 Pimephales promelas	>100 mg/L [static]	
96 Hr LC50 Pimephales promelas	13400 - 15100 mg/L [flow-through]	
48 Hr LC50 Daphnia magna	9268 - 14221 mg/L	
24 Hr EC50 Daphnia magna	10800 mg/L	
48 Hr EC50 Daphnia magna	2 mg/L [Static]	

Ethylbenzene (100-41-4)

Test & Species		Conditions
96 Hr LC50 Oncorhynchus mykiss	11.0-18.0 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	4.2 mg/L [semi-static]	
96 Hr LC50 Pimephales promelas	7.55-11 mg/L [flow-through]	
96 Hr LC50 Lepomis macrochirus	32 mg/L [static]	
96 Hr LC50 Pimephales promelas	9.1-15.6 mg/L [static]	
96 Hr LC50 Poecilia reticulata	9.6 mg/L [static]	
72 Hr EC50 Pseudokirchneriella subcapitata	4.6 mg/L	
96 Hr EC50 Pseudokirchneriella subcapitata	>438 mg/L	
72 Hr EC50 Pseudokirchneriella subcapitata	2.6 - 11.3 mg/L [static]	

96 Hr EC50 Pseudokirchneriella subcapitata	1.7 - 7.6 mg/L [static]	
48 Hr EC50 Daphnia magna	1.8 - 2.4 mg/L	

Benzene (71-43-2)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	10.7-14.7 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	5.3 mg/L [flow-through]	
96 Hr LC50 Lepomis macrochirus	22.49 mg/L [static]	
96 Hr LC50 Poecilia reticulata	28.6 mg/L [static]	
96 Hr LC50 Pimephales promelas	22330-41160 µg/L [static]	
96 Hr LC50 Lepomis macrochirus	70000-142000 µg/L [static]	
72 Hr EC50 Pseudokirchneriella subcapitata	29 mg/L	
48 Hr EC50 Daphnia magna	8.76 - 15.6 mg/L [Static]	
48 Hr EC50 Daphnia magna	10 mg/L	

Hexane (110-54-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	2.1-2.98 mg/L [flow-through]	
24 Hr EC50 Daphnia magna	>1000 mg/L	

Persistence/Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

Component Marine Pollutants

This material contains one or more of the following chemicals required by US DOT to be identified as marine pollutants.

Component	CAS #	
Gasoline, motor fuel	86290-81-5	DOT regulated marine pollutant

DOT Information

Shipping Name: Gasoline

UN #: 1203 **Hazard Class:** 3 **Packing Group:** II

Placard:

* * * Section 15 - Regulatory Information * * *

Regulatory Information

A: Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Toluene (108-88-3)

SARA 313: 1.0 % de minimis concentration
CERCLA: 1000 lb final RQ; 454 kg final RQ

Xylenes (o-, m-, p- isomers) (1330-20-7)

SARA 313: 1.0 % de minimis concentration
CERCLA: 100 lb final RQ; 45.4 kg final RQ

Benzene, 1,2,4-trimethyl- (95-63-6)

SARA 313: 1.0 % de minimis concentration

Ethylbenzene (100-41-4)

SARA 313: 0.1 % de minimis concentration
CERCLA: 1000 lb final RQ; 454 kg final RQ

Benzene (71-43-2)

SARA 313: 0.1 % de minimis concentration
CERCLA: 10 lb final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule); 4.54 kg final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule)

Hexane (110-54-3)

SARA 313: 1.0 % de minimis concentration
CERCLA: 5000 lb final RQ; 2270 kg final RQ

SARA Section 311/312 – Hazard Classes

Acute Health	Chronic Health	Fire	Sudden Release of Pressure	Reactive
X	X	X	--	--

Component Marine Pollutants

This material contains one or more of the following chemicals required by US DOT to be identified as marine pollutants.

Component	CAS #	
Gasoline, motor fuel	86290-81-5	DOT regulated marine pollutant

State Regulations

Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	**CAS**	**CA**	**MA**	**MN**	**NJ**	**PA**	**RI**
Gasoline, motor fuel	86290-81-5	No	No	No	No	Yes	No
Toluene	108-88-3	Yes	Yes	Yes	Yes	Yes	No
Butane	106-97-8	Yes	Yes	Yes	Yes	Yes	No
Xylenes (o-, m-, p- isomers)	1330-20-7	Yes	Yes	Yes	Yes	Yes	No
Benzene, 1,2,4-trimethyl-	95-63-6	No	Yes	Yes	Yes	Yes	No
Ethyl alcohol	64-17-5	Yes	Yes	Yes	Yes	Yes	No
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	Yes	No
Benzene	71-43-2	Yes	Yes	Yes	Yes	Yes	No
Hexane	110-54-3	No	Yes	Yes	Yes	Yes	No

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.
WARNING! This product contains a chemical known to the state of California to cause reproductive/developmental effects.

Component Analysis - WHMIS IDL

The following components are identified under the Canadian Hazardous Products Act Ingredient Disclosure List:

Component	CAS #	Minimum Concentration
Toluene	108-88-3	1 %
Butane	106-97-8	1 %
Benzene, 1,2,4-trimethyl-	95-63-6	0.1 %
Ethyl alcohol	64-17-5	0.1 %
Ethylbenzene	100-41-4	0.1 %
Benzene	71-43-2	0.1 %
Hexane	110-54-3	1 %

Additional Regulatory Information

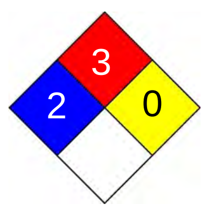
Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
Gasoline, motor fuel	86290-81-5	No	DSL	EINECS
Toluene	108-88-3	Yes	DSL	EINECS
Butane	106-97-8	Yes	DSL	EINECS
Xylenes (o-, m-, p- isomers)	1330-20-7	Yes	DSL	EINECS
Benzene, 1,2,4-trimethyl-	95-63-6	Yes	DSL	EINECS
Ethyl alcohol	64-17-5	Yes	DSL	EINECS
Ethylbenzene	100-41-4	Yes	DSL	EINECS
Benzene	71-43-2	Yes	DSL	EINECS
Hexane	110-54-3	Yes	DSL	EINECS

* * * Section 16 - Other Information * * *

NFPA® Hazard Rating

Health	2	
Fire	3	
Reactivity	0	



HMIS® Hazard Rating

Health	2	Moderate
Fire	3	Serious
Physical	0	Minimal
		*Chronic

Key/Legend

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration., NJTSR = New Jersey Trade Secret Registry.

Literature References

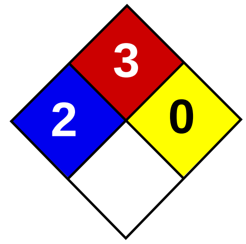
None

Other Information

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

End of Sheet



Health	2
Fire	3
Reactivity	0
Personal Protection	H

Material Safety Data Sheet
Benzene MSDS

Section 1: Chemical Product and Company Identification

Product Name: Benzene

Catalog Codes: SLB1564, SLB3055, SLB2881

CAS#: 71-43-2

RTECS: CY1400000

TSCA: TSCA 8(b) inventory: Benzene

CI#: Not available.

Synonym: Benzol; Benzine

Chemical Name: Benzene

Chemical Formula: C6-H6

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Benzene	71-43-2	100

Toxicological Data on Ingredients: Benzene: ORAL (LD50): Acute: 930 mg/kg [Rat]. 4700 mg/kg [Mouse]. DERMAL (LD50): Acute: >9400 mg/kg [Rabbit]. VAPOR (LC50): Acute: 10000 ppm 7 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of eye contact (irritant), of inhalation. Hazardous in case of skin contact (irritant, permeator), of ingestion. Inflammation of the eye is characterized by redness, watering, and itching.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH, 1 (Proven for human.) by IARC. MUTAGENIC EFFECTS: Classified POSSIBLE for human. Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female [POSSIBLE]. The substance is toxic to blood, bone marrow, central nervous system (CNS). The substance may be toxic to liver, Urinary System. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 497.78°C (928°F)

Flash Points: CLOSED CUP: -11.1°C (12°F). (Setaflash)

Flammable Limits: LOWER: 1.2% UPPER: 7.8%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Highly flammable in presence of open flames and sparks, of heat. Slightly flammable to flammable in presence of oxidizing materials. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Explosive in presence of oxidizing materials, of acids.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:
Extremely flammable liquid and vapor. Vapor may cause flash fire. Reacts on contact with iodine heptafluoride gas. Dioxygenyl tetrafluoroborate is as very powferful oxidant. The addition of a small particle to small samples of benzene, at ambient temperature, causes ignition. Contact with sodium peroxide with benzene causes ignition. Benzene ignites in contact with powdered chromic anhydride. Virgorous or incandescent reaction with hydrogen + Raney nickel (above 210 C) and bromine trifluoride.

Special Remarks on Explosion Hazards:
Benzene vapors + chlorine and light causes explosion. Reacts explosively with bromine pentafluoride, chlorine, chlorine trifluoride, diborane, nitric acid, nitryl perchlorate, liquid oxygen, ozone, silver perchlorate. Benzene + pentafluoride and methoxide (from arsenic pentafluoride and potassium methoxide) in trichlorotrifluoroethane causes explosion. Interaction

of nitryl perchlorate with benzene gave a slight explosion and flash. The solution of permanganic acid (or its explosive anhydride, dimaganese heptoxide) produced by interaction of permanganates and sulfuric acid will explode on contact with benzene. Peroxodisulfuric acid is a very powferful oxidant. Uncontrolled contact with benzene may cause explosion. Mixtures of peroxomonsulfuric acid with benzene explodes.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Flammable liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 0.5 STEL: 2.5 (ppm) from ACGIH (TLV) [United States] TWA: 1.6 STEL: 8 (mg/m3) from ACGIH (TLV) [United States] TWA: 0.1 STEL: 1 from NIOSH TWA: 1 STEL: 5 (ppm) from OSHA (PEL) [United States] TWA: 10 (ppm) from OSHA (PEL) [United States] TWA: 3 (ppm) [United Kingdom (UK)] TWA: 1.6 (mg/m3) [United Kingdom (UK)] TWA: 1 (ppm) [Canada] TWA: 3.2 (mg/m3) [Canada] TWA: 0.5 (ppm) [Canada]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor:
Aromatic. Gasoline-like, rather pleasant. (Strong.)

Taste: Not available.

Molecular Weight: 78.11 g/mole

Color: Clear Colorless. Colorless to light yellow.

pH (1% soln/water): Not available.

Boiling Point: 80.1 (176.2°F)

Melting Point: 5.5°C (41.9°F)

Critical Temperature: 288.9°C (552°F)

Specific Gravity: 0.8787 @ 15 C (Water = 1)

Vapor Pressure: 10 kPa (@ 20°C)

Vapor Density: 2.8 (Air = 1)

Volatility: Not available.

Odor Threshold: 4.68 ppm

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 2.1

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether, acetone.

Solubility:
Miscible in alcohol, chloroform, carbon disulfide oils, carbon tetrachloride, glacial acetic acid, diethyl ether, acetone. Very slightly soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, ignition sources, incompatibles.

Incompatibility with various substances: Highly reactive with oxidizing agents, acids.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Benzene vapors + chlorine and light causes explosion. Reacts explosively with bromine pentafluoride, chlorine, chlorine trifluoride, diborane, nitric acid, nitryl perchlorate, liquid oxygen, ozone, silver perchlorate. Benzene + pentafluoride and methoxide (from arsenic pentafluoride and potassium methoxide) in trichlorotrifluoroethane causes explosion. Interaction of nitryl perchlorate with benzene gave a slight explosion and flash. The solution of permanganic acid (or its explosive anhydride, dimaganese heptoxide) produced by interaction of permanganates and sulfuric acid will explode on contact with benzene. Peroxodisulfuric acid is a very powfferful oxidant. Uncontrolled contact with benzene may cause explosion. Mixtures of peroxomonsulfuric acid with benzene explodes.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 930 mg/kg [Rat]. Acute dermal toxicity (LD50): >9400 mg/kg [Rabbit]. Acute toxicity of the vapor (LC50): 10000 7 hours [Rat].

Chronic Effects on Humans:

CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH, 1 (Proven for human.) by IARC. MUTAGENIC EFFECTS: Classified POSSIBLE for human. Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female [POSSIBLE]. Causes damage to the following organs: blood, bone marrow, central nervous system (CNS). May cause damage to the following organs: liver, Urinary System.

Other Toxic Effects on Humans:
Very hazardous in case of inhalation. Hazardous in case of skin contact (irritant, permeator), of ingestion.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects (female fertility, Embryotoxic and/or foetotoxic in animal) and birth defects. May affect genetic material (mutagenic). May cause cancer (tumorigenic, leukemia)) Human: passes the placental barrier, detected in maternal milk.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Causes skin irritation. It can be absorbed through intact skin and affect the liver, blood, metabolism,and urinary system. Eyes: Causes eye irritation. Inhalation: Causes respiratory tract and mucous membrane irritation. Can be absorbed through the lungs. May affect behavior/Central and Peripheral nervous systems (somnolence, muscle weakness, general anesthetic, and other symptoms similar to ingestion), gastrointestinal tract (nausea), blood metabolism, urinary system. Ingestion: May be harmful if swallowed. May cause gastrointestinal tract irritation including vomiting. May affect behavior/Central and Peripheral nervous systems (convulsions, seizures, tremor, irritability, initial CNS stimulation followed by depression, loss of coordination, dizziness, headache, weakness, pallor, flushing), respiration (breathlessness and chest constriction), cardiovascular system, (shallow/rapid pulse), and blood.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Benzene UNNA: 1114 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Benzene California prop. 65 (no significant risk level): Benzene: 0.007 mg/day (value) California prop. 65: This product contains the following ingredients

for which the State of California has found to cause cancer which would require a warning under the statute: Benzene Connecticut carcinogen reporting list.: Benzene Connecticut hazardous material survey.: Benzene Illinois toxic substances disclosure to employee act: Benzene Illinois chemical safety act: Benzene New York release reporting list: Benzene Rhode Island RTK hazardous substances: Benzene Pennsylvania RTK: Benzene Minnesota: Benzene Michigan critical material: Benzene Massachusetts RTK: Benzene Massachusetts spill list: Benzene New Jersey: Benzene New Jersey spill list: Benzene Louisiana spill reporting: Benzene California Director's list of Hazardous Substances: Benzene TSCA 8(b) inventory: Benzene SARA 313 toxic chemical notification and release reporting: Benzene CERCLA: Hazardous substances.: Benzene: 10 lbs. (4.536 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F). CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R11- Highly flammable. R22- Harmful if swallowed. R38- Irritating to skin. R41- Risk of serious damage to eyes. R45- May cause cancer. R62- Possible risk of impaired fertility. S2- Keep out of the reach of children. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S39- Wear eye/face protection. S46- If swallowed, seek medical advice immediately and show this container or label. S53- Avoid exposure - obtain special instructions before use.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: h

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:35 PM

Last Updated: 05/21/2013 12:00 PM

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MATERIAL SAFETY DATA SHEET

3M
3M Center
St. Paul, Minnesota
55144-1000
1-800-364-3577 or (651) 737-6501 (24 hours)

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DIVISION: 3M SPECIALTY MATERIALS
TRADE NAME:
FC-201F LIGHT WATER(TM) AFFF 1%
ID NUMBER/U.P.C.:

98-0211-6542-2	00-51135-10364-7	98-0211-6543-0	00-51135-10365-4
ZF-0002-0838-7	- - -	ZF-0002-0839-5	- - -
ZF-0002-0840-3	- - -		

ISSUED: September 29, 2000
SUPERSEDES: September 29, 1998
DOCUMENT: 05-4931-1

1. INGREDIENT

1. INGREDIENT	C.A.S. NO.	PERCENT
WATER..................................	7732-18-5	35 - 38
DIETHYLENE GLYCOL BUTYL ETHER...........	112-34-5	36
Amphoteric Fluoroalkylamide Derivative +(5887P).............................	TradeSecret	6 - 10
Alkyl Sulfate Salts(2) +(5884P, 5886P)..	TradeSecret	11 - 15
TRIETHANOLAMINE........................	102-71-6	1 - 5
Perfluoroalkyl Sulfonate Salts(5) +(5885P).............................	2795-39-3	1 - 5
TOLYL TRIAZOLE.........................	29385-43-1	0.15

The components of this product are in compliance with the chemical notification requirements of TSCA. All applicable chemical ingredients in this material are listed on the European Inventory of Existing Chemical Substances (EINECS), or are exempt polymers whose monomers are listed on EINECS.

New Jersey Trade Secret Registry (EIN) 04499600-+

This product contains the following toxic chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Emergency Planning and Community Right-To-Know Act of 1986 and 40 CFR Part 372:
DIETHYLENE GLYCOL BUTYL ETHER

---

2. PHYSICAL DATA

BOILING POINT:................. ca. 100 C
VAPOR PRESSURE:................ ca. 16.2 mmHg
Calc. @ 20 C
VAPOR DENSITY:................. ca. 1.11 Air=1
Calc. @ 20 C
EVAPORATION RATE:.............. < 1.0 BuOAc=1
SOLUBILITY IN WATER:........... Miscible
SPECIFIC GRAVITY:.............. ca. 1.1 Water=1
PERCENT VOLATILE:.............. 72 %
pH:............................ 7.5 - 8.5
VISCOSITY:..................... N/D
MELTING POINT:................. N/A

APPEARANCE AND ODOR:
Clear, amber colored liquid.

---

3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:................... Non-flammable
FLAMMABLE LIMITS - LEL:........ N/A
FLAMMABLE LIMITS - UEL:........ N/A
AUTOIGNITION TEMPERATURE:...... N/A

EXTINGUISHING MEDIA:
Product is a fire-extinguishing agent.

SPECIAL FIRE FIGHTING PROCEDURES:
Not applicable

UNUSUAL FIRE AND EXPLOSION HAZARDS:
See Hazardous Decomposition section for products of combustion.

---

4. REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY - MATERIALS/CONDITIONS TO AVOID:
Not applicable.

HAZARDOUS POLYMERIZATION: Hazardous polymerization will not occur.

HAZARDOUS DECOMPOSITION PRODUCTS:
Carbon Monoxide and Carbon Dioxide, Oxides of Nitrogen, Oxides of
Sulfur, Hydrogen Fluoride

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4. REACTIVITY DATA (continued)

Thermal decomposition of usage concentrations does not present a hazard.

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5. ENVIRONMENTAL INFORMATION

SPILL RESPONSE:
Observe precautions from other sections. Ventilate area. Contain spill. Cover with absorbent material. Collect spilled material. Clean up residue with water. Place in a closed container.

RECOMMENDED DISPOSAL:
Discharge spent solutions and small quantities (less than 5 gal.(19 L)) to a wastewater treatment system. Reduce discharge rate if foaming occurs. Large quantities may adversely affect biological wastewater treatment systems. Incinerate large quantities in an industrial or commercial incinerator. Combustion products will include HF.

ENVIRONMENTAL DATA:
BIODEGRADATION:

Chemical Oxygen Demand (COD): 11,000 mgO2/l
5-Day Biochemical Oxygen Demand (BOD5): 6250 mgO2/l
%BOD5/COD = 56.8

AQUATIC TOXICITY:

Fathead minnow (Pimephales promelas) 96-hr LC50: > 1000 mg/L
Water flea (Daphnia magna) 48-hr EC50: 308 mg/L

REGULATORY INFORMATION:
Volatile Organic Compounds: 396 gms/liter South Coast Air Quality Mgmt Dist Method.
VOC Less H2O & Exempt Solvents: N/A gms/liter.

Since regulations vary, consult applicable regulations or authorities before disposal. In the event of an uncontrolled release of this material, the user should determine if the release qualifies as a reportable quantity. U.S. EPA Hazardous Waste Number = None (Not U.S. EPA Hazardous).

The components of this product are in compliance with the chemical registration requirements of: TSCA, EINECS, CDSL, AICS, MITI.

OTHER ENVIRONMENTAL INFORMATION:
Handling this product according to recommendations is important because its properties present a moderate environmental hazard.

---

5. ENVIRONMENTAL INFORMATION (continued)

There is insufficient component information to calculate the wastewater treatment system effects of this product.

The components labeled "readily biodegradable" are expected to fully degrade in wastewater treatment and in most aerobic water or soil environments.

The components labeled "partially biodegradable" are not readily biodegradable but are partially degraded in ready biodegradation tests.

The components labeled "insignificant biodegradation" did not degrade significantly in ready biodegradation tests.

The components labeled "resistant moieties" have chemical moieties that are resistant to biodegradation. They are likely to only undergo partial biodegradation in the environment.

The components labeled "perfluorinated" are completely fluorinated. Perfluoroalkyl compounds resist degradation in most natural environments.

Testing indicates this product has minimal toxicity to aquatic organisms (100 mg/L < Lowest LC50, EC50, or IC50 < or = 1000 mg/L).

Bioassays on the product have been run on organisms from less than three phyla. Organisms from taxa that were not tested may show greater sensitivity.

Some toxicity may persist after wastewater treatment or for days or longer in aquatic systems because components responsible for >10% to 50% of the toxicity are not readily biodegradable.

The toxicity of this product after the readily biodegradable components are removed is calculated to be >10 - 100.

The components labeled "Log Kow <3" have measured or calculated log Kow values <3 indicating they are unlikely to bioconcentrate to high concentrations in aquatic organisms by partitioning into lipid tissues

This product contains one or more organic fluorochemicals that have the potential to resist degradation and persist in the environment.

Readily Biodegradable: Diethylene Glycol Butyl Ether, Sodium Octyl Sulfate.
Partially Biodegradable: Alkyl Sulfate Salts(2) +(5884P, 5886P)
Insignificantly Biodegradable: Triethanolamine, Tolyl Triazole

Resistant Moieties: Amphoteric Fluoroalkylamide Derivative+(5887P)

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5. ENVIRONMENTAL INFORMATION (continued)

Perfluorinated: Perfluoroalkyl Sulfonate Salts(5)+(5885P)

Log Kow <3: Diethylene Glycol Butyl Ether, Triethanolamine, Tolyl Triazole

EPCRA HAZARD CLASS:
FIRE HAZARD: No PRESSURE: No REACTIVITY: No ACUTE: Yes CHRONIC: No

---

6. SUGGESTED FIRST AID

EYE CONTACT:
Immediately flush eyes with large amounts of water. Get immediate medical attention.

SKIN CONTACT:
Immediately wash skin with soap and large amounts of water. Remove contaminated clothing. If signs/symptoms occur, call a physician. Wash contaminated clothing before reuse and dispose of contaminated shoes.

INHALATION:
If signs/symptoms occur, remove person to fresh air. If signs/symptoms continue, call a physician.

IF SWALLOWED:
If swallowed, call a physician immediately. Only induce vomiting at the instruction of a physician. Never give anything by mouth to an unconscious person.

---

7. PRECAUTIONARY INFORMATION

EYE PROTECTION:
Avoid eye contact with vapor, spray, or mist. Wear vented goggles.

SKIN PROTECTION:
Avoid skin contact. Wear appropriate gloves when handling this material. A pair of gloves made from the following material(s) are recommended: butyl rubber.

RECOMMENDED VENTILATION:
Use with adequate dilution ventilation. If exhaust ventilation is not adequate, use appropriate respiratory protection. Provide ventilation adequate to control vapor concentrations below recommended exposure limits and/or control spray or mist.

---

7. PRECAUTIONARY INFORMATION (continued)

RESPIRATORY PROTECTION:
Avoid breathing of airborne material. Select one of the following NIOSH approved respirators based on airborne concentration of contaminants and in accordance with OSHA regulations: Half-mask organic vapor respirator with dust/mist prefilter.

PREVENTION OF ACCIDENTAL INGESTION:
Do not eat, drink or smoke when using this product. Wash exposed areas thoroughly with soap and water. Wash hands after handling and before eating.

RECOMMENDED STORAGE:
Store away from areas where product may come into contact with food or pharmaceuticals. Store at temperatures below 120 degrees F (49 degrees C). Store at temperatures above 32 degrees F (O degrees C). Keep container closed when not in use. Keep container in well-ventilated area.

FIRE AND EXPLOSION AVOIDANCE:
Keep container tightly closed. Nonflammable.

OTHER PRECAUTIONARY INFORMATION:
No smoking: Smoking while using this product can result in contamination of the tobacco and/or smoke and lead to the formation of the hazardous decomposition products mentioned in the Reactivity Data section of this MSDS.

HMIS HAZARD RATINGS: HEALTH: 2 FLAMMABILITY: 0 REACTIVITY: 0
PERSONAL PROTECTION: X (See precautions, section 7.)

EXPOSURE LIMITS

INGREDIENT	VALUE	UNIT	TYPE	AUTH	SKIN*
WATER................................	NONE	NONE	NONE	NONE	
DIETHYLENE GLYCOL BUTYL ETHER........	35	PPM	TWA	CMRG	
Amphoteric Fluoroalkylamide Derivative +(5887P)................	NONE	NONE	NONE	NONE	
Alkyl Sulfate Salts(2) +(5884P, 5886P)............................	NONE	NONE	NONE	NONE	
TRIETHANOLAMINE......................	5	MG/M3	TWA	ACGIH	
Perfluoroalkyl Sulfonate Salts(5) +(5885P)..........................	0.1	MG/M3	TWA	3M	Y
TOLYL TRIAZOLE.......................	NONE	NONE	NONE	NONE	

* SKIN NOTATION: Listed substances indicated with 'Y' under SKIN refer to the potential contribution to the overall exposure by the cutaneous route including mucous membrane and eye, either by airborne or, more particularly, by direct contact with the substance. Vehicles can alter skin absorption.

EXPOSURE LIMITS (continued)

INGREDIENT	VALUE	UNIT	TYPE	AUTH	SKIN*

SOURCE OF EXPOSURE LIMIT DATA:
- 3M: 3M Recommended Exposure Guidelines
- ACGIH: American Conference of Governmental Industrial Hygienists
- CMRG: Chemical Manufacturer Recommended Exposure Guidelines

- NONE: None Established

8. HEALTH HAZARD DATA

EYE CONTACT:
Moderate Eye Irritation: signs/symptoms can include redness, swelling, pain, tearing, and hazy vision.

SKIN CONTACT:
Moderate Skin Irritation: signs/symptoms can include redness, swelling, itching, and dryness.

Prolonged or repeated exposure may cause:

Allergic Skin Reaction: signs/symptoms can include redness, swelling, blistering, and itching.

INHALATION:
Single overexposure, above recommended guidelines, may cause:

Central Nervous System Depression: signs/symptoms can include headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness.

Irritation (upper respiratory): signs/symptoms can include soreness of the nose and throat, coughing and sneezing.

IF SWALLOWED:
Animal studies conducted on organic fluorochemicals which are present in this product indicate effects including liver disturbances, weight loss, loss of appetite, lethargy, and neurological, pancreatic, adrenal and hematologic effects. There are no known human health effects from anticipated exposure to these organic fluorochemicals when used as intended and instructed.

Ingestion may cause:

Aspiration Pneumonitis: signs/symptoms can include coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal.

WHILE THE FOLLOWING EFFECTS ARE ASSOCIATED WITH ONE OR MORE OF THE INDIVIDUAL INGREDIENTS IN THIS PRODUCT AND ARE REQUIRED TO BE

---

8. HEALTH HAZARD DATA (continued)

INCLUDED ON THE MSDS BY THE U.S. OSHA HAZARD COMMUNICATION STANDARD, THEY ARE NOT EXPECTED EFFECTS DURING FORESEEABLE USE OF THIS PRODUCT.

Ingestion may cause:

Irritation of Gastrointestinal Tissues: signs/symptoms can include pain, vomiting, abdominal tenderness, nausea, blood in vomitus, and blood in feces.

Central Nervous System Depression: signs/symptoms can include headache, dizziness, drowsiness, muscular weakness, incoordination, slowed reaction time, fatigue, blurred vision, slurred speech, giddiness, tremors and convulsions.

OTHER HEALTH HAZARD INFORMATION:
A Product Toxicity Summary Sheet is available.

This product contains one or more organic fluorochemicals that have the potential to be absorbed and remain in the body for long periods of time, either as the parent molecule or as metabolites, and may accumulate with repeated exposures. There are no known human health effects from anticipated exposure to these organic fluorochemicals when used as intended and instructed.

The presence of organic fluorochemicals in the blood of the general population and subpopulations, such as workers, has been published dating back to the 1970's. 3M's epidemiological study of its own workers indicates no adverse effects.

SECTION CHANGE DATES

INGREDIENTS SECTION CHANGED SINCE September 29, 1998 ISSUE
PRECAUTIONARY INFO. SECTION CHANGED SINCE September 29, 1998 ISSUE

The information in this Material Safety Data Sheet (MSDS) is believed to be correct as of the date issued. 3M MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR COURSE OF PERFORMANCE OR USAGE OF TRADE. User is responsible for determining whether the 3M product is fit for a particular purpose and suitable for user's method of use or application. Given the variety of factors that can affect the use and application of a 3M product, some of which are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for user's method of use or application.

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MATERIAL SAFETY DATA SHEET

3M
3M Center
St. Paul, Minnesota
55144-1000
1-800-364-3577 or (651) 737-6501 (24 hours)

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1) the information is copied in full with no changes unless prior agreement is obtained from 3M, and
2) neither the copy nor the original is resold or otherwise distributed with the intention of earning a profit thereon.

DIVISION: 3M SPECIALTY MATERIALS
TRADE NAME:
FX-8B 3M Fire Fighting Foam Intermediate
ID NUMBER/U.P.C.:
ZF-0002-0683-7 - - - ZF-0002-1168-8 - - -
ISSUED: December 23, 1999
SUPERSEDES: December 09, 1999
DOCUMENT: 06-7386-3

---

1. INGREDIENT

INGREDIENT	C.A.S. NO.	PERCENT
PERFLUOROOCTANESULFONYL FLUORIDE........	307-35-7	> 95.5
PERFLUOROHEPTANESULFONYL FLUORIDE.......	335-71-7	< 4.5

The components of this product are in compliance with the chemical notification requirements of TSCA. All applicable chemical ingredients in this material are listed on the European Inventory of Existing Chemical Substances (EINECS), or are exempt polymers whose monomers are listed on EINECS.

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2. PHYSICAL DATA

BOILING POINT:................. 154 C
VAPOR PRESSURE:................ < 10 mmHg
Calc. @ 20 C
VAPOR DENSITY:................. > 1.0 Air=1
Calc. @ 20 C
EVAPORATION RATE:.............. < 1.0 BuOAc=1
SOLUBILITY IN WATER:........... neglig.
SPECIFIC GRAVITY:.............. ca. 1.8 Water=1
PERCENT VOLATILE:.............. nil
pH:............................ N/A
VISCOSITY:..................... N/D
MELTING POINT:................. N/A

Abbreviations: N/D - Not Determined N/A - Not Applicable CA - Approximately

2. PHYSICAL DATA (continued)

APPEARANCE AND ODOR:
Clear liquid.

3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:................... > 100 C Setaflash
FLAMMABLE LIMITS - LEL:........ N/A
FLAMMABLE LIMITS - UEL:........ N/A
AUTOIGNITION TEMPERATURE:...... N/A

EXTINGUISHING MEDIA:
Water, Carbon dioxide, Dry chemical, Foam

SPECIAL FIRE FIGHTING PROCEDURES:
Wear full protective clothing, including helmet, self-contained, positive pressure or pressure demand breathing apparatus, bunker coat and pants, bands around arms, waist and legs, face mask, and protective covering for exposed areas of the head.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
See Hazardous Decomposition section for products of combustion.

4. REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY - MATERIALS/CONDITIONS TO AVOID:
Strong Bases, Amines.

HAZARDOUS POLYMERIZATION: Hazardous polymerization will not occur.

HAZARDOUS DECOMPOSITION PRODUCTS:
Carbon Monoxide and Carbon Dioxide, Oxides of Sulfur, Hydrogen Fluoride, Toxic Vapors, Gases or Particulates.

5. ENVIRONMENTAL INFORMATION

SPILL RESPONSE:
Observe precautions from other sections. Ventilate area. Contain spill. Cover with inorganic absorbent material. Collect spilled material. Clean up residue with an appropriate organic solvent. Read and follow safety precautions on the solvent label and MSDS. Place in a closed container.

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5. ENVIRONMENTAL INFORMATION (continued)

RECOMMENDED DISPOSAL:
Incinerate in an industrial or commercial facility in the presence of a combustible material. Combustion products will include HF. Disposal alternative: Dispose of completely absorbed waste product in a facility permitted to accept chemical wastes.

ENVIRONMENTAL DATA:
3M COMPOSED HAZARD ASSESSMENT

ENVIRONMENTAL FATE AND EFFECTS:

This substance did not degrade significantly in a ready biodegradation test. This compound is completely fluorinated (perfluorinated), or it contains perfluorinated portions. Perfluoroalkyl groups resist degradation in most natural environments.

This low-solubility substance has minimal toxicity to aquatic organisms (Lowest LL50 or EL50 > 1000 mg/L). LL50 (Lethal Level) and EL50 (Effective Level) are similar to LC50 and EC50, but tests the water phase from incompletely-miscible mixtures. Bioassays have been run on organisms from less than three phyla. Organisms from taxa that were not tested may show greater sensitivity.

SUPPORTING DATA

Biodegradation:

Chemical Oxygen Demand (COD): 500 - 720 mg/kg
20-Day Biochemical Oxygen Demand (BOD20): Nil

Aquatic toxicity:

96-HR LL50 Fathead minnow (Pimephales promelas) - >1000 mg/L.
No acute inhibition of microbial oxygen uptake at 1000 mg/L.

REGULATORY INFORMATION:
Volatile Organic Compounds: N/A.
VOC Less H2O & Exempt Solvents: N/A.

Since regulations vary, consult applicable regulations or authorities before disposal. U.S. EPA Hazardous Waste Number = None (Not U.S. EPA Hazardous).

OTHER ENVIRONMENTAL INFORMATION:
This product contains one or more organic fluorochemicals that have the potential to resist degradation and persist in the environment.

EPCRA HAZARD CLASS:

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5. ENVIRONMENTAL INFORMATION (continued)

FIRE HAZARD: No PRESSURE: No REACTIVITY: No ACUTE: No CHRONIC: No

6. SUGGESTED FIRST AID

EYE CONTACT:
Immediately flush eyes with large amounts of water. Get immediate medical attention.

SKIN CONTACT:
Flush skin with large amounts of water. If irritation persists, get medical attention.

INHALATION:
If signs/symptoms occur, remove person to fresh air. If signs/symptoms continue, call a physician.

IF SWALLOWED:
Drink two glasses of water. Call a physician.

7. PRECAUTIONARY INFORMATION

EYE PROTECTION:
Avoid eye contact with vapor, spray, or mist. Wear vented goggles.

SKIN PROTECTION:
Avoid skin contact. Wear appropriate gloves when handling this material. A pair of gloves made from the following material(s) are recommended: butyl rubber. Use one or more of the following personal protection items as necessary to prevent skin contact: coveralls.

RECOMMENDED VENTILATION:
If exhaust ventilation is not adequate, use appropriate respiratory protection. Provide ventilation adequate to control vapor concentrations below recommended exposure limits and/or control spray or mist.

RESPIRATORY PROTECTION:
Avoid breathing of airborne material. Select one of the following NIOSH approved respirators based on airborne concentration of contaminants and in accordance with OSHA regulations: Half-mask organic vapor respirator with dust/mist prefilter.

7. PRECAUTIONARY INFORMATION (continued)

PREVENTION OF ACCIDENTAL INGESTION:
Do not eat, drink or smoke when using this product. Wash exposed areas thoroughly with soap and water. Wash hands after handling and before eating.

RECOMMENDED STORAGE:
Store away from areas where product may come into contact with food or pharmaceuticals. Do not store containers on their sides. Store away from heat. Allow material to return to room temperature before use. Keep container closed when not in use. Keep container in well-ventilated area.

FIRE AND EXPLOSION AVOIDANCE:
Nonflammable.

OTHER PRECAUTIONARY INFORMATION:
No smoking: Smoking while using this product can result in contamination of the tobacco and/or smoke and lead to the formation of the hazardous decomposition products mentioned in the Reactivity Data section of this MSDS.

HMIS HAZARD RATINGS: HEALTH: 1 FLAMMABILITY: 1 REACTIVITY: 0
PERSONAL PROTECTION: X (See precautions, section 7.)

EXPOSURE LIMITS

INGREDIENT	VALUE	UNIT	TYPE	AUTH	SKIN*
PERFLUOROOCTANESULFONYL FLUORIDE.....	0.1	MG/M3	TWA	3M	Y
PERFLUOROHEPTANESULFONYL FLUORIDE....	0.1	MG/M3	TWA	3M	Y

* SKIN NOTATION: Listed substances indicated with 'Y' under SKIN refer to the potential contribution to the overall exposure by the cutaneous route including mucous membrane and eye, either by airborne or, more particularly, by direct contact with the substance. Vehicles can alter skin absorption.

SOURCE OF EXPOSURE LIMIT DATA:
- 3M: 3M Recommended Exposure Guidelines

8. HEALTH HAZARD DATA

EYE CONTACT:
Mild Eye Irritation: signs/symptoms can include redness, swelling, pain, and tearing.

8. HEALTH HAZARD DATA (continued)

SKIN CONTACT:
Product is not expected to be irritating to the skin.

May be absorbed through the skin and produce effects similiar to those caused by inhalation and/or ingestion.

INHALATION:
Single overexposure, above recommended guidelines, may cause:

Irritation (upper respiratory): signs/symptoms can include soreness of the nose and throat, coughing and sneezing.

IF SWALLOWED:
Animal studies conducted on organic fluorochemicals which are present in this product indicate effects including liver disturbances, weight loss, loss of appetite, lethargy, and neurological, pancreatic, adrenal and hematologic effects. There are no known human health effects from anticipated exposure to these organic fluorochemicals when used as intended and instructed.

OTHER HEALTH HAZARD INFORMATION:
This product contains one or more organic fluorochemicals that have the potential to be absorbed and remain in the body for long periods of time, either as the parent molecule or as metabolites, and may accumulate with repeated exposures. There are no known human health effects from anticipated exposure to these organic fluorochemicals when used as intended and instructed.

The presence of organic fluorochemicals in the blood of the general population and subpopulations, such as workers, has been published dating back to the 1970's. 3M's epidemiological study of its own workers indicates no adverse effects.

SECTION CHANGE DATES

HEADING	SECTION CHANGED SINCE December 09, 1999 ISSUE
INGREDIENTS	SECTION CHANGED SINCE December 09, 1999 ISSUE
ENVIRONMENTAL INFO.	SECTION CHANGED SINCE December 09, 1999 ISSUE

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LIQUINOX MSDS

Section 1 : MANUFACTURER INFORMATION

Supplier: Same as manufacturer.

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Supplier MSDS date: 2005/02/24

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state: Liquid.

Appearance & odor: Odourless.
Pale yellow.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): @ 20°C (68°F).
17

Vapour density (air=1): >1

Volatiles (%)

By volume: Not available.

Evaporation rate (butyl acetate = 1): < 1.

Boiling point (°C):	100 (212F)
Freezing point (°C):	Not available.
pH:	8.5
Specific gravity @ 20 °C:	(water = 1). 1.083
Solubility in water (%):	Complete.
Coefficient of water\oil dist.:	Not available.
VOC:	None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability:	Not flammable.
Conditions of flammability:	Surrounding fire.
Extinguishing media:	Carbon dioxide, dry chemical, foam. Water Water fog.
Special procedures:	Self-contained breathing apparatus required. Firefighters should wear the usual protective gear. Use water spray to cool fire exposed containers.
Auto-ignition temperature:	Not available.
Flash point (°C), method:	None
Lower flammability limit (% vol):	Not applicable.
Upper flammability limit (% vol):	Not applicable.

Not available.

Sensitivity to mechanical impact:	Not available.
Hazardous combustion products:	Oxides of carbon (COx). Hydrocarbons.
Rate of burning:	Not available.
Explosive power:	Containers may rupture if exposed to heat or fire.

Section 5 : REACTIVITY DATA

Chemical stability:	Product is stable under normal handling and storage conditions.
Conditions of instability:	Extreme temperatures.
Hazardous polymerization:	Will not occur.
Incompatible substances:	Strong acids. Strong oxidizing agents.
Hazardous decomposition products:	See hazardous combustion products.

Section 6 : HEALTH HAZARD DATA

Route of entry: Skin contact, eye contact, inhalation and ingestion.

Effects of Acute Exposure

Eye contact: May cause irritation.

Skin contact: Prolonged and repeated contact may cause irritation.

Inhalation: May cause headache and nausea.

Ingestion: May cause vomiting and diarrhea.
May cause gastric distress.

Effects of chronic exposure: See effects of acute exposure.

LD50 of product, species & route: > 5000 mg/kg rat oral.

LC50 of product, species & route: Not available.

Exposure limit of material: Not available.

Sensitization to product: Not available.

Carcinogenic effects: Not listed as a carcinogen.

Reproductive effects: Not available.

Teratogenicity: Not available.

Mutagenicity: Not available.

Synergistic materials: Not available.

Medical conditions aggravated by exposure: Not available.

First Aid

Skin contact: Remove contaminated clothing.
Wash thoroughly with soap and water.
Seek medical attention if irritation persists.

Eye contact: Check for and remove contact lenses.
Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.

Inhalation: Remove victim to fresh air.
If irritation persists, seek medical attention.

Ingestion: Do not induce vomiting, seek medical attention.
Dilute with two glasses of water.
Never give anything by mouth to an unconscious person.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak/Spill: Contain the spill.
Prevent entry into drains, sewers, and other waterways.
Wear appropriate protective equipment.
Small amounts may be flushed to sewer with water.
Soak up with an absorbent material.
Place in appropriate container for disposal.
Notify the appropriate authorities as required.

Waste disposal: In accordance with local and federal regulations.

Handling procedures and equipment: Protect against physical damage.
Avoid breathing vapors/mists.
Wear personal protective equipment appropriate to task.

Wash thoroughly after handling.
Keep out of reach of children.
Avoid contact with skin, eyes and clothing.
Avoid extreme temperatures.
Launder contaminated clothing prior to reuse.

Storage requirements: Store away from incompatible materials.
Keep containers closed when not in use.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:

Wear appropriate gloves.

Respiratory / Type: None required under normal use.

Eye / Type:

Safety glasses recommended.

Footwear / Type: Safety shoes per local regulations.

Clothing / Type: As required to prevent skin contact.

Other / Type: Eye wash facility should be in close proximity.
Emergency shower should be in close proximity.

Ventilation requirements: Local exhaust at points of emission.

APPENDIX D

CONFINED SPACE ENTRY PERMIT

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CONFINED SPACE ENTRY PERMIT

This permit (or a copy) shall be posted, when completed, at the entrance to the confined space <u>before</u> authorized entrants are allowed to enter. This permit is revoked if conditions in the confined space change and are no longer acceptable under the guidelines of this permit.

Date of issue: ____________________________ Expiration Date: __________________________

Entry time: ______________________________ Expiration Time: _________________________

Location of Space: ____

Description of Space: ____

Purpose of Entry: ____

Attendant(s): ____

Authorized Entrant(s): ____

HAZARD ASSESSMENT	YES	NO	HAZARD ASSESSMENT	YES	NO
Oxygen deficiency (<19.5%)			Materials harmful to the skin		
Combustible gases (>10% of LEL)			Noise		
H_2S (>10 ppm)			Asbestos		
CO (>25 ppm)			Electrical shock		
Other chemicals - List:			Heat stress		
List:			Darkness		

SAFETY EQUIPMENT	YES	NO	PERSONAL PROTECTIVE EQUIP.	YES	NO
Lockout/tagout			Self-contained Breathing Apparatus		
Pipe lines capped blanked/purged, flushed			Airline Supplied Respirator w/escape		
Mechanical ventilation			Air Purifying Respirator - Type:		
Area secure and signs posted			Five-minute escape air bottles		
Retrieval system/tripod			Safety glasses and goggles		
Communication equipment			Hard Hat		
Monitoring instr. - Type:			Chemical resistant clothing - Type:		
Fire extinguisher - Type:			Protective boots and/or gloves		
Ground fault circuit interrupter			Hearing protection - Type:		
Lighting			Tripod, winch, body harness, and life line		
Other permits - Type:			Other:		

Tests to be performed:

	TIME:______	TIME:______	TIME:______	TIME:______	TIME:______	TIME:______
OXYGEN						
FLAMMABILITY						
H_2S						
CO						
OTHER						

Sampling Equipment:

Type	Model	Serial	Calibration (Yes/No)

Signature of person who conducted testing: ____

Entry Supervisor (Print Name)	Signature	Date	Time

Rescue and Emergency Services Phone Number: ____

INSTRUCTIONS FOR USE OF THIS PERMIT

This permit is used to control entry and work in a permit-required confined space. This permit is initiated by the entry supervisor and all information must be completed and all requirements must be checked off as a “yes” on the permit, or if “no” is checked it must have an explanation or an “N/A” placed in the box.

A copy of this <u>completed</u> permit must be posted at the confined space <u>before</u> any person is allowed entry.

This permit is good <u>only</u> for the following:

- confined space identified
- period given
- operation(s) (purpose of entry) listed

If any of the operations within the confined space will generate flames, sparks, or heat, a Hot Work Permit must be completed and posted at the confined space along with this permit.

A copy of this completed permit must be returned to the office SHE Coordinator by the entry supervisor. A copy of this permit will be filed for a period of at least 1 year.

If the entry supervisor terminates the entry for any reason, this permit will be removed from the posted area.

The FM must ensure that all persons involved with the entry have received the prerequisite training <u>before</u> entry into the confined space is allowed.

The entry supervisor or the SHSC shall ensure that all required testing instruments are calibrated and working, that all communication devices are working, and all emergency equipment is available and in good condition.

NOTE: An entry is defined as any time a person’s face or other body part breaks the plane of the entrance to the confined space.

At the end of the entry, a copy of the permit shall be submitted to the regional SHE Manager to assist in program review.

APPENDIX B

Quality Project Plan/Quality Assurance Project Plan Acknowledgement Form

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QPP/QAPP Acknowledgement Form

The Quality Program Plan (QPP) presents the activities and associated quality objectives to be conducted for the site investigation of perfluorinated compounds (PFCs) release areas at 11 Base Realignment and Closure (BRAC) installations located nationwide. The general QPP is designed to provide program-level information for release determination activities that will be conducted at each of the 11 BRAC installations.

Project personnel are required to read and understand the QPP and the Quality Assurance Project Plan (QAPP) prior to any project implementation activities. Personnel sign below to indicate that they have read the QPP/QAPP and will perform the task as described. The signed worksheet along with the relevant QPP Summary of Revisions spreadsheet will be maintained in the project file for each installation.

Installation Name: ____________________________

Name	Organization/Role	Signature	Date

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APPENDIX C

Project Schedule

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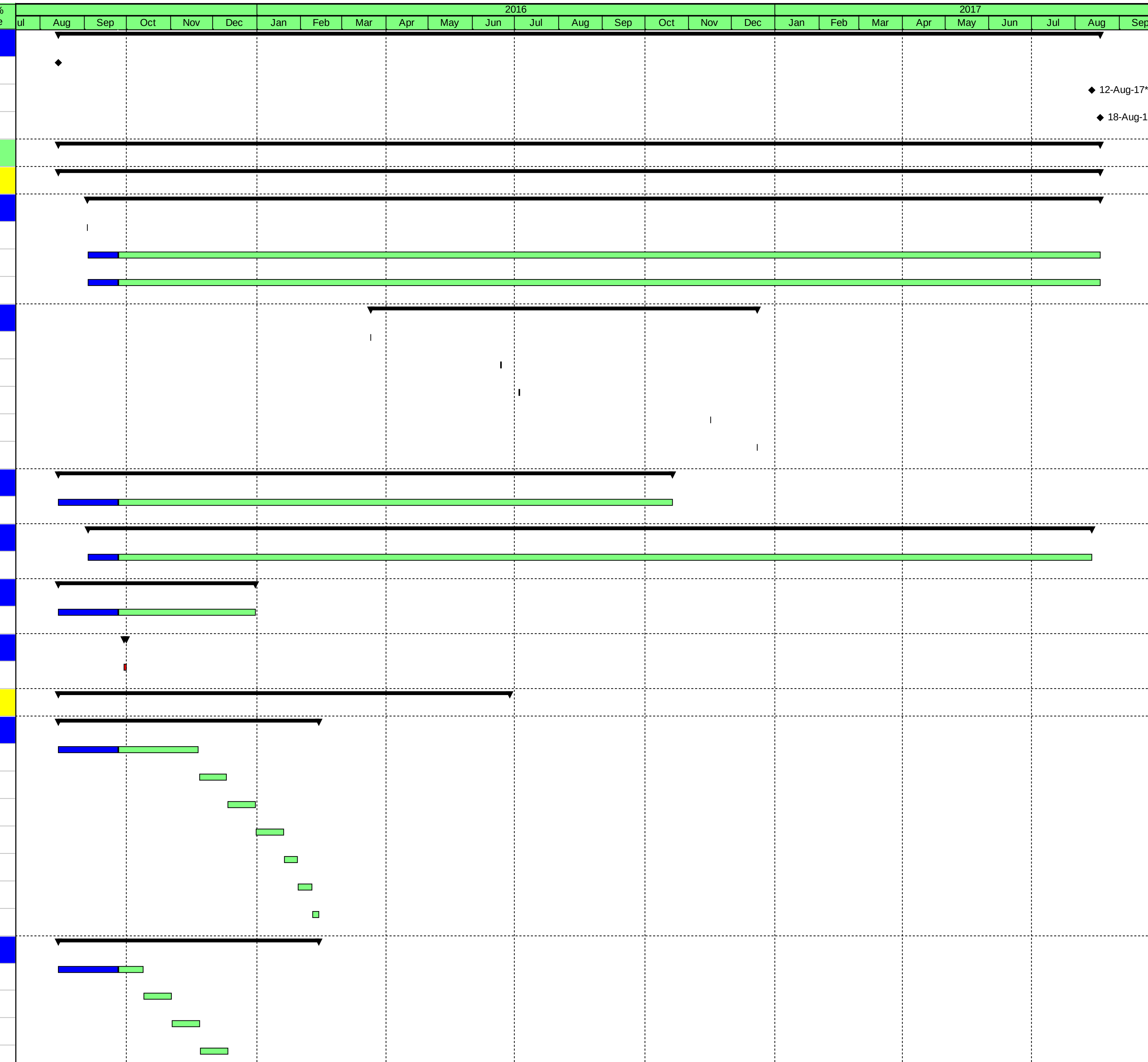
Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Castle		491	477	14-Aug-15 A	18-Aug-17	
C1000	Project Award	0	0	14-Aug-15 A		100%
C1015	Contract POP (24 Months)	0	0		12-Aug-17*	0%
C1005	Project Complete	0	0		18-Aug-17	0%
Castle		491	477	14-Aug-15 A	18-Aug-17	
0100 - Prog/Project Management		716	694	14-Aug-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		716	694	03-Sep-15 A	18-Aug-17	
C2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
C2500	Monthly CPSMR/FMER	715	694	04-Sep-15 A	18-Aug-17	2.94%
C2510	Monthly Status Teleconferences	715	694	04-Sep-15 A	18-Aug-17	2.94%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		274	274	21-Mar-16	19-Dec-16	
C1040	Other On-site Meeting #1	1	1	21-Mar-16*	21-Mar-16	0%
C1060	Additional Meeting #1	1	1	21-Jun-16*	21-Jun-16	0%
C1070	On-Site Technical Meeting #1	1	1	04-Jul-16*	04-Jul-16	0%
C1050	Other On-site Meeting #2	1	1	16-Nov-16*	16-Nov-16	0%
C1080	On-Site Technical Meeting #2	1	1	19-Dec-16*	19-Dec-16	0%
1.3 - Procurement		434	392	14-Aug-15 A	20-Oct-16	
C2520	Subcontractor Procurement/Closeout	434	392	14-Aug-15 A	20-Oct-16	9.68%
1.4 - Project Website		709	688	04-Sep-15 A	12-Aug-17	
C2530	Monthly CPSMR/FMER	709	688	04-Sep-15 A	12-Aug-17	2.96%
1.5 - Lab Audits and Reporting		139	97	14-Aug-15 A	30-Dec-15	
C2540	Lab Audits and Reporting	139	97	14-Aug-15 A	30-Dec-15	30.22%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
C2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		189	189	14-Aug-15 A	27-Jun-16	
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
C1130	Prepare and Submit Draft	60	57	14-Aug-15 A	20-Nov-15	5%
C1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
C1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
C1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
C1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
C1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
C1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		142	142	14-Aug-15 A	13-Feb-16	
C1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
C1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
C1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
C1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



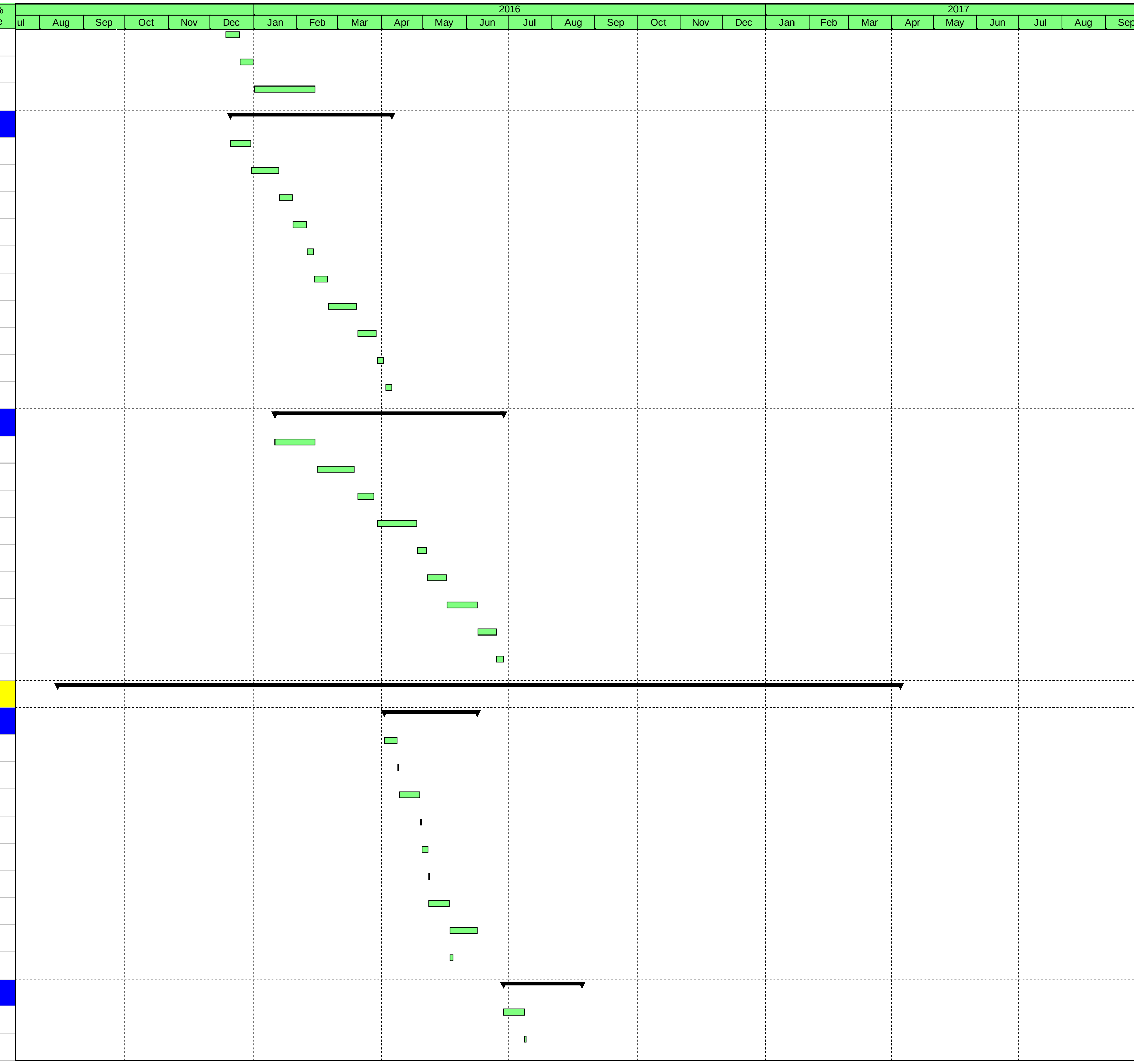
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Castle

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
C1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
C1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		80	80	15-Dec-15	08-Apr-16	
C1700	Prepare and Submit Working Copy	15	15	15-Dec-15*	29-Dec-15	0%
C1710	Air Force Review Working Copy	20	20	30-Dec-15	18-Jan-16	0%
C1720	Prepare and Submit Working Copy Rev 1	10	10	19-Jan-16	28-Jan-16	0%
C1730	Air Force Review Review and Approval	10	10	29-Jan-16	07-Feb-16	0%
C1740	Prepare and Submit Draft Copy	5	5	08-Feb-16	12-Feb-16	0%
C1750	Agency Review	10	10	13-Feb-16	22-Feb-16	0%
C1751	Prepare Response to Agency Comments	15	15	23-Feb-16	14-Mar-16	0%
C1752	Air Force Review of Response to Comments	10	10	15-Mar-16	28-Mar-16	0%
C1760	Agency Review of Response to Comments and Concurrence	5	5	29-Mar-16	02-Apr-16	0%
C1761	Prepare and Submit Final	5	5	04-Apr-16	08-Apr-16	0%
2.5 - Private/Production Well Survey		113	113	16-Jan-16	27-Jun-16	
C1230	Prepare and Submit Well Survey Plan Working Copy	29	29	16-Jan-16*	13-Feb-16	0%
C1240	Air Force Review Working Copy	27	27	15-Feb-16	12-Mar-16	0%
C1250	Prepare and Submit Working Copy Rev 1	12	12	15-Mar-16	26-Mar-16	0%
C1260	Air Force Review and Approval	29	29	29-Mar-16	26-Apr-16	0%
C1270	Prepare and Submit Draft Copy	7	7	27-Apr-16	03-May-16	0%
C1370	Agency Review	14	14	04-May-16	17-May-16	0%
C1371	Prepare Response to Agency Comments	15	15	18-May-16	08-Jun-16	0%
C1372	Air Force Review of Response to Comments	10	10	09-Jun-16	22-Jun-16	0%
C1380	Prepare and Submit Final	5	5	22-Jun-16	27-Jun-16	0%
0300 - Investigation, Monitoring and Scoping		413	384	14-Aug-15 A	07-Apr-17	
3.1 - Initial Site Investigation		67	67	03-Apr-16	08-Jun-16	
C1790	Coordinate Site Access	10	10	03-Apr-16	12-Apr-16	0%
C1410	Mob SI Soil/Well Installation Team	1	1	13-Apr-16	13-Apr-16	0%
C1420	Soil Borings and Sampling/Monitoring Well Installation	15	15	14-Apr-16	28-Apr-16	0%
C1430	Mob Groundwater Sampling Team	1	1	29-Apr-16	29-Apr-16	0%
C1440	Redevelop and Sample Monitoring Wells	5	5	30-Apr-16	04-May-16	0%
C1450	Demob Groundwater Sampling Team	1	1	05-May-16	05-May-16	0%
C1800	Sample Analysis	15	15	05-May-16	19-May-16	0%
C1810	Data Validation	20	20	20-May-16	08-Jun-16	0%
C1590	IDW Handling and Disposal	3	3	20-May-16	22-May-16	0%
3.3 - Well Survey and Sampling		56	56	27-Jun-16	22-Aug-16	
C1860	Coordinate Site Access	15	15	27-Jun-16	12-Jul-16	0%
C1920	Mob Private Well Sampling Team	1	1	12-Jul-16	13-Jul-16	0%



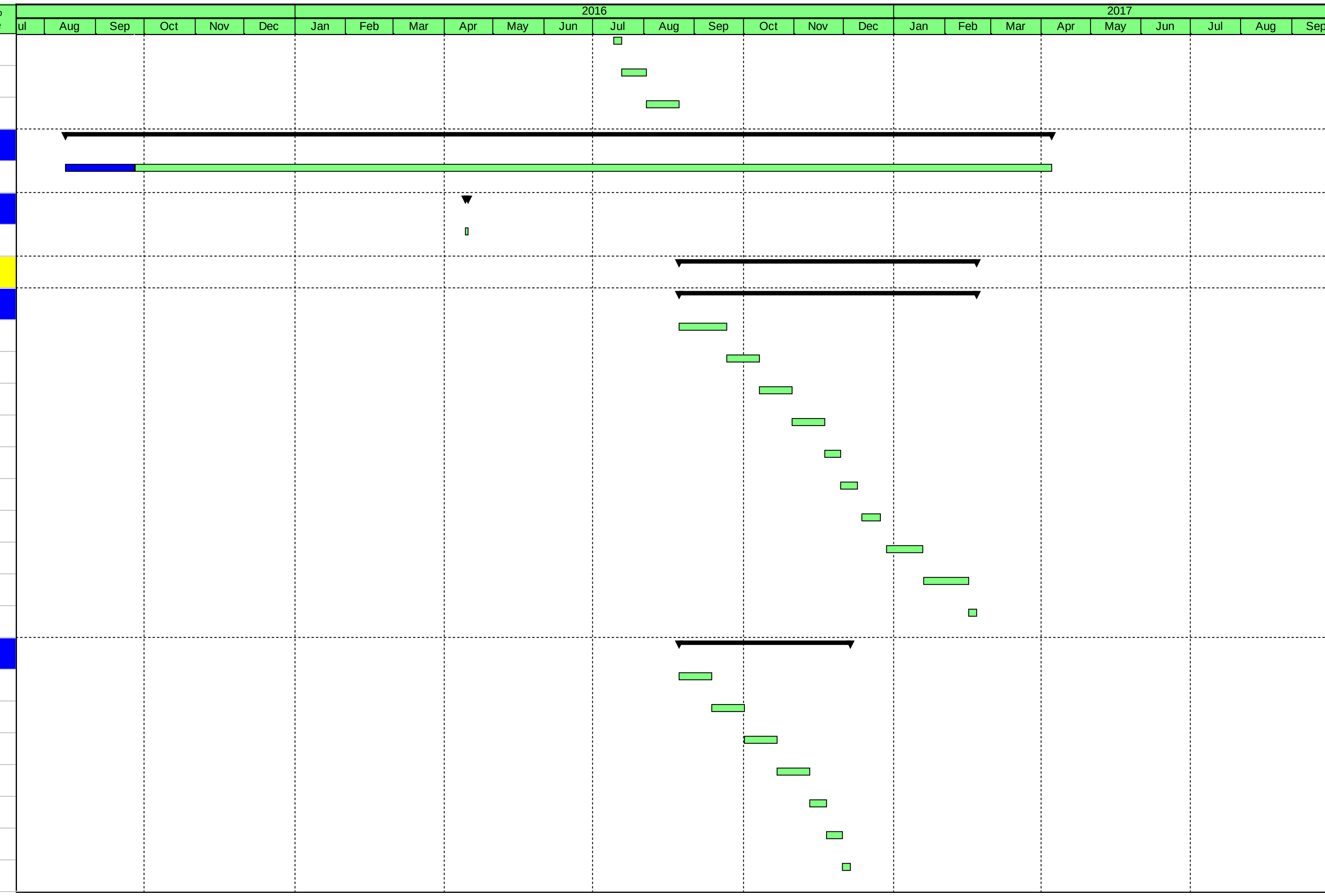
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Castle

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1890	Initial Water Sampling Private Wells	5	5	13-Jul-16	18-Jul-16	0%
C1870	Sample Analysis	15	15	18-Jul-16	02-Aug-16	0%
C1880	Data Validation	20	20	02-Aug-16	22-Aug-16	0%
3.6 - Data Management		413	384	14-Aug-15 A	07-Apr-17	
C1570	Data Management	413	384	14-Aug-15 A	07-Apr-17	7.02%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	14-Apr-16	15-Apr-16	
C1580	Field Audit	2	2	14-Apr-16	15-Apr-16	0%
0400 - Documentation		122	122	22-Aug-16	20-Feb-17	
4.2 - Site Investigation Report		122	122	22-Aug-16	20-Feb-17	
C2130	Prepare and Submit Working Copy Site Investigation Report	29	29	22-Aug-16	20-Sep-16	0%
C2140	Air Force Review Working Copy	20	20	20-Sep-16	10-Oct-16	0%
C2150	Prepare and Submit Working Copy Rev 1	20	20	10-Oct-16	30-Oct-16	0%
C2160	Airforce Reviw and Approval	20	20	30-Oct-16	19-Nov-16	0%
C2170	Prepare and Submit Draft	10	10	19-Nov-16	29-Nov-16	0%
C2180	Agency Review	10	10	29-Nov-16	09-Dec-16	0%
C2181	Prepare Response to Agency Comments	10	10	12-Dec-16	23-Dec-16	0%
C2182	Air Force Review of Response to Comments	15	15	27-Dec-16	18-Jan-17	0%
C2183	Agency Review of Response to Comments and Concurence	20	20	19-Jan-17	15-Feb-17	0%
C2190	Submit Final	5	5	15-Feb-17	20-Feb-17	0%
4.3 - Well Survey and Sampling Activity Report		105	105	22-Aug-16	05-Dec-16	
C2200	Prepare and Submit Draft Initial Transmittal	20	20	22-Aug-16	11-Sep-16	0%
C2210	Air Force Review	20	20	11-Sep-16	01-Oct-16	0%
C2220	Prepare and Submit Draft Final	20	20	01-Oct-16	21-Oct-16	0%
C2230	Agency Review	20	20	21-Oct-16	10-Nov-16	0%
C2240	Prepare and Submit Final	10	10	10-Nov-16	20-Nov-16	0%
C2250	Government Backcheck	10	10	20-Nov-16	30-Nov-16	0%
C2260	Submit Final	5	5	30-Nov-16	05-Dec-16	0%



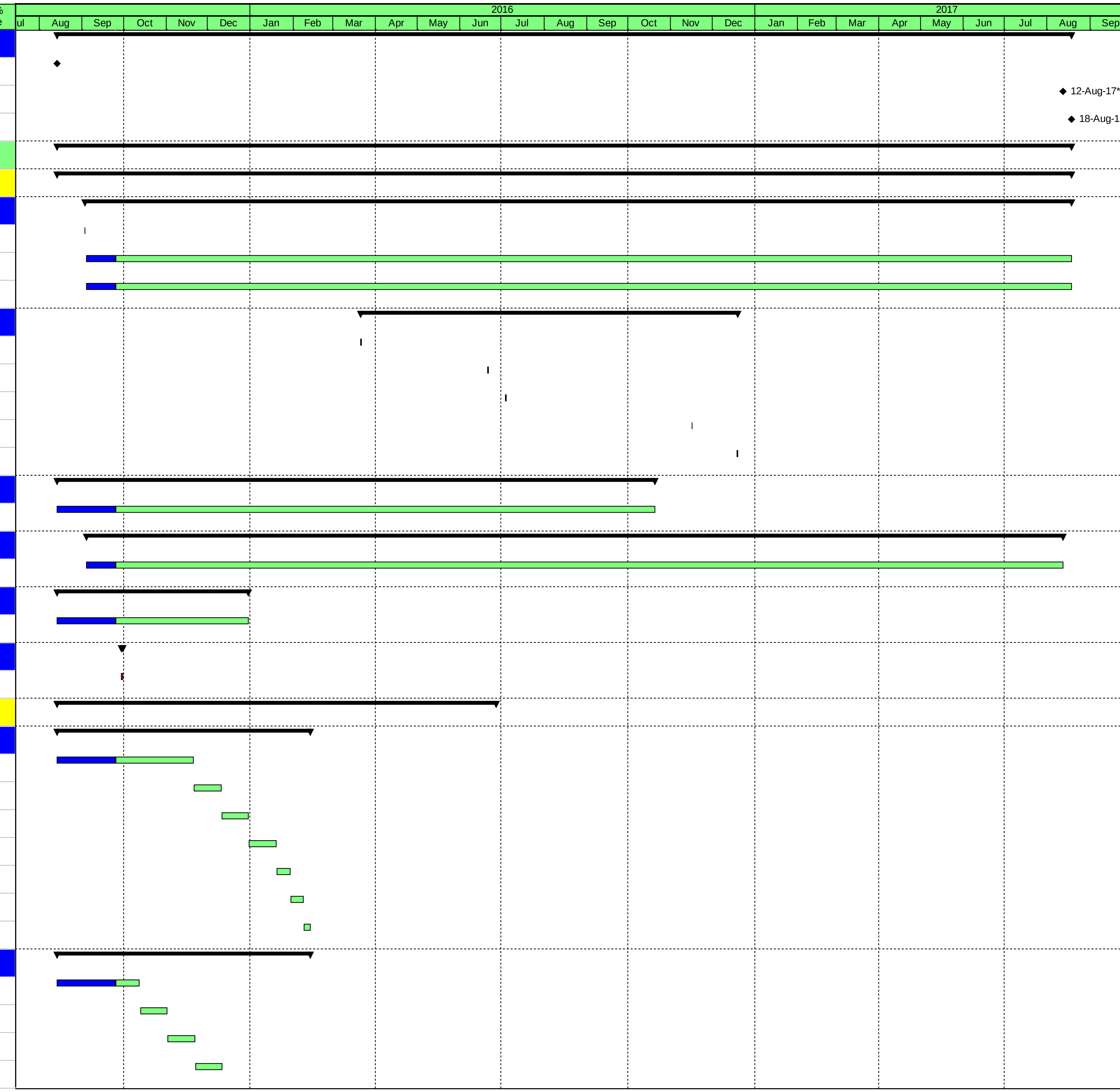
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Castle

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Chanute		491	477	14-Aug-15 A	18-Aug-17	
C1000	Project Award	0	0	14-Aug-15 A		100%
C1015	Contract POP (24 Months)	0	0		12-Aug-17*	0%
C1005	Project Complete	0	0		18-Aug-17	0%
Chanute		491	477	14-Aug-15 A	18-Aug-17	
0100 - Prog/Project Management		716	694	14-Aug-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		716	694	03-Sep-15 A	18-Aug-17	
C2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
C2500	Monthly CPSMR/FMER	715	694	04-Sep-15 A	18-Aug-17	2.94%
C2510	Monthly Status Teleconferences	715	694	04-Sep-15 A	18-Aug-17	2.94%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		274	274	21-Mar-16	19-Dec-16	
C1040	Other On-site Meeting #1	1	1	21-Mar-16*	21-Mar-16	0%
C1060	Additional Meeting #1	1	1	21-Jun-16*	21-Jun-16	0%
C1070	On-Site Technical Meeting #1	1	1	04-Jul-16*	04-Jul-16	0%
C1050	Other On-site Meeting #2	1	1	16-Nov-16*	16-Nov-16	0%
C1080	On-Site Technical Meeting #2	1	1	19-Dec-16*	19-Dec-16	0%
1.3 - Procurement		434	392	14-Aug-15 A	20-Oct-16	
C2520	Subcontractor Procurement/Closeout	434	392	14-Aug-15 A	20-Oct-16	9.68%
1.4 - Project Website		709	688	04-Sep-15 A	12-Aug-17	
C2530	Monthly CPSMR/FMER	709	688	04-Sep-15 A	12-Aug-17	2.96%
1.5 - Lab Audits and Reporting		139	97	14-Aug-15 A	30-Dec-15	
C2540	Lab Audits and Reporting	139	97	14-Aug-15 A	30-Dec-15	30.22%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
C2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		189	189	14-Aug-15 A	27-Jun-16	
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
C1130	Prepare and Submit Draft	60	57	14-Aug-15 A	20-Nov-15	5%
C1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
C1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
C1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
C1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
C1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
C1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		142	142	14-Aug-15 A	13-Feb-16	
C1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
C1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
C1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
C1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



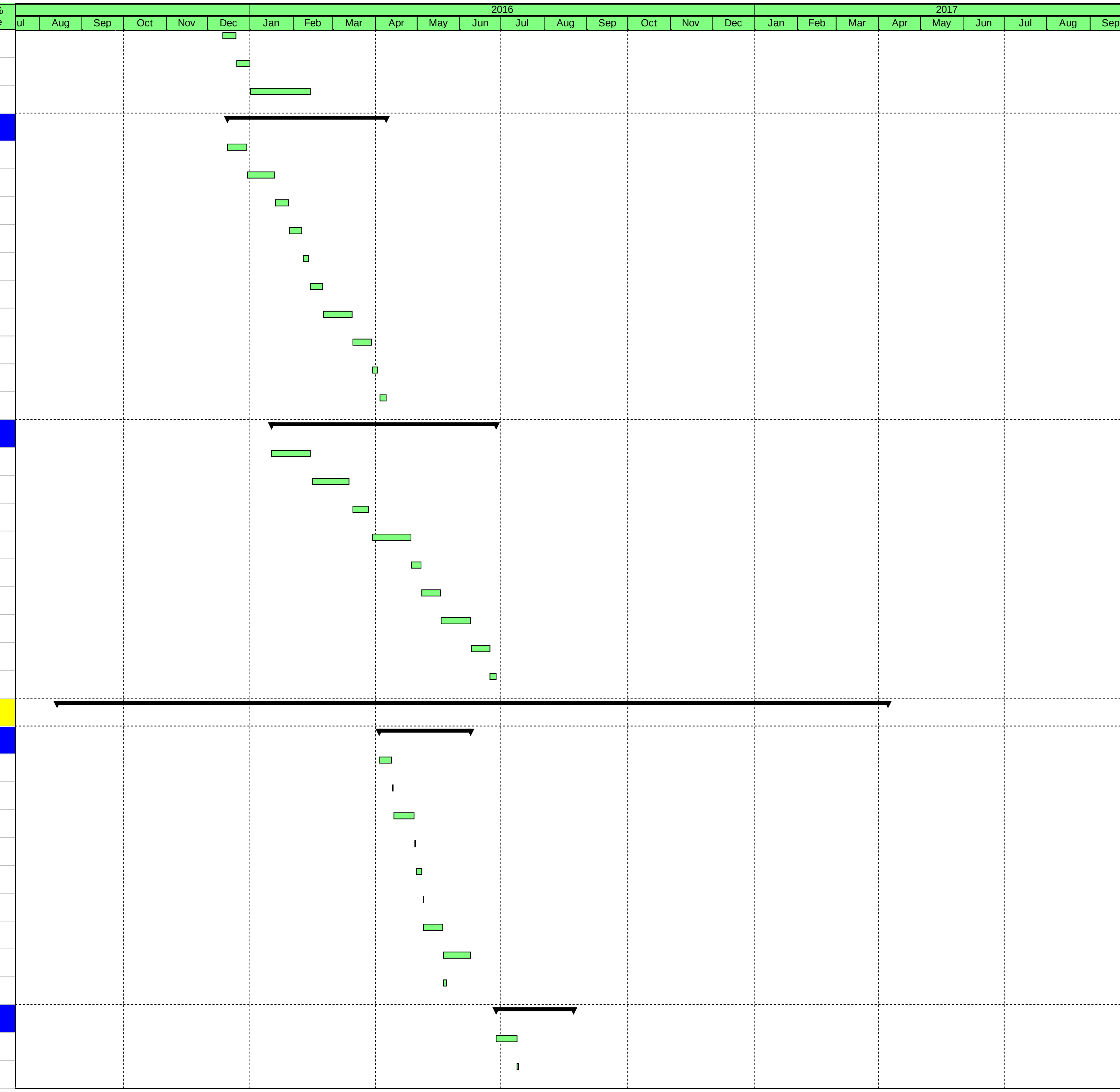
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Chanute

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
C1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
C1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		80	80	15-Dec-15	08-Apr-16	
C1700	Prepare and Submit Working Copy	15	15	15-Dec-15*	29-Dec-15	0%
C1710	Air Force Review Working Copy	20	20	30-Dec-15	18-Jan-16	0%
C1720	Prepare and Submit Working Copy Rev 1	10	10	19-Jan-16	28-Jan-16	0%
C1730	Air Force Review Review and Approval	10	10	29-Jan-16	07-Feb-16	0%
C1740	Prepare and Submit Draft Copy	5	5	08-Feb-16	12-Feb-16	0%
C1750	Agency Review	10	10	13-Feb-16	22-Feb-16	0%
C1751	Prepare Response to Agency Comments	15	15	23-Feb-16	14-Mar-16	0%
C1752	Air Force Review of Response to Comments	10	10	15-Mar-16	28-Mar-16	0%
C1760	Agency Review of Response to Comments and Concurrence	5	5	29-Mar-16	02-Apr-16	0%
C1761	Prepare and Submit Final	5	5	04-Apr-16	08-Apr-16	0%
2.5 - Private/Production Well Survey		113	113	16-Jan-16	27-Jun-16	
C1230	Prepare and Submit Well Survey Plan Working Copy	29	29	16-Jan-16*	13-Feb-16	0%
C1240	Air Force Review Working Copy	27	27	15-Feb-16	12-Mar-16	0%
C1250	Prepare and Submit Working Copy Rev 1	12	12	15-Mar-16	26-Mar-16	0%
C1260	Air Force Review and Approval	29	29	29-Mar-16	26-Apr-16	0%
C1270	Prepare and Submit Draft Copy	7	7	27-Apr-16	03-May-16	0%
C1370	Agency Review	14	14	04-May-16	17-May-16	0%
C1371	Prepare Response to Agency Comments	15	15	18-May-16	08-Jun-16	0%
C1372	Air Force Review of Response to Comments	10	10	09-Jun-16	22-Jun-16	0%
C1380	Prepare and Submit Final	5	5	22-Jun-16	27-Jun-16	0%
0300 - Investigation, Monitoring and Scoping		413	384	14-Aug-15 A	07-Apr-17	
3.1 - Initial Site Investigation		67	67	03-Apr-16	08-Jun-16	
C1790	Coordinate Site Access	10	10	03-Apr-16	12-Apr-16	0%
C1410	Mob SI Soil/Well Installation Team	1	1	13-Apr-16	13-Apr-16	0%
C1420	Soil Borings and Sampling/Monitoring Well Installation	15	15	14-Apr-16	28-Apr-16	0%
C1430	Mob Groundwater Sampling Team	1	1	29-Apr-16	29-Apr-16	0%
C1440	Redevelop and Sample Monitoring Wells	5	5	30-Apr-16	04-May-16	0%
C1450	Demob Groundwater Sampling Team	1	1	05-May-16	05-May-16	0%
C1800	Sample Analysis	15	15	05-May-16	19-May-16	0%
C1810	Data Validation	20	20	20-May-16	08-Jun-16	0%
C1590	IDW Handling and Disposal	3	3	20-May-16	22-May-16	0%
3.3 - Well Survey and Sampling		56	56	27-Jun-16	22-Aug-16	
C1860	Coordinate Site Access	15	15	27-Jun-16	12-Jul-16	0%
C1920	Mob Private Well Sampling Team	1	1	12-Jul-16	13-Jul-16	0%



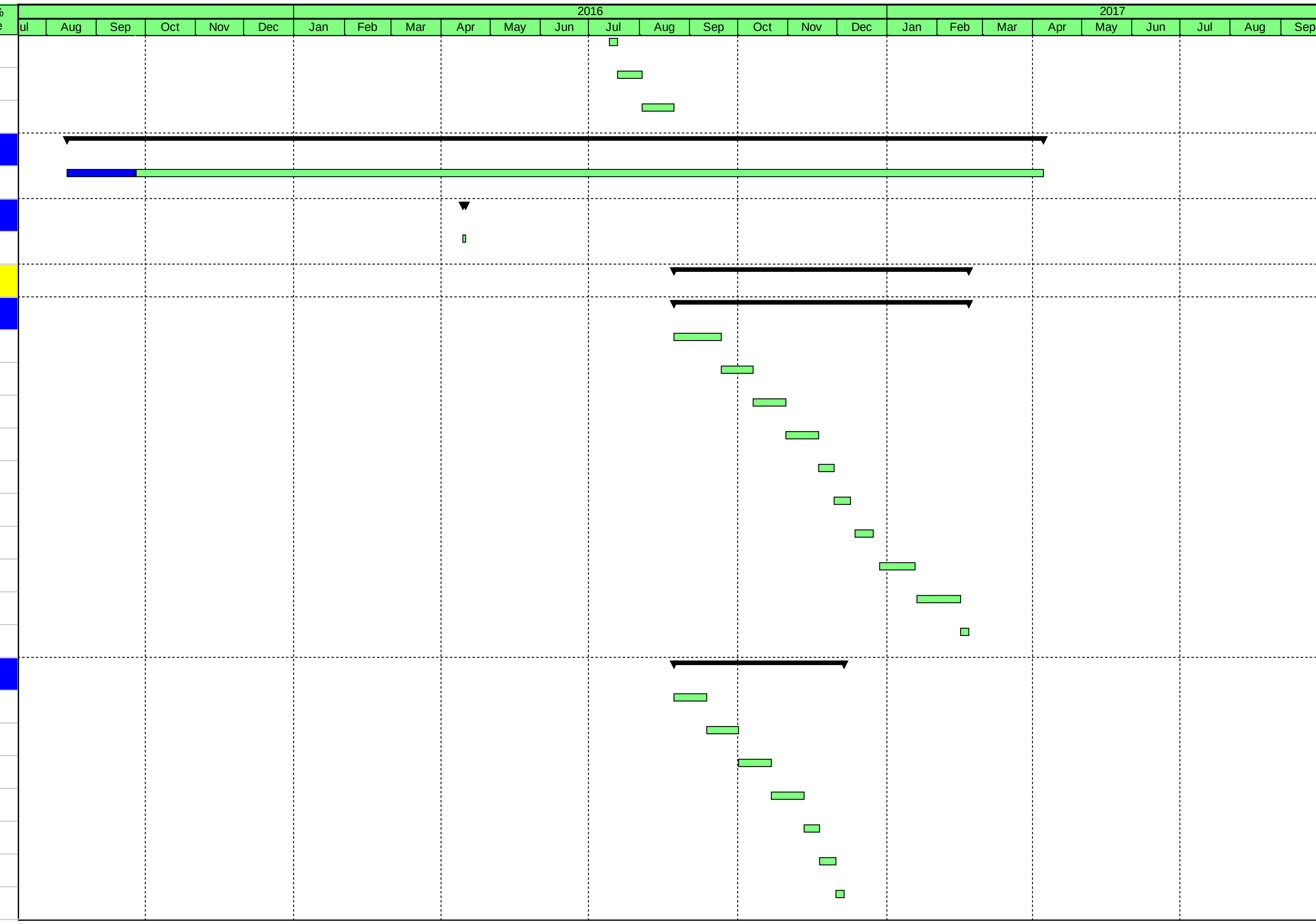
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Chanute

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1890	Initial Water Sampling Private Wells	5	5	13-Jul-16	18-Jul-16	0%
C1870	Sample Analysis	15	15	18-Jul-16	02-Aug-16	0%
C1880	Data Validation	20	20	02-Aug-16	22-Aug-16	0%
3.6 - Data Management		413	384	14-Aug-15 A	07-Apr-17	
C1570	Data Management	413	384	14-Aug-15 A	07-Apr-17	7.02%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	14-Apr-16	15-Apr-16	
C1580	Field Audit	2	2	14-Apr-16	15-Apr-16	0%
0400 - Documentation		122	122	22-Aug-16	20-Feb-17	
4.2 - Site Investigation Report		122	122	22-Aug-16	20-Feb-17	
C2130	Prepare and Submit Working Copy Site Investigation Report	29	29	22-Aug-16	20-Sep-16	0%
C2140	Air Force Review Working Copy	20	20	20-Sep-16	10-Oct-16	0%
C2150	Prepare and Submit Working Copy Rev 1	20	20	10-Oct-16	30-Oct-16	0%
C2160	Airforce Reviw and Approval	20	20	30-Oct-16	19-Nov-16	0%
C2170	Prepare and Submit Draft	10	10	19-Nov-16	29-Nov-16	0%
C2180	Agency Review	10	10	29-Nov-16	09-Dec-16	0%
C2181	Prepare Response to Agency Comments	10	10	12-Dec-16	23-Dec-16	0%
C2182	Air Force Review of Response to Comments	15	15	27-Dec-16	18-Jan-17	0%
C2183	Agency Review of Response to Comments and Concurence	20	20	19-Jan-17	15-Feb-17	0%
C2190	Submit Final	5	5	15-Feb-17	20-Feb-17	0%
4.3 - Well Survey and Sampling Activity Report		105	105	22-Aug-16	05-Dec-16	
C2200	Prepare and Submit Draft Initial Transmittal	20	20	22-Aug-16	11-Sep-16	0%
C2210	Air Force Review	20	20	11-Sep-16	01-Oct-16	0%
C2220	Prepare and Submit Draft Final	20	20	01-Oct-16	21-Oct-16	0%
C2230	Agency Review	20	20	21-Oct-16	10-Nov-16	0%
C2240	Prepare and Submit Final	10	10	10-Nov-16	20-Nov-16	0%
C2250	Government Backcheck	10	10	20-Nov-16	30-Nov-16	0%
C2260	Submit Final	5	5	30-Nov-16	05-Dec-16	0%



Remaining Level of Effort
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Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Chanute

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - General Mitchell		491	477	14-Aug-15 A	18-Aug-17	
C1000	Project Award	0	0	14-Aug-15 A		100%
C1015	Contract POP (24 Months)	0	0		12-Aug-17*	0%
C1005	Project Complete	0	0		18-Aug-17	0%
General Mitchell		491	477	14-Aug-15 A	18-Aug-17	
0100 - Prog/Project Management		716	694	14-Aug-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		716	694	03-Sep-15 A	18-Aug-17	
C2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
C2500	Monthly CPSMR/FMER	715	694	04-Sep-15 A	18-Aug-17	2.94%
C2510	Monthly Status Teleconferences	715	694	04-Sep-15 A	18-Aug-17	2.94%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		274	274	21-Mar-16	19-Dec-16	
C1040	Other On-site Meeting #1	1	1	21-Mar-16*	21-Mar-16	0%
C1060	Additional Meeting #1	1	1	21-Jun-16*	21-Jun-16	0%
C1070	On-Site Technical Meeting #1	1	1	04-Jul-16*	04-Jul-16	0%
C1050	Other On-site Meeting #2	1	1	16-Nov-16*	16-Nov-16	0%
C1080	On-Site Technical Meeting #2	1	1	19-Dec-16*	19-Dec-16	0%
1.3 - Procurement		434	392	14-Aug-15 A	20-Oct-16	
C2520	Subcontractor Procurement/Closeout	434	392	14-Aug-15 A	20-Oct-16	9.68%
1.4 - Project Website		709	688	04-Sep-15 A	12-Aug-17	
C2530	Monthly CPSMR/FMER	709	688	04-Sep-15 A	12-Aug-17	2.96%
1.5 - Lab Audits and Reporting		139	97	14-Aug-15 A	30-Dec-15	
C2540	Lab Audits and Reporting	139	97	14-Aug-15 A	30-Dec-15	30.22%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
C2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
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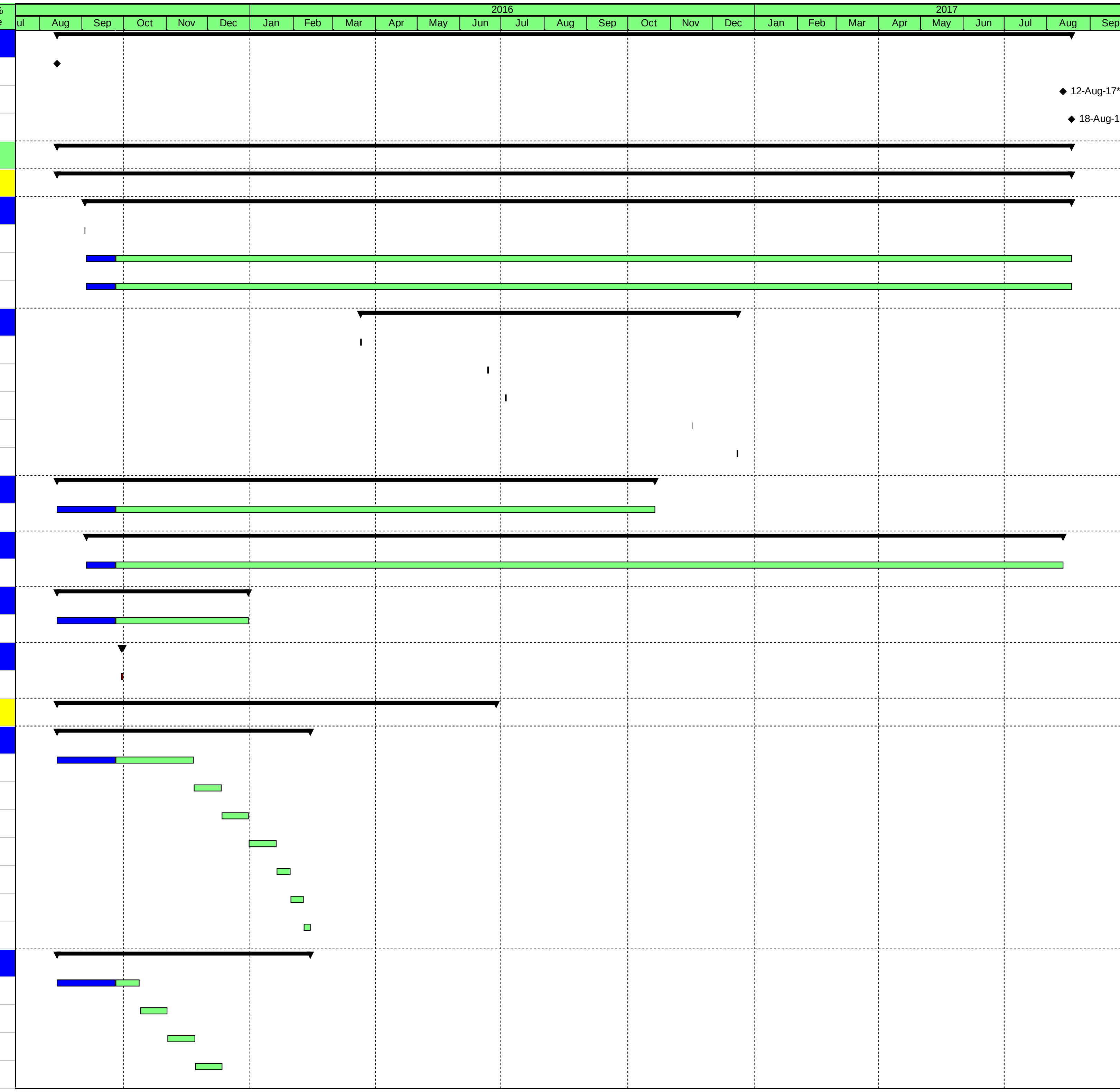
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
C1130	Prepare and Submit Draft	60	57	14-Aug-15 A	20-Nov-15	5%
C1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
C1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
C1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
C1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
C1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
C1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		142	142	14-Aug-15 A	13-Feb-16	
C1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
C1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
C1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
C1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



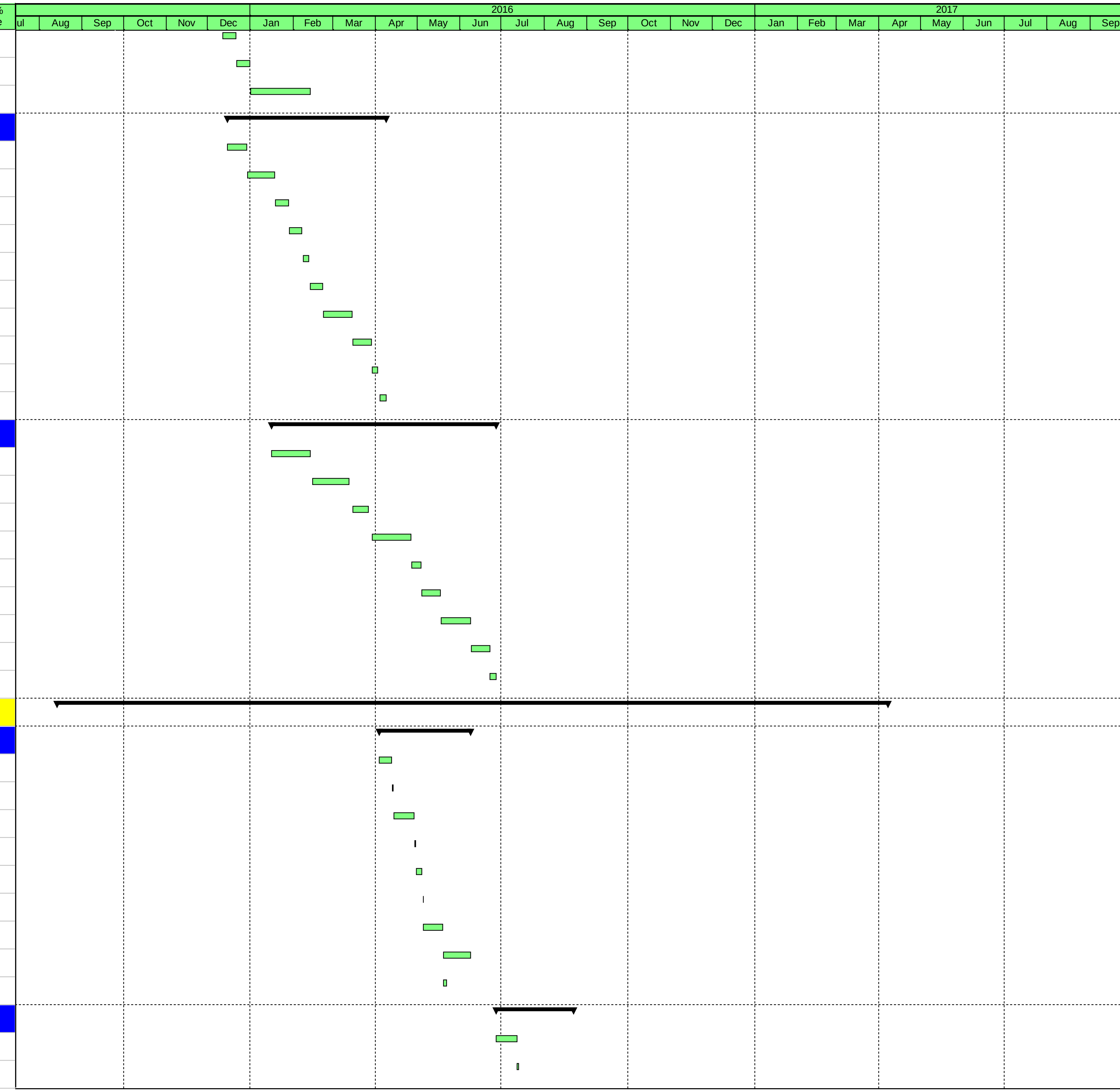
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - General Mitchell

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
C1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
C1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		80	80	15-Dec-15	08-Apr-16	
C1700	Prepare and Submit Working Copy	15	15	15-Dec-15*	29-Dec-15	0%
C1710	Air Force Review Working Copy	20	20	30-Dec-15	18-Jan-16	0%
C1720	Prepare and Submit Working Copy Rev 1	10	10	19-Jan-16	28-Jan-16	0%
C1730	Air Force Review Review and Approval	10	10	29-Jan-16	07-Feb-16	0%
C1740	Prepare and Submit Draft Copy	5	5	08-Feb-16	12-Feb-16	0%
C1750	Agency Review	10	10	13-Feb-16	22-Feb-16	0%
C1751	Prepare Response to Agency Comments	15	15	23-Feb-16	14-Mar-16	0%
C1752	Air Force Review of Response to Comments	10	10	15-Mar-16	28-Mar-16	0%
C1760	Agency Review of Response to Comments and Concurrence	5	5	29-Mar-16	02-Apr-16	0%
C1761	Prepare and Submit Final	5	5	04-Apr-16	08-Apr-16	0%
2.5 - Private/Production Well Survey		113	113	16-Jan-16	27-Jun-16	
C1230	Prepare and Submit Well Survey Plan Working Copy	29	29	16-Jan-16*	13-Feb-16	0%
C1240	Air Force Review Working Copy	27	27	15-Feb-16	12-Mar-16	0%
C1250	Prepare and Submit Working Copy Rev 1	12	12	15-Mar-16	26-Mar-16	0%
C1260	Air Force Review and Approval	29	29	29-Mar-16	26-Apr-16	0%
C1270	Prepare and Submit Draft Copy	7	7	27-Apr-16	03-May-16	0%
C1370	Agency Review	14	14	04-May-16	17-May-16	0%
C1371	Prepare Response to Agency Comments	15	15	18-May-16	08-Jun-16	0%
C1372	Air Force Review of Response to Comments	10	10	09-Jun-16	22-Jun-16	0%
C1380	Prepare and Submit Final	5	5	22-Jun-16	27-Jun-16	0%
0300 - Investigation, Monitoring and Scoping		413	384	14-Aug-15 A	07-Apr-17	
3.1 - Initial Site Investigation		67	67	03-Apr-16	08-Jun-16	
C1790	Coordinate Site Access	10	10	03-Apr-16	12-Apr-16	0%
C1410	Mob SI Soil/Well Installation Team	1	1	13-Apr-16	13-Apr-16	0%
C1420	Soil Borings and Sampling/Monitoring Well Installation	15	15	14-Apr-16	28-Apr-16	0%
C1430	Mob Groundwater Sampling Team	1	1	29-Apr-16	29-Apr-16	0%
C1440	Redevelop and Sample Monitoring Wells	5	5	30-Apr-16	04-May-16	0%
C1450	Demob Groundwater Sampling Team	1	1	05-May-16	05-May-16	0%
C1800	Sample Analysis	15	15	05-May-16	19-May-16	0%
C1810	Data Validation	20	20	20-May-16	08-Jun-16	0%
C1590	IDW Handling and Disposal	3	3	20-May-16	22-May-16	0%
3.3 - Well Survey and Sampling		56	56	27-Jun-16	22-Aug-16	
C1860	Coordinate Site Access	15	15	27-Jun-16	12-Jul-16	0%
C1920	Mob Private Well Sampling Team	1	1	12-Jul-16	13-Jul-16	0%



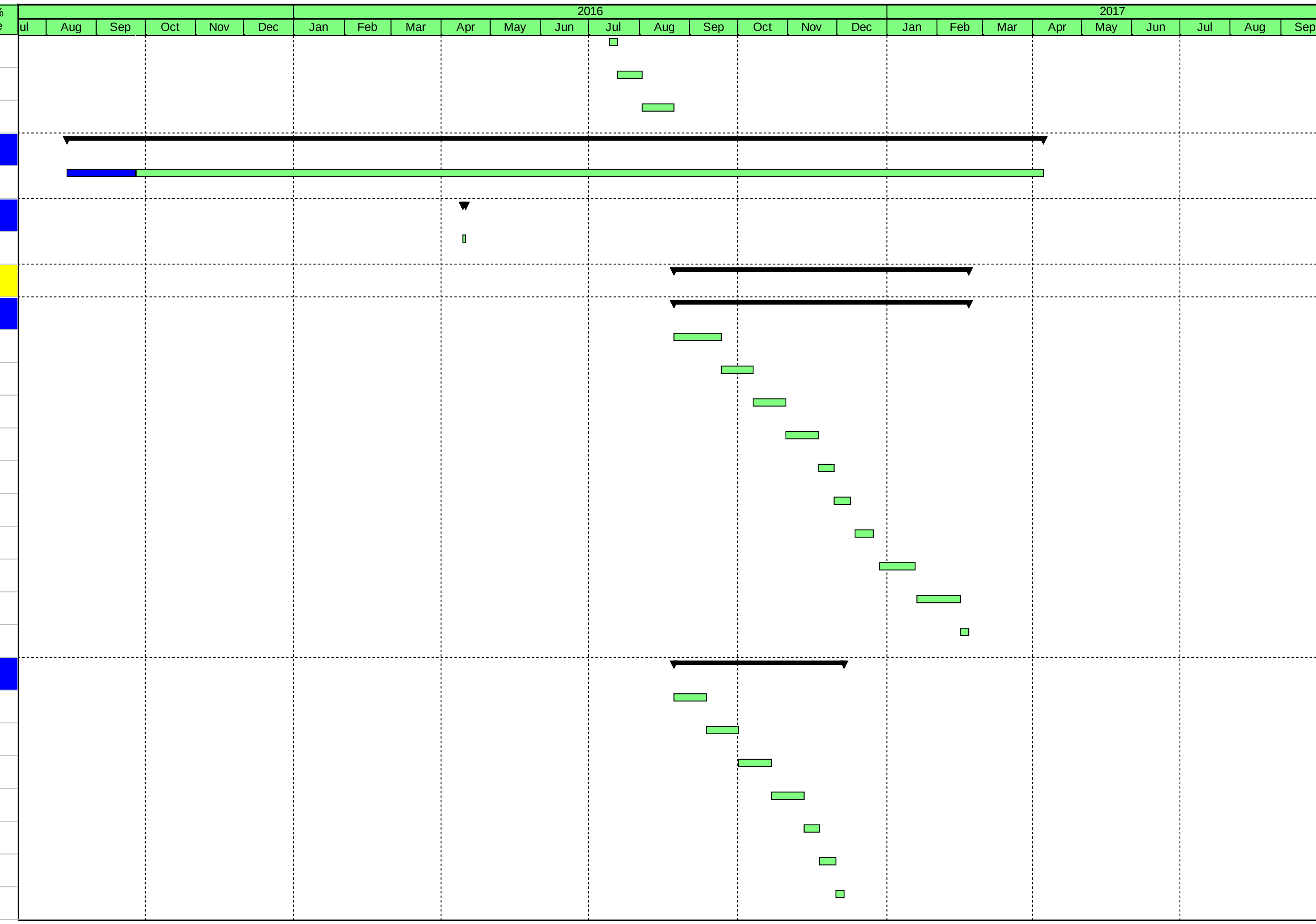
- Remaining Level of Effort
- Actual Level of Effort
- Actual Work
- Remaining Work
- Critical Remaining Work
- Milestone
- Summary

A/E Services for PFCs Release at Multiple BRAC Bases - General Mitchell

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1890	Initial Water Sampling Private Wells	5	5	13-Jul-16	18-Jul-16	0%
C1870	Sample Analysis	15	15	18-Jul-16	02-Aug-16	0%
C1880	Data Validation	20	20	02-Aug-16	22-Aug-16	0%
3.6 - Data Management		413	384	14-Aug-15 A	07-Apr-17	
C1570	Data Management	413	384	14-Aug-15 A	07-Apr-17	7.02%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	14-Apr-16	15-Apr-16	
C1580	Field Audit	2	2	14-Apr-16	15-Apr-16	0%
0400 - Documentation		122	122	22-Aug-16	20-Feb-17	
4.2 - Site Investigation Report		122	122	22-Aug-16	20-Feb-17	
C2130	Prepare and Submit Working Copy Site Investigation Report	29	29	22-Aug-16	20-Sep-16	0%
C2140	Air Force Review Working Copy	20	20	20-Sep-16	10-Oct-16	0%
C2150	Prepare and Submit Working Copy Rev 1	20	20	10-Oct-16	30-Oct-16	0%
C2160	Airforce Reviw and Approval	20	20	30-Oct-16	19-Nov-16	0%
C2170	Prepare and Submit Draft	10	10	19-Nov-16	29-Nov-16	0%
C2180	Agency Review	10	10	29-Nov-16	09-Dec-16	0%
C2181	Prepare Response to Agency Comments	10	10	12-Dec-16	23-Dec-16	0%
C2182	Air Force Review of Response to Comments	15	15	27-Dec-16	18-Jan-17	0%
C2183	Agency Review of Response to Comments and Concurence	20	20	19-Jan-17	15-Feb-17	0%
C2190	Submit Final	5	5	15-Feb-17	20-Feb-17	0%
4.3 - Well Survey and Sampling Activity Report		105	105	22-Aug-16	05-Dec-16	
C2200	Prepare and Submit Draft Initial Transmittal	20	20	22-Aug-16	11-Sep-16	0%
C2210	Air Force Review	20	20	11-Sep-16	01-Oct-16	0%
C2220	Prepare and Submit Draft Final	20	20	01-Oct-16	21-Oct-16	0%
C2230	Agency Review	20	20	21-Oct-16	10-Nov-16	0%
C2240	Prepare and Submit Final	10	10	10-Nov-16	20-Nov-16	0%
C2250	Government Backcheck	10	10	20-Nov-16	30-Nov-16	0%
C2260	Submit Final	5	5	30-Nov-16	05-Dec-16	0%



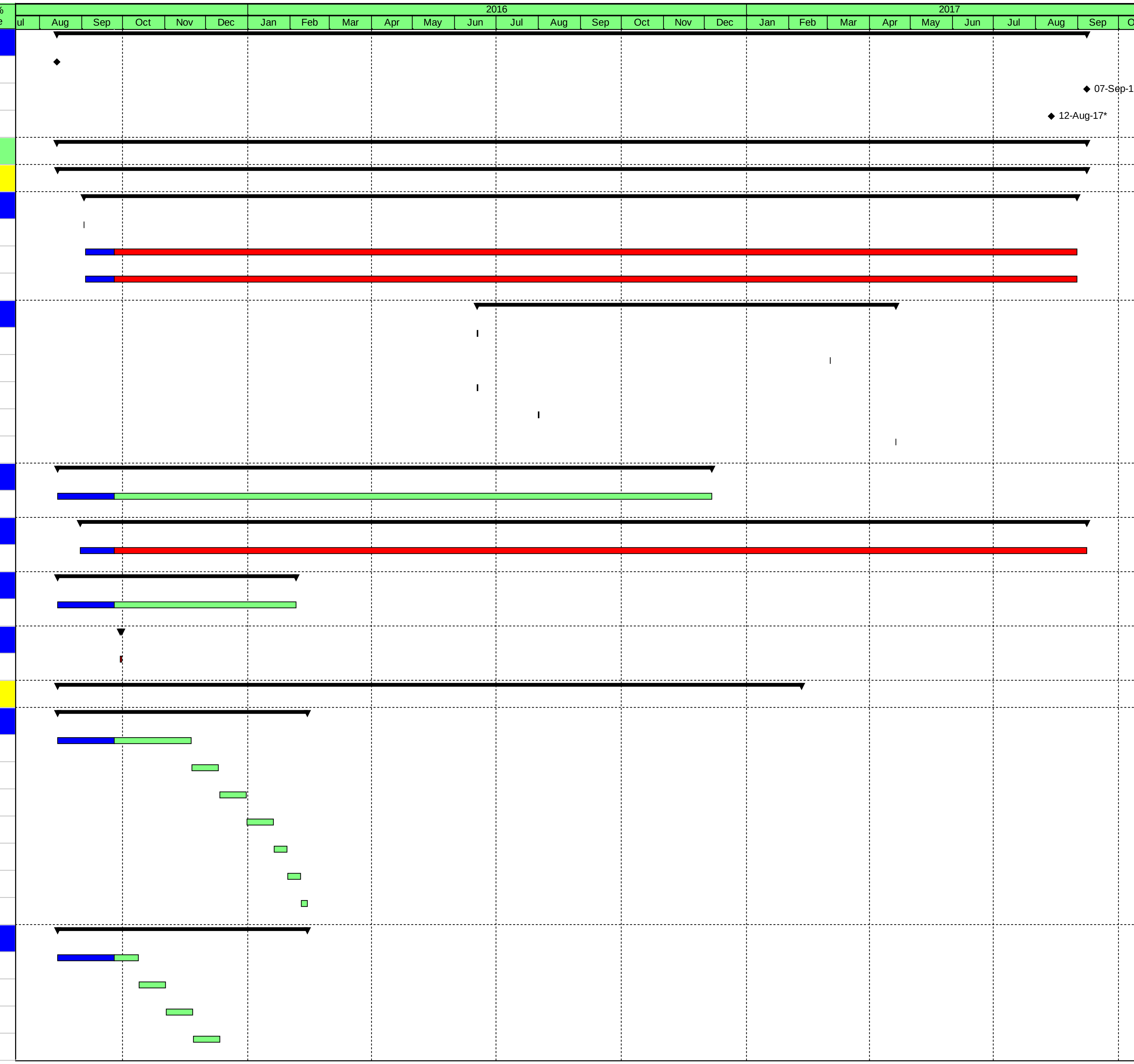
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - General Mitchell

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Griffiss		528	490	14-Aug-15 A	07-Sep-17	
A1000	Project Award	0	0	14-Aug-15 A		100%
A1005	Project Complete	0	0		07-Sep-17	0%
A1015	Contract POP (24 Months)	0	0		12-Aug-17*	0%
Griffiss		528	490	14-Aug-15 A	07-Sep-17	
0100 - Prog/Project Management		519	490	14-Aug-15 A	07-Sep-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		491	486	03-Sep-15 A	31-Aug-17	
A2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
A2500	Monthly CPSMR/FMER	490	486	04-Sep-15 A	31-Aug-17	0.82%
A2510	Monthly Status Teleconferences	490	486	04-Sep-15 A	31-Aug-17	0.82%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		211	211	17-Jun-16	20-Apr-17	
A1040	Other On-site Meeting #1	1	1	17-Jun-16	17-Jun-16	0%
A1050	Other On-site Meeting #2	1	1	03-Mar-17	03-Mar-17	0%
A1060	Additional Meeting #1	1	1	17-Jun-16	17-Jun-16	0%
A1070	On-Site Technical Meeting #1	1	1	01-Aug-16	01-Aug-16	0%
A1080	On-Site Technical Meeting #2	1	1	20-Apr-17	20-Apr-17	0%
1.3 - Procurement		329	300	14-Aug-15 A	06-Dec-16	
A2520	Subcontractor Procurement/Closeout	329	300	14-Aug-15 A	06-Dec-16	8.81%
1.4 - Project Website		508	490	31-Aug-15 A	07-Sep-17	
A2530	Monthly CPSMR/FMER	508	490	31-Aug-15 A	07-Sep-17	3.54%
1.5 - Lab Audits and Reporting		119	90	14-Aug-15 A	05-Feb-16	
A2540	Lab Audits and Reporting	119	90	14-Aug-15 A	05-Feb-16	24.37%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
A2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		374	345	14-Aug-15 A	10-Feb-17	
2.1 - General Quality Program Plan (UFP-QAPP)		184	142	14-Aug-15 A	13-Feb-16	
A1130	Prepare and Submit Draft	99	57	14-Aug-15 A	20-Nov-15	42.42%
A1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
A1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
A1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
A1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
A1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
A1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		184	142	14-Aug-15 A	13-Feb-16	
A1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
A1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
A1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
A1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



- Remaining Level of Effort
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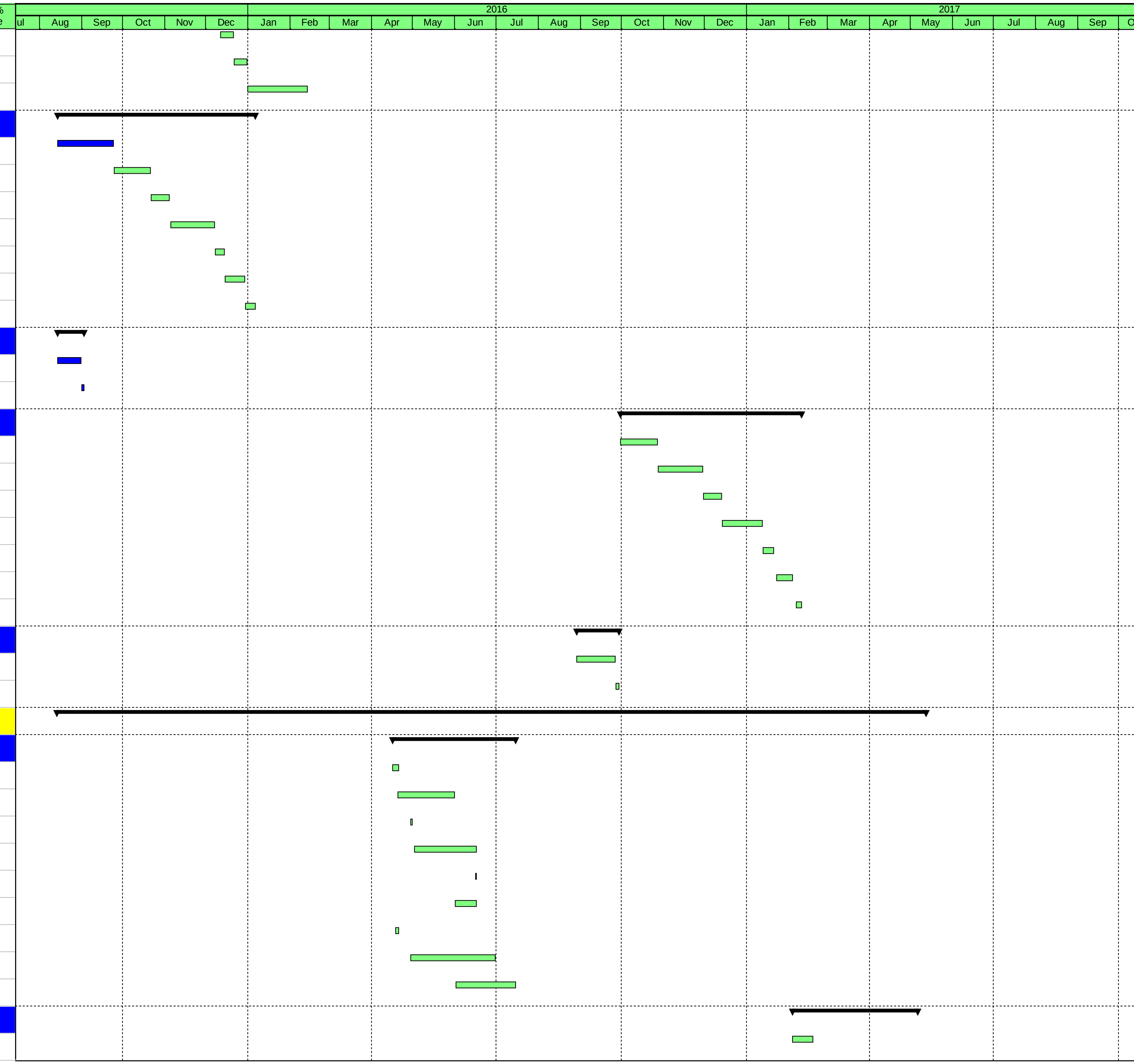
- Milestone
- Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Griffiss

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
A1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
A1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		98	69	14-Aug-15 A	06-Jan-16	
A1700	Prepare and Submit Draft	29	0	14-Aug-15 A	24-Sep-15 A	100%
A1710	Air Force Review Draft	20	19	25-Sep-15 A	21-Oct-15	5%
A1720	Prepare and Submit Draft Final	10	10	22-Oct-15	04-Nov-15	0%
A1730	Air Force Review Draft Final	20	20	05-Nov-15	07-Dec-15	0%
A1740	Prepare and Submit Final	5	5	08-Dec-15	14-Dec-15	0%
A1750	Government Backchek and Approval	10	10	15-Dec-15	29-Dec-15	0%
A1760	Issue Final	5	5	30-Dec-15	06-Jan-16	0%
2.4 - Initial Scoping Visit		14	0	14-Aug-15 A	02-Sep-15 A	
A1280	Prepare for Initial Scoping Visit	12	0	14-Aug-15 A	31-Aug-15 A	100%
A1290	Initial Scoping Visit	2	0	01-Sep-15 A	02-Sep-15 A	100%
2.5 - ISWPA		90	90	30-Sep-16	10-Feb-17	
A1230	Prepare and Submit Draft	20	20	30-Sep-16	27-Oct-16	0%
A1240	Air Force Review Draft	20	20	28-Oct-16	29-Nov-16	0%
A1250	Prepare and Submit Draft Final	10	10	30-Nov-16	13-Dec-16	0%
A1260	Air Force Review Draft Final	20	20	14-Dec-16	12-Jan-17	0%
A1270	Prepare and Submit Final	5	5	13-Jan-17	20-Jan-17	0%
A1370	Government Backchek and Approval	10	10	23-Jan-17	03-Feb-17	0%
A1380	Issue Final	5	5	06-Feb-17	10-Feb-17	0%
2.6 - Follow-on Scoping Visit		23	23	29-Aug-16	29-Sep-16	
A1770	Prepare for Follow-on Scoping Visit	20	20	29-Aug-16	26-Sep-16	0%
A1780	Follow-on Scoping Visit	3	3	27-Sep-16	29-Sep-16	0%
0300 - Investigation, Monitoring and Scoping		528	409	14-Aug-15 A	12-May-17	
3.1 - Initial Site Investigation		63	63	16-Apr-16	15-Jul-16	
A1410	Mob SI Soil/Well Installation Team	5	5	16-Apr-16	20-Apr-16	0%
A1420	Soil Borings and Sampling/Monitoring Well Installation	29	29	20-Apr-16	31-May-16	0%
A1430	Mob Groundwater Sampling Team	1	1	29-Apr-16	30-Apr-16	0%
A1440	Redevelop and Sample Monitoring Wells	33	33	02-May-16	16-Jun-16	0%
A1450	Demob Groundwater Sampling Team	1	1	16-Jun-16	16-Jun-16	0%
A1590	IDW Handling and Disposal	12	12	01-Jun-16	16-Jun-16	0%
A1790	Coordinate Site Access	3	3	18-Apr-16*	20-Apr-16	0%
A1800	Sample Analysis	62	62	29-Apr-16	30-Jun-16	0%
A1810	Data Validation	44	44	01-Jun-16	15-Jul-16	0%
3.2 - Follow-on Site Investigation		64	64	03-Feb-17	06-May-17	
A1460	Coordinate Site Access	15	15	03-Feb-17	18-Feb-17	0%



Remaining Level of Effort
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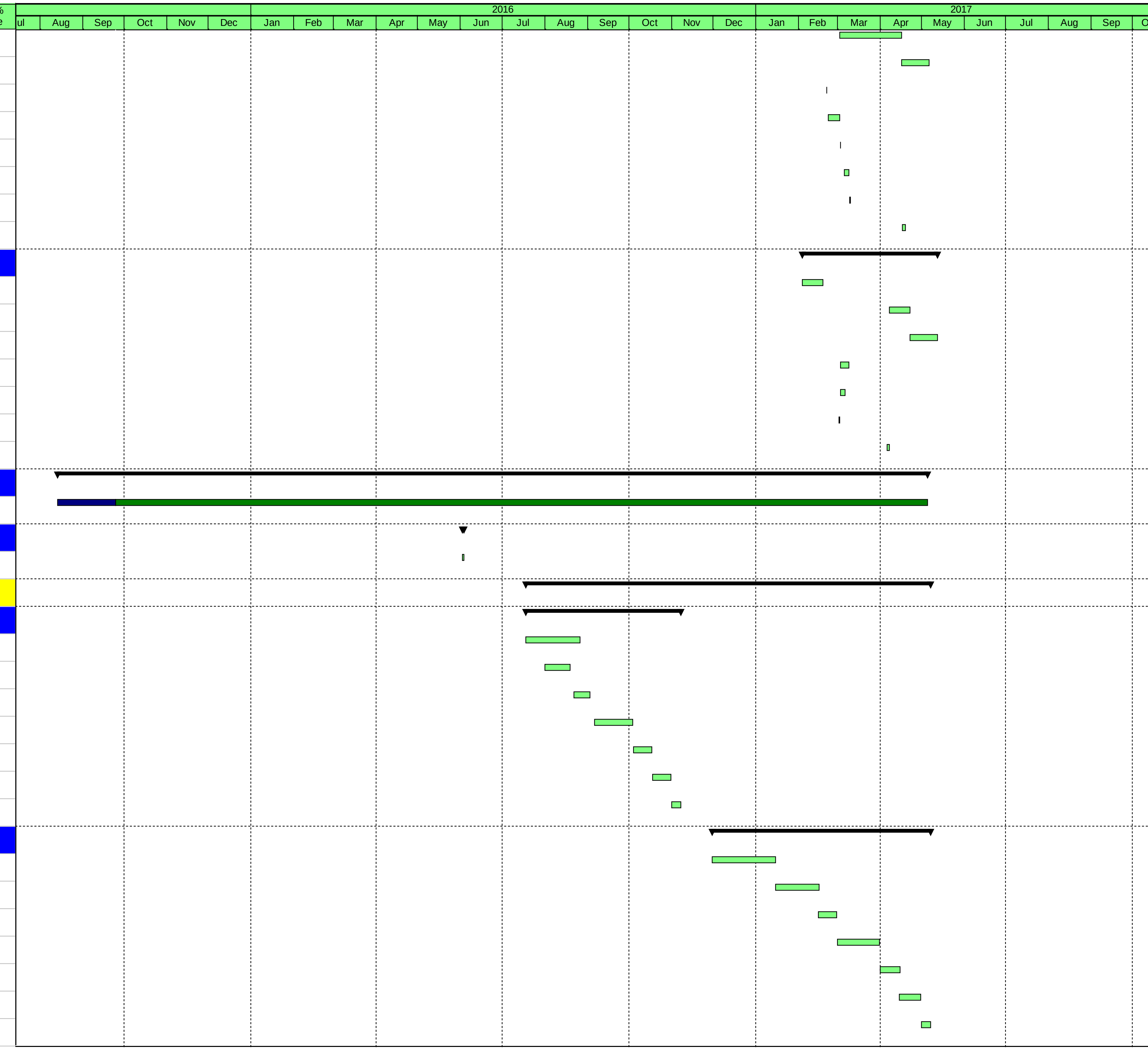
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Griffiss

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A1470	Sample Analysis	45	45	02-Mar-17	16-Apr-17	0%
A1480	Data Validation	20	20	16-Apr-17	06-May-17	0%
A1490	Mob Soil/Well Installation Team	1	1	21-Feb-17	21-Feb-17	0%
A1500	Soil Borings and Sampling/Monitoring Well Installation	7	7	22-Feb-17	02-Mar-17	0%
A1820	Mob Groundwater Sampling Team	1	1	03-Mar-17	03-Mar-17	0%
A1830	Redevelop and Sample Monitoring Wells	4	4	06-Mar-17	09-Mar-17	0%
A1840	Demob Groundwater Sampling Team	1	1	10-Mar-17	10-Mar-17	0%
A1850	IDW Handling and Disposal	3	3	17-Apr-17	19-Apr-17	0%
3.3 - Plume and Receptor Pathway Investigation		69	69	03-Feb-17	12-May-17	
A1860	Coordinate Site Access	15	15	03-Feb-17	18-Feb-17	0%
A1870	Sample Analysis	15	15	07-Apr-17	22-Apr-17	0%
A1880	Data Validation	20	20	22-Apr-17	12-May-17	0%
A1900	SW/Sediment Sampling	5	5	03-Mar-17	09-Mar-17	0%
A1910	Initial Pore-water Sampling	2	2	03-Mar-17	06-Mar-17	0%
A1920	Mob Private Well Sampling Team	1	1	02-Mar-17	02-Mar-17	0%
A1940	Pore-water Sampling Round 2	2	2	06-Apr-17	07-Apr-17	0%
3.6 - Data Management		528	404	14-Aug-15 A	05-May-17	
A1570	Data Management	528	404	14-Aug-15 A	05-May-17	23.48%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	02-Jun-16	03-Jun-16	
A1580	Field Audit	2	2	02-Jun-16	03-Jun-16	0%
0400 - Documentation		202	202	18-Jul-16	07-May-17	
4.1 - Initial Data Transmittal		80	80	18-Jul-16	07-Nov-16	
A2060	Prepare and Submit Draft Initial Transmittal	30	30	18-Jul-16	26-Aug-16	0%
A2070	Air Force Review	15	15	01-Aug-16	19-Aug-16	0%
A2080	Prepare and Submit Draft Final	10	10	22-Aug-16	02-Sep-16	0%
A2090	Agency Review	20	20	06-Sep-16	03-Oct-16	0%
A2100	Prepare and Submit Final	10	10	04-Oct-16	17-Oct-16	0%
A2110	Government Backcheck	10	10	18-Oct-16	31-Oct-16	0%
A2120	Submit Final	5	5	01-Nov-16	07-Nov-16	0%
4.2 - Site Investigation Report		158	158	30-Nov-16	07-May-17	
A2130	Prepare and Submit Draft Site Investigation Report	46	46	30-Nov-16	15-Jan-17	0%
A2140	Air Force Review	31	31	15-Jan-17	15-Feb-17	0%
A2150	Prepare and Submit Draft Final	14	14	15-Feb-17	28-Feb-17	0%
A2160	Agency Review	31	31	01-Mar-17	31-Mar-17	0%
A2170	Prepare and Submit Final	15	15	01-Apr-17	15-Apr-17	0%
A2180	Government Backcheck	16	16	15-Apr-17	30-Apr-17	0%
A2190	Submit Final	7	7	01-May-17	07-May-17	0%



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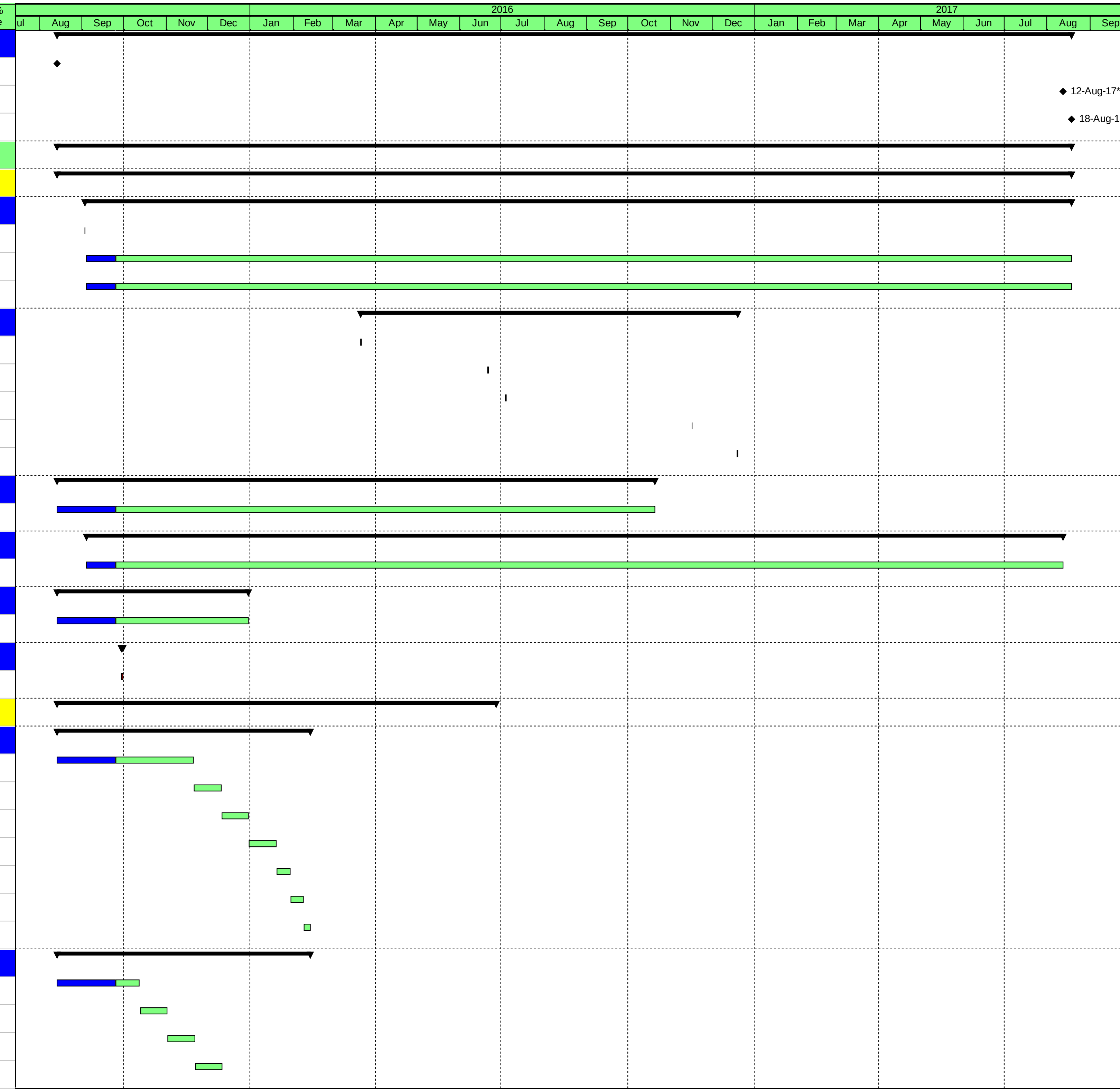
A/E Services for PFCs Release at Multiple BRAC Bases - Griffiss

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Kelly		491	477	14-Aug-15 A	18-Aug-17	
C1000	Project Award	0	0	14-Aug-15 A		100%
C1015	Contract POP (24 Months)	0	0		12-Aug-17*	0%
C1005	Project Complete	0	0		18-Aug-17	0%
Kelly		491	477	14-Aug-15 A	18-Aug-17	
0100 - Prog/Project Management		716	694	14-Aug-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		716	694	03-Sep-15 A	18-Aug-17	
C2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
C2500	Monthly CPSMR/FMER	715	694	04-Sep-15 A	18-Aug-17	2.94%
C2510	Monthly Status Teleconferences	715	694	04-Sep-15 A	18-Aug-17	2.94%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		274	274	21-Mar-16	19-Dec-16	
C1040	Other On-site Meeting #1	1	1	21-Mar-16*	21-Mar-16	0%
C1060	Additional Meeting #1	1	1	21-Jun-16*	21-Jun-16	0%
C1070	On-Site Technical Meeting #1	1	1	04-Jul-16*	04-Jul-16	0%
C1050	Other On-site Meeting #2	1	1	16-Nov-16*	16-Nov-16	0%
C1080	On-Site Technical Meeting #2	1	1	19-Dec-16*	19-Dec-16	0%
1.3 - Procurement		434	392	14-Aug-15 A	20-Oct-16	
C2520	Subcontractor Procurement/Closeout	434	392	14-Aug-15 A	20-Oct-16	9.68%
1.4 - Project Website		709	688	04-Sep-15 A	12-Aug-17	
C2530	Monthly CPSMR/FMER	709	688	04-Sep-15 A	12-Aug-17	2.96%
1.5 - Lab Audits and Reporting		139	97	14-Aug-15 A	30-Dec-15	
C2540	Lab Audits and Reporting	139	97	14-Aug-15 A	30-Dec-15	30.22%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
C2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		189	189	14-Aug-15 A	27-Jun-16	
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
C1130	Prepare and Submit Draft	60	57	14-Aug-15 A	20-Nov-15	5%
C1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
C1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
C1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
C1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
C1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
C1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		142	142	14-Aug-15 A	13-Feb-16	
C1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
C1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
C1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
C1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



Remaining Level of Effort
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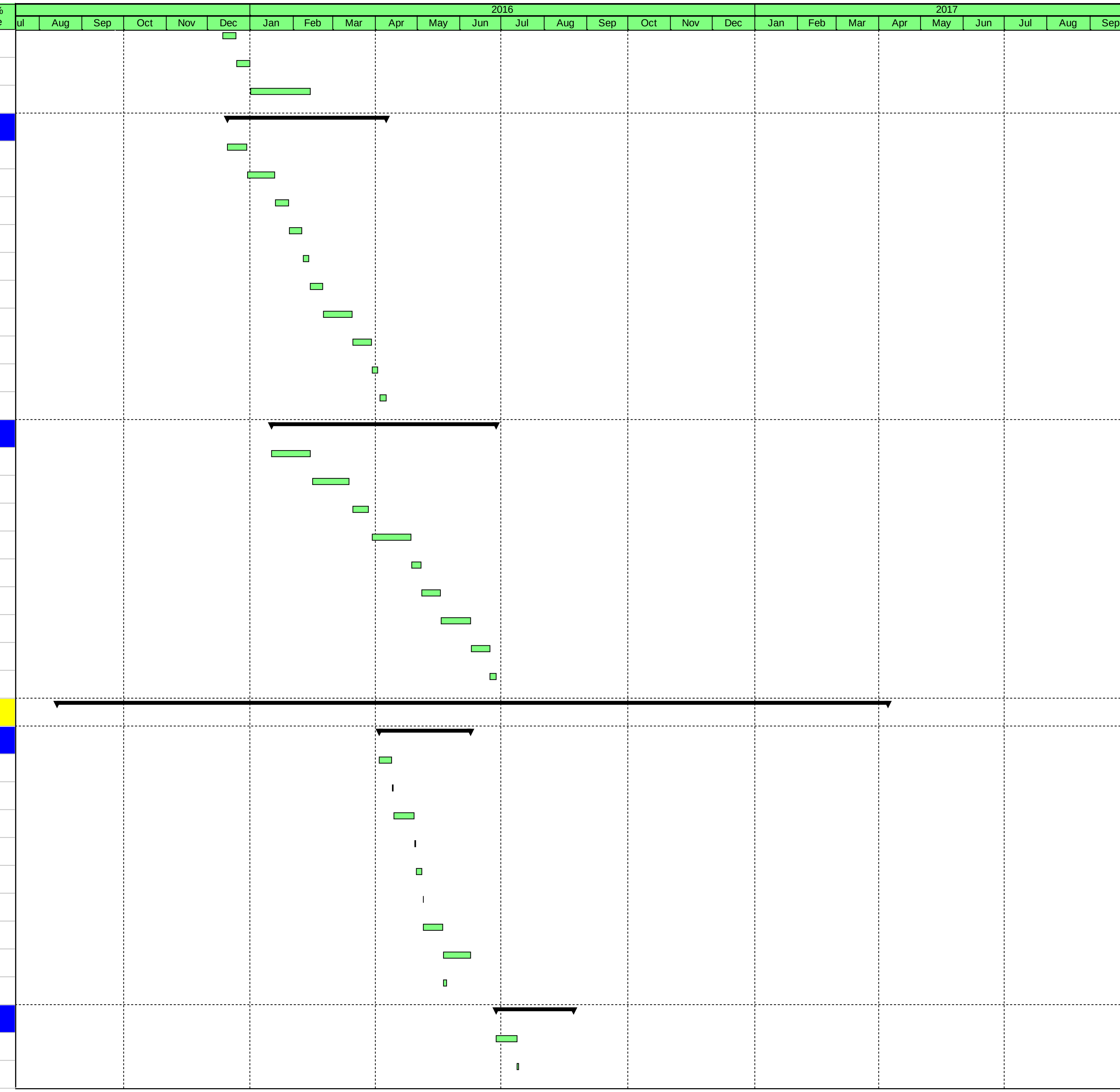
A/E Services for PFCs Release at Multiple BRAC Bases - Kelly

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
C1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
C1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		80	80	15-Dec-15	08-Apr-16	
C1700	Prepare and Submit Working Copy	15	15	15-Dec-15*	29-Dec-15	0%
C1710	Air Force Review Working Copy	20	20	30-Dec-15	18-Jan-16	0%
C1720	Prepare and Submit Working Copy Rev 1	10	10	19-Jan-16	28-Jan-16	0%
C1730	Air Force Review Review and Approval	10	10	29-Jan-16	07-Feb-16	0%
C1740	Prepare and Submit Draft Copy	5	5	08-Feb-16	12-Feb-16	0%
C1750	Agency Review	10	10	13-Feb-16	22-Feb-16	0%
C1751	Prepare Response to Agency Comments	15	15	23-Feb-16	14-Mar-16	0%
C1752	Air Force Review of Response to Comments	10	10	15-Mar-16	28-Mar-16	0%
C1760	Agency Review of Response to Comments and Concurrence	5	5	29-Mar-16	02-Apr-16	0%
C1761	Prepare and Submit Final	5	5	04-Apr-16	08-Apr-16	0%
2.5 - Private/Production Well Survey		113	113	16-Jan-16	27-Jun-16	
C1230	Prepare and Submit Well Survey Plan Working Copy	29	29	16-Jan-16*	13-Feb-16	0%
C1240	Air Force Review Working Copy	27	27	15-Feb-16	12-Mar-16	0%
C1250	Prepare and Submit Working Copy Rev 1	12	12	15-Mar-16	26-Mar-16	0%
C1260	Air Force Review and Approval	29	29	29-Mar-16	26-Apr-16	0%
C1270	Prepare and Submit Draft Copy	7	7	27-Apr-16	03-May-16	0%
C1370	Agency Review	14	14	04-May-16	17-May-16	0%
C1371	Prepare Response to Agency Comments	15	15	18-May-16	08-Jun-16	0%
C1372	Air Force Review of Response to Comments	10	10	09-Jun-16	22-Jun-16	0%
C1380	Prepare and Submit Final	5	5	22-Jun-16	27-Jun-16	0%
0300 - Investigation, Monitoring and Scoping		413	384	14-Aug-15 A	07-Apr-17	
3.1 - Initial Site Investigation		67	67	03-Apr-16	08-Jun-16	
C1790	Coordinate Site Access	10	10	03-Apr-16	12-Apr-16	0%
C1410	Mob SI Soil/Well Installation Team	1	1	13-Apr-16	13-Apr-16	0%
C1420	Soil Borings and Sampling/Monitoring Well Installation	15	15	14-Apr-16	28-Apr-16	0%
C1430	Mob Groundwater Sampling Team	1	1	29-Apr-16	29-Apr-16	0%
C1440	Redevelop and Sample Monitoring Wells	5	5	30-Apr-16	04-May-16	0%
C1450	Demob Groundwater Sampling Team	1	1	05-May-16	05-May-16	0%
C1800	Sample Analysis	15	15	05-May-16	19-May-16	0%
C1810	Data Validation	20	20	20-May-16	08-Jun-16	0%
C1590	IDW Handling and Disposal	3	3	20-May-16	22-May-16	0%
3.3 - Well Survey and Sampling		56	56	27-Jun-16	22-Aug-16	
C1860	Coordinate Site Access	15	15	27-Jun-16	12-Jul-16	0%
C1920	Mob Private Well Sampling Team	1	1	12-Jul-16	13-Jul-16	0%



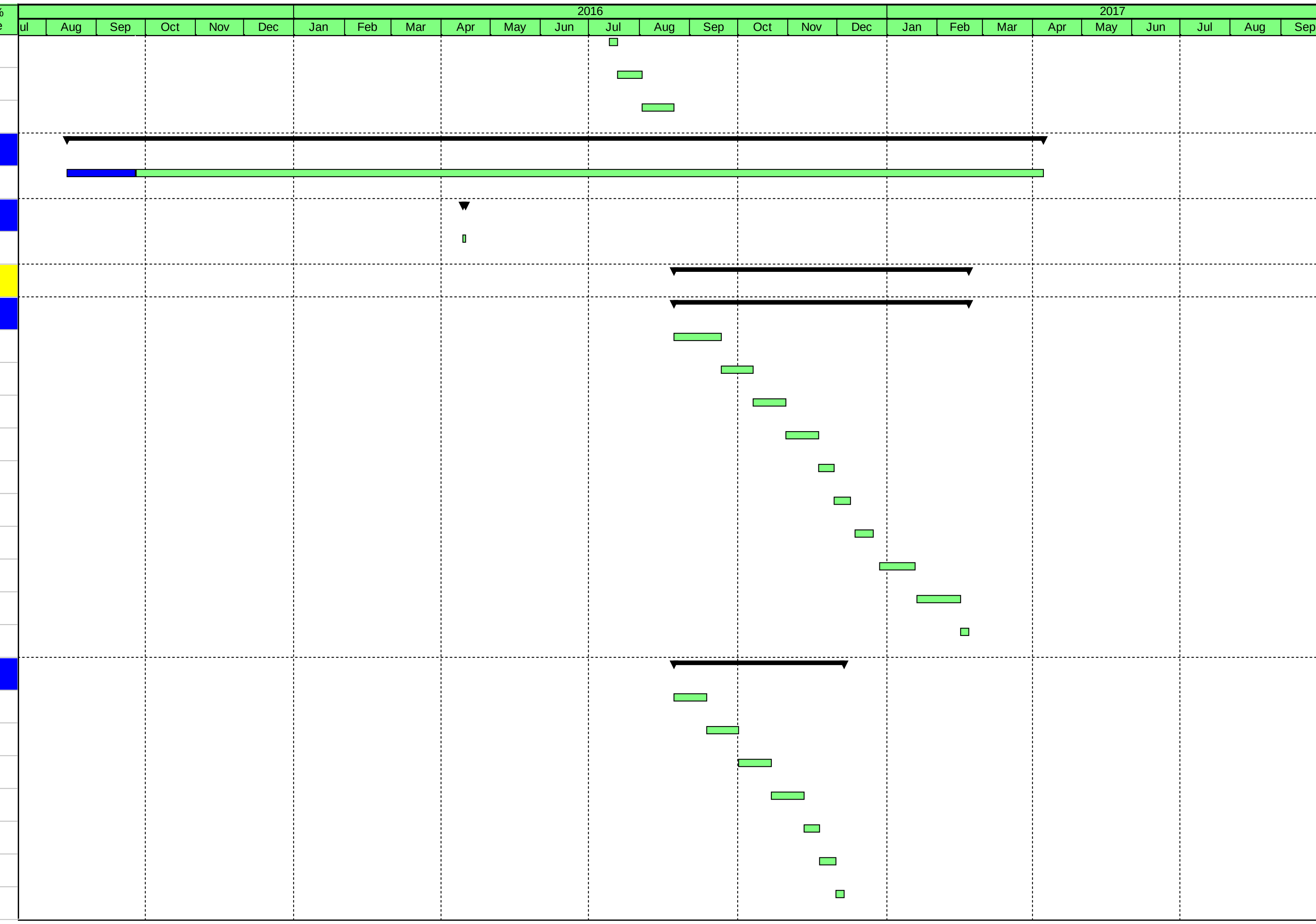
- Remaining Level of Effort
- Actual Level of Effort
- Actual Work
- Remaining Work
- Critical Remaining Work
- Milestone
- Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Kelly

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1890	Initial Water Sampling Private Wells	5	5	13-Jul-16	18-Jul-16	0%
C1870	Sample Analysis	15	15	18-Jul-16	02-Aug-16	0%
C1880	Data Validation	20	20	02-Aug-16	22-Aug-16	0%
3.6 - Data Management		413	384	14-Aug-15 A	07-Apr-17	
C1570	Data Management	413	384	14-Aug-15 A	07-Apr-17	7.02%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	14-Apr-16	15-Apr-16	
C1580	Field Audit	2	2	14-Apr-16	15-Apr-16	0%
0400 - Documentation		122	122	22-Aug-16	20-Feb-17	
4.2 - Site Investigation Report		122	122	22-Aug-16	20-Feb-17	
C2130	Prepare and Submit Working Copy Site Investigation Report	29	29	22-Aug-16	20-Sep-16	0%
C2140	Air Force Review Working Copy	20	20	20-Sep-16	10-Oct-16	0%
C2150	Prepare and Submit Working Copy Rev 1	20	20	10-Oct-16	30-Oct-16	0%
C2160	Airforce Reviw and Approval	20	20	30-Oct-16	19-Nov-16	0%
C2170	Prepare and Submit Draft	10	10	19-Nov-16	29-Nov-16	0%
C2180	Agency Review	10	10	29-Nov-16	09-Dec-16	0%
C2181	Prepare Response to Agency Comments	10	10	12-Dec-16	23-Dec-16	0%
C2182	Air Force Review of Response to Comments	15	15	27-Dec-16	18-Jan-17	0%
C2183	Agency Review of Response to Comments and Concurence	20	20	19-Jan-17	15-Feb-17	0%
C2190	Submit Final	5	5	15-Feb-17	20-Feb-17	0%
4.3 - Well Survey and Sampling Activity Report		105	105	22-Aug-16	05-Dec-16	
C2200	Prepare and Submit Draft Initial Transmittal	20	20	22-Aug-16	11-Sep-16	0%
C2210	Air Force Review	20	20	11-Sep-16	01-Oct-16	0%
C2220	Prepare and Submit Draft Final	20	20	01-Oct-16	21-Oct-16	0%
C2230	Agency Review	20	20	21-Oct-16	10-Nov-16	0%
C2240	Prepare and Submit Final	10	10	10-Nov-16	20-Nov-16	0%
C2250	Government Backcheck	10	10	20-Nov-16	30-Nov-16	0%
C2260	Submit Final	5	5	30-Nov-16	05-Dec-16	0%



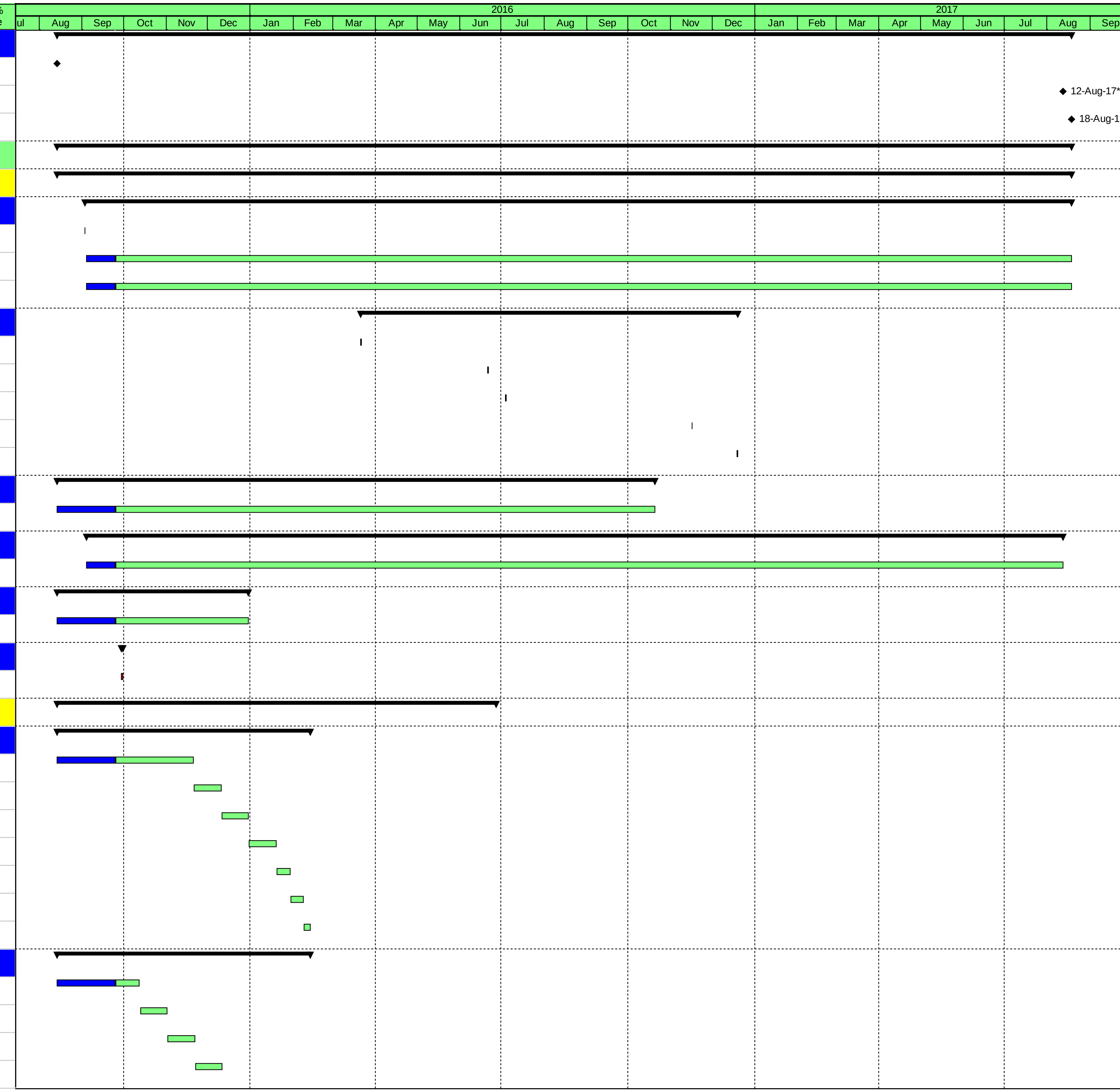
- Remaining Level of Effort
- Actual Level of Effort
- Actual Work
- Remaining Work
- Critical Remaining Work
- Milestone
- Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Kelly

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - KI Sawyer		491	477	14-Aug-15 A	18-Aug-17	
C1000	Project Award	0	0	14-Aug-15 A		100%
C1015	Contract POP (24 Months)	0	0		12-Aug-17*	0%
C1005	Project Complete	0	0		18-Aug-17	0%
KI Sawyer		491	477	14-Aug-15 A	18-Aug-17	
0100 - Prog/Project Management		716	694	14-Aug-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		716	694	03-Sep-15 A	18-Aug-17	
C2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
C2500	Monthly CPSMR/FMER	715	694	04-Sep-15 A	18-Aug-17	2.94%
C2510	Monthly Status Teleconferences	715	694	04-Sep-15 A	18-Aug-17	2.94%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		274	274	21-Mar-16	19-Dec-16	
C1040	Other On-site Meeting #1	1	1	21-Mar-16*	21-Mar-16	0%
C1060	Additional Meeting #1	1	1	21-Jun-16*	21-Jun-16	0%
C1070	On-Site Technical Meeting #1	1	1	04-Jul-16*	04-Jul-16	0%
C1050	Other On-site Meeting #2	1	1	16-Nov-16*	16-Nov-16	0%
C1080	On-Site Technical Meeting #2	1	1	19-Dec-16*	19-Dec-16	0%
1.3 - Procurement		434	392	14-Aug-15 A	20-Oct-16	
C2520	Subcontractor Procurement/Closeout	434	392	14-Aug-15 A	20-Oct-16	9.68%
1.4 - Project Website		709	688	04-Sep-15 A	12-Aug-17	
C2530	Monthly CPSMR/FMER	709	688	04-Sep-15 A	12-Aug-17	2.96%
1.5 - Lab Audits and Reporting		139	97	14-Aug-15 A	30-Dec-15	
C2540	Lab Audits and Reporting	139	97	14-Aug-15 A	30-Dec-15	30.22%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
C2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		189	189	14-Aug-15 A	27-Jun-16	
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
C1130	Prepare and Submit Draft	60	57	14-Aug-15 A	20-Nov-15	5%
C1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
C1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
C1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
C1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
C1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
C1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		142	142	14-Aug-15 A	13-Feb-16	
C1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
C1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
C1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
C1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



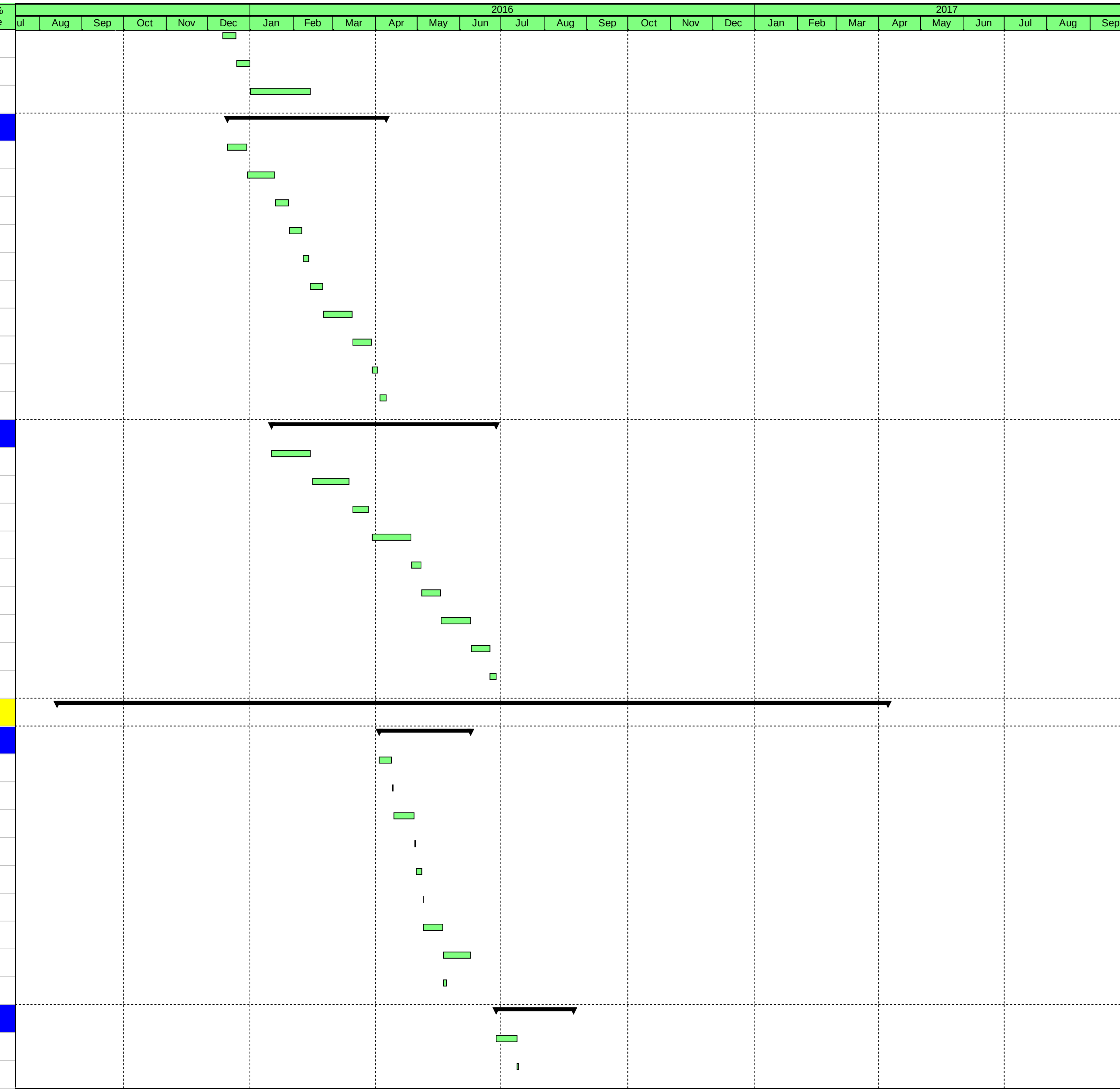
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - KI Sawyer

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
C1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
C1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		80	80	15-Dec-15	08-Apr-16	
C1700	Prepare and Submit Working Copy	15	15	15-Dec-15*	29-Dec-15	0%
C1710	Air Force Review Working Copy	20	20	30-Dec-15	18-Jan-16	0%
C1720	Prepare and Submit Working Copy Rev 1	10	10	19-Jan-16	28-Jan-16	0%
C1730	Air Force Review Review and Approval	10	10	29-Jan-16	07-Feb-16	0%
C1740	Prepare and Submit Draft Copy	5	5	08-Feb-16	12-Feb-16	0%
C1750	Agency Review	10	10	13-Feb-16	22-Feb-16	0%
C1751	Prepare Response to Agency Comments	15	15	23-Feb-16	14-Mar-16	0%
C1752	Air Force Review of Response to Comments	10	10	15-Mar-16	28-Mar-16	0%
C1760	Agency Review of Response to Comments and Concurrence	5	5	29-Mar-16	02-Apr-16	0%
C1761	Prepare and Submit Final	5	5	04-Apr-16	08-Apr-16	0%
2.5 - Private/Production Well Survey		113	113	16-Jan-16	27-Jun-16	
C1230	Prepare and Submit Well Survey Plan Working Copy	29	29	16-Jan-16*	13-Feb-16	0%
C1240	Air Force Review Working Copy	27	27	15-Feb-16	12-Mar-16	0%
C1250	Prepare and Submit Working Copy Rev 1	12	12	15-Mar-16	26-Mar-16	0%
C1260	Air Force Review and Approval	29	29	29-Mar-16	26-Apr-16	0%
C1270	Prepare and Submit Draft Copy	7	7	27-Apr-16	03-May-16	0%
C1370	Agency Review	14	14	04-May-16	17-May-16	0%
C1371	Prepare Response to Agency Comments	15	15	18-May-16	08-Jun-16	0%
C1372	Air Force Review of Response to Comments	10	10	09-Jun-16	22-Jun-16	0%
C1380	Prepare and Submit Final	5	5	22-Jun-16	27-Jun-16	0%
0300 - Investigation, Monitoring and Scoping		413	384	14-Aug-15 A	07-Apr-17	
3.1 - Initial Site Investigation		67	67	03-Apr-16	08-Jun-16	
C1790	Coordinate Site Access	10	10	03-Apr-16	12-Apr-16	0%
C1410	Mob SI Soil/Well Installation Team	1	1	13-Apr-16	13-Apr-16	0%
C1420	Soil Borings and Sampling/Monitoring Well Installation	15	15	14-Apr-16	28-Apr-16	0%
C1430	Mob Groundwater Sampling Team	1	1	29-Apr-16	29-Apr-16	0%
C1440	Redevelop and Sample Monitoring Wells	5	5	30-Apr-16	04-May-16	0%
C1450	Demob Groundwater Sampling Team	1	1	05-May-16	05-May-16	0%
C1800	Sample Analysis	15	15	05-May-16	19-May-16	0%
C1810	Data Validation	20	20	20-May-16	08-Jun-16	0%
C1590	IDW Handling and Disposal	3	3	20-May-16	22-May-16	0%
3.3 - Well Survey and Sampling		56	56	27-Jun-16	22-Aug-16	
C1860	Coordinate Site Access	15	15	27-Jun-16	12-Jul-16	0%
C1920	Mob Private Well Sampling Team	1	1	12-Jul-16	13-Jul-16	0%



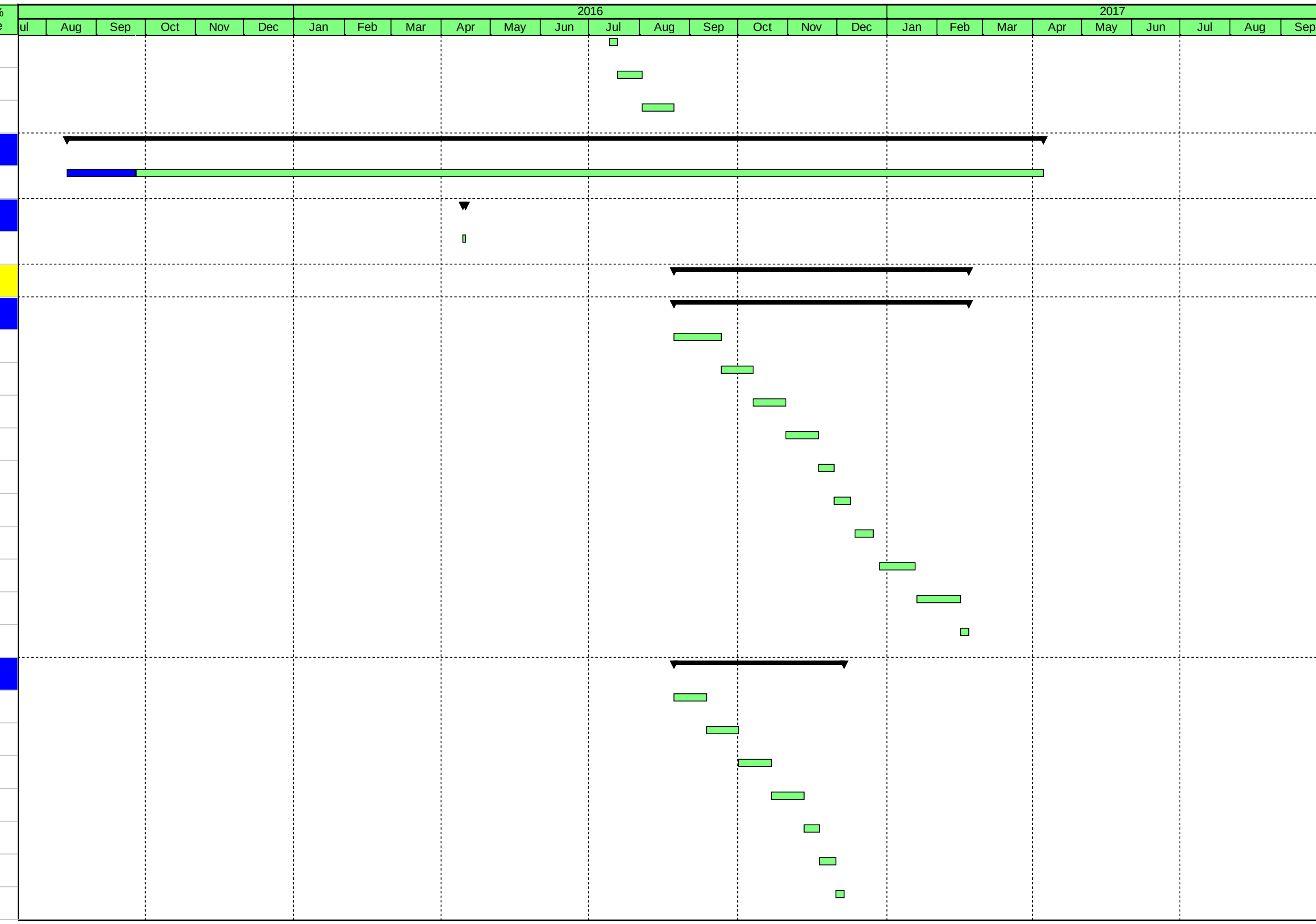
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - KI Sawyer

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1890	Initial Water Sampling Private Wells	5	5	13-Jul-16	18-Jul-16	0%
C1870	Sample Analysis	15	15	18-Jul-16	02-Aug-16	0%
C1880	Data Validation	20	20	02-Aug-16	22-Aug-16	0%
3.6 - Data Management		413	384	14-Aug-15 A	07-Apr-17	
C1570	Data Management	413	384	14-Aug-15 A	07-Apr-17	7.02%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	14-Apr-16	15-Apr-16	
C1580	Field Audit	2	2	14-Apr-16	15-Apr-16	0%
0400 - Documentation		122	122	22-Aug-16	20-Feb-17	
4.2 - Site Investigation Report		122	122	22-Aug-16	20-Feb-17	
C2130	Prepare and Submit Working Copy Site Investigation Report	29	29	22-Aug-16	20-Sep-16	0%
C2140	Air Force Review Working Copy	20	20	20-Sep-16	10-Oct-16	0%
C2150	Prepare and Submit Working Copy Rev 1	20	20	10-Oct-16	30-Oct-16	0%
C2160	Airforce Reviw and Approval	20	20	30-Oct-16	19-Nov-16	0%
C2170	Prepare and Submit Draft	10	10	19-Nov-16	29-Nov-16	0%
C2180	Agency Review	10	10	29-Nov-16	09-Dec-16	0%
C2181	Prepare Response to Agency Comments	10	10	12-Dec-16	23-Dec-16	0%
C2182	Air Force Review of Response to Comments	15	15	27-Dec-16	18-Jan-17	0%
C2183	Agency Review of Response to Comments and Concurence	20	20	19-Jan-17	15-Feb-17	0%
C2190	Submit Final	5	5	15-Feb-17	20-Feb-17	0%
4.3 - Well Survey and Sampling Activity Report		105	105	22-Aug-16	05-Dec-16	
C2200	Prepare and Submit Draft Initial Transmittal	20	20	22-Aug-16	11-Sep-16	0%
C2210	Air Force Review	20	20	11-Sep-16	01-Oct-16	0%
C2220	Prepare and Submit Draft Final	20	20	01-Oct-16	21-Oct-16	0%
C2230	Agency Review	20	20	21-Oct-16	10-Nov-16	0%
C2240	Prepare and Submit Final	10	10	10-Nov-16	20-Nov-16	0%
C2250	Government Backcheck	10	10	20-Nov-16	30-Nov-16	0%
C2260	Submit Final	5	5	30-Nov-16	05-Dec-16	0%



Remaining Level of Effort
Actual Level of Effort
Actual Work
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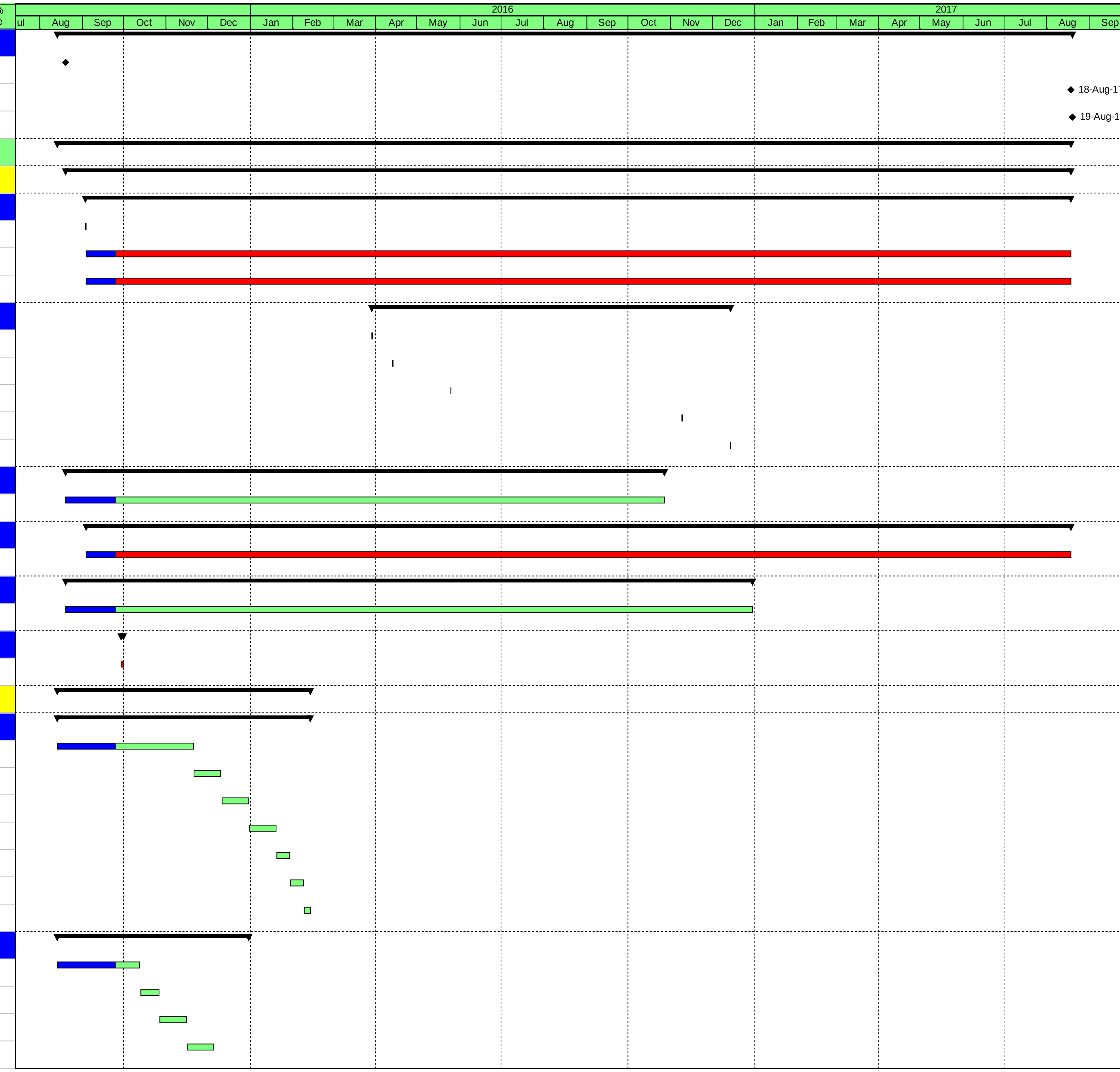
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - KI Sawyer

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Loring		506	477	14-Aug-15 A	19-Aug-17	
A1000	Project Award	0	0	20-Aug-15 A		100%
A1005	Project Complete	0	0		18-Aug-17*	0%
A1015	Contract POP (24 Months)	0	0		19-Aug-17*	0%
Loring		506	477	14-Aug-15 A	18-Aug-17	
0100 - Prog/Project Management		506	477	20-Aug-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		506	477	03-Sep-15 A	18-Aug-17	
A2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
A2500	Monthly CPSMR/FMER	491	477	04-Sep-15 A	18-Aug-17	2.85%
A2510	Monthly Status Teleconferences	491	477	04-Sep-15 A	18-Aug-17	2.85%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		181	181	29-Mar-16	14-Dec-16	
A1040	Other On-site Meeting #1	1	1	29-Mar-16*	29-Mar-16	0%
A1060	Additional Meeting #1	1	1	13-Apr-16*	13-Apr-16	0%
A1070	On-Site Technical Meeting #1	1	1	25-May-16*	25-May-16	0%
A1050	Other On-site Meeting #2	1	1	09-Nov-16*	09-Nov-16	0%
A1080	On-Site Technical Meeting #2	1	1	14-Dec-16*	14-Dec-16	0%
1.3 - Procurement		325	275	20-Aug-15 A	27-Oct-16	
A2520	Subcontractor Procurement/Closeout	325	275	20-Aug-15 A	27-Oct-16	15.38%
1.4 - Project Website		491	477	04-Sep-15 A	18-Aug-17	
A2530	Monthly CPSMR/FMER	491	477	04-Sep-15 A	18-Aug-17	2.85%
1.5 - Lab Audits and Reporting		342	317	20-Aug-15 A	30-Dec-16	
A2540	Lab Audits and Reporting	342	317	20-Aug-15 A	30-Dec-16	7.31%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
A2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		142	142	14-Aug-15 A	13-Feb-16	
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
A1130	Prepare and Submit Draft	69	57	14-Aug-15 A	20-Nov-15	17.39%
A1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
A1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
A1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
A1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
A1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
A1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		97	97	14-Aug-15 A	30-Dec-15	
A1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
A1190	Air Force Review Draft	14	14	13-Oct-15	26-Oct-15	0%
A1200	Prepare and Submit Draft Final	20	20	27-Oct-15	15-Nov-15	0%
A1210	Air Force Review Draft Final	20	20	16-Nov-15	05-Dec-15	0%



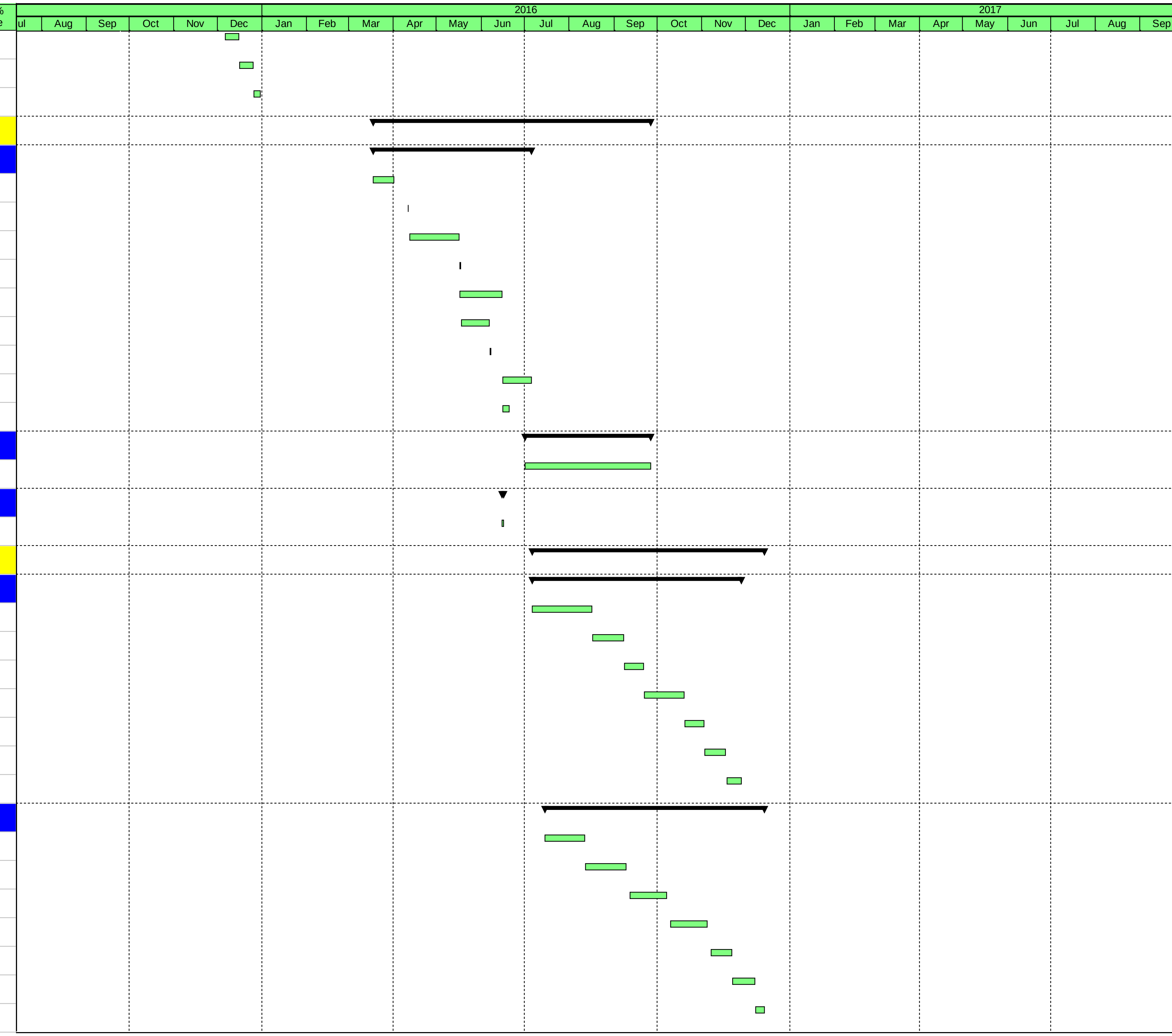
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Loring

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A1220	Prepare and Submit Final	10	10	06-Dec-15	15-Dec-15	0%
A1350	Government Backchek and Approval	10	10	16-Dec-15	25-Dec-15	0%
A1360	Issue Final	5	5	26-Dec-15	30-Dec-15	0%
0300 - Investigation, Monitoring and Scoping		134	134	18-Mar-16	26-Sep-16	
3.1 - Initial Site Investigation		76	76	18-Mar-16	05-Jul-16	
A1790	Coordinate Site Access	15	15	18-Mar-16	01-Apr-16	0%
A1410	Mob SI Soil/Well Installation Team	1	1	11-Apr-16	11-Apr-16	0%
A1420	Soil Borings and Sampling/Monitoring Well Installation	25	25	12-Apr-16	16-May-16	0%
A1430	Mob Groundwater Sampling Team	1	1	17-May-16	17-May-16	0%
A1800	Sample Analysis	30	30	17-May-16	15-Jun-16	0%
A1440	Redevelop and Sample Monitoring Wells	13	13	18-May-16	06-Jun-16	0%
A1450	Demob Groundwater Sampling Team	1	1	07-Jun-16	07-Jun-16	0%
A1810	Data Validation	20	20	16-Jun-16	05-Jul-16	0%
A1590	IDW Handling and Disposal	3	3	16-Jun-16	20-Jun-16	0%
3.6 - Data Management		60	60	01-Jul-16	26-Sep-16	
A1570	Data Management	60	60	01-Jul-16*	26-Sep-16	0%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	15-Jun-16	16-Jun-16	
A1580	Field Audit	2	2	15-Jun-16*	16-Jun-16	0%
0400 - Documentation		112	112	06-Jul-16	14-Dec-16	
4.1 - Initial Data Transmittal		100	100	06-Jul-16	28-Nov-16	
A2060	Prepare and Submit Draft Initial Transmittal	30	30	06-Jul-16	16-Aug-16	0%
A2070	Air Force Review	15	15	17-Aug-16	07-Sep-16	0%
A2080	Prepare and Submit Draft Final	10	10	08-Sep-16	21-Sep-16	0%
A2090	Agency Review	20	20	22-Sep-16	19-Oct-16	0%
A2100	Prepare and Submit Final	10	10	20-Oct-16	02-Nov-16	0%
A2110	Government Backcheck	10	10	03-Nov-16	17-Nov-16	0%
A2120	Submit Final	5	5	18-Nov-16	28-Nov-16	0%
4.2 - Site Investigation Report		105	105	15-Jul-16	14-Dec-16	
A2130	Prepare and Submit Draft Site Investigation Report	20	20	15-Jul-16	11-Aug-16	0%
A2140	Air Force Review	20	20	12-Aug-16	09-Sep-16	0%
A2150	Prepare and Submit Draft Final	20	20	12-Sep-16	07-Oct-16	0%
A2160	Agency Review	20	20	10-Oct-16	04-Nov-16	0%
A2170	Prepare and Submit Final	10	10	07-Nov-16	21-Nov-16	0%
A2180	Government Backcheck	10	10	22-Nov-16	07-Dec-16	0%
A2190	Submit Final	5	5	08-Dec-16	14-Dec-16	0%



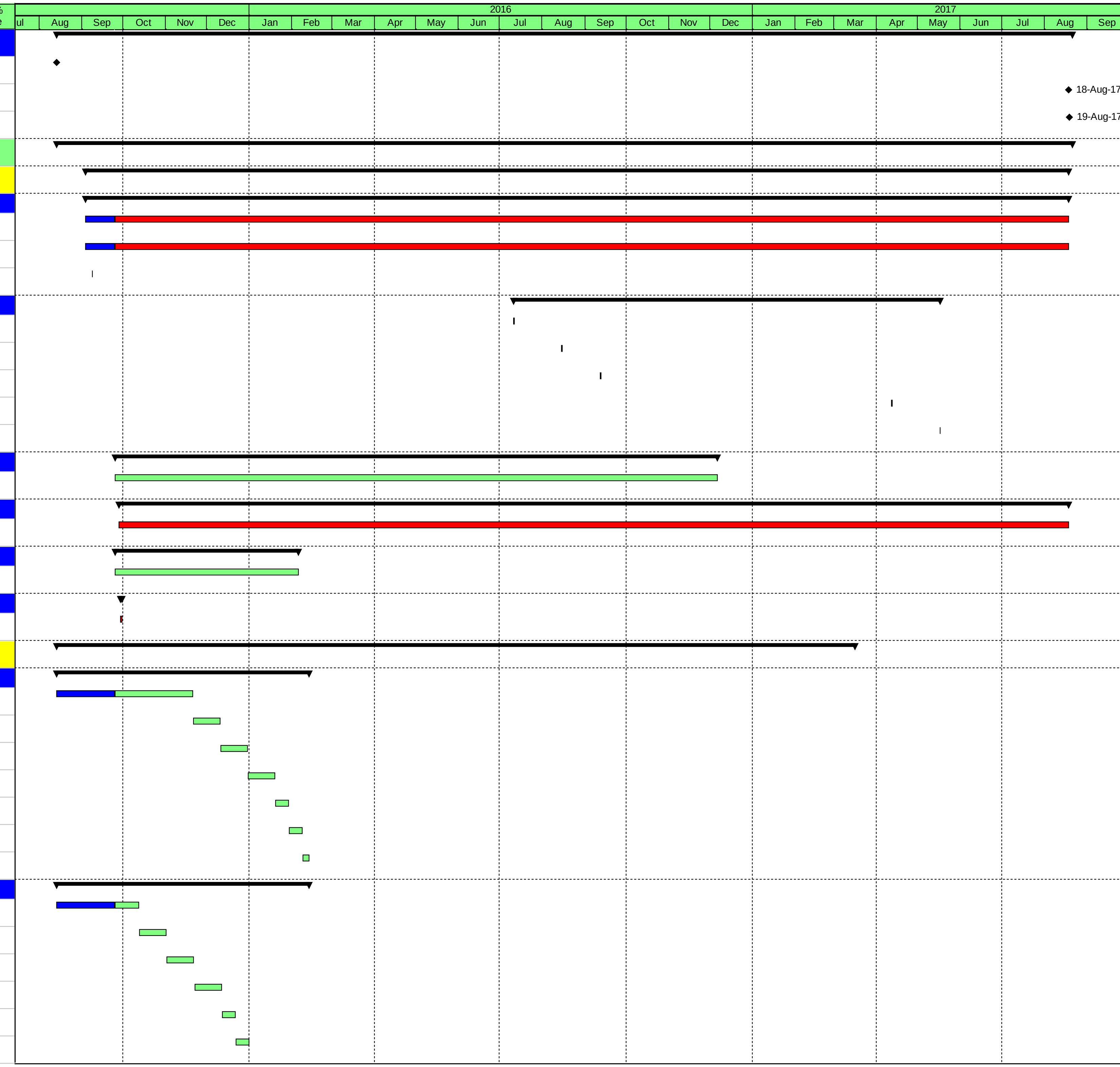
- Remaining Level of Effort
- Actual Level of Effort
- Actual Work
- Remaining Work
- Critical Remaining Work
- Milestone
- Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Loring

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Plattsburg		530	478	14-Aug-15 A	21-Aug-17	
A1000	Project Award	0	0	14-Aug-15 A		100%
A1005	Project Complete	0	0		18-Aug-17	0%
A1015	Contract POP (24 Months)	0	0		19-Aug-17*	0%
Plattsburgh		530	478	14-Aug-15 A	21-Aug-17	
0100 - Prog/Project Management		492	477	04-Sep-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		492	477	04-Sep-15 A	18-Aug-17	
A2500	Monthly CPSMR/FMER	491	477	04-Sep-15 A	18-Aug-17	2.85%
A2510	Monthly Status Teleconferences	491	477	04-Sep-15 A	18-Aug-17	2.85%
A2490	Kickoff Meeting	1	0	09-Sep-15 A	09-Sep-15 A	100%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		215	215	11-Jul-16	17-May-17	
A1040	Other On-site Meeting #1	1	1	11-Jul-16*	11-Jul-16	0%
A1060	Additional Meeting #1	1	1	15-Aug-16*	15-Aug-16	0%
A1070	On-Site Technical Meeting #1	1	1	12-Sep-16*	12-Sep-16	0%
A1050	Other On-site Meeting #2	1	1	12-Apr-17*	12-Apr-17	0%
A1080	On-Site Technical Meeting #2	1	1	17-May-17*	17-May-17	0%
1.3 - Procurement		300	300	25-Sep-15	06-Dec-16	
A2520	Subcontractor Procurement/Closeout	300	300	25-Sep-15	06-Dec-16	0%
1.4 - Project Website		476	476	28-Sep-15	18-Aug-17	
A2530	Monthly CPSMR/FMER	476	476	28-Sep-15*	18-Aug-17	0%
1.5 - Lab Audits and Reporting		90	90	25-Sep-15	05-Feb-16	
A2540	Lab Audits and Reporting	90	90	25-Sep-15	05-Feb-16	0%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
A2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		368	368	14-Aug-15 A	16-Mar-17	
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
A1130	Prepare and Submit Draft	99	57	14-Aug-15 A	20-Nov-15	42.42%
A1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
A1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
A1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
A1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
A1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
A1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		142	142	14-Aug-15 A	13-Feb-16	
A1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
A1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
A1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
A1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%
A1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
A1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%



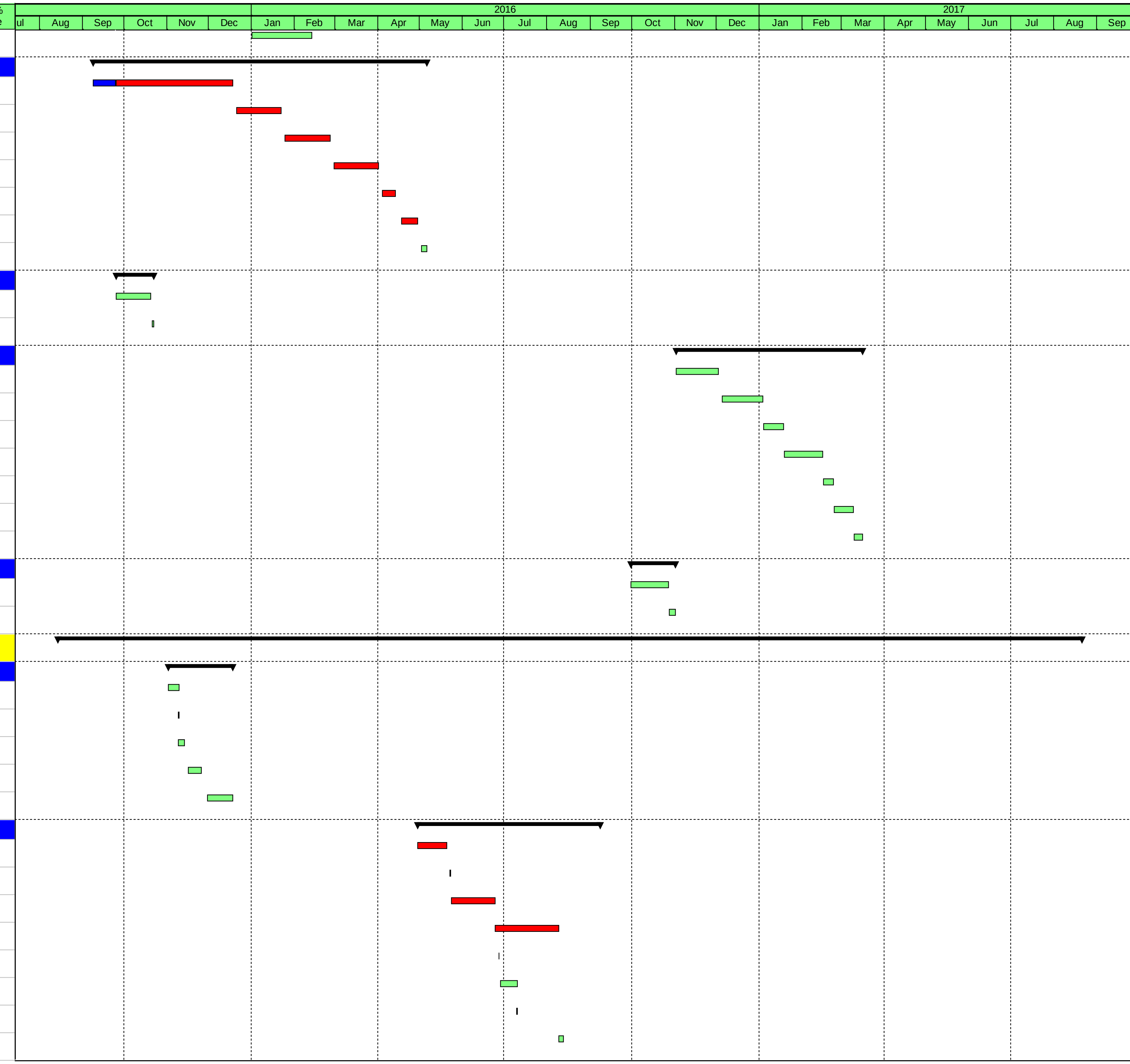
Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Plattsburg

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		131	154	09-Sep-15 A	06-May-16	
A1700	Prepare and Submit Draft	70	58	09-Sep-15 A	18-Dec-15	17.14%
A1710	Air Force Review Draft	22	22	21-Dec-15	22-Jan-16	0%
A1720	Prepare and Submit Draft Final	24	24	25-Jan-16	26-Feb-16	0%
A1730	Air Force Review Draft Final	25	25	29-Feb-16	01-Apr-16	0%
A1740	Prepare and Submit Final	8	8	04-Apr-16	13-Apr-16	0%
A1750	Government Backchek and Approval	10	10	18-Apr-16	29-Apr-16	0%
A1760	Issue Final	5	5	02-May-16	06-May-16	0%
2.4 - Initial Scoping Visit		20	20	25-Sep-15	22-Oct-15	
A1280	Prepare for Initial Scoping Visit	18	18	25-Sep-15	20-Oct-15	0%
A1290	Initial Scoping Visit	2	2	21-Oct-15	22-Oct-15	0%
2.5 - ISWPA		90	90	02-Nov-16	16-Mar-17	
A1230	Prepare and Submit Draft	20	20	02-Nov-16*	02-Dec-16	0%
A1240	Air Force Review Draft	20	20	05-Dec-16	03-Jan-17	0%
A1250	Prepare and Submit Draft Final	10	10	04-Jan-17	18-Jan-17	0%
A1260	Air Force Review Draft Final	20	20	19-Jan-17	15-Feb-17	0%
A1270	Prepare and Submit Final	5	5	16-Feb-17	23-Feb-17	0%
A1370	Government Backchek and Approval	10	10	24-Feb-17	09-Mar-17	0%
A1380	Issue Final	5	5	10-Mar-17	16-Mar-17	0%
2.6 - Follow-on Scoping Visit		23	23	30-Sep-16	01-Nov-16	
A1770	Prepare for Follow-on Scoping Visit	20	20	30-Sep-16*	27-Oct-16	0%
A1780	Follow-on Scoping Visit	3	3	28-Oct-16	01-Nov-16	0%
0300 - Investigation, Monitoring and Scoping		530	478	14-Aug-15 A	21-Aug-17	
3.1 - Private Well Assessment		32	32	02-Nov-15	18-Dec-15	
A3010	Coordinate Site Access	6	6	02-Nov-15*	09-Nov-15	0%
A3020	Mob groundwater and surface water team	1	1	09-Nov-15*	09-Nov-15	0%
A3030	Conduct well and surface water dev/sampling	4	4	09-Nov-15*	13-Nov-15	0%
A3050	Sample Analysis	8	8	16-Nov-15*	25-Nov-15	0%
A3080	Data Validation	15	15	30-Nov-15*	18-Dec-15	0%
3.2 - Initial Site Investigation		91	91	29-Apr-16	08-Sep-16	
A1790	Coordinate Site Access	21	21	29-Apr-16	20-May-16	0%
A1410	Mob SI Soil/Well Installation Team	1	1	23-May-16	23-May-16	0%
A1420	Soil Borings and Sampling/Monitoring Well Installation	23	23	24-May-16	24-Jun-16	0%
A1800	Sample Analysis	46	46	24-Jun-16	09-Aug-16	0%
A1430	Mob Groundwater Sampling Team	1	1	27-Jun-16	27-Jun-16	0%
A1440	Redevelop and Sample Monitoring Wells	13	13	28-Jun-16	10-Jul-16	0%
A1450	Demob Groundwater Sampling Team	1	1	10-Jul-16	10-Jul-16	0%
A1590	IDW Handling and Disposal	4	4	09-Aug-16	12-Aug-16	0%



- Remaining Level of Effort
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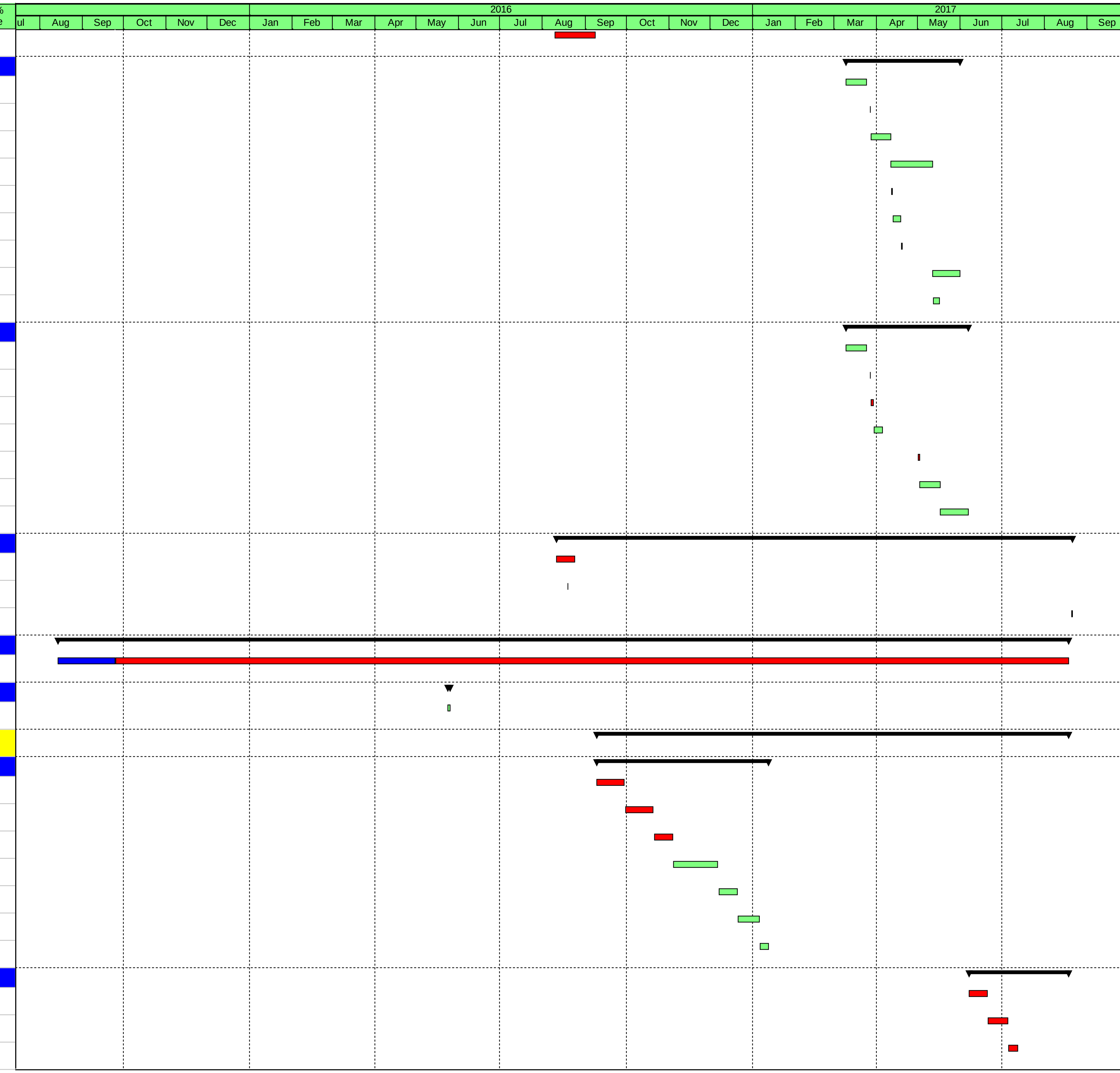
A/E Services for PFCs Release at Multiple BRAC Bases - Plattsburg

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A1810	Data Validation	30	30	10-Aug-16	08-Sep-16	0%
3.3 - Follow-on Site Investigation		58	58	09-Mar-17	31-May-17	
A1460	Coordinate Site Access	15	15	09-Mar-17	24-Mar-17	0%
A1490	Mob Soil/Well Installation Team	1	1	27-Mar-17	27-Mar-17	0%
A1500	Soil Borings and Sampling/Monitoring Well Installation	11	11	28-Mar-17	11-Apr-17	0%
A1470	Sample Analysis	30	30	11-Apr-17	11-May-17	0%
A1820	Mob Groundwater Sampling Team	1	1	12-Apr-17	12-Apr-17	0%
A1830	Redevelop and Sample Monitoring Wells	4	4	13-Apr-17	18-Apr-17	0%
A1840	Demob Groundwater Sampling Team	1	1	19-Apr-17	19-Apr-17	0%
A1480	Data Validation	20	20	11-May-17	31-May-17	0%
A1850	IDW Handling and Disposal	3	3	12-May-17	16-May-17	0%
3.4 - Plume and Receptor Pathway Investigation		62	62	09-Mar-17	06-Jun-17	
A1860	Coordinate Site Access	15	15	09-Mar-17	24-Mar-17	0%
A1920	Mob Private Well Sampling Team	1	1	27-Mar-17	27-Mar-17	0%
A1910	Initial Pore-water Sampling	2	2	28-Mar-17	29-Mar-17	0%
A1900	SW/Sediment Sampling	5	5	30-Mar-17	05-Apr-17	0%
A1940	Pore-water Sampling Round 2	2	2	01-May-17	02-May-17	0%
A1870	Sample Analysis	15	15	02-May-17	17-May-17	0%
A1880	Data Validation	20	20	17-May-17	06-Jun-17	0%
3.5 - Regular Groundwater Monitoring and Treatment System Installation		258	258	11-Aug-16	21-Aug-17	
A2040	Treatment System Installation	10	10	11-Aug-16	24-Aug-16	0%
A1960	Sample System 1	1	1	19-Aug-16	19-Aug-16	0%
A1990	Sample System 2	1	1	21-Aug-17	21-Aug-17	0%
3.6 - Data Management		530	477	14-Aug-15 A	18-Aug-17	
A1570	Data Managementt	530	477	14-Aug-15 A	18-Aug-17	10%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	24-May-16	25-May-16	
A1580	Field Audit	2	2	24-May-16	25-May-16	0%
0400 - Documentation		237	237	09-Sep-16	18-Aug-17	
4.1 - Initial Data Transmittal		85	85	09-Sep-16	12-Jan-17	
A2060	Prepare and Submit Draft Initial Transmittal	15	15	09-Sep-16	29-Sep-16	0%
A2070	Air Force Review	15	15	30-Sep-16	20-Oct-16	0%
A2080	Prepare and Submit Draft Final	10	10	21-Oct-16	03-Nov-16	0%
A2090	Agency Review	20	20	04-Nov-16	06-Dec-16	0%
A2100	Prepare and Submit Final	10	10	07-Dec-16	20-Dec-16	0%
A2110	Government Backcheck	10	10	21-Dec-16	05-Jan-17	0%
A2120	Submit Final	5	5	06-Jan-17	12-Jan-17	0%
4.2 - Site Investigation Report		52	52	07-Jun-17	18-Aug-17	
A2130	Prepare and Submit Draft Site Investigation Report	10	10	07-Jun-17	20-Jun-17	0%
A2140	Air Force Review	10	10	21-Jun-17	05-Jul-17	0%
A2150	Prepare and Submit Draft Final	5	5	06-Jul-17	12-Jul-17	0%



Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Plattsburg

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A2160	Agency Review	10	10	13-Jul-17	26-Jul-17	0%
A2170	Prepare and Submit Final	5	5	27-Jul-17	02-Aug-17	0%
A2180	Government Backcheck	5	5	03-Aug-17	09-Aug-17	0%
A2190	Submit Final	7	7	10-Aug-17	18-Aug-17	0%

2016 | 2017

Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct

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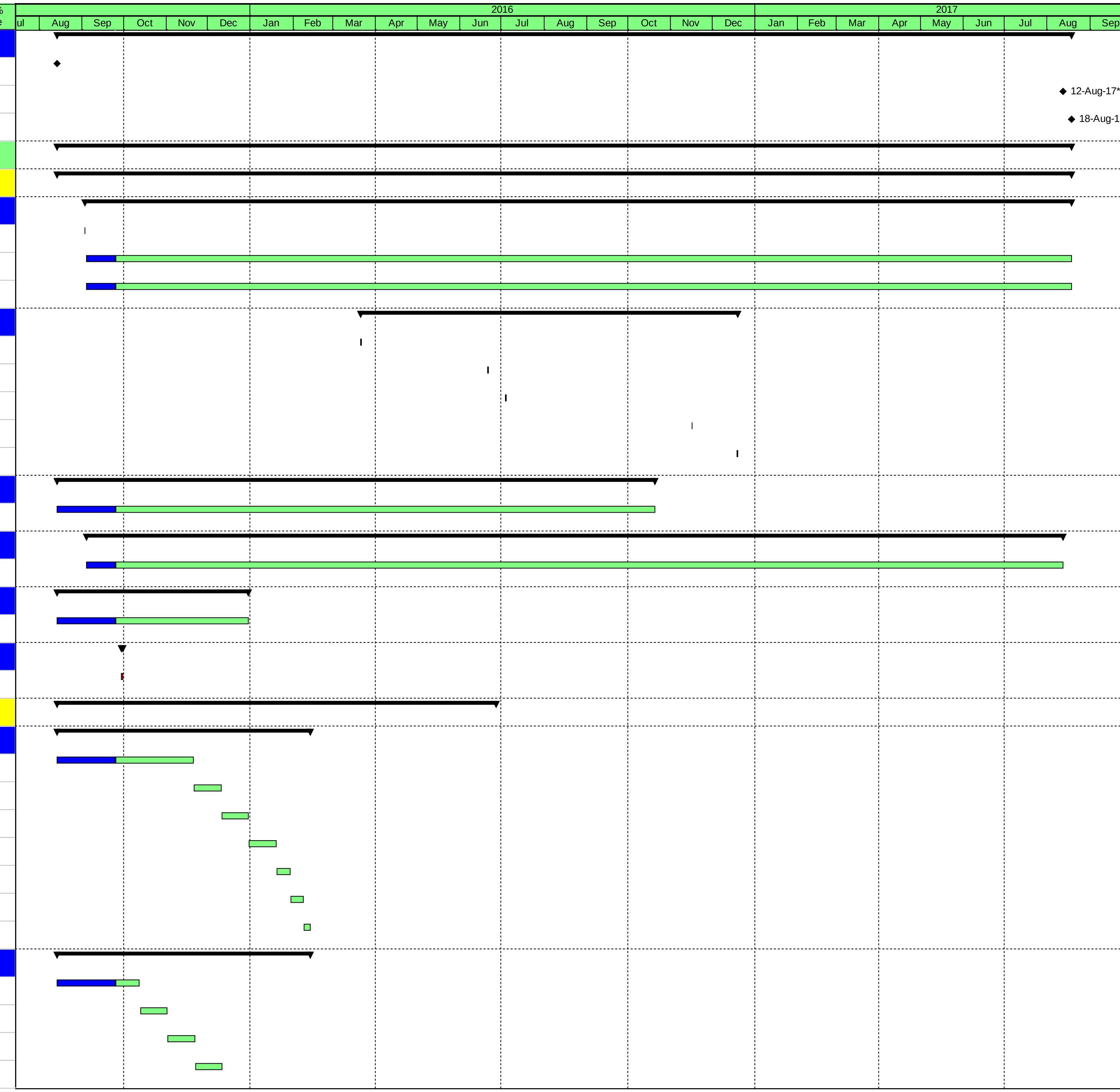
A/E Services for PFCs Release at Multiple BRAC Bases - Plattsburg

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Reese		491	477	14-Aug-15 A	18-Aug-17	
C1000	Project Award	0	0	14-Aug-15 A		100%
C1015	Contract POP (24 Months)	0	0		12-Aug-17*	0%
C1005	Project Complete	0	0		18-Aug-17	0%
Reese		491	477	14-Aug-15 A	18-Aug-17	
0100 - Prog/Project Management		716	694	14-Aug-15 A	18-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		716	694	03-Sep-15 A	18-Aug-17	
C2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
C2500	Monthly CPSMR/FMER	715	694	04-Sep-15 A	18-Aug-17	2.94%
C2510	Monthly Status Teleconferences	715	694	04-Sep-15 A	18-Aug-17	2.94%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		274	274	21-Mar-16	19-Dec-16	
C1040	Other On-site Meeting #1	1	1	21-Mar-16*	21-Mar-16	0%
C1060	Additional Meeting #1	1	1	21-Jun-16*	21-Jun-16	0%
C1070	On-Site Technical Meeting #1	1	1	04-Jul-16*	04-Jul-16	0%
C1050	Other On-site Meeting #2	1	1	16-Nov-16*	16-Nov-16	0%
C1080	On-Site Technical Meeting #2	1	1	19-Dec-16*	19-Dec-16	0%
1.3 - Procurement		434	392	14-Aug-15 A	20-Oct-16	
C2520	Subcontractor Procurement/Closeout	434	392	14-Aug-15 A	20-Oct-16	9.68%
1.4 - Project Website		709	688	04-Sep-15 A	12-Aug-17	
C2530	Monthly CPSMR/FMER	709	688	04-Sep-15 A	12-Aug-17	2.96%
1.5 - Lab Audits and Reporting		139	97	14-Aug-15 A	30-Dec-15	
C2540	Lab Audits and Reporting	139	97	14-Aug-15 A	30-Dec-15	30.22%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
C2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		189	189	14-Aug-15 A	27-Jun-16	
2.1 - General Quality Program Plan (UFP-QAPP)		142	142	14-Aug-15 A	13-Feb-16	
C1130	Prepare and Submit Draft	60	57	14-Aug-15 A	20-Nov-15	5%
C1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
C1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
C1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
C1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
C1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
C1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		142	142	14-Aug-15 A	13-Feb-16	
C1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
C1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
C1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
C1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



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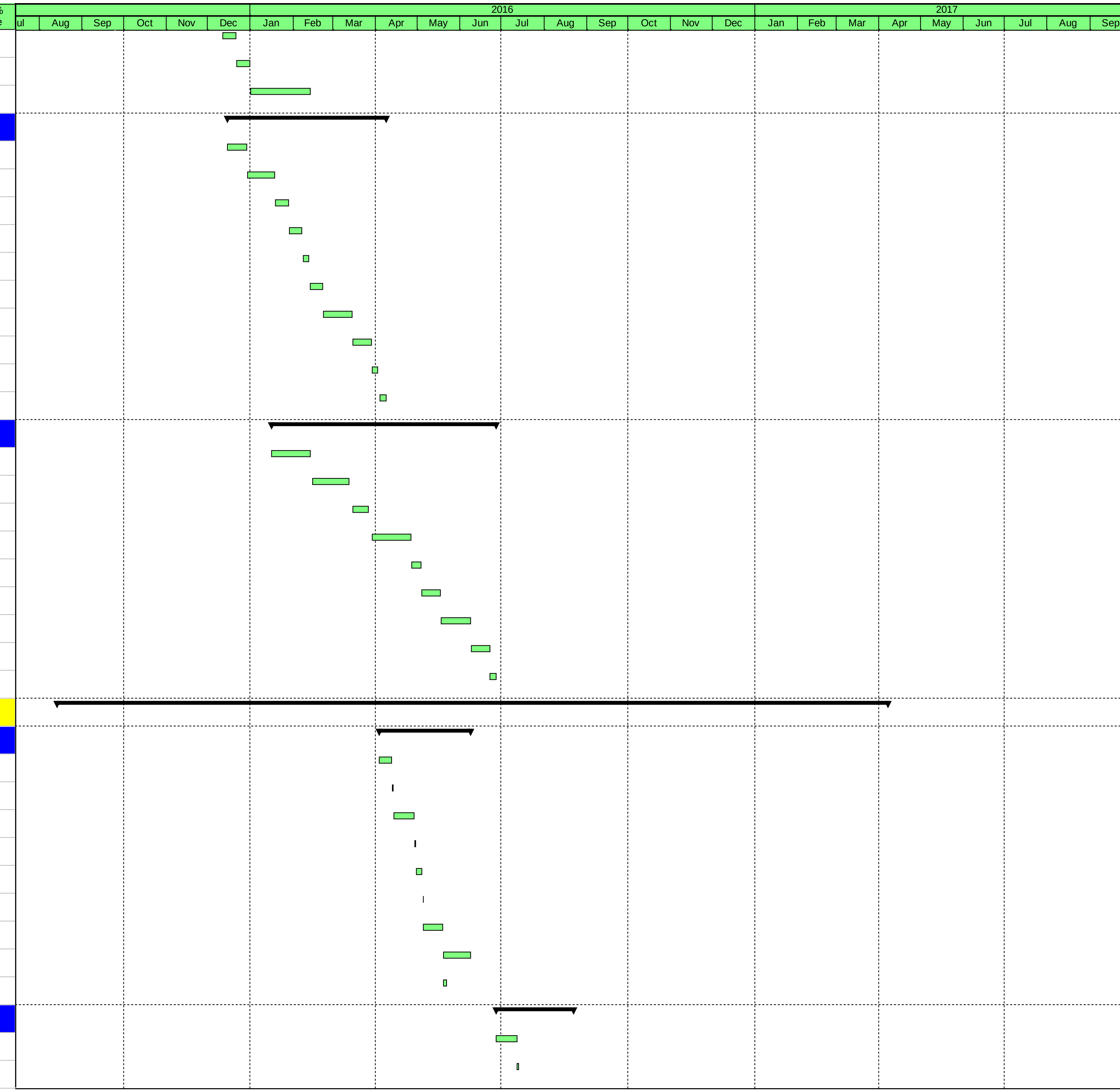
A/E Services for PFCs Release at Multiple BRAC Bases - Reese

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
C1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
C1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		80	80	15-Dec-15	08-Apr-16	
C1700	Prepare and Submit Working Copy	15	15	15-Dec-15*	29-Dec-15	0%
C1710	Air Force Review Working Copy	20	20	30-Dec-15	18-Jan-16	0%
C1720	Prepare and Submit Working Copy Rev 1	10	10	19-Jan-16	28-Jan-16	0%
C1730	Air Force Review Review and Approval	10	10	29-Jan-16	07-Feb-16	0%
C1740	Prepare and Submit Draft Copy	5	5	08-Feb-16	12-Feb-16	0%
C1750	Agency Review	10	10	13-Feb-16	22-Feb-16	0%
C1751	Prepare Response to Agency Comments	15	15	23-Feb-16	14-Mar-16	0%
C1752	Air Force Review of Response to Comments	10	10	15-Mar-16	28-Mar-16	0%
C1760	Agency Review of Response to Comments and Concurrence	5	5	29-Mar-16	02-Apr-16	0%
C1761	Prepare and Submit Final	5	5	04-Apr-16	08-Apr-16	0%
2.5 - Private/Production Well Survey		113	113	16-Jan-16	27-Jun-16	
C1230	Prepare and Submit Well Survey Plan Working Copy	29	29	16-Jan-16*	13-Feb-16	0%
C1240	Air Force Review Working Copy	27	27	15-Feb-16	12-Mar-16	0%
C1250	Prepare and Submit Working Copy Rev 1	12	12	15-Mar-16	26-Mar-16	0%
C1260	Air Force Review and Approval	29	29	29-Mar-16	26-Apr-16	0%
C1270	Prepare and Submit Draft Copy	7	7	27-Apr-16	03-May-16	0%
C1370	Agency Review	14	14	04-May-16	17-May-16	0%
C1371	Prepare Response to Agency Comments	15	15	18-May-16	08-Jun-16	0%
C1372	Air Force Review of Response to Comments	10	10	09-Jun-16	22-Jun-16	0%
C1380	Prepare and Submit Final	5	5	22-Jun-16	27-Jun-16	0%
0300 - Investigation, Monitoring and Scoping		413	384	14-Aug-15 A	07-Apr-17	
3.1 - Initial Site Investigation		67	67	03-Apr-16	08-Jun-16	
C1790	Coordinate Site Access	10	10	03-Apr-16	12-Apr-16	0%
C1410	Mob SI Soil/Well Installation Team	1	1	13-Apr-16	13-Apr-16	0%
C1420	Soil Borings and Sampling/Monitoring Well Installation	15	15	14-Apr-16	28-Apr-16	0%
C1430	Mob Groundwater Sampling Team	1	1	29-Apr-16	29-Apr-16	0%
C1440	Redevelop and Sample Monitoring Wells	5	5	30-Apr-16	04-May-16	0%
C1450	Demob Groundwater Sampling Team	1	1	05-May-16	05-May-16	0%
C1800	Sample Analysis	15	15	05-May-16	19-May-16	0%
C1810	Data Validation	20	20	20-May-16	08-Jun-16	0%
C1590	IDW Handling and Disposal	3	3	20-May-16	22-May-16	0%
3.3 - Well Survey and Sampling		56	56	27-Jun-16	22-Aug-16	
C1860	Coordinate Site Access	15	15	27-Jun-16	12-Jul-16	0%
C1920	Mob Private Well Sampling Team	1	1	12-Jul-16	13-Jul-16	0%



Remaining Level of Effort
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Milestone
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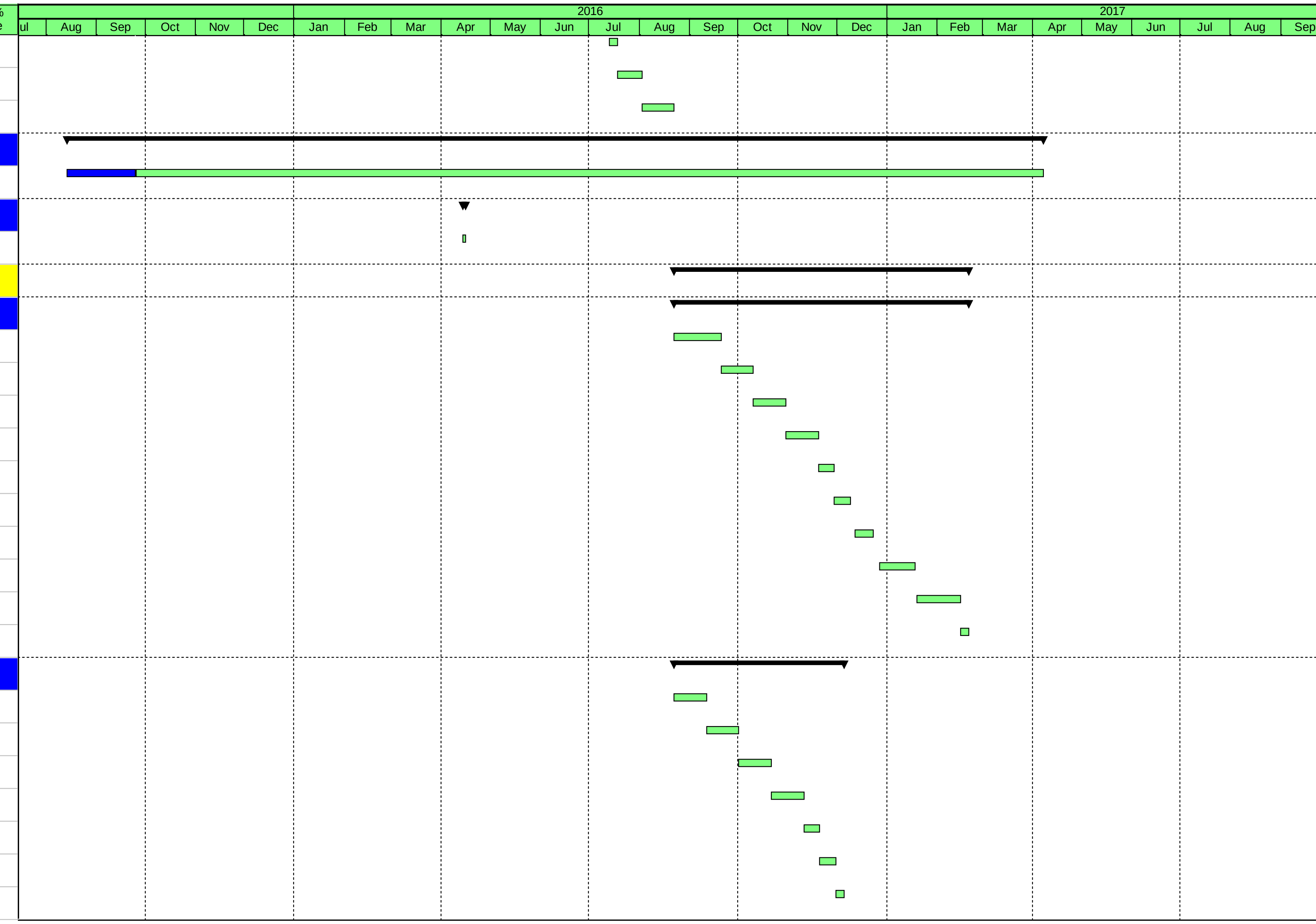
A/E Services for PFCs Release at Multiple BRAC Bases - Reese

DD: 25-Sep-15

amec foster wheeler

Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
C1890	Initial Water Sampling Private Wells	5	5	13-Jul-16	18-Jul-16	0%
C1870	Sample Analysis	15	15	18-Jul-16	02-Aug-16	0%
C1880	Data Validation	20	20	02-Aug-16	22-Aug-16	0%
3.6 - Data Management		413	384	14-Aug-15 A	07-Apr-17	
C1570	Data Management	413	384	14-Aug-15 A	07-Apr-17	7.02%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	14-Apr-16	15-Apr-16	
C1580	Field Audit	2	2	14-Apr-16	15-Apr-16	0%
0400 - Documentation		122	122	22-Aug-16	20-Feb-17	
4.2 - Site Investigation Report		122	122	22-Aug-16	20-Feb-17	
C2130	Prepare and Submit Working Copy Site Investigation Report	29	29	22-Aug-16	20-Sep-16	0%
C2140	Air Force Review Working Copy	20	20	20-Sep-16	10-Oct-16	0%
C2150	Prepare and Submit Working Copy Rev 1	20	20	10-Oct-16	30-Oct-16	0%
C2160	Airforce Reviw and Approval	20	20	30-Oct-16	19-Nov-16	0%
C2170	Prepare and Submit Draft	10	10	19-Nov-16	29-Nov-16	0%
C2180	Agency Review	10	10	29-Nov-16	09-Dec-16	0%
C2181	Prepare Response to Agency Comments	10	10	12-Dec-16	23-Dec-16	0%
C2182	Air Force Review of Response to Comments	15	15	27-Dec-16	18-Jan-17	0%
C2183	Agency Review of Response to Comments and Concurence	20	20	19-Jan-17	15-Feb-17	0%
C2190	Submit Final	5	5	15-Feb-17	20-Feb-17	0%
4.3 - Well Survey and Sampling Activity Report		105	105	22-Aug-16	05-Dec-16	
C2200	Prepare and Submit Draft Initial Transmittal	20	20	22-Aug-16	11-Sep-16	0%
C2210	Air Force Review	20	20	11-Sep-16	01-Oct-16	0%
C2220	Prepare and Submit Draft Final	20	20	01-Oct-16	21-Oct-16	0%
C2230	Agency Review	20	20	21-Oct-16	10-Nov-16	0%
C2240	Prepare and Submit Final	10	10	10-Nov-16	20-Nov-16	0%
C2250	Government Backcheck	10	10	20-Nov-16	30-Nov-16	0%
C2260	Submit Final	5	5	30-Nov-16	05-Dec-16	0%



Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Reese

DD: 25-Sep-15

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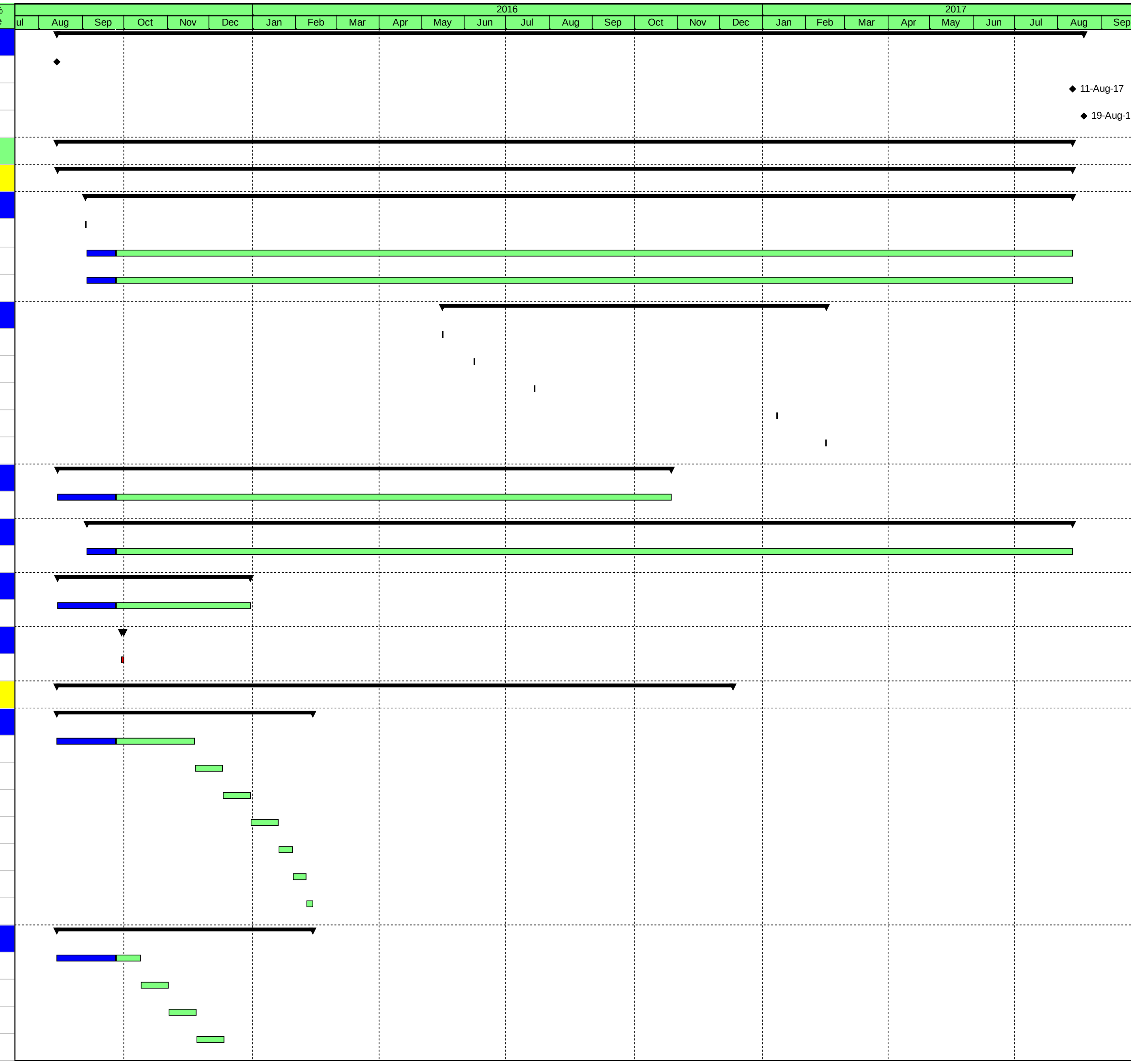
Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A/E Services for PFCs Release at Multiple BRAC Bases - Wurtsmith		506	477	14-Aug-15 A	19-Aug-17	
A1000	Project Award	0	0	14-Aug-15 A		100%
A1005	Project Complete	0	0		11-Aug-17	0%
A1015	Contract POP (24 Months)	0	0		19-Aug-17*	0%
Wurtsmith		506	472	14-Aug-15 A	11-Aug-17	
0100 - Prog/Project Management		506	472	14-Aug-15 A	11-Aug-17	
1.1 - Program/Project Management-Monthly Meeting and Reporting		492	472	03-Sep-15 A	11-Aug-17	
A2490	Kickoff Meeting	1	0	03-Sep-15 A	03-Sep-15 A	100%
A2500	Monthly CPSMR/FMER	491	472	04-Sep-15 A	11-Aug-17	3.87%
A2510	Monthly Status Teleconferences	491	472	04-Sep-15 A	11-Aug-17	3.87%
1.2 - Program/Project Management-Other On-site Meetings & On-site Community Relations Support		189	189	16-May-16	15-Feb-17	
A1040	Other On-site Meeting #1	1	1	16-May-16	16-May-16	0%
A1060	Additional Meeting #1	1	1	08-Jun-16	08-Jun-16	0%
A1070	On-Site Technical Meeting #1	1	1	21-Jul-16	21-Jul-16	0%
A1050	Other On-site Meeting #2	1	1	11-Jan-17	11-Jan-17	0%
A1080	On-Site Technical Meeting #2	1	1	15-Feb-17	15-Feb-17	0%
1.3 - Procurement		300	275	14-Aug-15 A	27-Oct-16	
A2520	Subcontractor Procurement/Closeout	300	275	14-Aug-15 A	27-Oct-16	8.33%
1.4 - Project Website		491	472	04-Sep-15 A	11-Aug-17	
A2530	Monthly CPSMR/FMER	491	472	04-Sep-15 A	11-Aug-17	3.87%
1.5 - Lab Audits and Reporting		90	65	14-Aug-15 A	30-Dec-15	
A2540	Lab Audits and Reporting	90	65	14-Aug-15 A	30-Dec-15	27.78%
1.6 - Calibration Session		2	2	29-Sep-15	30-Sep-15	
A2550	Calibration Session	2	2	29-Sep-15*	30-Sep-15	0%
0200 - Preparation of Site Specific Work Plan		328	303	14-Aug-15 A	10-Dec-16	
2.1 - General Quality Program Plan (UFP-QAPP)		178	142	14-Aug-15 A	13-Feb-16	
A1130	Prepare and Submit Draft	99	57	14-Aug-15 A	20-Nov-15	42.42%
A1140	Air Force Review Draft	20	20	21-Nov-15	10-Dec-15	0%
A1150	Prepare and Submit Draft Final	20	20	11-Dec-15	30-Dec-15	0%
A1160	Air Force Review Draft Final	20	20	31-Dec-15	19-Jan-16	0%
A1170	Prepare and Submit Final	10	10	20-Jan-16	29-Jan-16	0%
A1330	Government Backchek and Approval	10	10	30-Jan-16	08-Feb-16	0%
A1340	Issue Final	5	5	09-Feb-16	13-Feb-16	0%
2.2 - QPP-General Health and Safety Plan		178	142	14-Aug-15 A	13-Feb-16	
A1180	Prepare and Submit Draft	60	18	14-Aug-15 A	12-Oct-15	70%
A1190	Air Force Review Draft	20	20	13-Oct-15	01-Nov-15	0%
A1200	Prepare and Submit Draft Final	20	20	02-Nov-15	21-Nov-15	0%
A1210	Air Force Review Draft Final	20	20	22-Nov-15	11-Dec-15	0%



- Remaining Level of Effort
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- Actual Work
- Remaining Work
- Critical Remaining Work
- Milestone
- Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Wurtsmith

DD: 25-Sep-15

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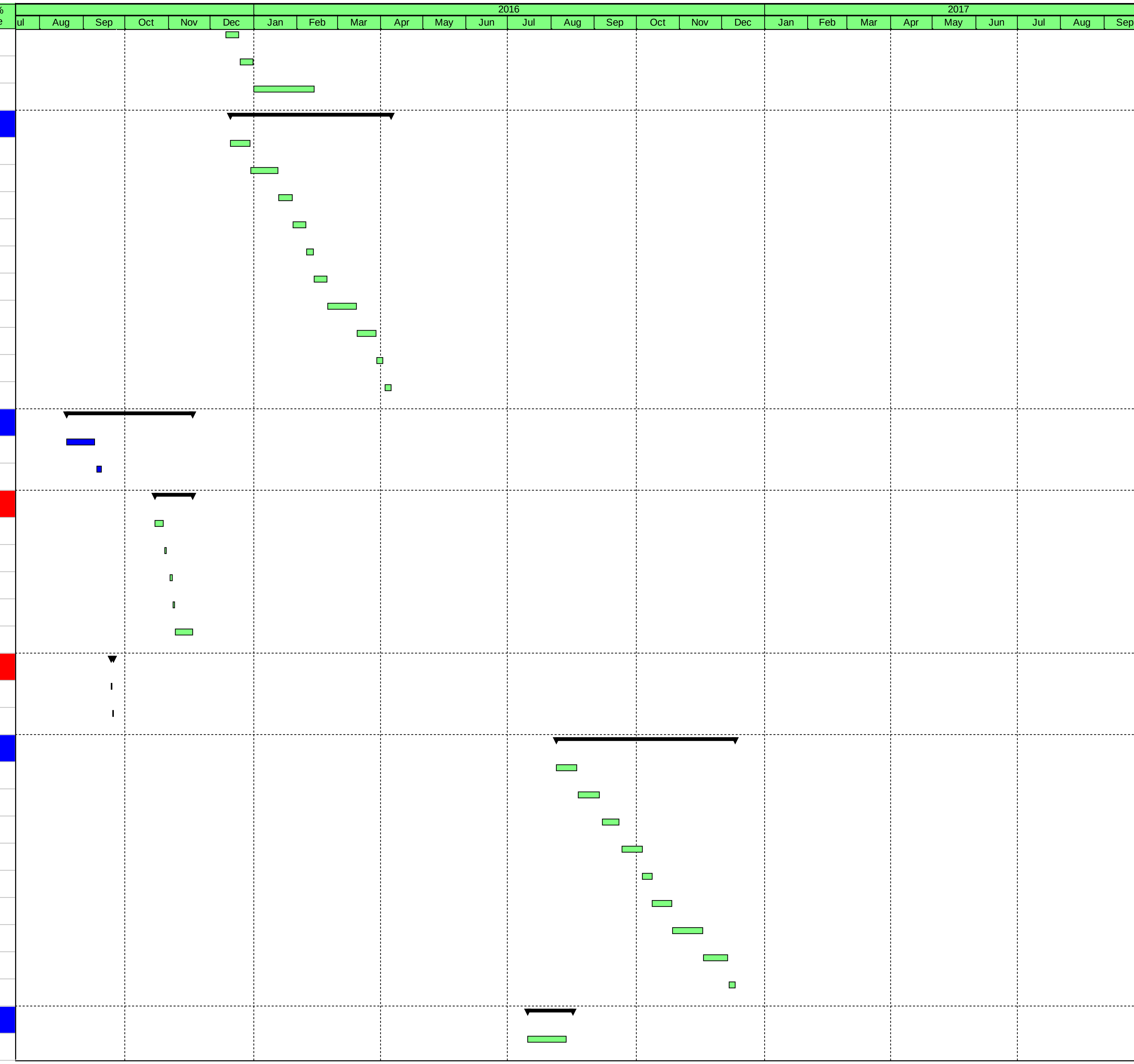
Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A1220	Prepare and Submit Final	10	10	12-Dec-15	21-Dec-15	0%
A1350	Government Backchek and Approval	10	10	22-Dec-15	31-Dec-15	0%
A1360	Issue Final	44	44	01-Jan-16	13-Feb-16	0%
2.3.1 - ISWP Preparation		80	80	15-Dec-15	08-Apr-16	
C1700	Prepare and Submit Working Copy	15	15	15-Dec-15*	29-Dec-15	0%
C1710	Air Force Review Working Copy	20	20	30-Dec-15	18-Jan-16	0%
C1720	Prepare and Submit Working Copy Rev 1	10	10	19-Jan-16	28-Jan-16	0%
C1730	Air Force Review Review and Approval	10	10	29-Jan-16	07-Feb-16	0%
C1740	Prepare and Submit Draft Copy	5	5	08-Feb-16	12-Feb-16	0%
C1750	Agency Review	10	10	13-Feb-16	22-Feb-16	0%
C1751	Prepare Response to Agency Comments	15	15	23-Feb-16	14-Mar-16	0%
C1752	Air Force Review of Response to Comments	10	10	15-Mar-16	28-Mar-16	0%
C1760	Agency Review of Response to Comments and Concurrence	5	5	29-Mar-16	02-Apr-16	0%
C1761	Prepare and Submit Final	5	5	04-Apr-16	08-Apr-16	0%
2.4 - Initial Scoping Visit		63	19	20-Aug-15 A	18-Nov-15	
A1280	Prepare for Initial Scoping Visit	15	0	20-Aug-15 A	09-Sep-15 A	100%
A1290	Initial Scoping Visit	2	0	11-Sep-15 A	14-Sep-15 A	100%
2.4.1 East of Base Well Survey and Sampling Plan		19	19	22-Oct-15	18-Nov-15	
A2560	Prepare and Submit Working Draft	5	5	22-Oct-15*	28-Oct-15	0%
A2570	Air Force Review	2	2	29-Oct-15	30-Oct-15	0%
A2580	Prepare Draft	2	2	02-Nov-15	03-Nov-15	0%
A2590	Agency Review Draft	2	2	04-Nov-15	05-Nov-15	0%
A2600	Prepare Final	8	8	06-Nov-15	18-Nov-15	0%
2.4.2 Whispiring Pines Sampling Work Plan		2	0	21-Sep-15 A	22-Sep-15 A	
A2610	Prepare and Submit Working Draft	1	0	21-Sep-15 A	21-Sep-15 A	100%
A2620	Air Force Review	1	0	22-Sep-15 A	22-Sep-15 A	100%
2.5 - ISWPA		87	87	04-Aug-16	10-Dec-16	
A1230	Prepare and Submit Work Plan	15	15	04-Aug-16	19-Aug-16	0%
A1240	Air Force Review Working Copy	15	15	20-Aug-16	04-Sep-16	0%
A1250	Prepare and Submit Working Copy Rev 1	12	12	06-Sep-16	18-Sep-16	0%
A1260	Air Force Review and Approval	15	15	20-Sep-16	05-Oct-16	0%
A1270	Prepare and Submit Draft Copy	7	7	05-Oct-16	12-Oct-16	0%
A1370	Agency Review	14	14	12-Oct-16	26-Oct-16	0%
A1371	Prepare Response to Agency Comments	15	15	27-Oct-16	17-Nov-16	0%
A1372	Air Force Review of Response to Comments	10	10	18-Nov-16	05-Dec-16	0%
A1380	Prepare and Submit Final	5	5	06-Dec-16	10-Dec-16	0%
2.6 - Follow-on Scoping Visit		23	23	15-Jul-16	16-Aug-16	
A1770	Prepare for Follow-on Scoping Visit	20	20	15-Jul-16	11-Aug-16	0%



- Remaining Level of Effort
- Actual Level of Effort
- Actual Work
- Remaining Work
- Critical Remaining Work
- Milestone
- Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Wurtsmith

DD: 25-Sep-15

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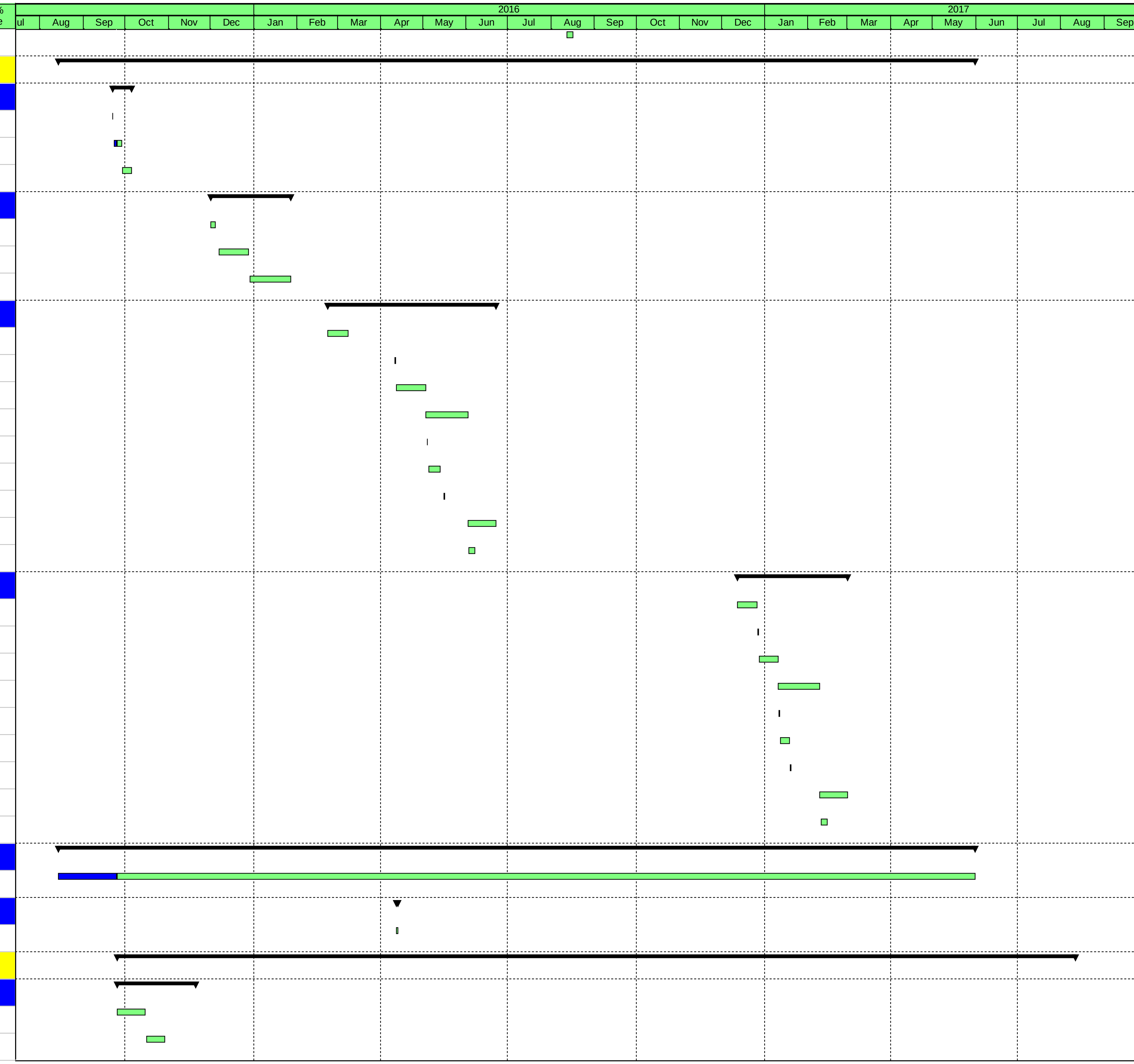
Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A1780	Follow-on Scoping Visit	3	3	12-Aug-16	16-Aug-16	0%
0300 - Investigation, Monitoring and Scoping		450	421	14-Aug-15 A	31-May-17	
3.1 - Wispering Pines Sampling		36	7	22-Sep-15 A	05-Oct-15	
A2630	Sample Collection	1	0	22-Sep-15 A	22-Sep-15 A	100%
A2640	Sample Analysis	5	2	23-Sep-15 A	28-Sep-15	60%
A2650	Data Validation	5	5	29-Sep-15	05-Oct-15	0%
3.2 - Well Survey and Sampling		39	39	01-Dec-15	27-Jan-16	
A2660	Door to Door Survey and Sampling	4	4	01-Dec-15*	04-Dec-15	0%
A2670	Sample Analysis	15	15	07-Dec-15	28-Dec-15	0%
A2680	Data Validation	20	20	29-Dec-15	27-Jan-16	0%
3.3 - Initial Site Investigation		86	86	23-Feb-16	22-Jun-16	
A1790	Coordinate Site Access	15	15	23-Feb-16	08-Mar-16	0%
A1410	Mob SI Soil/Well Installation Team	1	1	11-Apr-16	11-Apr-16	0%
A1420	Soil Borings and Sampling/Monitoring Well Installation	16	16	12-Apr-16	03-May-16	0%
A1800	Sample Analysis	30	30	03-May-16	02-Jun-16	0%
A1430	Mob Groundwater Sampling Team	1	1	04-May-16	04-May-16	0%
A1440	Redevelop and Sample Monitoring Wells	7	7	05-May-16	13-May-16	0%
A1450	Demob Groundwater Sampling Team	1	1	16-May-16	16-May-16	0%
A1810	Data Validation	20	20	02-Jun-16	22-Jun-16	0%
A1590	IDW Handling and Disposal	3	3	03-Jun-16	07-Jun-16	0%
3.4 - Follow-on Site Investigation		54	54	12-Dec-16	01-Mar-17	
A1460	Coordinate Site Access	15	15	12-Dec-16	26-Dec-16	0%
A1490	Mob Soil/Well Installation Team	1	1	27-Dec-16	27-Dec-16	0%
A1500	Soil Borings and Sampling/Monitoring Well Installation	9	9	28-Dec-16	10-Jan-17	0%
A1470	Sample Analysis	30	30	10-Jan-17	09-Feb-17	0%
A1820	Mob Groundwater Sampling Team	1	1	11-Jan-17	11-Jan-17	0%
A1830	Redevelop and Sample Monitoring Wells	4	4	12-Jan-17	18-Jan-17	0%
A1840	Demob Groundwater Sampling Team	1	1	19-Jan-17	19-Jan-17	0%
A1480	Data Validation	20	20	09-Feb-17	01-Mar-17	0%
A1850	IDW Handling and Disposal	3	3	10-Feb-17	14-Feb-17	0%
3.6 - Data Management		450	421	14-Aug-15 A	31-May-17	
A2750	Data Management	450	421	14-Aug-15 A	31-May-17	6.48%
3.7 - Field Audits (ERPIMS, Data Management Tool)		2	2	12-Apr-16	13-Apr-16	
A1580	Field Audit	2	2	12-Apr-16	13-Apr-16	0%
0400 - Documentation		472	472	25-Sep-15	11-Aug-17	
4.1 - Whispering Pines Data Summary Report		40	40	25-Sep-15	20-Nov-15	
A2690	Prepare Draft Summary Report	15	15	25-Sep-15	15-Oct-15	0%
A2700	Air Force Review	10	10	16-Oct-15	29-Oct-15	0%



Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

A/E Services for PFCs Release at Multiple BRAC Bases - Wurtsmith

DD: 25-Sep-15

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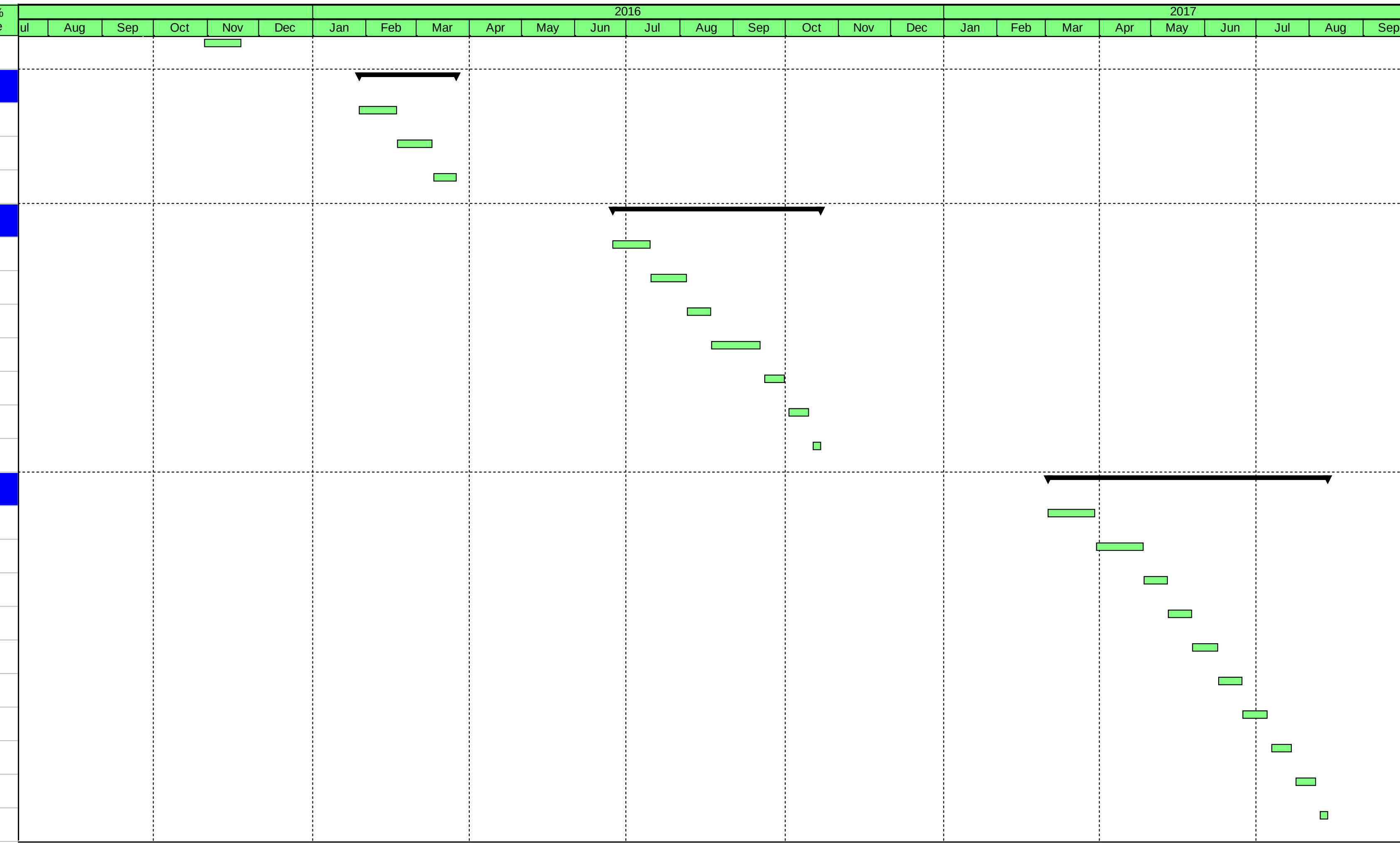
Activity ID	Activity Name	Original Duration	Remaining Duration	Start	Finish	Activity % Complete
A2710	Prepare Final Data Summary Report	15	15	30-Oct-15	20-Nov-15	0%
4.2 - Well Survey and Sampling Report		40	40	28-Jan-16	24-Mar-16	
A2720	Prepare Draft Well Survey and Sampling Report	15	15	28-Jan-16	18-Feb-16	0%
A2730	Air Force Review	15	15	19-Feb-16	10-Mar-16	0%
A2740	Prepare Final Well Survey and Sampling Report	10	10	11-Mar-16	24-Mar-16	0%
4.3 - Initial Data Transmittal		85	85	23-Jun-16	21-Oct-16	
A2060	Prepare and Submit Draft Initial Transmittal	15	15	23-Jun-16	14-Jul-16	0%
A2070	Air Force Review	15	15	15-Jul-16	04-Aug-16	0%
A2080	Prepare and Submit Draft Final	10	10	05-Aug-16	18-Aug-16	0%
A2090	Agency Review	20	20	19-Aug-16	16-Sep-16	0%
A2100	Prepare and Submit Final	10	10	19-Sep-16	30-Sep-16	0%
A2110	Government Backcheck	10	10	03-Oct-16	14-Oct-16	0%
A2120	Submit Final	5	5	17-Oct-16	21-Oct-16	0%
4.4 - Site Investigation Report		115	115	02-Mar-17	11-Aug-17	
A2130	Prepare and Submit Draft Working Copy Investigation Report	20	20	02-Mar-17	29-Mar-17	0%
A2140	Air Force Review	20	20	30-Mar-17	26-Apr-17	0%
A2150	Prepare and Submit Wokring Copy Rev 1	10	10	27-Apr-17	10-May-17	0%
A2160	Air Force Review and Approval	10	10	11-May-17	24-May-17	0%
A2170	Prepare and Submit Draft SI Report	10	10	25-May-17	08-Jun-17	0%
A2180	Agency Review	10	10	09-Jun-17	22-Jun-17	0%
A2200	Respond to Agency Comments	10	10	23-Jun-17	07-Jul-17	0%
A2210	Air Force Review of Response to Comments	10	10	10-Jul-17	21-Jul-17	0%
A2220	Agency Review and Concurrence	10	10	24-Jul-17	04-Aug-17	0%
A2190	Submit Final	5	5	07-Aug-17	11-Aug-17	0%



Remaining Level of Effort
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A/E Services for PFCs Release at Multiple BRAC Bases - Wurtsmith

DD: 25-Sep-15

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APPENDIX D

Standard Operating Procedures

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FIELD SAMPLING PROTOCOLS TO AVOID CROSS-CONTAMINATION OF PERFLUORINATED COMPOUNDS (PFCs)
SOP AFW-01 (PFCs)

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures/considerations when collecting soil, sediment, surface water, and groundwater samples at potential perfluorinated compound (PFC) release areas. This SOP also describes a tiered approach that should be used to assist with field decisions. Sampling specific SOPs should also be reviewed prior to conducting field sampling activities at PFC areas. The information contained within this SOP is included within sampling specific SOPs as applicable.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) personnel and subcontractors who collect or otherwise handle samples of soil, sediment, surface water, and groundwater for analysis of PFCs. This SOP should be reviewed by all on-site personnel prior to implementation of field activities.

3.0 REFERENCES

Transport Canada, 2013. *Perfluorochemical (PFC) Field Sampling Protocol*. May.

Delta Consultants, 2010. *Report of Investigation Activities at Select Firefighting Foam Training Areas and Foam Discharge Sites in Minnesota*. February. MPCA, 2008. *Closed Landfill Program Sampling Protocol for Monitoring Wells.* October.

4.0 GENERAL

Given the low detection limits associated with laboratory PFC analysis, and the many potential sources of trace levels of PFCs, field personnel are advised to act on the side of caution by strictly following the subject protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for false detections of PFCs. Specific items related to field sampling are discussed below.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with field sampling for analysis of PFCs. Proper procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information:

- Sample collection objectives;
- Locations to be sampled;
- Number and volume of samples to be collected at each location;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control (QC) procedures and sampling required;
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary; and,
- At a minimum, the procedures outlined in this SOP for field sampling will be followed.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead shall provide the Quality Project Plan (QPP), and installation-specific work plan to the Field Lead, which shall include the sampling requirements for each investigation area. The Base Lead will report deviations to the procedure provided in this SOP to the QC Manager and the Air Force Civil Engineer Center Contracting Office Representative.

Field Lead

The Field Lead shall ensure that samples are collected using procedures that are in accordance with the QPP, installation-specific work plans, and applicable SOPs. The Field Lead shall also be required to make rational and justifiable decisions when deviations from these procedures are necessary because of field conditions or unforeseen issues and report the deviations to the Base Lead.

Quality Control Manager

The QC Manager will be responsible for conducting field audits during selected sampling activities. During these audits, the QC Manager will ensure that field crews are adhering to the procedures provided in the QPP and in the installation-specific work plans, including, but not limited to, sampling techniques, field documentation, decontamination, sample packaging, chain of custody documentation procedures, and equipment calibration.

Field Personnel

Field personnel assigned to sampling activities are responsible for completing their tasks according to specifications outlined in the QPP, installation-specific work plans, applicable SOPs, and other appropriate procedures. Field personnel are responsible for reporting deviations from procedures to the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release areas. A summary of the prohibited and acceptable items for PFC investigation areas is included in Table 1. A checklist, provided as Attachment 1, shall be used by the Field Manager daily prior to the commencement of fieldwork to ensure the field team is in compliance with this protocol.

Field Equipment

- **Do not use Teflon®-containing materials** (e.g., Teflon® tubing, bailers, tape, plumbing paste, or other Teflon® materials) since Teflon® contains fluorinated compounds.
- High-density polyethylene (HDPE), low-density polyethylene (LDPE), and silicon materials are acceptable for sampling. Samples should not be stored in containers made of LDPE materials.
- Amec Foster Wheeler will use peristaltic pumps for groundwater sample collection at depths shallower than 25 feet. Amec Foster Wheeler will use ProActive SS Pumps with polyvinyl chloride (PVC) leads or Geotech SS Geosub pumps for groundwater sample collection at depths greater than 25 feet. These pumps are constructed with stainless steel and will minimize introductions of PFCs. However, for groundwater sample depths greater than 150 feet, a Grundfos RediFlo pump (or similar) may be used due to the pumping limitations of stainless steel pumps.
- When using liners to collect soil samples during direct-push technology or during conventional drilling and sampling methodologies, acetate liners are to be used.
- **Rite in the Rain products are the only waterproof field books that may be used**. To avoid plastic coating or glue materials, do not use other brands of waterproof field books. If Rite in the Rain products are not available, field reports will be documented on loose paper secured on masonite or aluminum clipboards (i.e. plastic clipboards, binders, or spiral hard cover notebooks are not acceptable) using a pen or pencil. Sharpies®/markers may also be used.
- **Post-It Notes are not allowed** on project sites.

- **Do not use markers other than Sharpies®markers.** Pens will be used when documenting field activities in the field log and on field forms as well as labeling sample containers and preparing the Chain of Custody.
- **Do not use chemical (blue) ice packs** during the sampling program. This includes the use of ice packs for the storage of food and/or samples.

Field Clothing and Personal Protective Equipment

- **Do not wear water resistant, waterproof, or stain-treated clothing** during the field program. Field clothing made of synthetic and natural fibers (preferably cotton) are acceptable. Field clothing should be laundered without the use of fabric softener. Preferably, field gear should be cotton construction and well laundered (i.e., washed a minimum of 6 prior to use after purchase). New clothing may contain PFC related treatments. **Do not use new clothing** while sampling or sample handling.
- **Do not wear clothing or boots containing Gore-Tex™** during the sampling program as it contains a PFC membrane.
- Safety footwear will consist of steel-toed boots made with polyurethane and PVC, untreated leather boots, or well-worn leather boots. Newer leather boots may be worn if they are covered with polypropylene, polyethane, or PVC boot covers.
- Disposable nitrile gloves must be worn at all times. Further, a new pair of nitrile gloves shall be donned prior to the following activities at each sample location:
    - Decontamination of re-usable sampling equipment;
    - Prior to contact with sample bottles or water containers;
    - Insertion of anything into the well (e.g., HDPE tubing, HydraSleeve bailer, etc.);
    - Insertion of silicon tubing into the peristaltic pump;
    - Completion of monitor well purging, prior to sample collection;
    - Handling of any quality assurance/quality control samples including field blanks and equipment blanks; and,
    - After the handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.

Sample Containers

- Different laboratories may supply sample collection containers of varying sizes dependent on the type of media to be sampled (e.g., soil, groundwater, etc.). All samples should be collected in polypropylene or HDPE bottles. The screw cap will be made of polypropylene or HDPE and may be lined or unlined. However, if lined, the liner may not be made of Teflon® or contain PFCs.

- Container labels will be completed using pen after the caps have been placed back on each bottle.
- Glass sample containers are not to be used due to potential loss of analyte through adsorption.

Wet Weather

- Field sampling occurring during wet weather (e.g., rainfall and snowfall) should be conducted while wearing appropriate clothing that will not pose a risk for cross-contamination. Teams will avoid synthetic gear that has been treated with water-repellant finishes containing PFCs. Use rain gear made from polyurethane, vinyl, and wax or rubber-coated materials.
- Teams should consider the use of a gazebo tent, which can be erected overtop of the sample location and provide shelter from the rain. It should be noted that the canopy material is likely a treated surface and should be handled as such; therefore, gloves should be worn when setting up and moving the tent, changed immediately afterwards and further contact with the tent should be avoided until all sampling activities have been finished and the team is ready to move on to the next sample location.

Equipment Decontamination

- Field sampling equipment, including oil/water interface meters and water level indicators, and other downhole equipment used at each sample location, will require cleaning between uses. Alconox® and Liquinox® soap is acceptable for use since the Safety Data Sheets do not list fluoro-surfactants as an ingredient. However, Decon 90 will not be used during decontamination activities. Water used for the final rinse during decontamination of sampling equipment will be laboratory certified "PFC-free" water.
- For larger equipment (e.g., drill rig and large downhole drilling and sampling equipment), decontamination will be conducted with potable water using a high-pressure washer and then rinsed using potable water.

Personnel Hygiene

- Field personnel will not use cosmetics, moisturizers, hand cream, or other related products as part of their personal cleaning/showering routine on the morning of a sampling event, unless the products are applied to a part of the body that will be coved by clothing. These products may contain surfactants and represent a potential source of PFCs.

- Many manufactured sunblock and insect repellants contain PFCs and should not be brought or used on-site. Sunblock and insect repellants that are used on-site should consist of 100% natural ingredients, unless previously vetted by the project chemist. A list of acceptable sunscreens and insect repellents is provided in Table 1.
- For washroom breaks, field personnel will leave the exclusion zone and then remove gloves and overalls. Field personnel should wash as normal with extra time for rinsing with water after soap use. When finished washing, the use of a mechanical dryer is preferred and the use of paper towel for drying is to be avoided (if possible).

Food Considerations

- No food or drink shall be brought on-site, with the exception of bottled water and hydration drinks (i.e., Gatorade® and Powerade®), which will only be allowed to be brought and consumed within the staging area.

Visitors

- Visitors to the investigation area are asked to remain outside of the exclusion zone during sampling activities.

6.0 TIERED APPROACH TO ASSIST WITH FIELD DECISIONS

In evaluating whether products contain PFCs and are suitable for use in the field, the tiered approach presented in Table 2 will be used to assist with field decisions. Any member of the field team should contact the Project Manager, Regional Lead, or Project Chemists with questions.

Table 1. Summary of Prohibited and Acceptable Items for PFC Sampling

Prohibited Items	Acceptable Items
Field Equipment	
Teflon® containing materials	High-density polyethylene (HDPE) and Low density polyethylene (LDPE) materials
Storage of samples in containers made of LDPE materials	Acetate liners
Teflon® tubing	Silicon tubing
Waterproof field books not manufactured by Rite in the Rain	Rite in the Rain products or Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
	Sharpies®, pens
Post-It Notes	
Chemical (blue) ice packs	Regular ice
Excel Purity Paste TFW Multipurpose Thread Sealant Vibra-Tite Thread Sealant	Gasoils NT Non-PTFE Thread Sealant Bentonite
Equipment with Viton Components (need to be evaluated on a case by case basis, Viton contains PTFE, but may be acceptable if used in gaskets or O-rings that are sealed away and will not come into contact with sample or sampling equipment.)	
Field Clothing and PPE	
New clothing or water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of synthetic or natural fibers (preferable cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™	Boots made with polyurethane and PVC, well-worn or untreated leather boots, leather boots with boot covers
	Reflective safety vests, Tyvek®, Cotton Clothing, synthetic under clothing, body braces
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling, unless the products are applied to body parts that will be covered by clothing.	**Sunscreens** - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are “free” or “natural” **Insect Repellents** - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics, Deep Woods Off **Sunscreen and insect repellant -** Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion

Table 1. Summary of Prohibited and Acceptable Items for PFC Sampling (continued)

Prohibited Items	Acceptable Items
Sample Containers	
LDPE or glass containers	HDPE or polypropylene
Teflon®-lined caps	Lined or unlined HDPE or polypropylene caps
Rain Events	
Waterproof or resistant rain gear	Polyurethane, vinyl, wax or rubber-coated rain gear. Gazebo tent that is only touched or moved prior to and following sampling activities
Equipment Decontamination	
Decon 90	Alconox® and/or Liquinox®
Water from an on-site well	Potable water from municipal drinking water supply
Food Considerations	
All food and drink, with exceptions noted on the right	Bottled water and hydration drinks (i.e. Gatorade® and Powerade®) to be brought and consumed only in the staging area

Table 2. Tiered Approach

Tier and Description	Action
Tier 1: Products that *will come into direct contact* with field samples include, but are not limited to, drilling grease, sampling equipment, sample containers, and well construction materials	These products will undergo the greatest scrutiny and requires chemist's input to help evaluate the materials as a possible source of contamination[A] and as possible sampling or storage materials or both
Tier 2: Products that *will not come into direct contact* with samples, but could be *reasonably expected to contain PFCs*, such as waterproof or nonstick products	Project team/affected person can review the Safety Data Sheet (SDS)[B] and if it shows PFCs, product should not be used. If product SDS does not indicate PFCs, confirm with chemist before use
Tier 3: Products that *will not come into direct contact* with samples and are *not expected to contain PFCs*, such as ballpoint pens, zipper bags, and body braces	Project team/affected person can review SDS and if no PFCs, then appropriate to use

[A] Tier 1 products will undergo the closest scrutiny. It may be necessary to have Tier 1 products analyzed for PFCs to confirm that a specific batch or lot number does not contain PFCs. Alternate products will need to be evaluated/used if PFCs are identified in the product.

[B] SDS Check: To evaluate product SDS and/or manufacturing specs, check if the product contains anything with "fluoro" in the name or the acronyms TPE, FEP, ETFE, and/or PFA. If fluorinated compounds are not listed in the manufacturing specs and/or on the SDSs, product can be used.

Date: ______________________ Installation Name: ______________________________________

Weather (*temp./precipitation*): ________________ Investigation Area:______________________________

Field Clothing and PPE:

☐ Field crew in compliance with Tables 1 and 2, SOP AFW-01

☐ Field crew has not used fabric softener on clothing

☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products on exposed body parts this morning

☐ Field crew has not applied unacceptable sunscreen or insect repellant

Field Equipment:

☐ No Teflon® containing materials on-site

☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene

☐ No waterproof field books on-site other than Rite in the Rain products

☐ No plastic clipboards, binders, or spiral hard cover notebooks on-site

☐ No adhesives (Post-It Notes) on-site

☐ Coolers filled with regular ice only. No chemical (blue) ice packs in possession

Sample Containers:

☐ All sample containers made of HDPE or polypropylene. Samples are not stored in containers made of LDPE

☐ Caps are lined or unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

☐ For personnel in direct contact with samples and/or sampling equipment, wet weather gear made of vinyl, polyurethane, PVC, wax or rubber- coated materials only

Equipment Decontamination:

☐ "PFC-free" water on-site for decontamination of sample equipment

☐ Alconox and Liquinox to be used as decontamination materials

Food Considerations:

☐ No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area

If any applicable boxes cannot be checked, the Field Manager shall describe the noncompliance issues below and work with field personnel to address noncompliance issues prior to commencement of that day's work. Corrective action shall include removal of noncompliance items from the investigation area or removal of worker offsite until in compliance. Repeated failure to comply with PFC sample protocols will result in the permanent removal of worker(s) from the investigation area.

Describe the noncompliance issues (include personnel not in compliance) and action/outcome of noncompliance:

____

____

____

Field Manager Name: ________________________________

Field Manager Signature: _______________________________ Time: _____________________

SOIL SAMPLING
SOP AFW-02 (PFCs)

1.0 PURPOSE

The purpose of this technical procedure is to describe the methodology for collecting soil samples in order to document the areal and vertical extent of contaminated soil and to determine the geotechnical, physical, and chemical properties of the soil while conducting perfluorinated compound (PFC) investigation sampling.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors who collect or otherwise handle samples of surficial or subsurface soil during PFC investigations.

3.0 REFERENCES

ASTM International (ASTM), *Standard Practice for Clarification of Soils for Engineering Purposes (Unified Soil Classification System), Method D-2487-11,*

(ASTM), 1999, *Standard Method for Penetration Test and Split-Barrel Sampling of Soils*, Method D-1586-99, Philadelphia, Pennsylvania.

ASTM International (ASTM), 1994, *Standard Practice for Thin-Walled Tube Sampling of Soils*, Method D-1587-94, Philadelphia, Pennsylvania. International (ASTM), 1995, *Standard Practice for Ring-Lined Barrel Sampling of Soils*, Method D-3550-84 (1995)e1, Philadelphia, Pennsylvania.

Barth, D.S. and B.J. Mason. 1984. *Soil Sampling Quality Assurance User's Guide.* EPA-600/4-84-043.

Environmental Protection Agency. 1984. *Characterization of Hazardous Waste Sites - A Methods Manual, Available Sampling Methods.* Volume II, 2nd Edition. EPA-600/4-84-076.

Mason, B.J. 1983. *Preparation of Soil Sampling Protocol: Techniques and Strategies.* EPA-600/4-83-020.

Hewitt, Alan D., et al. 2007. *Protocols for Collection of Surface Soil Samples at Military Training and Testing Ranges for the Characterization of Energetic Munitions Constituents*. U.S. Army Corps of Engineers. ERDC/CRREL TR-07-10.

4.0 DEFINITIONS

Borehole - Any hole drilled or hydraulically driven into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing monitoring wells.

Composite soil sample – a combination of soil aliquots collected at various locations, or at various depths at a single location. Analysis of composite samples yields a value representing an average over the various sampled sites or depths from which individual samples were collected.

Core Sampler – A metal tube (probe rod), generally 4- to 5-feet long by 2.25- to 3.25-inch OD, typically utilized along with drive rods and a polyvinyl chloride (PVC) or acetate or equivalent liner that is used to collect soil cores utilizing a direct-push rig. Inside the probe rods are smaller diameter, center rods affixed with a solid drive tip that seals the lower end of the probe rods during pushing. After reaching the target depth, advancement is halted and the center rods and drive tip are removed, which opens the bottom end of the probe rods. A sample liner is attached to the rod string and is lowered to the bottom of the push rods, and the assembly is then advanced to collect the soil sample within the liner. The center rod string is withdrawn from the probe rods, and the liner is removed to access the recovered soil core. The process of direct-pushing and soil core recovery may be repeated within the same boring until reaching total boring depth.

Discrete soil sample – a discrete aliquot from a distinct sampling interval (of a specific sample size) that is representative of one specific location at a specific point in time.

Drilling Jars – A set pair of linked, heat-treated steel bars. The jars may be attached to a wireline sampling string incorporating a split spoon or other impact sampler. The jars are used to drive the sampler into the soil ahead of the bottom of the borehole

Shelby Tube Sampler – A thin-walled metal tube used to recover relatively undisturbed samples. These tubes are available in various sizes, ranging from 2 to 5 inches in outside diameter and 18 to 54 inches in length. A stationary piston device is included in the sampler to reduce sampling disturbance and increase sample recovery.

Split-Spoon Sampler – A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into resistant (semiconsolidated) materials using a drive weight or drilling jars mounted in the drilling rig. A standard split-spoon sampler (used for performing standard penetration tests) is 2 inches in outside diameter and 1-3/8 inches in inside diameter. This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. Six-inch long sleeves (tubes) of brass, stainless steel, or plastic are commonly placed inside the sampler to collect and retain soil samples. A five-foot long split-spoon sampler is also available. A California modified split-spoon sampler is also commonly used. The design is similar to the standard split-spoon except the outside diameter is 2 1/2 inches and the inside diameter is 2 inches.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with soil sampling for analysis of PFCs. Proper procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information:

- Sample collection objectives;
- Locations to be sampled;
- Number and volume of samples to be collected at each location;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control procedures and sampling required;
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary; and
- At a minimum, the procedures outlined in this SOP for field sampling will be followed.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead shall provide installation-specific work plan to the Field Lead, which shall include the sampling requirements, locations and depths for the project.

Field Lead

The Field Lead shall ensure that soil samples are collected according to this technical procedure. The Field Lead shall also be required to make rational and justifiable decisions when deviations from this procedure are necessary because of field conditions or unforeseen problems.

Field Personnel

Field personnel assigned to subsurface soil sampling activities during drilling or probing are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

Collecting soil samples is an important site characterization activity. Soil samples are used to determine the nature and extent of contamination, to identify hazardous substance source areas, and to determine the geotechnical, hydrogeologic, physical, and chemical properties of a site. Soil sampling strategies will be determined and documented before initiating sampling. Field conditions at the investigation area may preclude collection at one or more predetermined sampling locations. Additional soil sampling may be required if unexpected subsurface conditions are observed during the course of the sampling. Proper sampling techniques, proper selection of sampling equipment, and proper decontamination procedures will eliminate cross-contamination and the introduction of contaminants from external sources. Soil conditions can vary widely at a hazardous waste site. Such variations can affect the rate of contaminant migration through the soil. Therefore, it is important that detailed records be maintained during sampling, particularly with respect to the sample location, depth, color, odor, lithology, hydrogeology, and readings derived from field monitoring equipment. Surface and shallow subsurface soil samples shall be described utilizing the Unified Soil Classification System and / or ASTM guidance D2487 Standard Practices for Classification of Soils for Engineering Purposes (Unified Soil Classification System), unless otherwise specified by the work plan.

The following are procedures/considerations to be made during field activities at potential PFC release areas.

5.2.1 FIELD EQUIPMENT

Equipment and supplies used to collect, document, and package surface or subsurface soil samples may include, but is not limited to, the following items:

- Nitrile gloves;
- Stainless steel spoons/trowels;
- Stainless steel hand auger;
- Stainless steel split spoon, split barrel, or continuous sampler;
- Stainless steel bowls/pans;
- Field logbook and boring log (**Not** “write in the rain” © or other water resistant paper);
- Pens;
- Paper towels;
- Aluminum foil;

- Appropriate decontamination equipment;
- Appropriate personnel protective equipment and safety equipment as specified in the Health and Safety Plan and in other SOPs;
- Sample cooler with ice (no blue ice);
- Sample jars (i.e., no glass) and labels;
- Bubble wrap;
- Chain-of-Custody forms;
- Munsell Soil Color charts;
- Grain size charts;
- Hand lens;
- Brass sleeves;
- Brass caps;
- Acetate liners;
- Ziplock freezer bags;
- Stainless steel deionized water spraying devices;
- Non PFC plastic sheeting; and
- Non PFC tape.

5.2.2 DECONTAMINATION

Before collecting any soil samples, all sampling devices shall be decontaminated. If dedicated or disposable equipment is used, it will be rinsed with deionized water where applicable. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field. Each piece of sampling equipment shall be decontaminated before initiation of sampling operations and between each sample location and interval. Decontamination solutions shall be replenished between sampling locations as needed. Spent decontamination fluids will be containerized, properly labeled and appropriately disposed of according to the investigation derived waste (IDW) plans addressed in the installation-specific work plan.

5.2.3 SURFACE SOIL SAMPLING

Any surface vegetation will be removed before sampling with a decontaminated shovel or sampling spoon. Surface soil samples may be collected as either discrete or composite samples. Each surface soil sample will be collected using either a stainless steel spoon or trowel. The sampler, wearing clean disposable nitrile gloves, will remove pebbles, roots, etc. from the mixture as the sample is collected. Each sample will be collected by thoroughly homogenizing material from the zero (i.e., zero is considered ground surface where no vegetation is present, and/or the surface directly below where vegetation must be removed) to 6-inch below ground surface depth interval (unless other depth intervals are specified in the work plan). A decontaminated stainless steel scoop or trowel will be used to remove a thin layer of soil from the area that comes into contact with the shovel (if used to gain a specific sampling depth). A second decontaminated stainless steel spoon or trowel will then be used to collect the soil sample.

Each soil sample fraction collected will be thoroughly mixed (i.e., homogenized) using the sampling spoon or trowel. The homogenized material will then be divided among the appropriate sample containers. The sample containers will then be sealed tightly. Care should be taken to ensure the container (bowl, pan, etc.) used for homogenization and the sampling utensils do not interfere with the analytes of interest (e.g., an aluminum pan should not be used for soil samples submitted for inorganic analyses; only stainless steel bowls are allowed).

All personnel who collect or handle the soil samples will wear disposable nitrile gloves to prevent cross-contamination and provide personal protection. New gloves shall be donned for sample collection at each sampling location (i.e., at each new vertical or horizontal position), or whenever gloves are torn or otherwise compromised.

If collecting a composite sample, each aliquot will be collected by placing equal amounts of soil collected from multiple locations into a decontaminated collection container. The aliquots will then be combined (i.e. homogenized) using a spoon or trowel. The homogenized material will then be divided equally among the appropriate sample containers.

5.2.4 SUBSURFACE SOIL SAMPLING

Split-Spoon Sampling

Split-spoon samples for chemical analysis are usually obtained in brass, plastic, or stainless steel sleeves. The type of sleeve to be used if applicable, along with the length and type of sampler, will be stated in the project work plans. The split-spoon sampler is connected to the drill rod string or a wireline sampling string and is driven by a drive hammer (140 or 340 pound, depending on the size of the sampler) or drilling jars into the undisturbed soil ahead of the bottom of the borehole. The procedure for collecting samples from the split-spoon sampler will be outlined in the project work plans. The standard procedure is described below.

- Calibrate all field analytical and health and safety monitoring equipment according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

- Wear the appropriate personal protective equipment as specified in the project work plans and the applicable drilling method SOP.
- Between each sampling location and prior to each sampling run, decontaminate the sampler, sleeves, and other nondisposable sampling equipment as described in SOP AFW-10.
- Advance the borehole to the desired depth or target horizon where the sampling run is to begin.
- When the desired sampling depth or target horizon is reached, remove the drill bit or plug from inside the drive casing or augers.
- Insert the sleeves into the split-spoon sampler (if determined necessary), connect the halves, and screw together the rear threaded collar and front drive shoe. Attach the split-spoon sampler to the bottom end of the drill rod string or wireline sampling string. Set up and attach the specified weight hammer, if used.
- Drive the sampler into the soil at the bottom of the borehole. Record the type of sampler assembly and hammer weight on the Boring Log and/or other appropriate form(s), as specified in the project work plans. To minimize off-gassing of the volatiles, the sampler should not be driven until the sampling team is ready to process the sample.
- Pull the drill rod or wireline sampling string up from the bottom of the borehole and remove the sampler.
- Remove the drive shoe and rear collar from the sampler and open the split barrel.
- If sleeves are used, remove the sleeves one at a time, starting with the sleeve adjoining the drive shoe. Observe and record the amount of sample recovery on the Boring Log. Any observed field problems associated with the sampling attempt (e.g., refusal) or lack of recovery should be noted on the Boring Log.
- If sleeves are used, select sleeve(s) to be submitted for laboratory analysis. Sample sleeve selection should be based on four factors: judgment that the sample represents relatively undisturbed intact material, not slough; proximity to the drive shoe; minimal exposure to air; lithology; and obvious evidence of contamination. The soil core should also be visually recorded on a Boring Log.
- Appropriately label and number each sleeve or soil sample container to be submitted for analysis. The label will contain, at a minimum, the following information:
  - Project number;

- Location ID;
- Boring number;
- Sample number;
- Bottom depth of sleeve, if applicable;
- Date and time of sample collection;
- Parameters for analysis; and,
- Sampler's initials.

- Document the sampling event on the Soil Sample Collection Field Sheet or an equivalent form as specified in the project work plans. At a minimum, this log will contain:
  - Project name and number;
  - Location ID
  - Date and time of the sampling event;
  - Drilling and sampling methods;
  - Sample number;
  - Sample location;
  - Boring number;
  - Sample depth;
  - Sample description;
  - Unusual events; and,
  - Signature or initials of the sampler.
- Appropriately preserve (no blue ice permitted to cool samples), package, handle, and ship the sample in accordance with the procedures outlined in SOP AFW-11 and the project work plans. The samples shall also be maintained under proper chain of custody. Samples stored on-site will be subject to the provisions of SOP AFW-11.
- Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample collected.

Core Sampling using Direct Push Technology (DPT)

A core sampler may be used to collect subsurface soil samples. The procedure for collecting soil samples using a core sampler should be outlined in the project work plans. The standard procedure is described below.

- Calibrate all field analytical and health and safety monitoring equipment.
- Wear the appropriate personal protective equipment.

- Between each sampling location and prior to each sampling run, decontaminate the sampler and other sampling equipment as described in SOP AFW-10.
- Advance the probe rods equipped with a solid drive tip to the desired depth or target horizon where the sampling run is to begin. After reaching the target depth, the center rods and drive tip are removed and a new acetate liner is attached to the center rod string.
- Once the liner and center rods are inserted into the probe rods, the assembly is advanced to collect the soil sample within the liner. The assembly is pushed about 4 to 5 feet into the soil with a continuous, rapid motion. At shallow depths and/or in soft soils, the assembly may be advanced without impact from the drive hammer. At greater depths and in harder substrates impact from the drive hammer is likely required to advance the sampling assembly. The liner and center rods are withdrawn from the probe rods, noting which end of the liner is up.
- The DPT contractor will cut the liner and present it to the geologist/engineer for inspection and sample collection. Upon receiving the liner, the field geologist/engineer will observe and record the amount of sample recovery and any associated problems.
- Sample selection should be based on five factors: judgment that the sample represents relatively undisturbed intact material, not slough; proximity to the drive shoe; minimal exposure to air; lithology; and obvious evidence of contamination. The soil core should also be visually recorded on a soil Boring Log.
- Appropriately label and number each soil sample container to be submitted for analysis. The label will contain, at a minimum, the following information:
  - Project number;
  - Location ID;
  - Boring number;
  - Sample number;
  - Date and time of sample collection;
  - Parameters for analysis; and,
  - Sampler’s initials.
- Document the sampling event on the soil sample collection field sheet or an equivalent form as specified in the project work plans. At a minimum, this log will contain:
  - Project name and number;
  - Location ID;
  - Date and time of the sampling event;
  - Drilling and sampling methods;
  - Sample number;

- Sample location;
- Boring number;
- Sample depth;
- Sample description;
- Unusual events; and,
- Signature or initials of the sampler.

- Appropriately preserve (no blue ice permitted to cool samples), package, handle, and ship the sample in accordance with the procedures outlined in SOP AFW-11 and the project work plans. The samples shall also be maintained under proper chain of custody. Samples stored on-site will be subject to the provisions of SOP AFW-11.
- Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample collected.

GROUNDWATER SAMPLING
SOP AFW-03 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of groundwater samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all groundwater samples. Additional specific procedures and requirements will be provided in the installation-specific work plans, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors who collect or otherwise handle groundwater samples during perfluorinated compound (PFC) investigations.

3.0 REFERENCES

ASTM International, 2007, *Standard Guide for Sampling Ground-Water Monitoring Wells*, D 4448-01 (Reapproved 2007).

Barcelona et al, 1985, *Practical Guide for Groundwater Sampling*, Illinois State Water Survey, Champaign, Illinois, ISWS Contract Report 374, November.

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

EPA, 1992, *EPA RCRA Groundwater Monitoring: Draft Technical Guidance*, November.

4.0 DEFINITIONS

Bailer – A bailer is an enclosed cylindrical tube containing a floating ball check-valve at the bottom. Lowering the bailer into water causes the ball to float allowing water to enter the cylinder. Raising the bailer through the water column causes the ball to settle, creating a seal to trap the water so that it can be brought to the surface.

Bladder Pump – A bladder pump is an enclosed cylindrical tube containing a flexible membrane bladder. Well water enters the bladder through a one-way check-valve at the bottom. Gas is forced into the annular space (positive displacement) surrounding the bladder through a gas supply line. The gas displaces the well water through a one-way check-value at the top. The water is brought to the surface through a water discharge line. Gas (air or nitrogen) is provided by compressors or cylinders.

Dedicated Groundwater Monitoring Equipment – Dedicated groundwater monitoring equipment is used to purge and sample only one well. The equipment is commonly installed within, and remains in the well, for the duration of the monitoring program. Dedicated equipment does not need to be decontaminated between sampling events.

Electric Submersible Pump – An electric submersible pump is an enclosed cylindrical tube containing a motor with rotary attachments. Well water enters the cylinder through a one-way check valve. Electrical power to the motor causes rotors or impellers to turn and displace the groundwater.

Peristaltic Pump – A peristaltic pump is a self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement that causes water to be drawn through the tubing. During purging and sampling, only the tubing is placed down the well. All of the mechanical systems of the pump remain above ground during purging and sampling activities. The peristaltic pump is typically limited to sampling at depths of less than 25 feet. Operating two or more peristaltic pumps in parallel can increase operational depths slightly.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with groundwater sampling. Proper groundwater sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The work plans will generally provide the following information:

- Sample collection objectives;
- Locations of groundwater samples to be collected;
- Numbers and volumes of samples to be collected;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control (QC) procedures and sampling required;
- Management procedures for groundwater investigation derived waste (IDW); and
- Any additional groundwater sampling requirements or procedures beyond those covered in this SOP, as necessary.
- At a minimum, the procedures outlined in this SOP for groundwater sampling will be followed.

5.1 RESPONSIBILITIES

Compliance with this procedure is the responsibility of project management and field personnel. This SOP and the installation-specific work plans should be reviewed before performing groundwater sampling at the project investigation area.

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to groundwater sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release areas.

5.2.1 FIELD EQUIPMENT

Purging and sampling equipment is constructed from a variety of materials. The most inert material (e.g., silicone and high-density polyethylene), with respect to known or anticipated contaminants in the well(s), will be used whenever possible. The various types of purging and sampling equipment available for groundwater sampling are described in *ASTM Standard Guide for Sampling Ground-Water Monitoring Wells, D 4448-01* (ASTM, 2007) or *Collection of Groundwater Samples at Known or Suspected Groundwater Contaminated Sites* or *Compendium of Superfund Field Operations Methods* (EPA, 1987).

If non-dedicated sampling equipment is to be used, and the contaminant histories of the wells are known, it is advisable to establish a sampling order starting with the least contaminated well and progressing to the most contaminated well last.

5.2.2 DECONTAMINATION

Before collecting any groundwater samples, all sampling devices shall be decontaminated. If dedicated or disposable equipment is used, it will be rinsed with deionized water where applicable. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field. Each piece of sampling equipment shall be decontaminated daily before initiation of sampling operations and between each sample location and interval. Decontamination solutions shall be replenished between sampling locations as needed. Spent decontamination fluids will be containerized, properly labeled and appropriately disposed of according to the investigation derived waste (IDW) plans addressed in the installation-specific work plan.

5.2.3 GROUNDWATER PURGING AND SAMPLING

Groundwater Purging and Sampling with a Bladder Pump

Pre-sample purging and sampling should be conducted in accordance with the installation-specific work plans. The standard procedure for purging and sampling using a bladder pump is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and will be conducted as described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.
- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.
- If non-dedicated equipment is being used, decontaminate the equipment as described in SOP AFW-10. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Log and brought to the attention of the Field Lead.
- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static depth to water level measurement. If the total well depth has not been verified within the past year, obtain a total well depth measurement. Calculate the volume of water in the well (cased well volume) as follows:

$$\pi\left(\frac{d}{2}\right)^2 (h_1 - h_2) \, x \, 7.48 = \text{ cased well volume (in gallons)}$$

Where:

d = inside diameter of well casing (in feet)

h_1 = depth of well from top of casing (in feet)

h_2 = depth to water from top of casing (in feet)

- Record static water level, total well depth, and volume calculations on the sample collection field sheet.
- If using non-dedicated equipment, lower the pump and associated tubing and/or lines into the well. The pump intake should be located near the middle of the saturated portion of the screened interval and the depth of the pump intake will be recorded on the Groundwater Sample Collection Form. For low yielding wells it may be necessary to gently lower the pump during purging to follow the declining water level in the well.
- Attach the compressor or cylinder to the controller and the controller to the gas supply line, making sure that the compressor is downwind of the monitoring well. Attach the sampling tube to the discharge supply line. Adjust the pressure/discharge cycle on the controller.
- Begin purging. Collect and dispose of purge water in accordance with the criteria specified by the project work plans.
- Physical parameters (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) of the purge water will be measured when purging begins, after each well casing volume, and then periodically throughout the purging procedure. These measurements will be recorded on Groundwater Sample Collection Forms. Purging is considered complete when water quality indicator parameters have stabilized (i.e., three consecutive readings are within tolerances specified in Table 4-1) (ASTM, 2007; EPA, 1992 and Barcelona et al, 1985). If stability is not reached within the removal of three well casing volumes, then purging is continued until stability is attained, up to a maximum purging period of one hour. If parameters have not stabilized after the additional hour of purging, the sample may be collected.

Table 4-1

Parameter	Units	Requirement
pH	Standard Units	± 0.1
Specific Conductivity	Micromhos/centimeter (umho/cm, or µS/cm)	± 3 percent
Temperature	Degrees Celcius (ºC)	± 0.5 ºC
Oxidation-Reduction Potential (ORP)	Millivolts (mV)	± 10 percent
Dissolved Oxygen	Milligrams/liter (mg/L)	± 10 percent
Turbidity	Nephelometric Turbidity Units (NTUs)	± 10 percent, but less than 10 NTUs

- For slowly recharging wells, the parameters may not stabilize before the well casing is emptied, even when using low flow purging rates. In this case, purging will be considered complete when one well volume (i.e., well casing plus filter pack volume) has been purged from the well and the well goes dry.
- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA 8330) must be concurrently and completely filled following a single recharge event. The date and time of each sample collection will be recorded.
- Inspect the sample bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.
- Turn on the pump and adjust the pressure/discharge cycle on the pump controller so that the water will flow smoothly and without agitation into the sample containers.

- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analysis should be filled to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AFW-11, following appropriate chain of custody procedures. Samples stored temporarily on-site will be maintained per SOP AFW-10.

Groundwater Purging and Sampling with a Peristaltic Pump

Purging and sampling will be conducted per the project work plans. The standard procedure for groundwater purging and sampling using a peristaltic pump is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and will be conducted as described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity, and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.
- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.

- Conduct equipment decontamination; however, the old silicone tubing used in the pump head should not be decontaminated. New tubing should be used for each well.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Log and brought to the attention of the Field Manager.
- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static water level measurement and calculate the cased well volume as described in Section 4.2.2 of this SOP.
- Connect new silicone tubing to the rotor head of the pump motor and tighten until snug.
- Run a short section of the tubing from the discharge side of the pump head to a collection vessel.
- Insert the free end of the influent tubing into the well and lower it to the middle of the saturated portion of the well screen. The depth of the tubing intake will be recorded on the Groundwater Sample Collection Form. For low yielding wells, it may be necessary to gently lower the tubing intake during purging to follow the declining water level in the well.
- Begin purging. Collect and dispose of purge water in accordance with the criteria specified by the installation-specific work plan.
- Physical parameters (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) of the purge water will be measured when purging begins, after each well casing volume, and then periodically throughout the purging procedure. These measurements will be recorded on Groundwater Sample Collection Forms. Purging is considered complete when water quality indicator parameters have stabilized (i.e., three consecutive readings are within tolerances specified in Table 4-1) (ASTM, 2007; EPA, 1992 and Barcelona et al, 1985). If stability is not reached within the removal of three well casing volumes, then purging is continued until stability is attained, up to a maximum purging period of one hour. If parameters have not stabilized after the additional hour of purging, the sample may be collected.

- For slowly recharging wells, the parameters may not stabilize before the well casing is emptied, even when using low flow purging rates. In this case, purging will be considered complete when one well volume (i.e., well casing plus filter pack volume) has been purged from the well and the well goes dry.
- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA 8330) must be concurrently and completed filled following a single recharge event. The date and time of each sample collection will be recorded.
- Inspect the sample bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.
- Turn on and adjust the rotor speed of the pump so that the water will flow smoothly and without agitation into the sample containers.
- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.

- Handle and ship the sample according to the procedures outlined in SOP AFW-11 following appropriate chain of custody procedures. Samples stored temporarily on-site will be maintained per SOP AFW-10.

***Groundwater* Purging and Sampling with an Electric Submersible Pump**

Purging and sampling will be conducted in accordance with the project work plans. The standard procedure for purging and sampling using a submersible pump is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and is described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.
- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.
- If non-dedicated equipment is being used, decontaminate the equipment as described in SOP AFW-10. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Log and brought to the attention of the Field Manager.
- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static water level measurement and calculate the cased well volume as described in Section 4.2.2 of this SOP.
- If using non-dedicated equipment, lower the pump and associated lines into the well. The pump intake should be located near the middle of the saturated portion of the

screened interval and the depth of the pump intake will be recorded on the field form. For low yielding wells it may be necessary to gently lower the pump during purging to follow the declining water level in the well.

- Place the generator downwind of the well. Start the generator, and then plug the pump into the generator.
- Begin purging. Collect and dispose of purge water in accordance with the criteria specified by the project work plans.
- Physical parameters (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity, and temperature) of the purge water will be measured when purging begins, after each well casing volume, and then periodically throughout the purging procedure. These measurements will be recorded on Groundwater Sample Collection Forms. Purging is considered complete when water quality indicator parameters have stabilized (i.e., three consecutive readings are within tolerances specified in Table 4-1) (ASTM, 2007; EPA, 1992 and Barcelona et al, 1985). If stability is not reached within the removal of three well casing volumes, then purging is continued until stability is attained, up to a maximum purging period of one hour. If parameters have not stabilized after the additional hour of purging, the sample may be collected.
- For slowly recharging wells, the parameters may not stabilize before the well casing is emptied, even when using low flow purging rates. In this case, purging will be considered complete when one well volume (i.e., well casing plus filter pack volume) has been purged from the well and the well goes dry.
- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA 8330) must be concurrently and completely filled following a single recharge event. The date and time of each sample collection will be recorded.
- Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of

preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.

- Turn on and adjust the flow rate of the pump by using the check-valve on the discharge line so that the water will flow smoothly and without agitation into the sample bottles.
- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AFW-11, following appropriate chain of custody procedures. Samples stored temporarily on-site will be maintained per SOP AFW-10.

Groundwater Purging and Sampling with a Bailer

Purging and sampling will be conducted in accordance with the project work plans. The standard procedure for purging and sampling with a bailer is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and is described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.

- An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.
- If non-dedicated equipment is being used, decontaminate the equipment as described in SOP AFW-10. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.
- Visually inspect the well to ensure that it is undamaged, properly labeled, and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Activity Daily Log and brought to the attention of the Field Manager.
- Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Sample Collection Form.
- Obtain a static water level measurement and calculate the cased well volume as described in Section 4.2.2 of this SOP.
- Secure the bailer to a five foot length of stainless bailer wire with a bowline knot or clip. Attach the bailer wire to bailing line or chain.
- Begin purging by slowly lowering the bailer into the groundwater. Allow the floating ball valve to seat, and slowly retrieve the bailer. Repeat this procedure to purge the well. Collect, transport, and dispose of purge water in accordance with the criteria specified in the project work plans.
- During purging, the descent of the bailer should be controlled to prevent freefall inside the well. In the event the bailer encounters an obstruction inside the well, no attempts should be made to push the bailer beyond the obstruction. If the bailer becomes lodged in the well, the line should not be pulled with such force that it would part from the bailer. Such conditions should also be noted on the Groundwater Sampling Form and brought to the immediate attention of the Field Manager.
- The well will then be allowed to recharge, and sampling must be initiated within 24-hours of purging. The depth to the water level in the well will be measured and recorded immediately prior to sample collection. If the volume of water in the recharged well is not sufficient to completely fill all required sample containers, then sample collection may follow multiple well recharge events within 48 hours after completion of purging. All sample containers for a given analytical method (e.g., EPA

8330) must be concurrently and completed filled following a single recharge event. The date and time of each sample collection will be recorded.

- Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.
- Lower the sample collection bailer and submerge into the water column as above. Retrieve the bailer and insert a bottom-emptying device into the bailer so that the water will flow smoothly and without agitation into the sample bottles.
- Collect the sample water directly into the provided sample bottles (containers), allowing the discharge to flow gently down the inside of the bottles, minimizing aeration of the sample. Completely fill the bottles; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AFW-11, following appropriate chain of custody procedures. Samples stored temporarily on-site will be maintained per SOP AFW-10.

Groundwater Sampling using Inflatable Packers

Inflatable Packers are used to isolate portions of an open-hole bedrock well for sampling or other hydrogeological assessment purposes. Expandable rubber bladders are positioned one above the other on a metal pipe. Their configuration permits discharge and power supply lines to pass through the packers with a pump sandwiched in between. The packers are inflated with compressed air to hydraulically isolate water-bearing fractures identified through borehole geophysical logging or core samples.

Pumping of water from within a packed interval can be used to estimate yield of the selected zone, and for the analysis of samples collected from a targeted zone, facilitating the assessment of the vertical extent of groundwater contamination. If samples are to be collected for field screening or laboratory analysis, low-flow sampling techniques would be employed before sample collection. The resolution of the groundwater quantity and quality within the borehole is based on the length of the bedrock borehole interval tested and usually does not exceed 20 feet in length. The steps for collecting groundwater samples using inflatable packers are outlined below:

- If packers are not seated properly, water will leak around the system during the sampling event. To determine if leakage around the packer is occurring, the water level above the top packer is monitored to see if the level drops while the target interval is being pumped. If the water level drops, the packers will be re-seated by deflating and re-inflating the packers. A dropping water level does not necessarily mean the packers have a poor seal. Another possibility is that there are vertical fractures that connect fractures within the sampling zone to fractures above the top packer.
- Packers are assembled at the surface with the selected pump sandwiched between individual bladders.
- Assembled unit is lowered to a predetermined depth.
- Bladders are inflated from air-lines originating at the surface. Bladder pressures are determined accordingly:

  G = Inflation pressure at gauge (PSI)

  DP = Depth to top of packer (feet)

  DW = Depth to static water level in well (feet)

  Sp = Unconfined packer pressure rating for the well size (PSI)

  PP = Injection pump pressure (PSI)

  To calculate Packer Inflation Pressure for sampling (i.e., pump out):

  G = [(DP - DW) x .43] + Sp + [(DP - DW) x .43 x .2]

- Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.
- Turn on and adjust the flow rate of the pump so that the water will flow smoothly and without agitation into the sample bottles.
- Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the samples for the analysis of the most volatile parameters first, followed by the samples for the least volatile parameters. The samples for volatiles analysis should be collected during one full discharge cycle. Do not partially fill a container for volatile parameter analysis during one cycle and complete the filling during the next cycle.
- Document the sampling event on the Groundwater Sample Collection Form.
- As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AFW-11, following appropriate chain of custody procedures. Samples stored temporarily on-site will be maintained per SOP AFW-10.

MONITORING WELL INSTALLATION
SOP AFW-04 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides procedures and requirements for the installation of monitoring wells using various drilling techniques, including but not limited to, direct push technology (DPT), hollow-stem auger, rotary, sonic, or dual-tube percussion. The details within this SOP should be used in conjunction with installation-specific work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform monitoring well installation activities during perfluorinated compound (PFC) investigations.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1986, *Resource Conservation and Recovery Act (RCRA) Ground Water Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Government Printing Office, Washington D.C.

EPA, 1987, *A Compendium of Superfund Field Operations Methods*, EPA-500/P-87/001, U.S. Government Printing Office, Washington D.C.

4.0 DEFINITIONS

Air Rotary Casing Hammer Drilling – A drilling method using a non-rotating drive casing that is advanced simultaneously with a slightly smaller diameter rotary bit attached to a string of drill pipe. The drive casing is a heavy-walled, threaded pipe that allows for pass-through of the rotary drill bit inside the center of the casing. Air is forced down through the center drill pipe to the bit, and then upward through the space between the drive casing and the drill pipe. The upward return stream of air removes cuttings from the bottom of the borehole.

Annular Space – The space between:

- Concentric drill pipes;

- An inner drill pipe and outer drive casing;
- Drill pipe or drive casing and the borehole wall; or,
- Well screen or casing and the borehole wall.

Borehole – Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil or rock samples, and/or installing groundwater wells.

Cuttings – Pieces of soil, sediment, or rock cut by a bit in the process of drilling borings.

Direct Push Drilling – For the purposes of this monitoring well installation SOP, the term "direct push drilling" refers to using DPT to push or drive hollow rods into the ground for the purpose of installing monitoring wells with a maximum inside diameter of 1 inch when using 2.625 inch inside diameter DPT rods. Direct push drilling uses an expendable drive point that is fitted to the lower end of a string of drive rods that are advanced into the ground using percussive hammering. No cuttings are brought to the surface during drilling, although soil cores may be retrieved using various sampling tools.

Dual-Tube Percussion Drilling – A drilling method using non-rotating drive casing with a bit on the bottom of the casing string. A smaller diameter tube or drill pipe is positioned inside the drive casing. The drive casing is advanced by the use of a percussion hammer, thereby causing the bit to cut or break up the sediment or soil at the bottom of the boring. Air is forced down the annular space between the drive casing and inner drill pipe and cuttings are forced upward with the return stream of air within the center of the inner drill pipe.

Filter Pack – Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole wall to increase the effective diameter of the well and to minimize the movement of fine-grained material into the well.

Grout – For the purposes of this SOP, the term "grout" consists of a neat cement grout mixture generally containing five to six gallons of clean water mixed with each 94 pound bag of Portland cement. The grout is emplaced within a borehole as a slurry, and once properly set and cured, is capable of restricting movement of water.

Hollow-Stem Auger Drilling – A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

Monitoring Well – A well that provides for the collection of representative groundwater samples, the detection and collection of representative light and dense non-aqueous phase organic liquids, the measurement of fluid levels, and the assessment of hydrogeologic characteristics of saturated materials in the vicinity of the well.

Mud Rotary Drilling – For the purposes of this monitoring well installation SOP, the term "mud rotary drilling" refers to direct circulation (as opposed to reverse circulation) mud rotary drilling. Mud rotary drilling uses a rotating drill bit which is attached to the lower end of a string of drill pipe. Drilling mud is pumped down through the inside of the drill pipe and out through the bit. The mud then flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension, within the drilling mud, to the surface.

Sonic Drilling – Sonic drilling uses a combination of rotary motion, oscillation/vibration, and hydraulic downward force to advance a drill bit and drive casing. Soil or rock cores are retrieved using a core barrel as the drive casing is advanced.

Tremie – A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space of a borehole.

Well Screen – A commercially available, factory-perforated, wire wound, continuous wrap, or slotted casing segment used in a well to maximize the entry of groundwater from the producing zone and to minimize the entrance of sand.

5.0 PROCEDURES

This section contains both the main project team responsibilities and the procedures for monitoring well installation activities. The procedures described herein are applicable as requirements for monitoring well installations using DPT, hollow-stem auger, mud rotary, air rotary, air rotary casing hammer, sonic, or dual tube percussion drilling techniques. Site-specific factors need to be considered in the selection of well construction and completion materials, specification of well designs, and choosing borehole drilling methods. These factors will be incorporated in project planning activities and the compilation of installation-specific work plans. The work plans will contain the following information related to monitoring well installation:

- Objectives of the monitoring well;
- Specific location of the well to be installed;
- Zone or depth well is to be installed;
- Drilling method(s) to be used;
- Well construction materials to be used;
- Specification of well design(s) including Well Construction Diagrams; and,
- Additional procedures or requirements beyond the scope of this SOP.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that all monitoring well installation activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by quality assurance/quality control (QA/QC) monitoring activities.

Field Lead

The Field Lead is responsible for periodic observation of well installation activities to assure implementation of this SOP. The Field Lead is also responsible for the review and approval of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to monitoring well installation requirements, issuing nonconformances, etc.) identified during the performance of these activities.

Field Personnel

Field personnel assigned to monitoring well installation activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. Field staff are responsible for reporting deviations from the procedures to the Base Lead or the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release areas.

5.2.1 FIELD PREPARATION

Before mobilization of a rig to the well site, ensure that the monitoring well location has been appropriately cleared of all underground utilities, buried objects, and overhead utilities, and that drill permits (e.g., FAA permits) have been issued per the project work plans. Review all forms and diagrams documenting the location of the cleared monitoring well site and the location of any identified underground utility lines, other buried objects, and overheard utilities.

Decontaminate drill rig and drilling equipment, including down-hole equipment and well construction materials, before borehole drilling and monitoring well installation.

Clear the work area of brush and minor obstructions and then mobilize the rig to the planned monitoring well location. The responsible field personnel (e.g., rig geologist or engineer) should then review with the driller the proposed borehole and well design and the details of the monitoring well installation plan, including any potential drilling or completion problems.

Calibrate field equipment according to the instrument manufacturer's specifications. Document the calibration results on the appropriate form(s). Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

Workers will be provided with, and don, the appropriate personal protective equipment as specified by the installation-specific work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves and steel-toed boots.

5.2.2 BOREHOLE DRILLING

Commence drilling and advance the borehole while conducting health and safety air monitoring according to the work plans. Perform air monitoring as often as necessary to ensure the safety of workers. Record all measurements in the field log and/or other appropriate form(s) as specified in the installation-specific work plans. Record other pertinent information (date, investigation area, well or boring number, and location) in the field log and/or on other appropriate form(s) as specified by the work plans. In addition, note and record observed field conditions, any unusual circumstances, and weather conditions.

During drilling, collect representative cutting and/or soil samples as required by the installation-specific work plans. Compile a Boring Log or lithologic log from the cuttings and samples.

At total depth, remove soil cuttings through circulation or by rapidly spinning the augers as applicable, prior to constructing the well. Review logs and notes with the driller for any zones or depths exhibiting drilling problems that may affect the planned well installation. Condition the hole or take other actions mutually agreed upon by the rig geologist (or engineer), lead technical personnel, and the driller to ensure or aid in the well development.

Remove the drill pipe and bit if using sonic or rotary techniques, remove the center bit plug if using the hollow-stem auger technique, or disengage the expendable drive point if using DPT. The well construction materials will then be installed inside the open borehole or through the center of the drive casing or augers.

Measure the total depth of the completed boring using a weighted sounding line. The borehole depth is checked to assure that formation material has not collapsed or heaved to fill the borehole. If heaving has taken place or the borehole has collapsed, options for cleaning, re-drilling, or installation in the open section of the boring should be discussed with lead technical personnel.

In the event that the borehole was over-drilled, bentonite pellets, or bentonite chips (as specified in the installation-specific work plans) may be added to the boring to raise the bottom of the borehole to the desired depth. The bentonite should be installed through a tremie pipe to fill the borehole from the bottom of the boring upward. During installation, the tremie pipe should be submerged below the top of the bentonite column in the borehole to prevent free-fall and bridging. Bentonite should be added gradually to the borehole to prevent bridging. Bentonite addition will stop when its level has reached approximately one foot below the desired base of the well string (i.e., casing, screen, end plug or sump, etc.). The bentonite plug will be hydrated for at least one hour before installation of a well string and filter pack.

5.2.3 WELL INSTALLATION

Calculate volumes of filter pack, bentonite pellets/slurry, and grout required, based on borehole and well casing dimensions. If required by the installation-specific work plans, determine the filter pack and well screen slot size for the monitoring well. For most monitoring well installations, the filter pack and well screen slot size will be determined prior to the start of the installation activities.

Inspect the casing, screen, and any other well construction materials prior to installation to assure that no damage has occurred during shipment and decontamination activities. Measure and record the length of each section of well screen, blank casing, and the end cap in order to determine the actual total length of well string and screen interval, and to calculate desired stickup.

Connect and carefully lower the well string through the open borehole, drive rods or casing, or inside of the augers until the well string is at the desired depth. The well string should be suspended by the installation rig and should not rest on the bottom of the boring. In the event the well string was dropped, lowered abruptly, or for any other reason suspected of being damaged during placement, the string should be removed from the boring and inspected. In certain instances, the well string may rise after being placed in the borehole due to heaving sands. If this occurs, the driller must not place any drilling equipment on the well string (drill pipe, hammers, etc.) to prevent the casing from rising. The amount of rise should be noted by the rig geologist or engineer who should then consult lead technical personnel for an appropriate course of action.

Record, at a minimum, the following information on the appropriate forms per the installation-specific work plans:

- Total length of well string;
- Actual calculated length between top of blank casing and top of screen interval;
- Total measured length of screen interval;
- Total measured length between bottom of screen interval and end cap or sump;
- Total depth of boring;
- Depth from ground surface to top of grout or bentonite backfill in bottom of borehole (if present);

- Installed depth to base of well string (i.e. bottom of end cap or sump); and,
- Installed depth to top and bottom of well screen.

When using the mud rotary drilling technique, tremie the filter pack into the annular space around the screen. Clean, potable water may be used to assist with the filter pack tremie operation. For all other drilling techniques, the filter pack may be allowed to free fall or be tremied per the installation-specific work plans. If using DPT rods, drive casing, or augers, the drive rods, casing, or augers should be pulled slowly during filter pack installation in increments no greater than 5 feet. For DPT-installed wells, a pre-pack filter may be attached to or fitted around the screen and placed concurrently with the well string.

Filter pack settlement should be monitored by initially measuring the sand level before beginning to withdraw the drive casing/augers. In addition, depth soundings using a weighted tape shall be taken repeatedly to continually monitor the level of the sand. The top of the well casing shall also be monitored to detect any movement due to settlement or from drive casing/auger removal. If the top of the well casing moves upwards at any time during the well installation process, the driller should not be allowed to set drilling equipment (e.g., downhole hammers, drill pipe, etc.) on the top of the casing to prevent further movement.

Filter pack should be added until its height is approximately 2 feet above the top of the screen (unless otherwise specified in the installation-specific work plans), and verification of its placement (by sounding) should be conducted. The filter pack should then be gently surged using a surge block or swab in order to settle the pack material and reduce the possibility of bridging. Surging is completed by lowering a surge block or swab into the well casing and alternately lowering and raising it within the saturated portion of the screen.

The height of the filter pack will then be re-sounded and additional filter pack placed as necessary. Once the placement of the filter pack is completed, the depth to the top of the pack is measured and recorded on the appropriate forms per the work plans.

A 3-foot thick (unless otherwise specified in the installation-specific work plans) bentonite seal is then installed on top of the filter pack. If pellets or chips are used, they should be added gradually to avoid bridging. Repeated depth readings will be taken using a weighted tape to ascertain the top of the bentonite seal. Bentonite chips and pellets will not hydrate properly if they are not continually submerged in water and must be allowed to hydrate for a minimum of

12 hours prior to grout installation. Granular bentonite must be used if the seal is to be placed above the water table.

After hydration of the bentonite seal, grout (or cement bentonite grout, as specified in the installation-specific work plans) is then pumped through a side-discharging tremie pipe and filled from the top of the bentonite seal upward. The bottom of the tremie pipe should be maintained below the top of the grout column to prevent free fall and bridging. When using drive casing or hollow-stem auger techniques, the drive casing/augers should be raised in incremental intervals, keeping the bottom of the drive casing/augers below the top of the grout. Grouting will cease when the grout level has risen to within approximately 1 to 2 feet of the ground surface, depending on the surface completion type (flush mount or aboveground). Grout levels should be monitored to assure that grout taken into the formation is replaced by additional grout. If settling of the grout occurs, additional topping off of the grout may be necessary.

Record, at a minimum, the following information on the appropriate forms per the installation-specific work plans:

- Type and total volume of filter pack material installed;
- Total surging time and amount of settlement;
- Final measured depth to top of filter pack;
- Type and total volume of bentonite seal material installed;
- Amount of water added to hydrate bentonite seal;
- Amount of time bentonite seal hydrated;
- Final measured depth to top of bentonite seal;
- Type and mixture of grout material(s) used;
- Total volume of grout installed;
- Total number of lifts used to install grout;
- Final measured depth to top of grout seal;
- Final top of casing measurement after installation completion (feet below ground surface or feet above ground surface); and
- Type of well cap (lockable hinged or expansion plug) used to secure well.

5.2.4 SURFACE COMPLETION

For aboveground completions, the protective steel casing will be centered on the well casing and inserted into the grouted annulus. Prior to installation, a 2-inch deep temporary spacer shall be placed between the PVC well cap and the bottom of the protective casing cover to keep the protective casing from settling onto the well cap. After the protective casing has set, a drainage hole may be drilled into the protective casing if required by the installation-specific work plans. The drainage hole is positioned approximately 2 inches above ground surface. The protective casing will be painted with a rust-preventive colored paint. The well head will be labeled to identify, at a minimum, the well identification, total depth, and date of installation. A minimum of 24 hours after grouting should elapse before installation of the concrete pad and steel guard posts for aboveground completions, or street boxes or vaults for flush mount completions.

For aboveground completions, a concrete pad, a minimum of 2-foot by 2-foot by 4-inch thick, is constructed at ground surface around the protective steel casing. The concrete pad is sloped away from the protective casing to promote surface drainage from the well. If traffic conditions warrant extra protection, three steel bucking posts will be embedded to a depth approximately 2 feet below the top of the concrete pad. The posts will be installed in concrete filled post holes spaced equally around the well at a distance of approximately 2 feet from the protective steel casing. Where removal of bucking posts is required for well access, mounting sleeves should be imbedded into the concrete.

For flush mount (or subgrade) completions, a street box or vault is set and cemented in position. The top of the street box or vault will be raised slightly above grade and the cement sloped to grade to promote surface drainage away from the well.

Record, at a minimum, the following information on the appropriate forms per the installation-specific work plans:

- Type and dimensions of surface completion installed;
- Dimensions of concrete pad installed (for above ground completions);
- Number and position of steel bucking posts (if applicable); and
- Number, type and size of bolts (for flush mount completions).

5.2.5 DEMOBILIZATION

Following well completion and demobilization of the rig, the well site should be cleared of all debris and trash and restored to a neat and clean appearance per the installation-specific work plans. All investigation-derived waste generated at the well site should be appropriately contained and managed per the work plans.

MONITORING WELL DEVELOPMENT
SOP AFW-05 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes general guidelines for developing new groundwater monitoring wells and redeveloping existing monitoring wells. Additional site-specific well development procedures and requirements may be provided in the installation-specific work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform monitoring well development activities during perfluorinated compound (PFC) investigations.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1992, *Monitoring Well Development Guidelines For Superfund Project Managers*, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Ground Water Forum, April.

4.0 DEFINITIONS

Surge Block – A plunger-like tool, consisting of leather or rubber discs sandwiched between steel or wooden disks that may be solid or valved, that is used in well development.

Surging – A well development technique where the surge block is alternately lifted and dropped within the well casing above or adjacent to the screen to create a strong inward and outward movement of water through the well intake.

Well Development – The act of stressing the formation around the well screen so that mobile, artifact particulates are removed from the well, filter pack, and formation in the immediate vicinity of the monitoring well. The purpose of development is to try to ensure proper hydraulic connection between the well and the geologic materials in the vicinity of the well, produce a well capable to yielding groundwater samples of acceptably low turbidity, and to obtain groundwater samples as similar as possible to in situ conditions.

5.0 PROCEDURES

This section contains both the main project team responsibilities and the procedures for monitoring well development activities. The procedures described herein are applicable as requirements for monitoring well development methods including surging and bailing, surging and pumping, or combinations of these processes. Site-specific factors need to be considered in the selection of well development methods. These factors will be incorporated in project planning activities and the compilation of installation-specific work plans. The standard procedure for field personnel to use in assessing and documenting well development is described below and is intended only for development methods listed above.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that monitoring wells are properly developed and that the development process is properly documented. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic inspections and review of field generated documentation associated with well development. If deviations from project requirements occur, the Field Lead is also responsible for issuing nonconformance reports and requests for corrective action.

Field Personnel

Field personnel are responsible for conducting monitoring well development and documentation in accordance with the specifications outlined in this SOP and with the project work plans. All field staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release areas.

5.2.1 FIELD PREPARATION

Decontaminate the rig and development equipment. For a newly installed monitoring well, allow the grout to cure for a minimum of 24 hours prior to development.

Calibrate all field analytical test equipment (e.g., pH, temperature, conductivity, oxidation and reduction potential, and turbidity) according to the instrument manufacturer's specifications and the project-specific work plan or sampling and analysis plan. Specific test equipment to be used should be identified in the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

An exception to the daily calibration requirements will be made in the case of the water level meters. The tape of these instruments will be checked prior to the beginning of the project, and each succeeding six months, using a steel surveyor's tape.

Workers will be provided with, and don, the appropriate personal protective equipment as specified by the installation-specific work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves and steel-toed boots.

5.2.2 WELL DEVELOPMENT/REDEVELOPMENT

Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any observed problems with the well head should be noted in the field log and reported to the Field Manager.

Unlock the well and obtain a depth to water level measurement. Calculate the volume of water in the well (cased well volume) as follows:

$$\pi\left(\frac{d}{2}\right)^2(h_1 - h_2)\times 7.48 = \text{gallons per cased well volume}$$

Where:
d = inside diameter of well casing, ft
h_1 = depth of well from top of casing, ft
h_2 = depth to water from top of casing, ft.

The depth to the bottom of the well should be measured and then compared to the well completion form or diagram for the well. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Report such conditions to the Field Manager and obtain approval to continue or cease well development activities.

Begin development by first gently surging the well with a surge block, followed by bailing or pumping. This is then continued with alternate surging and bailing or pumping. At no time should the surge block be forced down the well if excessive resistance is encountered. During development, the surge block or bailer should not be allowed to free-fall or descend rapidly such that it becomes lodged in the casing or damages the end cap or sediment trap at the bottom of the well.

Use of a surge block may not be required in the development of certain wells, particularly small diameter wells (i.e., 2-inches or less). Equipment typically used to develop small diameter wells (e.g., bladder pumps, electric submersible pumps, bailers, and tubing with check valve, may be raised and lowered in the water column to effectively surge the well during the development process.

While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the well development record. If a well is pumped or bailed to dryness, then development will cease and not resume until the water level in the well recovers to approximately 80 percent of static, pre-development water level conditions.

While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development From.

While developing, water is also periodically collected and readings taken of the indicator parameters: pH, specific conductance, oxidation/reduction potential, dissolved oxygen, turbidity, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans or within 10% if not otherwise specified) and the maximum turbidity is 50 NTUs or less, or the well develops dry. Additionally, three times the amount of water used during drilling and well installation activities will be removed during development of newly installed wells. In certain instances, for slow recharging wells or small-diameter wells, the parameters may not stabilize. In this case, well development is considered complete upon the removal of three times the amount of water used during drilling and well installation activities (if used) or when the best achievable water quality has been attained (i.e. no further improvement observed) using a combination of surging and pumping as described above.

Obtain a water level and turbidity measurement at the completion of development.

Complete documentation of the well development event on the Well Development Form. At a minimum this record must contain:

- Project name and number;
- Well identification number;
- Well depth, casing size, and completion date;
- Method of development;
- Volume of water removed;
- Water levels (including the time of measurement);
- Physical description of the water (e.g., discoloration, turbidity, odor, etc.) and solids removed from the well;
- Test equipment readings for pH, conductivity, temperature and turbidity (including the time of collection); and,
- Signature of the well development observer.

Collect and appropriately dispose of water removed from the well in accordance with criteria listed in the project-specific work plans and regulatory requirements.

Allow the well to recover for at least 24 hours prior to sampling.

BOREHOLE ABANDONMENT
SOP AFW-06 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use in the supervision of borehole or soil boring abandonment and groundwater monitoring well abandonment activities. Additional specific borehole and well abandonment procedures and requirements will be provided in the project work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform soil boring or monitoring well abandonment activities during perfluorinated compound (PFC) investigations.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1991, *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells,* EPA/600/4-89/034, U.S. Environmental Protection Agency, Office of Research and Development, March.

4.0 DEFINITIONS

Borehole Abandonment – The process whereby boreholes or soil borings are grouted or sealed following completion of drilling, sampling and/or logging.

5.0 PROCEDURES

This section contains responsibilities, procedures and requirements for borehole abandonment. Abandonment procedures to be used at a particular investigation area must incorporate project-specific regulatory requirements. Consequently, the installation-specific work plans will identify the following:

- Abandonment objectives,
- Boreholes to be abandoned,

- Specific procedures for borehole abandonment beyond those covered in this SOP (e.g., state-specific procedures); and,
- Applicable site-specific regulatory requirements for borehole abandonment.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodically observing field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to the abandonment requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to borehole and well abandonment activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the Base Lead or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

After drilling, logging and/or sampling, boreholes should be backfilled by the method required by the applicable regulatory agency and described in the installation-specific work plans. This typically consists of backfilling to the surface with bentonite chips, pellets or bentonite-cement grout. If bentonite chips or pellets are used, they should be added to the borehole in 2-foot lifts and hydrated with water from a potable water supply. This process should be repeated until the entire borehole is plugged using no less than 5 gallons water per ten feet of borehole. If bentonite grout is used the following guidelines should be followed:

- Bentonite should be thoroughly mixed into the grout and within the percentage range specified in the work plans. If not otherwise specified in the work plans, the cement-bentonite grout mixture should be of the following proportions: 94 pounds of Portland cement, 5 pounds of powdered bentonite and a maximum of 8 gallons of water. The grout is usually tremied into the hole; however, for selected boreholes (e.g., shallow borings well above the water table) at certain sites, the grout may be allowed to free fall. In either case, care must be taken to ensure the grout does not bridge, forming gaps or voids in the grout column.
- The volume of the borehole prior to sealing should be calculated and compared to the grout volume used during abandonment to aid in verifying that bridging did not occur.
- When using a tremie pipe to place grout in the borehole, the bottom of the tremie should be submerged into the grout column and withdrawn slowly as the hole fills with grout. If allowing the grout to free fall (and not using a tremie), the grout should be poured slowly into the boring. The rise of the grout column should also be visually monitored or sounded with a weighted tape.
- If the method used to drill the boring utilized a drive casing, the casing should be slowly extracted during grouting such that the bottom of the casing does not come above the top of the grout column.
- During the grouting process, the drilling hands performing the task should be supervised to assure that potentially contaminating material (oil, grease, or fuels from gloves, pumps, hoses, et. al) does not enter the grout mix and that personnel are properly wearing personal protective equipment as specified in the project Health and Safety Plan.
- Following grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole.
- The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the installation-specific work plans.

SEDIMENT SAMPLING
SOP AFW-07 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of sediment samples for chemical and physical analysis. This SOP does not include the procedures and equipment selection for sediment sampling to support biological analysis, which is very specific to the aquatic environment and type of analysis (e.g., toxicological and bioaccumulation tests, benthic community analysis, etc.), and would be covered in the project work plan. This SOP is only applicable to bedload sediment sampling, and does not include suspended load sampling.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who perform sediment sampling activities during perfluorinated compound (PFC) investigations.

3.0 REFERENCES

American Society for Testing and Materials (ASTM), 1995, *Standard Guide for Core Sampling Submerged, Unconsolidated Sediments*, ASTM D 4823-95, reapproved October 1, 2008.

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

EPA, 2001, *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual,* Office of Water, EPA 823-B-01-002.

EPA, 2007, *Sediment Sampling,* Region 4 Science and Ecosystem Support Division (SESD), Operating Procedure, Number SESDPROC-200-R1, November.

4.0 DEFINITIONS

Composite Samples – Composite samples are comprised from at least two grab samples that are thoroughly mixed in a decontaminated bowl to be representative of an area, transect, or vertical section. The resulting data typically is considered an average concentration of the area or column of sediment sampled. Composited samples are NOT acceptable for VOC analysis.

There are two types of composite samples: horizontal and vertical. Horizontal composites are obtained by collecting multiple grab samples over an area (such as over the surface of a point bar) or across the channel or basin as a transect. Vertical composites are obtained by collecting multiple short (1-foot) core samples at different depths or one long core at the same location, and are collected when the sediment deposit is deep and a surficial sample would not represent historical conditions.

Disturbed Sediment Sample – A sediment sample whose in situ physical structure and fabric has been disturbed as the direct result of the sample collection procedure. Disturbed sediment samples can be collected using hand augers, spoons, or scoops as described in Section 4.2.

Grab Samples – A disturbed sediment sample that is collected by using such devices as the sample container (e.g., wide-mouth jar), or a stainless steel spoon, scoop, or hand auger, and is representative of the current conditions at the location sampled.

Sediment – Sediment is generally considered as those unconsolidated mineral and organic deposits found underwater, such as on the bottom of rivers, streams, creeks, ponds, lakes, lagoons, and estuaries; however, with constant changes in stream channel morphology, fluvial sediment deposits often emerge above base flow level and are sometimes abandoned as the flow channel migrates, leaving dry to saturated point bars and islands. Broadly speaking, sediment is "eroded material which lies below surface water the majority of the time where the surface water is capable of providing for an aquatic biota habitat." Bedload sediment lies on top of, and is transported along, the surface of the channel or basin floor, that can be comprised of soil or bedrock. The inorganic particles of sediment range from clay to gravel size. Many contaminants in sediment are trapped in the interstitial water, while other contaminants are adsorbed onto the organic matter. Therefore, coarse sand- to gravel-size sediment is usually not a good candidate sample for chemical analysis, as the water and organic content is usually low.

Sediment Sample – Environmental samples of sediment can be collected as a single grab sample or as a composite sample, and as a surficial sample (top 6 inches of bedload sediment) or along a vertical profile. Surficial grab samples of bedload sediment (single or composited) are preferred when: the source of contamination is recent; the sedimentation rate is low; the surface water is known to have been a contaminant migration pathway; and the horizontal distribution of the contamination is being assessed. Vertical profile samples of bedload sediment (discrete depths or composited) are preferred when the source of contamination is historical and it is not known whether the surface water was a contaminant migration pathway, and therefore any contamination present in the sediment may be buried by recent sedimentation and is most likely stratified within the deposit. The method and type of sampling conducted will depend on the project and data quality objectives as defined in the installation-specific work plans.

Undisturbed Sediment Sample – A sediment sample whose in situ physical structure and fabric has not been disturbed as the result of sample collection. Undisturbed sediment samples can be collected using the core samplers described in Section 4.2.

5.0 PROCEDURES

This section contains both the team member responsibilities and procedures involved with sediment sampling. Proper sediment sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information:

- Sample collection objectives;
- Approximate locations and depths of sediment samples to be collected;
- Numbers and volumes of sediment samples to be collected;
- Types of analyses to be conducted for the samples;
- Specific quality control procedures required; and,
- Any additional sediment sampling requirements or procedures beyond those covered in this SOP, as necessary.

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5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for observing sampling activities and periodic review of field generated documentation. The Field Lead is responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to quality control sampling requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to sediment sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release areas.

5.2.1 SEDIMENT SAMPLING EQUIPMENT

A number of devices are available for the collection of sediment samples, the proper selection of which is dependent on the sampling objectives, whether the sediment is above or below water, the sediment thickness, the depth of water above the sediment, the accessibility and conditions of the sampling locations, and the analytical requirements. Therefore, it is prudent to conduct a site visit of the sampling locations before the development of the work plan. Two types of sediment sampling devices will typically be used: core samplers and grab samplers.

Most of these devices are constructed of stainless steel, and some core samplers allow a sleeve (should be made of HDPE) to be inserted into the core barrel to retain the sample.

Core Samplers

The collection of submerged sediment samples, and most sediment deposits above water, may be conducted with a core sampler (i.e., both grab and composite samples). The advantage of a core sampler over a grab sampler is that discrete and less disturbed samples can be collected if needed, a complete vertical profile may be collected for deposits up to several feet thick, and when sampling submerged sediment, there is no loss of fines as the sample is raised to the surface (ASTM, 2008). The simplest core sampler is a hand-driven, hollow, stainless steel or polycarbonate core barrel, with a beveled edge on the head assembly at the leading end and a check valve or flapper valve at the opposite end to keep the sample in the barrel by partial vacuum (end-filling type). The trailing end has a T-handle to push and/or twist the core barrel into the soft sediment. Core barrels are typically 1- to 2-inches in diameter and are available in 2- and 4-foot lengths; however, core barrels are available in lengths up to 8 feet (for deeply submerged sediment sampling). For deeper submerged sediments (> 2 feet below the water surface), usually collected from a boat, handle extensions can be added to the top of the hand core sampler.

A sample sleeve, or core liner can be inserted into some core samplers to obtain discrete samples that are handled and shipped in the sleeve. Upon extrusion from the core barrel, cores can be subsampled or homogenized. One disadvantage to core samplers is that the volume of sediment retrieved in one core barrel may be insufficient if full suites of analyses are needed, thus requiring multiple cores to be collected at each location.

Grab Samplers

Grab samplers will disturb the sediment during collection, which may be a limiting factor for some sampling parameters and objectives. If sampling dry to moist surficial sediments is the sampling objective, then a sample can be collected by using grab samplers such as stainless steel hand augers, spoons, scoops, or the sample containers themselves (wide-mouth jar). If sampling shallow submerged sediment (< 6 inches below the water surfcae), then the sample container may be used as the preferred collection device to minimize loss of fines upon raising the sample to the surface. The lid of the sample container may be used to cover the mouth of the sample container before raising it to the surface.

For deeper submerged sediments (>2 feet below the water surface), usually collected from a boat, a Ponar grab sampler is an option for surficial deposits. This type of sampler has a jaw-type mechanism that is tripped from above in order to close the jaws and collect the sample. The dredge is lowered slowly through the water to the sediment with the jaws in the open position. As the dredge is retrieved, the jaws close and the isolated sediment is brought to the surface. The disadvantage to using these types of grab samplers is that a pebble or stick can often prevent the jaws from shutting completely, and the sample will be washed or lost upon raising the sampler to the surface. If sample collection at depth is not successful using a grab sampler, then use of a core sampler may be required.

5.2.2 FIELD PREPARATION

Pre-Sample Planning

- Review carefully the Health and Safety Plan and/or the Hazard Assessment.
- If current information is not available, conduct a reconnaissance of all sediment sampling locations to determine accessibility to the water body, depth of water, dangerous conditions (e.g., strong currents, boggy bottoms, log jams or beaver dams, waterfalls, steep banks, thick vegetation, etc.), sediment accumulation points to flag for sampling (e.g., pools, convex side of meanders, mid-channel islands, downstream side of boulders, deltas, etc.), and sampling and personal protection equipment selection criteria. Access to water bodies such as streams may be hampered by thick vegetation, and lakes and ponds that will require the use of a boat may not be accessible by road. Therefore, the logistics of getting the sampling equipment and containers to and from the sampling sites must be considered before attempting to sample.
- The total depth of the sediment column should be determined prior to sampling when conducting vertical profile sampling to ensure that the proposed sampling location is an accumulation point, and to determine the total depth in which samples will be collected. This may be done using one of several methods, which may include: 1) shovel 2) post-hole digger 3) push probe or 4) core sampler. A field geologist or environmental scientist will be on-site to determine the preferred depth for biased samples, if needed. Depth measurements will be recorded in the field log.
- The timing of sediment sampling relative to stream flow is critical, even when fluctuation in stream flow is not a variable of concern in the project objectives. Avoid sampling during high water or flood conditions, not only for safety reasons, but also

because most sediment deposits will be submerged under deeper water, will be eroding due to turbulent flow, and will be migrating and/or in suspension. If the same locations are being sampled on a periodic basis (e.g., quarterly, semi-annually, yearly), it is critical to sample under the same flow conditions (e.g., base flow) during each periodic event.

- Plan to collect sediment (and co-located surface water) samples along a water body in the upstream direction, starting from the most downstream sampling location. This procedure will insure that any mobilized contaminants or fine particles resulting from sampling activities, which will migrate downstream, do not affect the representativeness of the subsequent samples. This procedure must be followed even in lakes or ponds that are stream fed.
- Select biased locations where sediment occurs. Transects may have to be diagonal to stream flow instead of perpendicular to include point bars on opposite sides. For establishing a grid or transects in a lake, placing buoys at the nodes/sampling locations works well. At small ponds, transects can be marked by stretching a cord or cable between stakes on opposing shores, using turn-buckles to provide tauntness and flagging tape to mark sampling locations.
- If accessing and reaching the sampling locations is difficult, taking a portable global positioning system (GPS) instrument to obtain X-Y coordinates during sampling is recommended, to avoid repeating trips. Such difficult locations will be costly to land survey. If a GPS is ineffective due to the terrain or tree canopy, marking the locations on a topographic map or aerial photograph at the time of sampling is the next best alternative.
- When surface water samples are collected at sediment sampling locations, collect the surface water sample prior to the sediment sample (i.e., sediment sampling will suspend the fines), no more than 1 foot above the top of the sediment, unless samples are to be collected in a stratified water column as specified in the facility-specific work plans.
- When selecting a boat to access sampling locations on lakes, ponds, or rivers, make sure the hull design will not disturb the bottom and is stable enough to haul loaded samplers to the surface (flat vs V-shaped). Jon boats or small pontoons work well in most situations. Care must be given to avoid disturbing the bottom near the sampling locations with oars,a motor’s propeller, or boat anchors. If necessary, use two anchors to anchor both ends of the boat to prevent rotation during sampling.
- Prior to sampling, decontaminate nondisposable sample equipment according to SOP AFW-10 and procedures outlined in the installation-specific work plan.

5.2.3 GENERAL SAMPLING PROCEDURES

- Review carefully the Health and Safety Plan and/or the Hazard Assessment.
- Don appropriate personal protection equipment, such as tall rubber boots or waders and personal floatation devices, as specified in the installation-specific work plan, prior to entering the water. Rubber boots or waders also serve as good protection (against snake bites and abrasion) when traversing through woods, marsh, or thick vegetation to access the sampling locations. Hats, with or without mosquito netting, may also be needed to protect against exposure to prolonged sunlight and to insects. A walking stick or trekking pole is often needed when wading in unclear water, to probe the bottom for sure footing and depth of water.
- Due to uneven terrain, water hazards (e.g., currents, holes, ice, drowning, etc.), hazardous biota (e.g., snakes, spiders, stinging nettles, etc.), remoteness, and the hauling of equipment, gear, and sample containers, always sample sediments as a team of at least two personnel, with one team member as a site health and safety officer.
- Approach submerged sampling locations from downstream and collect the sample facing upstream. Wading disturbs the sediment bottom and the suspended fines migrate downstream.
- Never wade in water deeper than 2 feet, and generally no deeper than the top of the knee. Instability increases in deeper water, especially in a current, and it becomes more hazardous, and difficult, to sample. If the water is not clear (unable to see the bottom), proceed with extreme caution, probing the bottom ahead with a walking stick for depth and unevenness. One of the team members should stay on or close to shore to hand equipment and supplies back and forth. If deemed necessary, the sampler may need to don a seat harness and be on a safety rope that is controlled by the other team member.
- When using a hand coring device, slowly push the corer into the sediment until there is a noticeable resistance (usually indicating the channel or basin floor), or until the trailing end of the core barrel is at the sediment surface.
- For sediment sampling using a boat, gently lower all grab and core samplers to the bottom so as not to create a bow wave and disturb the fine sediment on the surface. After the sample is collected at a given location, measure the depth of water with a weighted fiberglass tape and record this information on the sample collection log. These data are useful for profiling the lake or pond bottom.

- Retrieve the sampling device slowly through the water to avoid washout by creating turbulent flow. Immediately extrude (for core samplers) or directly transfer (for grab samplers) the sample to a stainless steel bowl (depending on the analytical parameters), and check to see that sediment recovery is acceptable (no visible signs of sediment loss or washing). If sediment recovery is unacceptable or the volume is insufficient, collect another sample close to, but upstream of, the previous attempt.
- When using a core sampler and collecting discrete samples for a vertical profile, extrude individual segments of sediment into separate labeled bowls for homogenizing.
- Thoroughly homogenize the collected sediment sample in a mixing bowl (due to the stratified nature of sediment deposits), whether from a grab or core sampler, after removing excess water (being careful not to lose the fines in the process), rocks, sticks, leaves, and other organic debris. Then transfer the sediment into the sample containers using a stainless steel spoon or spatula. Fill the sample container such that little to no headspace exists.
- If using core sleeves to transport the samples directly to the lab, place tape over each end of the sleeve and seal each end with plastic end caps. With a pen, write a “T” for top on the trailing end and a “B” for bottom on the leading end of the sleeve.
- Collect X-Y coordinates of the sample location using a portable GPS instrument. If a GPS is ineffective due to the terrain or tree canopy, mark the location in the field with a stake or flag.
- Appropriately label and number the sample containers. The label will be filled out with a pen and will contain, at a minimum, the following information:
  - Project number
  - Sample number
  - Sample location
  - Sample depth
  - Sample type
  - Date and time of collection
  - Parameters for analysis
  - Sampler’s initials
- Document the sampling event on a Sediment Sample Collection Log or an equivalent form as specified in the installation-specific work plan. Note any pertinent field observations, conditions, or problems on the Sediment Sample Collection Log. Any

encountered problems (i.e., access issues, flooding by beaver dams, etc.) or unusual conditions should also be immediately brought to the attention of the Field Manager.

- Appropriately preserve, handle, package, and ship the samples per SOP AFW-11, or the installation-specific work plan.

SURFACE WATER SAMPLING

SOP AFW-08 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface water samples for laboratory analyses and water quality measurements. Proper collection procedures are necessary to assure the quality and integrity of all surface water samples. Additional specific procedures and requirements will be provided in the installation-specific work plan, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors with the responsibility for determining water quality in the field and for the collection, preparation, preservation, and submittal of surface water samples for laboratory analyses.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

De Vera, E.R., B.P. Simians, R.D. Stephens, and D.L. Storm. 1990. *Samplers and Sampling Procedures for Hazardous Waste Streams*. EPA-600/2-80-018.

Korte, N. and P. Kearl. 1984. *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells*. U.S. Department of Energy, Grand Junction, Colorado.

4.0 DEFINITIONS

Surface water – Includes all water on the surface of the ground directly exposed to the atmosphere, including, but not limited to, lakes, ponds, reservoirs, artificial impoundments, streams, rivers, springs, seeps, and wetlands.

Vernal pool – Temporary small, shallow bodies of freshwater that support communities of amphibians and invertebrates.

5.0 PROCEDURES

This section contains both the team member responsibilities and procedures involved with surface water sampling. Proper surface water sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information:

- Sample collection objectives;
- Approximate locations and depths of surface water samples to be collected;
- Numbers and volumes of surface water samples to be collected;
- Types of analyses to be conducted for the samples;
- Specific quality control procedures required; and,
- Any additional surface water sampling requirements or procedures beyond those covered in this SOP, as necessary.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to surface water sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or the Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release areas.

5.2.1 EQUIPMENT SELECTION

For most investigation areas, a decontaminated bottle sampler attached to a pole (e.g., PVC pipe) can be used as the sampling device, or the sample container itself can serve as the sampling device.

There are several more sophisticated sampling devices that can be used to collect water at discrete depths in deep bodies of water (e.g., Van Dorn and Kemmerer samplers). However, for most routine area investigations of shallow lakes, ponds, and streams, this equipment is not necessary.

The following equipment will typically be used during surface water sampling events:

- Water Quality Meter;
- Laboratory-provided sample containers;
- Self-adhesive sample bottle labels;
- High-density polyethylene (HDPE), stainless-steel, or glass beakers, dippers, bailers or other sampling device;
- Appropriate health and safety equipment specified in the Health and Safety Plan;
- Field notes and data sheets (e.g., sample collection form and Chain of Custody);
- Pen;
- Plastic bags;
- Cooler with ice; and,
- GPS receiver.

Laboratory-provided sample containers will be used to directly collect water samples if sample containers do not contain preservatives. Where required by site conditions, remote sampling into sample containers will be allowed by clamping the container onto the end of a clean extension rod. The extension rod must be made of material that does not include contaminants of interest.

Beakers or dippers (i.e., transfer containers), which may be attached to extension rods, may be used if sample containers have preservatives or remote sampling site conditions prevent sampling by direct sample container immersion. The beakers or dippers will be obtained from a scientific instrument supplier so that the material composition of such a sampling container may be documented. The selected type of transfer device, the composition of this device, and the volume of the device will be recorded on the sample log. Bailers may be used if direct access to the sampling point can be reached. Sample transfer containers must be disposable or decontaminated prior to each use. Discrete depth sampling devices may be used when the installation-specific work plan directs that specific depth intervals be sampled.

5.2.2 FIELD PREPARATION

Pre-Sample Planning

In general, surface water sample locations may include shallow or deep lakes, ponds and other types of impoundments, creeks and streams, ditches, low-lying areas, and intermittently wet drainage areas. These bodies of water may receive contaminant input from surface runoff; groundwater; or from direct discharge through a sluice, ditch, or pipe.

If up-to-date information is not available, conduct a reconnaissance of all planned surface water sample locations to determine accessibility to the water body, depth of water, dangerous conditions (e.g., strong currents, boggy bottoms, log jams or beaver dams, waterfalls, steep banks, thick vegetation, etc.), and sampling and personal protection equipment selection criteria. Access to water bodies such as streams may be hampered by thick vegetation, and lakes and ponds that will require the use of a boat may not be accessible by road. Therefore, the logistics of getting sampling equipment and containers to and from the investigation areas must be considered before attempting to sample.

As a general rule, samples should not be collected after heavy rains or during storm events because they will not be representative samples reflecting normal (i.e., baseline) conditions.

When surface water samples are collected at sediment sample locations, the surface water sample should be collected prior to the sediment sample (i.e., the sediment sample will suspend the fines), and the surface water sample should be collected no more than 1 foot above the sediment, unless samples are to be collected in a stratified water column. If samples are to be collected in a stratified water column, the sample depths will be specified in the installation-specific work plans.

The number of sample points, and the specific analytes to be measured, are provided in the installation-specific work plans. Sample locations and the number of samples collected will vary with the size of the water body and the nature of the source input.

Streams, Tributaries, and Creeks

In moving water bodies such as streams, tributaries, and creeks, sample points should be located where the water is homogeneous both horizontally and vertically. Samples should be taken far enough downstream from the source input for the discharge to be completely mixed. Locations immediately below riffle areas will be vertically mixed and narrow channel areas promote horizontal or cross-channel mixing. Sampling should take place downstream of riffle areas and narrow channel areas where low flow and minimal turbulence conditions are present. The selection of strategically located sample sites may depend on several factors, such as homogeneity, accessibility, intake points for water supplies, stream velocity, and geomorphology.

In general, a single grab sample collected at mid-depth in the center of the channel is adequate to represent the entire mixed cross-section of small streams less than 20 feet wide. The installation-specific work plan will designate whether a single mid-point sample, vertical profile samples, or discrete depth samples are required. If vertical profile samples are specified in the installation-specific work plan for larger and deeper streams or creeks, these samples should be taken from mid-stream just below the surface, at mid-depth, and just above the bottom and composited. If discrete depth samples are specified by the installation-specific work plan, these samples should be taken at the desired depths, if possible. The pH, temperature, specific conductivity, and dissolved oxygen should be measured for each sample point when vertical composite samples are collected. The number of vertical composites and the depths sampled are determined in the installation-specific work plan. Water depth can either be measured with a graduated staff (e.g., yardstick) at shallow depths or with one of various manual or electronic devices available for deeper depths.

Stagnated areas or pools in a stream or creek could contain different contaminant concentrations than those from the flowing areas, depending on the physical and chemical properties of the contaminant and the proximity of these areas to the source. A sample may be taken at mid-depth to determine if these areas represent contaminant sinks.

Lakes, Lagoons, Ponds, and Impoundments

The selection of representative sample points in standing bodies of water depends on the size, shape, and depth of the basin, and will be specified in the installation-specific work plan. Samples can be collected along a vertical transect and/or horizontal grid. The installation-specific work plan will designate whether a single mid-point sample, vertical profile samples, or discrete depth samples are required. In larger basins, stratification may inhibit uniform vertical mixing. In these instances, discrete depth samples may be collected at each stratification layer. In smaller basins, such as ponds, lagoons, and impoundments, the entire water column is generally uniformly mixed and one sample at the deepest point may be adequate. The deepest point is usually in the center of small ponds and other containment catch basins. For impoundments with a dam, the deepest point is generally near the base of the dam. Water depth can either be measured with a graduated staff (e.g., yardstick) at shallow depths or with one of various manual or electronic devices for deeper depths.

Wading into the water body to collect samples is not recommended in shallow lakes and ponds. Wading will disturb bottom sediments, which may contaminate the water column resulting in a false positive parameter result. Therefore, a boat is typically used to collect representative water samples in lakes, lagoons, ponds, and impoundments.

Equipment Decontamination

Before sampling begins, sampling devices (e.g., bailers, beakers, dippers, etc.) shall be decontaminated. Mobile decontamination supplies may be utilized so that equipment can be decontaminated on-site. Each piece of sampling equipment shall be decontaminated before sampling operations and between sampling locations. Decontamination of field equipment will be performed in accordance with SOP AFW-10.

5.2.3 GENERAL SAMPLING PROCEDURES

- Samples will be collected first from areas that are suspected of being the least contaminated to minimize the risk of sample cross-contamination. In flowing water bodies, sampling shall progress from downstream to upstream to avoid sediment disturbance affecting subsequent samples.
- Prior to sampling, the water body characteristics (e.g., size and depth) should be observed and described in the field logbook.
- Collect X-Y coordinates of the sample location using a portable GPS instrument. If a GPS is ineffective due to the terrain or tree canopy, mark the location in the field with a stake or flag after sampling is complete.
- Don a clean pair of nitrile gloves.
- Surface debris (i.e., sticks, leaves, vegetation) will be cleared from the sample location prior to sample collection, taking care not to disturb bottom or attached sediments.
- Measure water quality parameters (pH, dissolved oxygen, specific conductivity, and temperature) at each sample location prior to collecting a water sample. Samples for water quality parameters will be collected in a separate container at a like location and depth as the samples for laboratory analysis.
- Collect the sample in accordance with the appropriate method-specific procedures in Section 5.2.4.
- Document the sampling event on the sample collection form.As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziploc®). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.
- Handle and ship the sample according to the procedures outlined in SOP AFW-11, following appropriate chain of custody procedures. Samples stored temporarily on-site will be maintained per SOP AFW-10.

Note: Collection of surface water samples in deep-water areas may require the use of a boat. The Base Lead and Health and Safety Manager shall be consulted for additional health and safety requirements.

5.2.4 METHOD SPECIFIC SAMPLE COLLECTION PROCEDURES

Samples Collected by Container Immersion

Surface water sample collection by container immersion will be done in accordance with the following procedures:

- The outside of all capped sample containers shall be triple rinsed with the surface water being sampled before filling the containers with the sample to be analyzed.
- Submerge the sample container or transfer container below the water surface with minimal surface disturbance and with the open end pointed upstream.
- If possible, the sample container or transfer container will be lowered no closer than 3 to 6 inches above the bottom sediments.

Samples Collected by Bailer

Surface water sample collection with a bailer will be done in accordance with the following procedures:

- A disposable HDPE bailer or equivalent will be used;
- Depth of water at each sampling site will be measured and the bailer will be lowered to the appropriate sampling location in accordance with the sampling plan;
- If possible, the bailer will be lowered no closer than 3 to 6 inches above the bottom sediments;
- The bailer will be inserted facing downstream and withdrawn very slowly and carefully to avoid agitation of the bottom sediments; and,
- Transfer the sample from the bailer directly into the sample container. Minimize aeration of the sample as much as possible.

Samples Collected by Discrete Depth Sampling Devices

Surface water sample collection with a discrete depth sampling device will be done in accordance with the following procedure:

- A Van Dorn sampler, Kemmerer sampler, or equivalent will be used.
- Depth of water at each sampling site will be measured and the sampling device will be lowered to the appropriate sampling depth in accordance with the installation-specific work plan.
- If possible, the sampling device will be lowered no closer than 3 to 6 inches above the bottom sediments.

- The sampling device will be lowered facing upstream and opened once at the desired sampling depth. The device will be withdrawn very slowly and carefully to avoid agitation of the bottom sediments.
- Transfer the sample from the device directly into the sample container. Minimize aeration of the sample as much as possible.

6.0 RECORDS

Field notes shall be recorded on the Daily Field Record and Surface Water Sampling Form. The following information is required according to the sampling method performed:

- GPS coordinates, or distance to two fixed objects, or distance and compass bearing from at least one fixed object;
- Distance of sample collection point from right or left edge of water;
- Water depth;
- Estimate of surface area of water body;
- Sample depth interval;
- Sample collection method (grab, discrete);
- Surface water and investigation area conditions (e.g., floating oil or debris, gassing, etc.);
- Location of any discharge pipes, sewers, or tributaries;
- Instrument calibration;
- Required investigation area maps (If a staff gauge is measured and not co-located with surface water location it must be included in the investigation area map).; and,
- Weather observations (e.g., wind speed, is it sunny or cloudy, and approximate wave height).

GROUNDWATER TREATMENT SYSTEM INFLUENT AND EFFLUENT SAMPLING
SOP AFW-09 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of the collection of, influent and effluent samples from groundwater treatment systems for perfluorinated compound (PFC) chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all samples. Additional investigation area specific information or procedures and applicable area and system specific requirements will be provided in the installation-specific work plans, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel involved in the sampling of groundwater treatment systems. Construction and operation of systems will vary; therefore, this SOP may not be applicable to all situations.

This procedure has been developed to serve as management-approved professional guidance for the Amec Foster Wheeler Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviation from this procedure in planning or in the execution of planned activities must be approved by the Base Lead.

3.0 REFERENCES

Barcelona et al, 1985, *Practical Guide for Groundwater Sampling, Illinois State Water Survey, Champaign, Illinois, ISWS Contract Report 374*, November.

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations, Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01*, August.

EPA, 1992, *EPA RCRA Groundwater Monitoring: Draft Technical Guidance*, November.

4.0 DEFINITIONS

Effluent – Treated groundwater exiting a groundwater treatment system.

Influent - Un-treated groundwater entering into a groundwater treatment system.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with groundwater treatment system sampling. Proper groundwater treatment system sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation specific work plan addendums. The installation specific work plan addendums will generally provide the following information:

- Sample collection objectives;
- Locations of groundwater treatment system samples to be collected;
- Numbers and volumes of samples to be collected;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control (QC) procedures and sampling required;
- Any additional groundwater treatment system sampling requirements or procedures beyond those covered in this SOP, as necessary; and,
- At a minimum, the procedures outlined in this SOP for groundwater treatment system sampling will be followed.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e. retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to groundwater sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 METHOD SUMMARY

The basic procedures for sampling groundwater treatment systems are similar to those for sampling of groundwater monitoring wells, as specified in Groundwater Sampling SOP AFW-03 (PFCs), and sampling of private and public supply wells, as specified in Private And Public Water Supply Well Sampling SOP AFW-13 (PFCs). The procedure can be summarized as follows.

- Decontaminate any equipment that will come into contact with water inside the well and/or sampled water as specified in SOP AFW-10 (PFCs);
- Purge water until specific parameters have stabilized, toward ensuring formation water (as opposed to stagnant well water) will be sampled;
- Collect samples in laboratory-supplied containers; and
- Follow standard sample handling and custody procedures to contain and transport samples to the off-site laboratory.

5.3 FIELD PROCEDURES

Field procedures will incorporate other applicable project-specific SOPs, particularly SOP AFW-01 (PFCs), *Field Sampling Protocols to Avoid Cross-Contamination at Perfluorinated Compounds (PFCs) Sites*.

Treatment Plant Access

Contact treatment plant personnel prior to sampling to procure access and to confirm applicable site specific and system specific health and safety requirements.

Influent and Effluent Sampling Considerations

Upon arriving at treatment plant, the treatment plant operator will inform the sampler if the treatment system is operating or if it is off. The operator will also show the sampler the location of the sampling ports. A design drawing of the treatment system should be obtained to identify the source of wastewater from sampling ports and determine the appropriate sampling location. If the treatment system is off, the sampler will wait until the operator starts the system. Once the system is operating, sampling will be performed as described below. If the treatment plant is operating upon arrival, perform the minimum one minute purge and sample as described below.

- Inspect the laboratory provided sampling bottles prior to sampling to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the installation specific work plan addendums.
- Open the sampling port.
- Purge for a minimum of 1 minute, a high flow volume into a bucket to flush the sampling port tube.
    - During the purge, collect one set of physical parameters (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature).

Table 4-1

Parameter	Units
pH	Standard Units
Specific Conductivity	Micromhos/centimeter (umho/cm, or µS/cm)
Temperature	Degrees Celcius (˚C)
Oxidation-Reduction Potential (ORP)	Millivolts (mV)
Dissolved Oxygen	Milligrams/liter (mg/L)
Turbidity	Nephelometric Turbidity Units (NTUs)

- Upon completion of the one minute purge, adjust the flow rate downward prior to filling the laboratory supplied sample bottles.

- Collect the sample directly into the provided sample bottle(s) (containers), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle where applicable; however, samples collected for metals and general water chemistry analyses should be filled only to the base of the bottleneck.
- The samples should be collected in the order of volatility, collecting the most volatile samples first, followed by the least volatile samples.
- Document the sampling event on the Groundwater Sample Collection Form.
- Appropriately seal, store, handle, and ship the samples per SOP AFW-11.
- Sample both the effluent and influent ports following the same procedures.
- Upon completion of sampling, empty the purge water from the bucket into a location determined by the treatment plant operator.

As the sample is collected directly into the laboratory provided container and directly from the system itself, there is no decontamination required, though fresh gloves should be donned prior to each sampling event at each port.

EQUIPMENT DECONTAMINATION
SOP AFW-10 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for use by field personnel in the decontamination of drilling, sampling, development, and heavy equipment. The details within this SOP are applicable as general requirements for drilling and heavy equipment decontamination, and should also be used in conjunction with installation-specific work plans.

2.0 SCOPE

These procedures apply to all Amec Foster Wheeler personnel and subcontractors who prepare equipment for use during investigation at potential perfluorinated compound (PFC) release areas. This SOP should be reviewed by all on-site personnel prior to implementation of field activities.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

EPA, 1991, *Management of Investigation Derived Wastes During Site Inspections*, EPA 540/G-191/009, May.

4.0 DEFINITIONS

Heavy Equipment – Drill rigs, excavators, dozers, back-hoes, trucks, or other similar type machinery used to drill soil borings, break concrete, excavate soil or other similar type activity.

Laboratory Grade Detergent – A standard brand of laboratory-grade detergent, such as "Alconox" or "Liquinox."

Potable Water – Water dispensed from a municipal water system or a water supply well used and approved for drinking.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with equipment decontamination. Proper decontamination procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The work plans will generally provide the following information:

- Sample collection objectives;
- Specific quality control (QC) procedures and sampling required; and
- Management procedures for investigation derived waste (IDW).

At a minimum, the procedures outlined in this SOP for equipment decontamination will be followed.

5.1 RESPONSIBILITIES

Compliance with this procedure is the responsibility of project management and field personnel. This SOP and the installation-specific work plans should be reviewed before implementing drilling, sampling, development, and heavy equipment decontamination at the project investigation area.

Base Lead

The Base Lead is responsible for ensuring that decontamination of drilling, sampling, development and heavy equipment is conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead has the responsibility for periodic review of procedures and documentation associated with the decontamination of equipment. The Field Lead is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to monitor the subject decontamination activities are responsible for ensuring these tasks are completed according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or the Field Lead.

5.2 GENERAL

This section provides requirements for the construction of a temporary decontamination facility for drilling, development, and heavy equipment and the decontamination procedures to be followed. The installation-specific work plans will provide detailed information regarding:

- Types of equipment requiring decontamination under this SOP;
- Location of the decontamination station;
- Types and/or specifications on materials to be used in the fabrication of the decontamination station; and,
- Types of materials and additional details on the procedures to be used in the decontamination process.

Field personnel associated with construction of the decontamination station or decontamination of drilling or heavy equipment must read both this SOP and the installation-specific work plans prior to implementation of related decontamination activities.

5.3 DECONTAMINATION FACILITY

A decontamination facility will be set up in an area exclusively for decontamination of drilling, sampling, well development, and/or heavy equipment. Decontamination of equipment will be conducted within the station.

At a minimum, the station will be constructed such that all rinsates, liquid spray, soil, debris, and other decontamination wastes are fully contained and may be collected for appropriate waste management and disposal. The facility may be as simple as a bermed pad lined with polyethylene sheeting with an impermeable sump for collecting rinse water. More sophisticated designs involving self-contained metal decontamination pads in combination with bermed polyethylene sheeting may also be used, depending on project-specific requirements. These requirements along with specific equipment and construction specifications for the decontamination facility will be provided in the installation-specific work plans.

5.4 DECONTAMINATION PROCEDURES

Each piece of drilling and sampling equipment shall be decontaminated daily before initiation of sampling operations and between each sample location and interval. Decontamination solutions shall be replenished between sampling locations as needed. Spent decontamination fluids will be containerized, properly labeled and appropriately disposed of according to the investigation derived waste (IDW) plans addressed in the installation-specific work plan.

5.4.1 DOWNHOLE EQUIPMENT

Downhole drilling, sampling, and development equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, nondisposable bailers, etc.) will be thoroughly decontaminated before mobilization to each investigation area and between borings or wells at each investigation area or as required in the installation-specific work plans. The standard procedure will be performed as described below.

- Appropriate personal protective equipment (as specified in the installation-specific work plans) must be worn by all personnel involved with the subject task to limit personal exposure.
- Equipment caked with drill cuttings, soil, or other material will initially be scraped or brushed. The scrapings will be containerized and appropriately disposed.
- Equipment will then be sprayed with potable water using a high-pressure washer.
- Washed equipment will then be rinsed with “PFC-free” water.
- Decontaminated downhole equipment (e.g., drill pipe, drive casing, bits, tools, bailers, etc.) will be placed on clean plastic sheeting to prevent contact with contaminated soil and allowed to air dry. If equipment is not used immediately, it will be covered or wrapped in plastic sheeting to minimize airborne contamination (i.e., dust).

- Field sampling equipment and other downhole equipment used multiple times at each sample location will require cleaning between uses utilizing a four stage decontamination process. The equipment will first be rinsed in a bucket containing a mixture of potable water and soap. Alconox® and Liquinox® soap is acceptable for use since the Material Safety Data Sheets do not list fluoro-surfactants as an ingredient. The equipment will then be rinsed in each of two buckets of clean potable water. Water used for the final rinse during decontamination of sampling equipment will be laboratory certified "PFC-free" water.
- Decontamination activities will be documented by the Field Lead, lead geologist, or lead engineer in the field log and/or appropriate form(s), as specified in the installation-specific work plans.

5.4.2 HEAVY EQUIPMENT

Heavy equipment (e.g., drill rigs, development rigs, backhoes, trucks, and other earthmoving equipment) will be decontaminated between drilling locations and at the decontamination facility upon entering and prior to leaving the installation. Decontamination will be performed in accordance with the installation-specific work plans. The standard procedure will be performed as described below.

- Appropriate personal protective equipment will be worn by all personnel involved in the task, in order to limit personal exposure.
- Heavy equipment caked with drill cuttings, soil, or other material will be initially scraped or brushed to remove bulk soil and containerized in accordance with the installation-specific work plan.
- Heavy equipment will then be moved to the decontamination pad and sprayed with potable water using a high pressure washer.
- Heavy equipment will then be rinsed with "PFC-free" water.
- During the decontamination effort, fluid collection and containment systems should be inspected for any leaks or problems, which might potentially result in an inadvertent release at the investigation area, thereby contributing to the volume of waste or contamination. Any identified problems should be immediately repaired and documented.

- Decontamination activities will be documented in the field log and/or appropriate form(s), as specified in the installation-specific work plans.
- Between boreholes at the same location the back-end of the drilling rigs will be washed with potable water until surfaces are visibly free of soil buildup.

SAMPLE HANDLING AND CUSTODY
SOP AFW-11 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the handling and custody procedures for environmental samples. Proper sample handling and collection procedures are necessary to assure the quality and integrity of media samples. Additional specific procedures and requirements will be provided in the installation-specific work plan, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors collecting environmental PFC samples.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), Office of Emergency and Remedial Response, EPA/540/R-96/0, Dec 96 -*Sampler's Guide to the Contract Laboratory Program.*

EPA, Office of Emergency and Remedial Response, EPA/540/R-941/013, Feb 94 - *User's Guide to the Contract Laboratory Program.*

AFCEE (U.S. Air Force Center for Environmental Excellence. 2000 (September). Quality Program Plan. AFC-J23-35Q85101-M3-0002. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

American Society for Testing and Materials. 1996. *Standard Guide for Sampling Chain-of-Custody Procedures*. D 4840-95.

4.0 DEFINITIONS

Chain-of-Custody Record – legal documentation of custody of sample materials and instructions for analytical laboratory.

Custody – physical possession or control. A sample is under custody if it is in possession or under control so as to prevent tampering or alteration of its characteristics.

Sample Label – a record attached to samples to ensure legal documentation of traceability.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with sample handling and chain of custody. An essential part of the sampling activities of any environmental project is assuring the integrity of the sample from collection to data reporting. Sample labels and chain-of-custody forms are used to document identification and handling of samples from the time of collection through the completion of chemical analysis. In some projects, analytical data may be used in litigation. Accountability of the history of a sample must be available to demonstrate that the data are a true representation of the media sampled. The chain-of-custody record is used as evidence in legal proceedings to demonstrate that a sample was not tampered with or altered in any way that may bias the analytical accuracy of the laboratory results. It is extremely important that chain-of-custody records be complete, accurate and consistent. At a minimum, the procedures outlined in this SOP for sample handling and chain of custody will be followed.

5.1 RESPONSIBILITIES

Compliance with this procedure is the responsibility of project management and field personnel. This SOP and the installation-specific work plans should be reviewed before sample handling at the project investigation area.

Base Lead

The Base Lead is responsible for ensuring that sample handling and custody activities are conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead shall ensure that the samples are correctly collected, labeled, tracked by chain-of-custody, and stored until they are delivered directly to the shipper or laboratory (i.e., on-site or off-site).

Field Personnel

Sample Collector

The Sample Collector shall ensure the samples are correctly collected, labeled, tracked by chain-of-custody, and stored until they are delivered directly to the Sample Shipper or laboratory (i.e. on-site or off-site). The Sample Collector shall maintain custody of the samples until they are relinquished to the Sample Shipper or laboratory. The Sample Collector shall be responsible for informing the Sample Shipper of sampling conditions and if any of the samples are potentially hazardous. (NOTE: The Sample Collector and Sample Shipper can be the same person.)

Sample Shipper

The Sample Shipper shall pack the sample shipping coolers, ensure that the chain-of-custody forms are correct, and ship and/or deliver the samples to the laboratory. The Sample Shipper shall determine which samples are potentially hazardous and ship them accordingly.

5.2 SAMPLE CUSTODY

Sample custody procedures are designed to ensure that sample integrity is maintained from collection to final disposition. A critical aspect of sound sample collection and analysis protocols is the maintenance of strict chain-of-custody procedures as described in this technical procedure. Chain-of-custody procedures include tracking and documentation during sample collection, shipment, and laboratory processing. A sample is considered to be in an individual's custody if it is: (1) in the physical possession of the responsible party; (2) in view of the responsible party after being in their possession (3) secured to prevent tampering; or (4) placed in a designated, secure area that is controlled and restricted by the responsible party.

Custody will be documented throughout all sampling activities on the chain-of-custody record for each day of sampling. This record will accompany the samples from the investigation area to the laboratory. All personnel with sample custody are required to sign, date, and note on the record the time when receiving and relinquishing samples from their immediate custody. Any discrepancies will be noted at this time. Samples will be shipped to subcontract laboratories via overnight air courier. Bills of lading will be used as custody documentation during this time and will be retained as part of the permanent sample custody documentation. In some cases, samples may be hand delivered to the laboratory; hand delivery will be noted on the chain-of-custody form. The subcontractor laboratory is responsible for sample custody once samples are received.

5.3 SAMPLE LABELS

A label will be attached to all sample containers at the time of sample collection. The label will contain the following information:

- Unique chain-of-custody control number;

- Sample identification
- Analyses requested; and,
- Preservative used.

When sample collection is complete; the Sample Collector fills in the following information in ink:

- Date and time of sample collection; and,
- Sampler's initials.

5.4 CHAIN-OF-CUSTODY RECORDS

Chain-of-custody forms will be used to document the integrity of all samples to maintain a record of sample collection, transfer of samples between personnel, shipment of samples, and receipt of samples at the laboratory. Each sample/analysis at each sampling location will be logged onto a chain-of-custody form. The chain-of-custody forms shall include the following information:

- Project name and project number if applicable;
- Name and address of laboratory to receive the samples;
- Chain-of-custody control number;
- Sample type, sample method;
- Location ID, sample ID;
- Matrix code;
- Analyses requested;
- Field QC for matrix spike (MS)/matrix spike duplicate (MSD), if applicable;
- Container type, size and number;
- Preservatives used;
- Turn-around-time for laboratory analysis; and,
- Comments to Laboratory or Sample Collector, if applicable.

The Sample Collector will enter the following information using black or blue ink:

- Sampler's initials;
- Date of collection;
- Time of collection (24-hour format);
- Depths, if applicable;
- Pump/equipment number, if applicable; and,
- Void reason, if applicable.

The Sample Collector shall verify the chain-of-custody record is complete, accurate in all aspects, and consistent with all other sample documentation (e.g. number of samples, sample labels, field logs). The Sample Collector will sign the "Sampled By" and "Relinquished By" fields on the chain-of-custody record, marking the date and time custody is transferred to the Sample Shipper or other authorized person.

The Sample Shipper will perform the following duties:

- Obtain the signature of the Sample Collector, on the chain-of-custody form, to transfer sample custody;
- Record the carrier service and airbill number on the chain-of-custody;
- Sign and enter the date and time relinquished to the shipper; and,
- Prepare the samples for shipment from the field to the laboratory.

The Sample Shipper will sign the "Received By" box, marking the date and time of receipt of the samples from the Sample Collector or other sample custodian. Every transfer of physical custody shall be documented on the chain-of-custody record.

Any corrections to the chain-of-custody form entries will be made by a single-line strike mark through the incorrect item, and then entering the correct entry adjacent to the strikeout item. Corrections will be initialed and dated by the person making the change. After the form has been inspected and determined to be complete, the sample shipper will sign, date, and note the time of transfer and will reference a shipper tracking number on the form. The chain-of-custody form will be placed inside the cooler after the sample packer has detached or made an appropriate copy of the form. Field copies of the completed chain of custody forms maintained in project files.

5.5 SAMPLE STORAGE

In some cases, samples that cannot be shipped immediately to a laboratory must be temporarily stored in an Amec Foster Wheeler controlled sample refrigerator until arrangements can be made for delivery. The Sample Collector or Shipper shall place samples in the refrigerator [samples and signed chain of custody record(s)] and secure the refrigerator with a unique, keyed lock, restricting access to one field personnel at a time. A temperature blank must accompany samples overnight.

Samples temporarily stored in the refrigerator must be received by the field personnel that placed them in storage, and in turn, may be “relinquished to” the appropriate laboratory, the Sample Shipper or another sample custodian. Each transfer of custody shall be recorded on the appropriate chain-of-custody form(s).

6.0 RECORDS

Distribution of the chain-of-custody record:

- Original form sealed in a plastic bag and taped inside the top of the shipping container; and,
- Copies to the Base Lead.

PROTOCOL TO PROVIDE WATER FREE OF PERFLUORINATED COMPOUNDS FOR COLLECTION OF FIELD BLANKS AND EQUIPMENT BLANKS
SOP AFW-12 (PFCs)

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and limit trace perfluorinated compound (PFC) detections introduced through low-level PFC contamination in the laboratory-supplied water used for field blanks, equipment blanks, and decontamination of sampling equipment; ambient PFC contamination from atmospheric conditions or sample containers; or decontamination procedures. The following procedures will be used to provide traceable PFC-free water for equipment decontamination, field blanks, and equipment blanks.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors who use or provide PFC-free water for field blanks, equipment blanks, and equipment decontamination.

3.0 REFERENCE

Department of Defense, 2013. *Quality Systems Manual for Environmental Laboratories, Version 5.0*. July.

4.0 DEFINITIONS

Per the Department of Defense Quality Systems Manual for Environmental Laboratories Version 5.0, water will be defined as being PFC-free if there are no target analyte detections at concentrations equal to or greater than half the limits of quantification (LOQs) specified in the Table 1. Target analyte detections at or greater than half the LOQ will disqualify all the water in the associated batch from being used for equipment decontamination, field blanks, or equipment blanks.

Table 1. Perfluorinated Compounds, Limits of Detection, Limits of Quantification, and Action Limits

Analytes	Synonym	LOD (ng/L)	LOQ (ng/L)	Action Limits (ng/L)
Perfluorohexanoic acid	PFHXa	16	20	-
Perfluoroheptanoic acid	PfHpA	16	20	-
Perfluorooctanoic acid	PFOA	16	20	400
Perfluorononanoic acid	PFNA	16	20	-
Perfluorodecanoic acid	PFDA	16	20	-
Perfluorobutanesulfonic acid	PFBS	16	20	-
Perfluorohexanesulfonic acid	PFHxS	16	20	-
Perfluoroheptanesulfonic acid	PFHpS	16	20	-
Perfluorooctanesulfonic acid	PFOS	16	20	200
Perfluorodecanesulfonic acid	PFDS	16	20	-

Notes:

-	No defined action limit
LOD	limit of detection
ng/L	nanograms per liter

5.0 GENERAL

Given the low detection limits associated with PFC analysis and the many potential sources of trace levels of PFCs, laboratory and field personnel are advised to act on the side of caution by strictly following these protocols.

6.0 RESPONSIBILITIES

Analytical Laboratories

The analytical laboratories will be responsible for providing Amec Foster Wheeler with PFC-free water to use for field and equipment blanks. The laboratories must certify that each batch of deionized water is PFC-free following the procedures specified below before shipment to the field. Procedures to be used for certification of the PFC-free water are:

1) If the laboratory provides water from its internal ultrapure water system, that water must be used for the routine preparation of method blanks for PFC analysis, and the laboratory must:
    a. Provide copies of their control charts showing that PFC concentrations in the method blanks are consistently less than the concentrations specified in Section 7 below with each shipment of water;

b. Fill a bottle from each "manufacturers lot" of bottles/caps with the laboratory's PFC-free water, and analyze an aliquot of water from that bottle to show that the water in the bottle meets the requirements of Section 7 below; and,
c. Assign a unique Batch Number to each shipment of PFC-free water to Amec Foster Wheeler, and maintain a record of the preparation date and bottle/cap lot number used to prepare that PFC-free water batch. If multiple bottle types (e.g. cubitainers for large volumes and 125 ml bottles for rinsate blanks) are used, separate batch numbers should be used for each bottle type.

2) If the laboratory provides purchased ultra pure water to Amec Foster Wheeler for equipment decontamination and blanks, the laboratory must analyze an aliquot of each manufacturer's batch before the water is shipped to Amec Foster Wheeler. If target analytes are detected in the water at concentrations equal to or greater than half the LOQs specified in Table 1 the water must be considered contaminated, and it will not be shipped to Amec Foster Wheeler. The manufacturer name and batch or lot number will be used for purposes of maintaining traceability of purchased water.

If target analytes are not detected at concentrations equal to or greater than half the LOQs specified in Table 1, the water is suitable to be shipped to Amec Foster Wheeler. The laboratory must provide a certificate of analysis with results for the water batch to the Amec Foster Wheeler's Project Chemist, or designee, before the water is shipped to the field. Each batch of PFC-free water must be clearly marked with a unique batch identification number.

Amec Foster Wheeler

Prior to use, the field crew will collect a field blank from each batch of PFC-free water by pouring an aliquot of the water into a sample container. Before sample collection, field crews will decontaminate the equipment and will using the PFC-free water as a final rinse. During sampling, field crews will collect equipment blanks at a frequency of 1 per 10 samples collected using the same sampling equipment.

Amec Foster Wheeler field crews will clearly associate field blanks and equipment blanks with both the associated laboratory water batch identification number and associated field samples on daily field forms and/or in an electronic sample tracker. The Amec Foster Wheeler Chemist will maintain records and will chart results of the source water, equipment blank, and field blank analytical data. Amec Foster Wheeler will evaluate the data to identify any trends or anomalies that warrant a change of this or field sampling procedures.

7.0 EVALUATION

This procedure will provide documentation that the source water used for equipment rinsing and blanks is PFC-free, with PFC levels less than 1/40 the project action limit for perfluorooctanoic acid (PFOA), less than 1/20 the project action limit for perfluorooctanesulfonic acid (PFOS), or less than half the LOQ for analytes without project action limits. Amec Foster Wheeler will track analyte concentrations in the water from shipment from the laboratories, to the field, and ultimately to the water's use to rinse sampling equipment. This will eliminate concern about the PFC-free water itself as a source of contamination, and facilitate evaluation and identification of sources or actions that contribute to cross-contamination, so that the project team can adjust procedures if needed. The blanks dataset will be used as part of Amec Foster Wheeler's overall quality control assessment of ambient sources of PFC contamination relative to sample concentrations.

PRIVATE AND PUBLIC WATER SUPPLY WELL SAMPLING

SOP AFW-13 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures by which Amec Foster Wheeler personnel should conduct groundwater sampling at private and public water supply wells that may contain perfluorinated compounds (PFCs). Proper procedures are necessary to assure the quality and integrity of groundwater analytical results. Additional specific procedures and requirements will be provided in installation-specific work plans and/or field work notifications, as applicable.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel involved in the sampling of private and/or public water supply wells. Construction and operation of water supply wells will vary; therefore, this SOP may not be applicable to all situations.

This procedure has been developed to serve as management-approved professional guidance for the Amec Foster Wheeler Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviation from this procedure in planning or in the execution of planned activities must be approved by the Base Lead.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 2013. *Science and Ecosystem Support Division (SESD) Operating Procedure: Potable Water Supply Sampling. SESDPROC-305-R3.* Effective date May 30, 2013.

EPA, 1998. Safe Drinking Water Act: *Definition of a Public Water System. Section 1401(4). Amended by the 1996 Safe Drinking Water Act Amendments.* Effective date August 6, 1998.

4.0 DEFINITIONS

Potable Water – Water that meets the standards for drinking purposes of the State or local authority having jurisdiction, or water that meets the standards prescribed by the EPA's National Primary Drinking Water Regulations (40 CFR 141).

Private Water Supply Well – A well that can serve as a private drinking water system, has fewer than 15 individual connections, or regularly serves an average of less than 25 individuals for less than 60 days out of the year.

Public Water Supply Well – A well and distribution system that has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. The term includes (1) any collection, treatment, storage, and distribution facilities under control of the supplier of water and used primarily in connection with the system; and (2) any collection (including wells) or pretreatment storage facilities not under the control of the supplier which are used primarily in connection with the system.

Note: The definitions provided for private and public water supply wells are generally accepted industry-wide. However, the definitions should be confirmed with the local and state regulatory authorities where the work is being conducted. Site-specific definitions should be included in the installation-specific work plans.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with sampling private and public supply wells. Proper procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information:

- Sample collection objectives;
- Water well locations to be sampled;
- Number and volume of samples to be collected at each well;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control procedures and sampling required;
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary; and
- At a minimum, the procedures outlined in this SOP for water supply well sampling will be followed.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Base Lead will select the appropriate sampling methodology and analytical program based on the objectives of the sampling. The Base Lead is also responsible for ensuring that the investigation area-specific sampling plan is clear in defining sampling methods.

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e. retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to water supply well sampling activities are responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 METHOD SUMMARY

The basic procedures for sampling private and public water supply wells are similar to those for sampling of groundwater monitoring wells, as specified in Groundwater Sampling SOP AFW-03 (PFCs), and sampling of water at a treatment system, as specified in Groundwater Treatment System Influent and Effluent Sampling SOP AFW-09 (PFCs). The main difference is how or where the well water is accessed. Wells with in-place plumbing are commonly found at residences, and water supply wells may or may not have sampling ports at the well head. The procedure can be summarized as follows.

- Decontaminate any equipment that will come into contact with water inside the well and/or sampled water as specified in SOP AFW-10 (PFCs);
- Purge water until specific parameters have stabilized, toward ensuring formation water (as opposed to stagnant well water) will be sampled;
- Collect samples in laboratory-supplied containers; and
- Follow standard sample handling and custody procedures to contain and transport samples to the off-site laboratory.

5.3 FIELD PROCEDURES

Field procedures will incorporate other applicable project-specific SOPs, particularly SOP AFW-01 (PFCs), *Field Sampling Protocols to Avoid Cross-Contamination at Perfluorinated Compounds (PFCs) Sites*.

5.3.1 PREPARATION

Office Procedures

- Contact the well owner with the proposed schedule for sampling, and coordinate with the well owner on timing; obtain information on the pumping rate and frequency during the last several weeks, if available.
- Review the installation-specific work plan and the procedure including well construction, development, and sampling information on the wells to be tested, if available.
- Check out and ensure the proper operation of all field equipment.
- Assemble a sufficient number of field forms to complete the field assignment (do not use waterproof paper).
- Assemble appropriate testing equipment.

Equipment Selection and Sampling Considerations

This SOP assumes that private or public water supply wells are equipped with operational mechanical systems to collect samples. If the mechanical systems for supply wells are not operational, then the sampling should be conducted as described in SOP AFW-03 (PFCs) for Groundwater Sampling and the details provided in the installation-specific work plans.

The following should be considered when choosing the location to collect a potable water sample from a private and/or public water supply well (EPA, 2013):

- Taps selected for sample collection should be supplied with water from a service pipe connected directly to a water main in the segment of interest.
- Whenever possible, choose the tap closest to the water source, and prior to the water lines entering the residence, office, building, etc., and also prior to any holding or pressurization tanks. If the tap closest to the water source is located in a crawl space or other confined space, the technician will make note of the confined space condition, and identify the next closest tap for sample collection. If sampling in a confined space is deemed necessary, it will be conducted only by a trained sampling team in possession of a confined space entry permit in accordance with the with General Health and Safety Plan.
- The sampling tap must be protected from exterior contamination associated with being too close to a sink bottom or to the ground. Contaminated water or soil from the faucet exterior may enter the bottle during the collection procedure because it is difficult to place a bottle under a low tap without grazing the neck interior against the outside faucet surface. If the tap is too close to the ground for direct collection into the appropriate sample container, it is acceptable to use a smaller container to transfer sample to a larger container. The smaller container should be made of high-density polyethylene (HDPE) or polypropylene, and should be decontaminated as specified in SOP AFW-10 (PFCs).
- When filling any sample container, care should be taken that splashing drops of water from the ground or sink do not enter into either the bottle or cap.
- Leaking taps that allow water to discharge from around the valve stem handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.

- Disconnect any hoses, filters, or aerators attached to the tap before sampling. These devices can harbor a bacterial population if they are not routinely cleaned or replaced when worn or cracked.
- Taps where the water flow is not constant should be avoided because temporary fluctuation in line pressure may cause clumps of microbial growth that are lodged in a pipe section or faucet connection to break loose. A smooth flowing water stream at moderate pressure without splashing should be used. The sample should be collected without changing the water flow.

Data Form

The Private and Public Water Supply Well Sample Collection Log form shall be used to record sampling information and observations. All entries shall be made in indelible ink.

5.3.2 PERFORMING THE SAMPLING

Private and public water supply well samples will be collected by filling sample containers from sample ports at each designated location. Ideally, the sample should be collected from a tap or spigot located at or near the well head or pump house and before the water supply is introduced into any storage tanks or treatment units. If the sample must be collected at a point in the water line beyond a tank, a sufficient volume of water should be purged to provide a complete exchange of fresh water into the tank and the tap or spigot. If the sample is collected from a tap or spigot located just before a storage tank, spigots located downstream of the tank should be turned on to prevent any backflow from the tank to the tap or spigot. Several spigots may be opened to provide for a rapid exchange of water.

The following general procedures will be used. These procedures may be modified to reflect investigation area-specific conditions.

- Don personal protective equipment (PPE) appropriate for the task, in accordance with the site-specific Health and Safety Plan and Activity Hazard Analysis, as applicable.
- Sample wells from least contaminated to most contaminated, if possible.
- The sample port for a private water supply well will be opened and allowed to flush for at least 15 minutes, when possible. The sample port for a public water supply well will be

allowed to flush for at least three minutes. Flow rate will be measured and recorded in order to calculate the approximate total purge volume.

- During flushing activities, collect a minimum of three sets of physical parameters (i.e. pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity and temperature). An adequate purge is achieved when the pH and specific conductance of the potable water have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU) and the specific conductance varies no more than approximately 10 percent.
- If, after 15 minutes, the physical parameters have not stabilized according to the above criteria, use professional judgement to determine whether or not to collect a sample or to continue purging.
- If routinely sampled locations have shown consistency in physical parameters readings, collection of parameters during subsequent sampling events may be discontinued at the direction of the Base Lead. If physical parameters are not collected, purge volume is relied upon to ensure stagnant well and system water is not sampled.
- The samples will then be collected directly from the sample port into the laboratory-supplied container. Samples should be collected with as little agitation or disturbance as possible.
- SOP AFW-09 (PFCs) "Groundwater System Influent and Effluent Sampling" will be used to collect groundwater samples from distribution points.

Note: According to EPA (2013), "[a] well with an intermittently run pump should, in all respects, be treated like a well without a pump. In these cases, parameters are measured and the well is sampled from the pump discharge after parameter conditions have been met. Generally, under these conditions, 15 to 30 minutes will be adequate."

SLUG TESTING

SOP AFW-14 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures by which Amec Foster Wheeler personnel should conduct slug tests at monitoring wells that may contain perfluorinated compounds (PFCs). Proper procedures are necessary to assure the quality and integrity of slug test results. Additional specific procedures and requirements will be provided in installation-specific work plans and/or field work notifications, as applicable.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel involved in conducting slug test and the preliminary interpretation of slug tests. It is not intended to be a comprehensive documentation of slug test analysis.

This procedure has been developed to serve as management-approved professional guidance for the Amec Foster Wheeler Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviation from this procedure in planning or in the execution of planned activities must be approved by the Project Manager.

A slug test is a common procedure for single-well hydraulic testing. A slug test is restricted in application because it is a measure of the well and near-well hydrogeologic conditions. The results of the test generally provide an order of magnitude estimate of the horizontal hydraulic conductivity of the aquifer, and are most useful in low-permeability materials. Storativity cannot be determined accurately using this method.

3.0 REFERENCES

Bouwer, H. and R.C. Rice. 1976. *A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells*, Water Resource Research, Vol. 12, No. 3.

Bouwer, H. 1989. *The Bouwer and Rice Slug Test - An Update.* Groundwater Vol. 27 No. 3, pp. 304-309.

Butler, James J. 1998. *The Design, Performance, and Analysis of Slug Tests.* Lewis Publishers, Boca Raton, Florida, 252 p.

Cooper, Jr., H.H., J.D. Bredenhoeft, and S.S. Papadopulos. 1967. *Response of a Finite-Diameter Well to an Instantaneous Charge of Water,* Water Resource Research, Vol. 3, pp. 263-269.

Hvorslev, M.J. 1951. *Time Lag and Soil Permeability in Ground-Water Observations,* bul. no. 26, Waterways Experiment Station, Corps of Engineers, U.S. Army, Vicksburg, Mississippi.

Rohrich, Thomas and Schlumberger Water Services. 2007. *Aquifer Test v.4.2 User's Manual*. Advanced Pumping Test & Slug Test Analysis Software. Schlumberger Water Services, Waterloo, Canada.

Duffield, G.M. 2007. AQTESOLV for Windows v. 4.50. HydroSOLVE, Inc., Reston, VA.

4.0 DEFINITIONS

Confined Aquifer - An aquifer situated between two layers having very low hydraulic conductivity. The water level in a well in a confined aquifer usually rises above the top of the aquifer.

Delayed Yield - Water that drains vertically downward from the newly created unsaturated zone during an unconfined aquifer test after the water table has been lowered from its initial level.

Hydraulic Boundaries - A geologic or hydrologic feature that affects the movement or distribution of groundwater.

Hydraulic Conductivity - The rate of flow through a unit area cross section under a unit hydraulic gradient, at the prevailing temperature. Hydraulic conductivity is typically reported as feet per day (reduced from ft3/day/ft2). In the Standard Industrial (SI) system, the units are typically m3/day/m2 or m/day. The letter "K" is typically used to denote hydraulic conductivity.

Observation Well - A well drilled in a selected location for the purpose of observing parameters such as water levels and water quality.

Pumping Well - A well from which water is withdrawn by pumping in order to evaluate aquifer characteristics by monitoring the response to pumping in the pumping or observation wells.

Skin Effects - A decrease in measured hydraulic conductivity caused by drill cuttings or fluids accumulating along the wall of the boring.

Specific Yield - The ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass. Specific yield (Sy) is applied to unconfined aquifers only. Typical values of specific yield are 10-1 to 10-3.

Storage Coefficient - The volume of water an aquifer releases from, or takes into storage, per unit surface area of the aquifer per unit change in head. Storage coefficient (S) is unitless, and is applied only to confined aquifers. Typical values of storage coefficients range from 10-3 to 10-5.

Transmissivity - Transmissivity (T) is the product of the hydraulic conductivity (K) and saturated aquifer thickness (b) and is the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Transmissivity values are given in area per time units, typically ft2/day in the English Engineering system.

Unconfined Aquifer - An unconfined aquifer is also known as a water-table aquifer and is an aquifer in which the water table forms the upper boundary. The water level in an unconfined aquifer lies at the water table.

Well-Bore Storage Effects (Casing Effects) - The delayed drawdown response observed in the initial phases of a pump test due to removal of water from storage in the well casing and filter pack.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with slug testing. Proper procedures are necessary to insure the quality and integrity of the tests. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information:

- Slug testing objectives;
- Well locations to be tested;
- Number of tests at each well;
- Specific quality control procedures required; and,
- Any additional slug testing requirements or procedures beyond those covered in this SOP, as necessary.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and with any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC). The Base Lead, with input from Amec Foster Wheeler geologists and/or hydrogeogists, is responsible for selecting the appropriate aquifer test based on the objectives of the test. The Base Lead is also responsible for ensuring that the investigation area-specific sampling plan is clear in defining test methods.

Field Lead

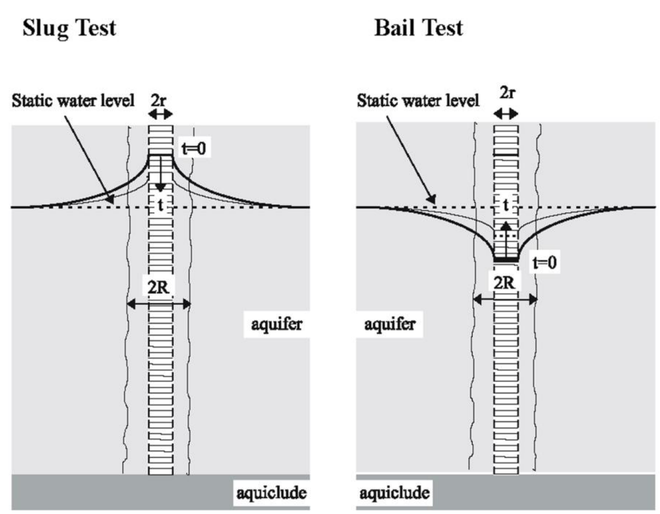
The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e. retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to aquifer testing activities are responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 METHOD SUMMARY

A slug test involves the instantaneous injection ("slug test" or "rising head") or withdrawal ("bail test" or "falling head") of a mass (slug) of water or object displacing a known volume of water



into or from a well and measuring the induced water level fluctuation. A pneumatic slug test utilizes air pressure as the slug, allowing an instantaneous displacement of water; this method is generally preferred (as instantaneous discharge can be effected without potential disturbance to the pressure transducer monitoring equipment), but cannot be used where the groundwater level bisects the well screen.

The primary advantages of using slug tests to estimate hydraulic conductivities are: a) estimates can be made in-situ, thereby avoiding errors incurred in laboratory testing of disturbed soil samples; b) tests can be performed quickly at relatively low cost because only one observation well is required; and c) the hydraulic conductivity of small discrete portions of an aquifer can be estimated (e.g. sand layers in a clay). Estimates of storativity or specific storage cannot be reliably established from slug tests. Slug tests should generally be used only to evaluate water-bearing zones with relatively low hydraulic conductivities. However, slug tests performed in high conductivity zones may exhibit underdamped (oscillatory) responses and will need to be analyzed using appropriate techniques (e.g. Van der Kamp solution). In addition, the use of a data logger coupled to a pressure transducer is recommended for slug testing.

5.3 INTERFERENCES AND POTENTIAL PROBLEMS

The zone of investigation provided by a slug test is limited to the immediate vicinity of the well bore. Thus, the test interpretation may be strongly influenced by the hydraulic properties of the well casing, filter pack, and borehole, and possibly reflect variations in well development. If possible, consistent well construction and development methods shall be maintained at an investigation area to minimize the potential for variation in slug test results.

The slug test may also be affected by potential problems associated with pumping tests in general. These include:

- Localized or regional pumping;
- Aquifer compression (e.g. trains, traffic); and,
- Heterogeneous and anisotropic aquifers.

Many of these potential complications may be detected during the pre-test period, or anticipated from an examination of existing hydrogeological data.

Information regarding the location, completion, and development of the tested wells may be useful in evaluating potential complications. Complicating factors may include:

- Partially penetrating wells;
- Improperly completed or developed wells;
- Low-permeability conditions that may lead to well-bore storage effects, well dewatering, or slow responding observation wells;
- Wells completed within aquitards, possibly designed to evaluate the pressure response and leakage into adjacent aquifers; and,
- Potential skin effects due to well bore conditions.

Water levels within a borehole will often oscillate rapidly after the introduction/withdrawal of a slug volume. This is not unusual and is not an indication of problems with performance of the slug test. If a well is screened both above and below the water table, a slug injection method will tend to store water in the filter pack and yield a higher estimate of hydraulic conductivity than would be expected. In these cases, the slug withdrawal method will yield more accurate data.

5.4 PREPARATION

Office Procedures

- Review the work plan and the procedure including well construction, development, and sampling information on the wells to be tested.
- Review the operator's manual provided with the electronic data-logger.
- Verify the displacement volume of the slug or pneumatic test equipment. Relative to the slug, this may be accomplished by accurately measuring the dimensions of a solid displacement slug or by accurately measuring the volume of water discharged from a liquid slug. Relative to the pneumatic test equipment, this may be accomplished by checking that all seals are air-tight and the pressure gauge is operational.
- Check out and ensure the proper operation of all field equipment. Ensure that the electronic data-logger is fully charged. Test the electronic data-logger using a container of water (e.g. sink, bucket of water). Additional transducers should be brought to the investigation area in case of malfunctions.
- Assemble a sufficient number of field forms to complete the field assignment.

Equipment List

The following equipment is needed to perform slug tests. All of the equipment shall be decontaminated and tested prior to commencing field activities.

- Tape measure (subdivided into tenths of feet);

- Water pressure transducer;
- Electric water level indicator or steel tape (subdivided into hundredths of feet);
- Electronic data-logger;
- Solid or liquid slug of a known volume (stainless steel, PVC, and ABS plastic are appropriate construction materials), or pneumatic slug testing apparatus
- Watch or stopwatch with second hand;
- Semi-log graph paper;
- Temperature/pH/electrical conductivity meter (optional);
- Appropriate references and calculator;
- Electrical tape; and,
- Health and safety equipment as required.

Data Form

The slug test data form shall be used to record observations. All entries shall be made in indelible ink. The slug test data form, provided as Attachment 1, shall include:

- Investigation Area ID - Identification number assigned to the area and the well.
- Date - The date when the test data were collected.
- Slug Volume (ft3) or Displacement (ft) – If a solid slug is used for the test, provide manufacturer's specification for the known volume or displacement of the slug device. If a pneumatic apparatus is used for the test, indicate the pressure reading and displacement within the well casing.
- Logger - identifies the company or person responsible for performing the field measurements.
- Test Method - The slug device is either injected ("slug test" or "rising head") or withdrawn ("bail test" or "falling head") from the monitor well. Indicate the test situation being run.
- Comments - Appropriate observations or information for which no other blanks are provided.
- Depth to water (ft) - Depth of water recorded to 0.01 feet.
- Configuration of the data logger (e.g. sample rate, duration, transducer type, etc.).

The electronic data-logger and pressure transducer will store all data internally or on removable media. The information will be transferred directly to a computer and analyzed.

Before beginning the slug test, information shall be recorded and entered into the electronic data-logger. The type of information may vary depending on the model used. Consult the operator's manual for the proper data entry sequence to be used. Do not set a reference datum elevation, e.g. top of casing elevation. The data-logger should be set to record actual pressure head (water level) above the pressure transducer. The test will need to record water-level displacement over time.

The data-logger acquisition rates need to be set that correspond to the anticipated formation response. Data loggers will need a maximum acquisition rate of at least five measurements per second (5 Hz), and be able to take measurements in equal log-time increments. For example, high-K formations may require an acquisition rate up to 5 Hz, while low-K formations will require log-time measurements to optimize the response data acquisition.

Decontaminate the transducer and cable and solid cylinder slug, following SOP AFW-10 (PFCs).

Collect initial water level measurements from monitoring well. The installation-specific work plan will identify if water level measurements in nearly upgradient to downgradient monitoring wells are required.

5.5 PERFORMING THE SLUG TEST

The following general procedures may be used to collect and report slug test data. These procedures may be modified to reflect investigation area specific conditions.

- Test wells from least contaminated to most contaminated, if possible.
- Determine the static water level in the well by measuring the depth to water periodically for several minutes.
- Cover sharp edges of the well casing with duct tape to protect the transducer cables.
- Install the transducer and cable in the well to a depth below the target drawdown estimated for the test but at least two feet from the bottom of the well. Be sure this depth of submergence is within the design range stamped on the transducer. Temporarily secure the transducer cable to the well using alligator clips (or similar) to keep the transducer at a constant depth. For a pneumatic slug test, attach the pneumatic slug to the well and insert the transducer through the transducer access hole.
- Connect the transducer cable to the electronic data-logger.
- Enter the initial water level and transducer design range into the recording device according to the manufacturer's instructions (the transducer design range will be stamped on the side of the transducer). Compare manual and pressure transducer measurements to check that the transducer is operational and accurate. Thermal drift may occur until the transducer equilibrates with the water in a well.

- Instantaneously introduce or remove a known volume or “slug” to the well. This may be done by using a solid cylinder of known volume to displace and raise the water level. For example, with a solid slug, a falling head test is performed following introduction of the slug, and a rising head test is performed following water level equilibrium and removal of the slug. This same procedure can be performed by introducing or removing air pressure from a well using a pneumatic apparatus on the well head. It is important to remove or add the volumes as quickly as possible because the analysis assumes an "instantaneous" change in volume is created in the well. Recommendation: Use a step ladder and a pulley to precisely position the slug within the well to avoid rubbing the well casing during the introduction and removal process.
- With the moment of volume addition or removal assigned time zero, measure and record the depth to water and the time using the data logger. The number of depth-time measurements necessary to complete the test is variable. It is critical to make as many measurements as possible in the early part of the test. The number and intervals between measurements will be determined from earlier previous aquifer tests or evaluations, when available. Continue measuring and recording depth-time measurements until the water level returns to equilibrium conditions or is within 10% of the initial (static) water level.
- For quality control purposes and data accuracy, a minimum of three (3) slug tests will be performed at each well. Prior to starting subsequent slug tests, the water level within the well must return to equilibrium conditions or is within 10% of the initial (static) water level.
- Retrieve the slug (if applicable) and follow appropriate decontamination procedures.

The time required for a slug test to be completed is a function of the volume of the slug, the hydraulic conductivity of the formation, and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.

If the well is to be used as a monitoring well, precautions should be taken to ensure that the well is not contaminated by material introduced into the well. Bailers or measuring devices shall be cleaned prior to the test. If tests are performed on more than one monitoring well, care must be taken to avoid cross contamination of the wells.

Slug tests shall be conducted on relatively undisturbed wells. If a test is conducted on a well that has recently been pumped for water sampling purposes, the measured water level must be within 0.1 foot of the static water level prior to testing.

5.6 POST TESTING OPERATIONS

Decontaminate and/or dispose of equipment according to procedure SOP AFW-10 (PFCs).

For the electronic data-logger, implement the following procedure:

- Stop logging sequence.
- Save the data and disconnect the battery at the end of the day's activities.
- Inventory sampling equipment and supplies. Repair or replace all broken or damaged equipment.
- Replace expendable items.
- Return equipment to the Equipment Manager and report incidents of malfunctions or damage.
- Review field forms for completeness.
- Interpret slug test field results with the Project Manager or hydrogeologist. Analyze the slug test using appropriate software packages or graphical solutions.
- Send data-logger or pressure transducers to factory for recalibration, if needed.

5.6.1 SLUG TEST INTERPRETATION

The results of slug tests should be viewed as order of magnitude estimates of hydraulic conductivity and should not be performed as a substitute for constant discharge pump tests. The interpretation of the water level response generally requires a number of simplifying assumptions, and the physical properties of the well casing and filter pack are rarely included in the analysis. Many methods exist for interpreting the response data from a slug test (Butler 1998). The appropriate method will depend, in part, on:

- Type of response
    - Linear
    - Nonlinear
- Type of aquifer
    - Confined
    - Unconfined
    - Fractured

- Type of media
    - Low-K
    - High-K
- Well orientation
    - Fully penetrating
    - Partially penetrating
- Well screen orientation
    - Screened fully below the water table
    - Screened across the water table

A decision tree / flow chart to aid in the selection of the appropriate method is provided in Butler (1998, Figure 12.2).

Two software packages that may be used to analyze slug test response data are:

- AQTESOLV (Duffield, 2007)
- Aquifer Test Pro (Rohrich and Schlumberger Water Services, 2007)

FISH SAMPLING FOR LABORATORY TISSUE ANALYSIS

SOP AFW-15 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures by which Amec Foster Wheeler personnel should collect fish speciems for laboratory analysis for perfluorinated compounds (PFCs). This SOP includes procedures that may be used to collect fish from streams, rivers, or lakes/ponds. Proper procedures are necessary to assure the quality and integrity of fish tissue analytical results and that apporopriate fish samples are are collected to meet the data objectives described in the QAPP and this SOP. Field sampling protocols described in SOP AFW-01, *Field Sampling Protocols to Avoid Cross-Contamination of Polyfluorinated Compounds (PFCs)* should be reviewd prior to beginning sample collection tasks to avoid contamination of field samples.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel involved in the collection of fish for laboratory analysis. Fish will be collected using fish capture techniques described in Section 5.3.2 and held in holding tanks. Fish will be selected as laboratory samples based on data objectives described in the QAPP and in this SOP. A the time of sample collection, sample location information, sample ID codes, and biological specimen information will be recorded on the Fish Sample Collection Record (Attachment 1). Samples will be prepared for shippment and marked with appropriate sample ID code described in Section 5.3. This procedure has been developed to serve as management-approved professional guidance for the Amec Foster Wheeler Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviation from this procedure in planning or in the execution of planned activities must be approved by the Project Manager.

3.0 REFERENCES

U.S. Environmental Protection Agency (EPA), 2000. “Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories”; Volume 1 Fish Sampling and Analysis; Office of Water; EPA-823-B-00-007, November 2000.

U.S. Environmental Protection Agency (EPA), 2003. "Standard Operating Procedures (SOP) for the Sampling of Fish in Wadeable Streams Through the Use of Electrofishing"; The Office of Environmental Measurement and Evaluation; EPA New England - Region 1; August 2003

4.0 DEFINITIONS

Fish Sample Collection Record (FSCR) – Field record form used to record sample collection information.

PFCs – Polyfluorinated Compounds

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with the collection of fish from streams, rivers, lakes and ponds for laboratory analysis. Proper procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project objectives defined in associated QAPP worksheets. The QAPP worksheets provide the following information:

- Sample collection objectives;
- Stream, river, lake and pond locations to be sampled;
- Number, volume, and type of fish samples to be collected at each location;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control procedures and sampling required;
- Field sample preparation procedures and laboratory analytical sample preparation procedures; and,
- Any additional sampling requirements or procedures beyond those covered in this SOP.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Base Lead will select the appropriate sampling methodology and analytical program based on the objectives of the sampling. The Base Lead is also responsible for ensuring that the investigation area-specific sampling plan is clear in defining sampling methods.

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e. retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to fish sampling activities are responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 METHOD SUMMARY

A variety of fish collection techniques are described as options in this document. Field personnel will decide which techniques are most appropriate for the water body being sampled. The field sampling fish capture techniques that are expected to be used in the field should be identified as option in the Scientific Collection Permit for the sampling program. The following procedures are established as options for fish capture:

- Hook and line fishing
- Backpack electrofishing
- Boat electrofishing
- Netting Techniques (seines and gillnets)

Field personnel are responsible for reviewing project planning documents and understanding the project objects of the fish collection and analysis task. Project objectives may include:

- identification of sample locations
- identification of target species
- fish handling requirements
- determination/selection of fish size

- required information of fish specimens (length, weight, observations)
- laboratory sample fish composition (composite or individual specimen)
- laboratory sample preparation scope (frozen in field)
- sample container/wrapping material requirements
- laboratory sample labeling requirements
- sampling record requirements (logbooks, Fish Sample Collection Records, photos, chain of custody, shipping records)

5.3 FIELD PROCEDURES/CONSIDERATIONS

Field procedures will incorporate other applicable project-specific SOPs, particularly SOP AFW-01 (PFCs), Field Sampling Protocols to Avoid Cross-Contamination of Perfluorinated Compounds (PFCs).

5.3.1 PREPARATION

Office Procedures

Fish collection permits may be required to collect fish from State waters and will be obtained if applicable. The fish collection permits, if required, will establish which fish collection procedures are approved for use and what species and quantities of fish are allowed to be removed from sampling locations. The fish collection permit will be carried in the field by field personnel when completing the sampling tasks.

- Review the installation-specific work plan and/or QAPP and identify the fish sample program objectives.
- Obtain maps and figures needed to identify sample locations.
- Determine how fish are to be handled in the field and how samples will be packaged and shipped to the laboratory.
- Determine field sample ID codes
- Obtain sample collection forms, pens or pencils (sharpies, ball point), measuring tape or board, and balances needed to record fish sample information.
- Obtain sample collection equipment and materials for the techniques planned.
- Checkout and ensure the proper operation of all equipment.
- Assemble appropriate testing equipment.

Data Form

The Fish Sample Collection Record form shall be used to record sampling information and observations. A separate form will be completed for each laboratory sample. All entries shall be made in indelible ink.

5.3.2 GENERAL SAMPLING PROCEDURES

Prior to mobilization, a review of equipment and supplies needed for a given fish sampling technique is completed. Supplies will be obtained and organized prior to starting the sampling event. The following supplies will be used for most fish collection techniques. Additional supplies are listed in the subsection describing each fishing technique.

- Fish Collection Field Record forms
- Writing utensils
- Ruler or length measuring board (if required)
- Scale or balance for weight fish (if required)
- Chest waders
- Life jackets
- Long handled nets
- Short handled dip net
- Laboratory sample containers or wrapping materials (High Density Polyethylene or polypropylene bag) and labels
- Cooler and dry ice if samples are to be shipped frozen
- Chain of Custody Forms
- Fish holding tank/container and aerator with batteries
- 5 gallon buckets
- Electric freezer unit to store frozen samples prior to shipping
- Camera
- First Aid Kit with Automatic External Defibrillator (AED)

Captured fish will be held in holding containers at the time of sample collection at a given sampling location. Upon capture, they are immediately transferred to the container and kept alive until sampling at the location is completed and adequate number and/or sizes of fish have been captured to meet the project objectives. Fish are selected for laboratory samples based on the sample collection objectives. Fish not used for laboratory samples will be released back into the water at the location sampled.

Hook and Line Fishing

In some fish collection situations, use of hook and line fishing may be appropriate for the collection of samples. This involves use of traditional sport fishing techniques such as spin casting (with lures or live bait) and fly fishing.

Supplies

- Fishing rods and reels
- Lures, flies, hooks, baits
- Boat or canoe

Backpack Electrofishing

Backpack electrofishing is done as a team of two or more individuals with a mobile backpack power unit carried on the back of one of the team members. Additional samplers follow the backpack fisher with long handled nets capturing fish that are stunned by the shocking unit, The field samplers should be trained in the operation of the equipment, read the manufactures operation manual, and be familiar with equipment operation prior to operating the shocking unit. Special safety precautions should be taken to avoid electric shock when operating this unit. Safety considerations are described in the manufacturers operations manual (Attachment 3) and the USEPA Region I SOP on backpack electrofishing (USEPA, 2003). Refer to the project Health and Safety Plan for additional safety information.

Supplies

- battery or gas powered portable backpack shocking unit with safety kill switch, anode ring, and rat tail cathode
- appropriately mixed gasoline and/or spare charged batteries per manufacturer instructions
- elbow length rubber lineman's gloves for each team member
- rubber chest waders for each team member
- polarized sunglasses for each sampling team member
- wood or plastic handle dip nets

Boat Electrofishing

Boat electrofishing is done from a boat specially equipped for electrofishing lakes and ponds. The boat has power unit onboard and anode/cathodes that hang in the water at the front of the boat. The boat moves slowly across the lake surface. Samplers stand on the bow and capture fish with long handled nets that are stunned by the shocking unit. If electrofishing from a boat is necessary to meet project objectives, the services of a subcontractor will be obtained to supply the boat and operator. The field samplers should be aware of safety precautions associated with this sample procedure. Subcontractors will provide a safety plan and training of team members prior to sampling. Refer to the project Health and Safety Plan for safety precautions associated with boating and use of electrofishing equipment.

<u>Supplies</u>

- vessel outfitted for electrofishing and operator
- battery or gas powered shocking unit with safety kill switch
- anode and cathode outriggers
- elbow length rubber lineman's gloves for each team member
- rubber boots for each team member
- polarized sunglasses for each sampling team member
- wood or plastic handle dip nets

Netting Techniques (seines and gillnets)

Fish samples may be collected using seine nets or gill nets if these techniques are approved. Seine net fishing is done using a seine net that is used to surround fish and enclose them in the net. The seine net hangs vertically in the water with its bottom edge held down by weights and its top edge buoyed by floats. Seine nets can be deployed from the shore as a beach seine, or from a boat. The net is deployed out into the water body using a boat and looped back to the shore capturing fish.

Gill nets are vertical netting normally set in a straight line across the water body to be sampled. Fish are caught in the mesh of the net and retrieved when the net is removed fromt the water. The appropraite net mesh size, or multimesh size should be selected based on the size fish that is target of the sampling task. A higher level of fish mortality is assocatied with gill netting. The length of time that the gill nets are set should be established for each sampling task. Gillnet are deployed from the bow of a boat run in reverse. Floats to mark the location of the net and are used to retrieve the net. In most cases nets are deployed perpendicular to the shore.

Supplies

- Seine net
- Gill net
- Boat
- Net anchors and floats

5.3.3 FIELD SAMPLE PREPARATION, STORAGE, AND SHIPPING

Data from edible portions of catchable size specimens will be analyzed for PFCs. A sample will consist of a single fish composite consisting of 3 to 5 individual fish collected from each designated sampling location. Information on the Fish Sample Collection Record will be recorded for each fish including the length and weight of each fish included in the composite. Once all information on individual fish is recored, the composite group of 3 to 5 fish will be wrapped together as a single field sample in HDPE or polypropylene bags. The sample will be frozen on-site and stored in a secure location until shipment to the laboratory. Samples will be labeled with the following information:

- Project number and name;
- Field Sample ID;
- Time and date collected;
- Analytical method; and
- Sampler initials.

Samples will remain frozen until shipment to the laboratory. Frozen samples will be placed on dry ice in an insulated cooler when shipped to the laboratory. Sufficient dry ice will be present in each cooler to ensure that samples remain frozen until delivered to the laboratory. Typically, an amount of dry ice equal to one third of the total cooler volume will be adequate for this purpose. Chain-of-custody (COC) forms will be completed, copied, sealed in HDPE or polypropylene bags, and shipped with fish samples to the laboratory. Copies of all forms will be maintained in project files.

POREWATER SAMPLING SOP
AFW-16 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of pore water samples for perfluorinated compound (PFC) chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all pore water samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel and subcontractors with the responsibility for determining water quality in the field and for the collection, preparation, preservation, and submittal of surface water samples for laboratory analyses.

3.0 REFERENCES

Maine Department of Environmental Protection (ME DEP), 2009, *Protocol for Groundwater/Surface Water Interface Sampling Using a Pore Water Sampler*, RWM-DR-023, April.

Syracuse Research Corporation, ESC, 2001, *Technical Standard Operating Procedure: Porewater Sampling*, SCR-OGDEN-01, July.

U.S. Environmental Protection Agency (EPA), 2013, Pore Water Sampling Operating Procedure, SESDPROC-513-R2, February.

U.S. Environmental Protection Agency (EPA), 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14, September.

EPA, 1988, *EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01, August.

4.0 DEFINITIONS

Drive Point Piezometer – A drive point piezometer is a 6-inch long stainless steel pipe with holes in it that are screened to allow pore water to flow into the sampler. The top of the sampler has a ¾ inch NPT coupling on top for attaching pipe to drive the sampler into the substrate using a slide hammer. Inside the coupling is a barbed fitting used to attach silicon tubing to draw out the sample. Drive-point piezometers typically are used for single use installations only.

Peristaltic Pump – A peristaltic pump is a self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement that causes water to be drawn through the tubing. The peristaltic pump is limited to sampling at depths of less than 25 feet. (Note: Amec Foster Wheeler will use peristaltic pumps for all well sampling at depths 25 feet or shallower, utilizing silicon and HDPE sample tubing only).

Pore Water Observation Device (POD) – A POD pore water sampler constructed of two nested PVC slotted screens, an inner and an outer, silicon tubing is attached to the inner screen for sample collection. The inner screen is constructed of a section of 1-inch diameter slotted screen. The inside screen is constructed of a section of 2-inch slotted screen. The annular space between the two nested screens is filled with filter sand. The samplers are approximately 3 inches long with length of silicon tubing inserted through the caps on the outer and inner screen from which the sample is drawn.

Power Supply – A 12-volt power supply will be necessary to operate the peristaltic pump.

Push Point Sampler – A push point pore water sampler is comprised of a strengthening rod and the pore water sampler itself, both made of stainless steel. The pore water sampler is a hollow tube slotted at its tip to allow pore water to percolate through. The strengthening rod slides into the pore water sampler, and while in place, blocks all water from entering the pore water sampler during installation of the device.

Sample Collection Containers – These will be provided by the lab, and will vary depending on parameters to be sampled.

Tubing – High density polyethylene (HDPE) and Silicon tubing of one-quarter inch outside diameter is the standard size tubing used in conjunction with peristaltic pumps. This size tubing should also be used to connect the peristaltic pump to the pore water sampler.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved with pore water sampling. Proper pore water sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with installation-specific work plans. The project work plans will generally provide the following information:

- Sample collection objectives;
- Locations of pore water samples to be collected;
- Numbers and volumes of samples to be collected;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control (QC) procedures and sampling required;
- Any additional pore water sampling requirements or procedures beyond those covered in this SOP, as necessary; and,
- At a minimum, the procedures outlined in this SOP for pore water sampling will be followed.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to pore water sampling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 FIELD PROCEDURES/CONSIDERATIONS

The following are procedures/considerations to be made during field activities at potential PFC release areas.

5.2.1 EQUIPMENT SELECTION AND SAMPLING CONSIDERATIONS

Purging and sampling equipment is constructed from a variety of materials. The most inert material (e.g. stainless steel, silicone, and HDPE), with respect to known or anticipated contaminants at the investigation area, will be used whenever possible. The various types of purging and sampling equipment available for pore water sampling are described in *Pore Water Sampling Operating Procedure (EPA, 2013).*

For PFC sampling Amec Foster Wheeler will use peristaltic pumps with silicon and HDPE tubing for pore water sample collection. Amec Foster Wheeler will use push point samplers, PODs and/or, drive point piezometers. Push point samplers and drive point piezometers are constructed of stainless steel and inherently lack any PFC containing material, and have been successfully utilized at other PFC sites. The PODs are constructed of slotted PVC pipe and silicon tubing and will not contribute PFCs to the samples. Push point samplers are temporary points whereby they are inserted in the sediment, sampled, and then removed. PODs and drive point piezometers are permanent (i.e., dedicated) sample points that are typically installed at a sample location and left in place, which is more conducive to collection of pore water over multiple sampling events.

If non-dedicated sampling equipment is to be used and the contaminant histories of the sample locations are known, it is advisable to establish a sampling order starting with the least contaminated area and progressing to the most contaminated last.

5.2.2 GENERAL SAMPLING PROCEDURES

Purging and sampling will be conducted as specified in the installation-specific work plans. The standard procedure for pore water purging and sampling using a peristaltic pump is in agreement with procedures described in the *Compendium of Superfund Field Operations Methods* (EPA, 1987) and will be conducted as described below.

- Inspect the equipment to ensure that it is in good working order.
- Calibrate all field analytical test equipment (e.g. pH, specific conductance, dissolved oxygen, oxidation-reduction potential, turbidity, and temperature) according to the instrument manufacturers' specifications or scope-specific work plan. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturers' specifications will be removed from service and tagged.

- Using a push point sampler, carefully insert it into river/streambed to the desired depth (do not remove strengthening rod until instrument has been securely placed in sediment). Using a drive point piezometer, the piezometer is attached to a 4 – foot length of steel pipe (threaded on one end) and a slide hammer is used to install the piezometer to the desired depth. Prior to attaching the steel pipe a length of silicon tubing is attached to the barb fitting at the top of the piezometer. The tubing should be long enough to account for the depth of water and depth the sampler is installed, so the tubing is above the level of the water at the sample locations. Using at POD sampler, a small hole is excavated in the sediment and the sampler installed and backfilled with native sediment. The pore water sampler should be inserted deep enough so as to ensure the sample collected will contain only groundwater and no surface water (between 8 to 12 inches).
- Remove the strengthening rod from the push point sampler and connect pore water sampler to peristaltic pump using appropriate tubing (i.e., silicon and HDPE). The peristaltic pump is connected to the tubing attached to the sampler when using the drive point piezometer or the POD.
- Turn pump on and purge water for several minutes until purge water is relatively clear. Once the water appears clear field parameters are collected from the sampler and the overlying surface water. A difference between the dissolved oxygen (DO) should be observed to insure that pore water is being collected, pore water should have a lower DO than the overlying surface water.
- After water has been sufficiently purged, decrease pumping rate if necessary and begin collecting sample. Pumping rate should be low enough to ensure that surface water is not drawn down into the sample.
- If the formation intercepted by the screen is not transmissive enough for sample collection, gently advance and/or pull back the sampler in an attempt to find a more transmissive zone. If the formation does not allow adequate transmission of water, it may require a change in sampling location. This change should be made at the discretion of the sampler and should be documented in field notes.
- Neither the tubing nor the pore water sampler should be reused at subsequent sampling locations without appropriate decontamination. Do not put the strengthening rod back in the pore water sampler once sample has been collected, as sediment in the sampler must be flushed out first and properly decontaminated.
- If pore water sampling is to be repeated, use of permanent pore water samplers should be considered. The sampling point should be marked in a permanent manner. Additionally, all points should be located/identified with a global positioning system

(GPS).

- Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.
- Document each sample on a Pore Water Collection Form.
- Appropriately seal, store, handle, and ship samples per SOP AFW-11.

RESPONSE TO PFC TESTING OF PRIVATE WATER SUPPLIES

SOP AFW-17 (PFCs)

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures by which Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) personnel should respond following the sampling and analysis of perfluorinated compounds (PFCs) in private water supply wells. Proper procedures are necessary to assure timely, comprehensive response to PFC contamination of private water wells. Additional specific procedures and requirements will be provided in installation-specific work plans and/or field work notifications, as applicable. Response protocol are provided for three scenarios:

United States (U.S.) Environmental Protection Agency (USEPA) Provisional Health Advisories (PHAs) have been developed for two PFCs: perfluoroctanesulfonic acid (PFOS) at 0.2 micrograms per liter (µg/L) and perfluorooctanoic acid (PFOA) at 0.4 µg/L. This SOP details response protocol based on comparison of PFC test data for private water supply wells to the PHAs.

2.0 SCOPE

This procedure applies to all Amec Foster Wheeler personnel involved in the response to sampling results obtained from private water supplies. This procedure has been developed to serve as management-approved professional guidance for the Amec Foster Wheeler Program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviation from this procedure in planning or in the execution of planned activities must be approved by the USAF.

3.0 REFERENCES

Amec Foster Wheeler, 2015. *Working Copy Site Investigation of Potential Perfluorinated Compounds (PFC) Release Areas at Multiple United States Air Force USAF) Base Realignment and Closure (BRAC) Installations, Quality Program Plan,* December.

American Water Works Association, 2010. *Plan Talk About Drinking Water*, Fifth Edition.

Code of Federal Regulations (CFR), Title 40: *Protection of Environment*, Chapter I: *Environmental Protection Agency*, Subchapter D: *Water Programs*, Part 141: *National Primary Drinking Water Regulations*.

USEPA, 2009. *Provisional Health Advisories for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS)*, January 8.

4.0 DEFINITIONS

Owner – The owner of a private water supply well providing potable water to a residence, business, or other end user of the water supply; refer to definition of Private Water Supply Well.

PFC Treatment System – A treatment system proven to be effective in the treatment of PFC-contaminated groundwater, whereby PFOA and PFOS are reduced to concentrations below the USEPA PHAs.

Potable Water – Water that meets the standards for drinking purposes of the State or local authority having jurisdiction, or water that meets the standards prescribed by the USEPA's National Primary Drinking Water Regulations (40 CFR 141).

Private Water Supply Well – A well that can serve as a private drinking water system, has fewer than 15 individual connections, or regularly serves an average of less than 25 individuals for less than 60 days out of the year. This definition is generally accepted industry-wide. However, the definition should be confirmed with the local and state regulatory authorities where the work is being conducted. Installation-specific definitions should be included in the installation-specific work plans.

5.0 PROCEDURES

This section contains both the responsibilities and procedures involved in responding to PFC-contaminated private water supplies. The details within this SOP should be used in conjunction with installation-specific work plans. The installation-specific work plans will generally provide the following information relating to sampling, which may be required as part of the response protocol of this SOP:

- Sample collection objectives;
- Sample locations;
- Types of chemical analyses to be conducted for the samples;
- Specific quality control procedures for sampling; and,
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary.

5.1 RESPONSIBILITIES

Base Lead

The Base Lead is responsible for ensuring that response to PFC-contaminated private water supplies and associated sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Base Lead will guide the appropriate response to PFC-contaminated private water supplies and select the appropriate sampling methodology and analytical program based on the objectives of any required sampling.

Field Lead

The Field Lead is responsible for periodic observation of field activities and review of field generated documentation associated with this SOP. The Field Lead is also responsible for implementation of corrective action (e.g., retraining personnel, additional review of work plans and SOPs, variances to QA/QC requirements, issuing non-conformances, etc.) if problems occur.

Field Personnel

Field personnel assigned to PFC-contaminated private water supply response and related sampling activities are responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from procedures to the Base Lead or Field Lead.

5.2 METHOD SUMMARY

The priority for response to PFC-contaminated private water supplies is the protection of human health. This priority necessitates timely implementation of response measures, including data validation, notification, and coordination with the U.S. Air Force (USAF) and well owner, potable water supply replacement and follow-up sampling, among others. This SOP includes specific timelines for response to help assure timeliness and accountability of PFC program managers, data analysts, and field team members.

This SOP cross-references procedures for sampling private water supply wells (SOP AFW-13) and groundwater treatment systems (SOP AFW-09). The method also relies on the PFC response flow charts attached in **Appendix A**. The timeframes for response referenced in **Appendix A** are to be followed to the fullest extent feasible; any variations from these timeframes requires advanced notification and approval by the USAF. Any exceptions from the timeline must be documented.

5.3 FIELD PROCEDURES

This SOP for response to PFC-contaminated private water supplies includes three phases:

- Phase 1: Initial Test Round;
- Phase 2: Retesting; and,
- Phase 3: Water Supply Replacement.

The basic steps for response under each phase are provided in the flow charts included in **Appendix A**.

5.3.1 Phase 1: Initial Test Round

Initial Private Water Supply Sampling

Sampling of private water supplies for PFCs will be initiated in response to the requirements of an installation-specific work plan or other Air Force-driven initiative. Sampling of private water supplies will be conducted in accordance with SOP AFW-13, *Private and Public Water Supply Well Sampling*. Samples will be shipped to a certified laboratory (as presented in the QPP) for analysis. A standard turnaround time of ten working days will be requested for the initial round of samples.

As shown on **Appendix A**, response to the results of initial water supply sampling will fall under three scenarios:

- Scenario 1: PFCs not detected above laboratory detection limits;
- Scenario 2: PFCs detected at concentrations below PHAs; and
- Scenario 3: PFCs detected at concentrations $\geq$ PHAs.

Data Validation

Data validation is essential for assuring risk-related decisions are based on representative data. Given the necessity for timely response to PFC-contaminated private water supplies, data validation may include preliminary verbal reports. Final data validation must follow standard practices under the Quality Program Plan.

Notification

Scenarios 1 & 2: For scenarios where PFCs are not detected above laboratory reporting limits or are detected at concentrations below PHAs, notification is made to the USAF by telephone and a letter is sent to the Owner using notification letter templates A and B **(Appendix B)**, respectively, within 7 days.

Scenario 3: Under Scenario 3 where PFCs are detected at concentrations at or above PHAs, expedited data validation shall be promptly followed by notification to USAF by telephone, and with USAF approval, notification to the Owner by telephone within 4 hours of data receipt. The telephone notification shall include:

- The recommendation to discontinue use of the private water supply;
- Bottled water will be provided within 24 hours;
- The water supply will be retested to confirm the results;
- A discussion of water supply replacement options;

- USAF telephone number and contact for additional information; and
- Written notification of the test results.

Written notification shall follow within 7 days of data receipt using letter format C (**Appendix B**). Communications with Owners should follow the outreach guidance provided by the Frequently Asked Questions and PFC Talking Points in **Appendix C**.

Given the varied agencies and governmental departments involved across regions of the United States, the USAF shall be consulted on a case-by-case basis on the approach and timing for notifications to regulatory and municipal authorities.

Potable Water Supply Replacement

For properties where a PFC-contaminated water supply is identified, a temporary potable water alternative must be provided within 24 hours of test data receipt. This supply is likely to consist of bottled water, such as that provided by a local water service company with automated delivery. In accordance with recommendations of the American Water Works Association (2010), a minimum of one gallon of water per day, per person, shall be initially provided; the quantity of water should be adjusted based on follow-up with the Owner. The temporary water supply shall be provided until water treatment system installation and confirmation of treatment system efficacy. The USAF is to assume the financial responsibility of providing the potable water supply replacement.

5.3.2 Phase 2: Response Following Retesting

Retesting of Private Water Supply

Retesting of private water supplies shall occur within 24 hours of initial data receipt when PFC concentrations are detected at or above the PHAs. Samples will be shipped to a certified laboratory (as presented in the QPP) for analysis and a turnaround time of 5 working days will be requested for the retesting samples. Response following retesting is outlined in **Appendix A**.

If PFC concentrations during retesting are confirmed to remain at or above PHAs, notification shall be made to the USAF and Owner by telephone within 24 hours of data receipt. A review of water supply replacement options should be coordinated with the USAF and Owner within 7 days of data receipt, and the preferred alternative should be initiated with USAF approval. The Owner shall be notified of the results in writing using letter Format D within 7 days of data receipt (**Appendix B**).

If PFC concentrations during retesting are below PHAs, the USAF shall be notified and next steps coordinated within 24 hours. Coordination is required in response to the discrepancy between the initial and retest results (i.e., one round with concentrations at or above PHAs, one round with concentrations below). Discussions with the USAF should include possible causes for data variability and related responses (e.g., inherent variability in water quality, variability inherent in the test method, and cross-contamination).

5.3.3 Phase 3: Water Supply Replacement

Treatment System Installation

For scenarios where PFCs are detected at or above PHAs, long-term water supply replacement options shall be evaluated. The two primary alternatives include connection to a public water supply, if available, and installation of a water treatment system. If connection to a public water supply is feasible and approved by the USAF and Owner, steps toward implementation shall be initiated as soon as feasible.

If connection to a public water supply is not feasible, or approved by USAF or the Owner, Owner authorization for installation of a water treatment system at the Owner's property shall be requested. If authorized by the Owner, a treatment system shall be installed within 30 days of initial test data receipt under Phase 1. A treatment system typically includes three granular activated carbon (GAC) filters in series, a water flow meter, and multiple sampling ports; use of PFC-containing materials is prohibited. Steps for treatment system installation should include:

- Visit to the Owner's property by the treatment system installer (Installer) to evaluate access and available space for system installation;
- Collection of water samples by the Installer for treatment system design;
- Review and approval of proposed treatment system design by Installer;
- Authorization of a treatment system installation Access Agreement by the USAF and Owner (refer to sample in **Appendix D**);
- Treatment system installation; and,
- Confirmation testing (see below).

Installation of the treatment system shall be monitored and documented by an Amec Foster Wheeler representative.

Confirmation Testing

Treatment system influent and effluent shall be tested for PFCs to confirm that the treatment system is operating as designed (refer to SOP AFW-09 and SOP AFW-13). Water samples should be collected within 3 to 7 days from treatment system start-up, and shall include:

- Well head sample (at closest sample point to the supply well);
- Sample from port between the first and second GAC filters;
- Sample from port between the second and third GAC filters; and

- Sample from the faucet.

A waiting period of at least 3 days is recommended to allow saturation of the GAC and optimization of treatment system efficiency. Confirmation testing samples will be shipped to a certified laboratory (as presented in the QPP) for analysis and a turnaround time of 5 working days will be requested for these samples.

Notification

The USAF and Owner shall be notified by telephone of the results of confirmation testing within 48 hours of data receipt. When testing indicates concentrations of PFCs below PHAs (demonstrating that the treatment system is working effectively), the Owner shall be notified by telephone that private well water can be used for drinking following treatment. USAF approval shall be obtained prior to such notification.

In the unlikely event PFCs are detected at or above PHAs during confirmatory testing, site-specific follow-up will be coordinated with the USAF. For example, the need to evaluate the treatment system by the Installer, potential for cross-contamination, and need for supplemental testing.

Quarterly monitoring

A quarterly monitoring program shall be implemented to evaluate timing for potential PFC breakthrough from the treatment system (i.e., detection of PFCs in water following treatment by one or more GAC filters). The results from the first year of quarterly monitoring will be used to evaluate requirements for GAC filter replacement and future groundwater monitoring requirements, such as a reduction in the frequency of monitoring events.

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APPENDIX E

Field Forms

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Date: ______________________ Installation Name: ______________________________________

Weather (*temp./precipitation*): ________________ Investigation Area:______________________________

Field Clothing and PPE:

☐ Field crew in compliance with Tables 1 and 2; SOP AFW-01

☐ Field crew has not used fabric softener on clothing

☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products on exposed body parts this morning

☐ Field crew has not applied unacceptable sunscreen or insect repellant

Field Equipment:

☐ No Teflon® containing materials on-site

☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene

☐ No waterproof field books on-site other than Rite in the Rain products

☐ No plastic clipboards, binders, or spiral hard cover notebooks on-site

☐ No adhesives (Post-It Notes) on-site

☐ Coolers filled with regular ice only. No chemical (blue) ice packs in possession

Sample Containers:

☐ All sample containers made of HDPE or polypropylene. Samples are not stored in containers made of LDPE

☐ Caps are lined or unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

☐ For personnel in direct contact with samples and/or sampling equipment, wet weather gear made of vinyl, polyurethane, PVC, wax or rubber- coated materials only

Equipment Decontamination:

☐ "PFC-free" water on-site for decontamination of sample equipment

☐ Alconox and Liquinox to be used as decontamination materials

Food Considerations:

☐ No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area

If any applicable boxes cannot be checked, the Field Manager shall describe the noncompliance issues below and work with field personnel to address noncompliance issues prior to commencement of that day's work. Corrective action shall include removal of noncompliance items from the investigation area or removal of worker offsite until in compliance. Repeated failure to comply with PFC sample protocols will result in the permanent removal of worker(s) from the investigation area.

Describe the noncompliance issues (include personnel not in compliance) and action/outcome of noncompliance:

____

____

____

Field Manager Name: _________________________________

Field Manager Signature: ________________________________ Time: _____________________

TAILGATE SAFETY MEETING REPORT

Project Name:	Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations	**Project Number:**	775290218
Contract:	Contract FA8903-08-8766	**Task Order:**	Task Order 0218
Installation:		**Date and Time:**	
Field Manager Name:		**Site Health and Safety Officer (HSO):**	

Safety Meeting Type (circle one)**:** Initial Kickoff Safety Meeting Regular/Daily Tailgate Safety Meeting Unscheduled Tailgate Safety Meeting

Order of Business

Topics Discussed (check all that apply):

- ☐ Site History/Site Layout
- ☐ Scope of Work
- ☐ Personnel Responsibilities
- ☐ Medical Surveillance Requirements
- ☐ Training Requirements
- ☐ Safe Work Practices
- ☐ Logs, Reports, Recordkeeping
- ☐ Sanitation and Illumination
- ☐ Air Surveillance Type and Frequency
- ☐ Monitoring Instruments and Personal Monitoring
- ☐ Action Levels
- ☐ Accident Reporting Procedures
- ☐ Site Control (visitor access, buddy system, work zones, security, communications)
- ☐ Discussion of previous "near misses" including work crew suggestions to correct work practices to avoid similar occurrences
- ☐ Engineering Controls
- ☐ PPE Required/PPE Used
- ☐ Define PPE Levels, Donning, Doffing Procedures
- ☐ Physical Hazards and Controls (e.g., overhead utility lines)
- ☐ Decontamination Procedures for Personnel and Equipment
- ☐ General Emergency Procedures (e.g., locations of air horns and what 1 or 2 blasts indicate)
- ☐ Site/Regional Emergency Procedures (e.g. earthquake response, typhoon response, etc.)
- ☐ Medical Emergency Response Procedures (e.g., exposure control precautions, location of first aid kit, etc.)
- ☐ Hazardous Materials Spill Procedures
- ☐ Applicable SOPs (e.g., Hearing Conservation Program, Safe Driving, etc.)
- ☐ Injury/Illness Reporting Procedures
- ☐ Route to Hospital and Medical Care Provider Visit Guidelines
- ☐ Hazard Analysis of Work Tasks (chemical, physical, biological and energy health hazards and effects)

Safety suggestions by site workers:

Action taken on previous suggestions:

Injuries/accidents/personnel changes since previous meeting:

Observations of unsafe work practices/conditions that have developed since previous meeting:

Location of (or changes in the locations of) evacuation routes/safe refuge areas:

Additional comments:

Attendee signatures below indicate acknowledgment of the information and willingness to abide by the procedures discussed during this safety meeting.

Attendee Name (print)	Company	Signature

Meeting Conducted By (print)**:**	**Title and Company**	**Signature**

FIELD ACTIVITY DAILY LOG

Project Name:	Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations	**Project Number:**	775290218
Contract:	Contract FA8903-08-8766	**Task Order:**	Task Order 0218
Installation:		**Investigation Area:**	
Technician Name:		**Date and Time:**	
Personnel Onsite:			
Weather Conditions:			

Description of Daily Activities and Events:

List Samples Collected:

Deviation from Plans:

Visitors on Site:	**Important Telephone Calls / Photos Taken:**	**Technician Signature:**
		Technician Name (print)**:**

QA/QC'd by: **QA/QC Date:**

IDENTIFICATION AND DESCRIPTION OF SOILS IN THE FIELD USING THE VISUAL-MANUAL PROCEDURE

Group Symbol						Group Name
CL (LEAN CLAY)	<30% plus No. 200	<15% plus No. 200				LEAN CLAY
		~15-25% plus No. 200	% sand ≥ % gravel			LEAN CLAY WITH SAND
			% sand < % gravel			LEAN CLAY WITH GRAVEL
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel			SANDY LEAN CLAY
			≥ 15% gravel			SANDY LEAN CLAY WITH GRAVEL
		% sand < % gravel	<15% sand			GRAVELLY LEAN CLAY
			≥ 15% sand			GRAVELLY LEAN CLAY WITH SAND
CH (FAT CLAY)	<30% plus No. 200	<15% plus No. 200				FAT CLAY
		~15-25% plus No. 200	% sand ≥ % gravel			FAT CLAY WITH SAND
			% sand < % gravel			FAT CLAY WITH GRAVEL
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel			SANDY FAT CLAY
			≥ 15% gravel			SANDY FAT CLAY WITH GRAVEL
		% sand < % gravel	<15% sand			GRAVELLY FAT CLAY
			≥ 15% sand			GRAVELLY FAT CLAY WITH SAND
ML (SILT)	<30% plus No. 200	<15% plus No. 200				SILT
		~15-25% plus No. 200	% sand ≥ % gravel			SILT WITH SAND
			% sand < % gravel			SILT WITH GRAVEL
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel			SANDY SILT
			≥ 15% gravel			SANDY SILT WITH GRAVEL
		% sand < % gravel	<15% sand			GRAVELLY SILT
			≥ 15% sand			GRAVELLY SILT WITH SAND
MH (ELASTIC SILT)	<30% plus No. 200	<15% plus No. 200				ELASTIC SILT
		~15-25% plus No. 200	% sand ≥ % gravel			ELASTIC SILT WITH SAND
			% sand < % gravel			ELASTIC SILT WITH GRAVEL
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel			SANDY ELASTIC SILT
			≥ 15% gravel			SANDY ELASTIC SILT WITH GRAVEL
		% sand < % gravel	<15% sand			GRAVELLY ELASTIC SILT
			≥ 15% sand			GRAVELLY ELASTIC SILT WITH SAND
OL/OH (ORGANIC SOILS)	<30% plus No. 200	<15% plus No. 200				ORGANIC SOIL
		~15-25% plus No. 200	% sand ≥ % gravel			ORGANIC SOIL WITH SAND
			% sand < % gravel			ORGANIC SOIL WITH GRAVEL
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel			SANDY ORGANIC SOIL
			≥ 15% gravel			SANDY ORGANIC SOIL WITH GRAVEL
		% sand < % gravel	<15% sand			GRAVELLY ORGANIC SOIL
			≥ 15% sand			GRAVELLY ORGANIC SOIL WITH SAND
SAND (% sand > % gravel	≤5% fines	Well-graded		**SW**	< 15% gravel	WELL-GRADED SAND
					≥ 15% gravel	WELL-GRADED SAND WITH GRAVEL
		Poorly-graded		**SP**	< 15% gravel	POORLY-GRADED SAND
					≥ 15% gravel	POORLY-GRADED SAND WITH GRAVEL
	~10% fines	Well-graded	fines = ML or MH	**SW-SM**	< 15% gravel	WELL-GRADED SAND WITH SILT
					≥ 15% gravel	WELL-GRADED SAND WITH SILT AND GRAVEL
			fines = CL or CH	**SW-SC**	< 15% gravel	WELL-GRADED SAND WITH CLAY
					≥ 15% gravel	WELL-GRADED SAND WITH CLAY AND GRAVEL
		Poorly-graded	fines = ML or MH	**SP-SM**	< 15% gravel	POORLY-GRADED SAND WITH SILT
					≥ 15% gravel	POORLY-GRADED SAND WITH SILT AND GRAVEL
			fines = CL or CH	**SP-SC**	< 15% gravel	POORLY-GRADED SAND WITH CLAY
					≥ 15% gravel	POORLY-GRADED SAND WITH CLAY AND SAND
	≥15% fines		fines = ML or MH	**SM**	< 15% gravel	SILTY SAND
					≥ 15% gravel	SILTY SAND WITH GRAVEL
			fines = CL or CH	**SC**	< 15% gravel	CLAYEY SAND
					≥ 15% gravel	CLAYEY SAND WITH GRAVEL
GRAVEL (% gravel > % sand)	≤5% fines	Well-graded		**GW**	< 15% sand	WELL-GRADED GRAVEL
					≥ 15% sand	WELL-GRADED GRAVEL WITH SAND
		Poorly-graded		**GP**	< 15% sand	POORLY-GRADED GRAVEL
					≥ 15% sand	POORLY-GRADED GRAVEL WITH SAND
	~10% fines	Well-graded	fines = ML or MH	**GW-GM**	< 15% sand	WELL-GRADED GRAVEL WITH SILT
					≥ 15% sand	WELL-GRADED GRAVEL WITH SILT AND SAND
			fines = CL or CH	**GW-GC**	< 15% sand	WELL-GRADED GRAVEL WITH CLAY
					≥ 15% sand	WELL-GRADED GRAVEL WITH CLAY AND SAND
		Poorly-graded	fines = ML or MH	**GP-GM**	< 15% sand	POORLY-GRADED GRAVEL WITH SILT
					≥ 15% sand	POORLY-GRADED GRAVEL WITH SILT AND SAND
			fines = CL or CH	**GP-GC**	< 15% sand	POORLY-GRADED GRAVEL WITH CLAY
					≥ 15% sand	POORLY-GRADED GRAVEL WITH CLAY AND SAND
	≥15% fines		fines = ML or MH	**GM**	< 15% sand	SILTY GRAVEL
					≥ 15% sand	SILTY GRAVEL WITH SAND
			fines = CL or CH	**GC**	< 15% sand	CLAYEY GRAVEL
					≥ 15% sand	CLAYEY GRAVEL WITH SAND

IDENTIFICATION AND DESCRIPTION OF SOILS IN THE FIELD USING THE VISUAL-MANUAL PROCEDURE

GRAIN SIZE

Clear Square Sieve Openings — U.S. Standard Series Sieve

	12"	3"	3/4"	4	10	40	200	
SOILS	Boulders	Cobbles	Gravel		Sand			Silts & Clays
			Coarse	Fine	Coarse	Medium	Fine	
FILLS	Blocks	Pieces	Fragments		Particles			Specks
	300 mm	75 mm	19 mm	4.75 mm	2.0 mm	0.42 mm	0.075 mm	

COLOR

Description of soil color from Munsell Chart: *Color Name (Munsell Value_Chroma)*. Example: Brown (10YR 4/3).

MOISTURE CONTENT

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible water.
Wet	Visible free water, usually soil is below the water table.

PLASTICITY

Description	Criteria
Nonplastic	A 1/8" (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.
High	It takes considerable time rolling and kneeding to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

DILATANCY

Description	Criteria
No	No visible change in specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TOUGHNESS

Description	Criteria
Low	Only slight pressure is required to roll a 1/8" (3 mm) thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

DRY STRENGTH

Description	Criteria
No	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between thumb and a hard surface.

CONSISTENCY

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1" (25 mm).
Soft	Thumb will penetrate soil about 1" (25 mm).
Firm	Thumb will indent soil about 1/4" (6 mm).
Hard	Thumb will not indent soil but readily indented with thumbnail.
Very Hard	Thumbnail will not indent soil.

STRUCTURE

Description	Criteria
Stratified	Alternating Layers of varying material or color with layers at least 6 mm thick; note thickness.
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness.
Fissured	Breaks along definite planes of fracture with little resistence to fracturing.
Slickensided	Fracture planes appear polished and glossy, sometimes striated.
Blocky	Cohesive soils that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.
Homogeneous	Same color and appearance throughout.

TEST RESULTS SUMMARY

	Plasticity	Dilatancy	Toughness	Dry Strength
ML	non - low	slow - rapid	low	no - low
MH	low - medium	no - slow	low - medium	low - mediun
CL	medium	no - slow	medium	medium - high
CH	high	no - slow	high	high - very high

DRILLING LOG

DRILLING LOG			BORING/LOCATION ID	INSTALLATION/SITE	
			DRILL SUBCONTRACTOR		SHEET of SHEETS
PROJECT / PROJECT NUMBER Site Investigation of PFC Release Areas at Multiple BRAC Installations, Contract FA8903-08-8766 Task Order 0218 775290218.			DATE STARTED	DATE COMPLETED	
NAME OF DRILLER(S)			SURFACE ELEVATION		
SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT			WELL ELEVATION (TOC)		
			TOTAL DEPTH OF BOREHOLE	DEPTH OF GROUNDWATER ENCOUNTERED	
			OVERBURDEN THICKNESS	DEPTH DRILLED INTO ROCK	
DEPTH TO WATER (DURING DRILLING)			OTHER WATER LEVEL MEASUREMENTS (SPECIFY)		
DISPOSITION OF BORE HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)		
LOCATION SKETCH/COMMENTS				SCALE	

Name/Signature:	Date:
QAQC'd by:	Date:

DRILLING LOG	INSTALLATION/SITE:	BORING/LOCATION ID:
Site Investigation of PFC Release Areas at Multiple BRAC Installations Contract FA8903-08-8766 Project No. 775290218.		SHEET SHEETS OF

DEPTH (feet)	SAMPLES: Sample No.	Sample	Blows/ 6"	DESCRIPTION For Soil: NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency For Rock: type, color, mineralogy, weathering, features, texture		PID READING (ppm)	REMARKS

NAME/SIGNATURE:	DATE:	Page of

Rev. 3, Date: 10/22/2015

ROCK CORING LOG	INSTALLATION/SITE:	BORING/LOCATION ID:
Site Investigation of PFC Release Areas at Multiple BRAC Installations Contract FA8903-08-8766 Project No. 775290218.		SHEET SHEETS OF

Depth (ft bgs)	Sample No.	Sample	Penetration/ Recovery (ft)	Natural Core		Rock Quality				Drill Rate (min/ft)	Color	Rock Description and Comments on Drilling	Graphic Log	Additional Remarks
				Type / Dip	Surface Condition	Weathered Condition	Total 4" Core	RQD (%)	Rock Quality Description					

NAME/SIGNATURE:	DATE:	Page of

Rev. 1, Date: 10/22/2015

WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

amec foster wheeler

Project Name: Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations
Project Number: 775290218
Contract: Contract FA8903-08-8766 **Task Order:** Task Order 0218
Date:
Installation:
Calibration Start Time:
Sample Technician:
Calibration End Time:

Readings Before Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (mg/L)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments

Readings After Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (mg/L)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments

Calibration Materials Record:

pH Calibration Standards			Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards			Turbidity Standards		
Standard	Cal. Standard Lot #	Expiration Date	Standard	Cal. Standard Lot #	Expiration Date	Standard	Cal. Standard Lot #	Expiration Date
pH (4)			Spec. Conductance			10 NTUs		
pH (7)			Salinity			20 NTUs		
pH (10)			D.O.			100 NTUs		
			ORP			800 NTUs		

Instruments (Manufacturer, Model, and Serial No.):

	Manufacturer/Model	Serial No
Water Quality Meter:		
Turbidity Meter:		

Calibrated Within Acceptance Criteria (Y/N):

If No, Provide Explanation:

Notes:

Technician Signature:

Technician Name (print):

QA/QC'd by:

QA/QC Date:

GROUNDWATER SAMPLING RECORD

Project Name:	Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations	**Project Number:**	775290218
Contract:	Contract FA8903-08-8766	**Task Order:**	Task Order 0218
Installation:		**Sample Technician:**	
Well ID:		**Date:**	
Initial Depth to Water:		**Well Diameter (inches):**	
Total Depth of Well:		**1 Casing Volume (gal):**	
Method of Purging:		**3 Casing Volumes (gal):**	
Measuring Point (toc, tor, etc.):		**Pump Intake Depth (feet):**	

Time	Water Level (feet)	Flow Rate (mL/min)	Cum. Volume (gal.)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
			Stabilization Criteria	±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
Stability Reached (Y/N):						If No, Provide Explanation				
			Final Values:							

Sample ID:		**Method of Sampling:**	
MS/MSD Collected:		**Sample Date:**	
Duplicate ID:		**Sample Collection Time:**	
Sample Container Type(s):		**Total Volume Purged:**	
Preservative(s):		**Sample Depth:**	
Analysis/Method(s):		**Depth to Water After Sampling:**	

Instruments (Manufacturer, Model, and Serial No.):

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

Technician Signature:

Notes:

Technician Name (print):

QA/QC'd by: **QA/QC Date:**

SCREENED WELL CONSTRUCTION FORM

Project Name: Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations

Project Number: 775290218

Contract Number: Contract FA8903-08-8766

Task Order: Task Order 0218

Installation: ______

Location ID: ______

Drilling Subcontractor: ______

Well ID: ______

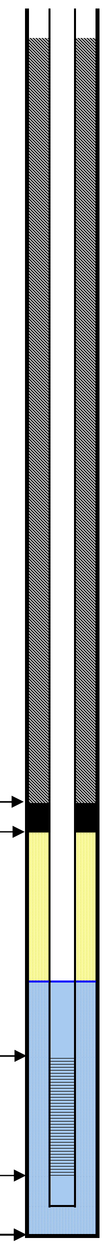
Drilling Personnel: ______

Date: ______

Technician Name: ______

Drilling Method: ______

Other Amec Foster Wheeler Representatives: ______



Measurement Point (riser)
Elevation (ft msl): ______

Land Surface Elevation (ft): ______

Approximate Diameter
of Borehole (in): ______

Depth to Water (ft): ______

During Drilling: ______

Date: ______

Post Development: ______

Date: ______

Hydrologic Unit:
(circle one)

Unknown	Unsaturated Zone
Aquifer	Water Table Aquifer
Bedrock Aquifer	Confining Layer/Aquiclude
Perched Aquifer	Lower/Confined Aquifer

Water added during
drilling (gal): ______

Water removed during
development (gal): ______

Top of Bentonite Seal (ft): ______

Top of Filter Pack (ft): ______

Top of Screen Interval (ft): ______

Bottom of Screened Interval (ft): ______

Bottom of Filter Pack (ft): ______

Bottom of Borehole (ft): ______

Protective Casing:

Type: ______

Dimensions (in): ______

Stickup (ft): ______

Length (ft): ______

Guard Post: ______

Surface Pad:

Dimensions: ______

Type: ______

Annular Seal (grout above well seal):

Material: ______

Installation Method: ______

Bentonite Seal:

Manufacturer: ______

Material: ______

Type: ______

Installation Method: ______

Hydration time (hrs): ______

Filter Pack Material:

Manufacturer: ______

Material: ______

Size: ______

Installation Method: ______

Surging time: ______

Well Casing (Riser):

Manufacturer: ______

Type/Material: ______

Length: ______

Diameter (in): ______

Well Screen:

Manufacturer: ______

Type/Material: ______

Diameter (in): ______

Slot Size (in): ______

Slot Type: ______

Sump/End Cap: ______

Notes:

______

Technician Signature: ______

Technician Name (print):

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).

QA/QC'd by:

QA/QC Date:

OPEN HOLE BEDROCK WELL CONSTRUCTION FORM

Project Name: Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations

Project Number: 775290218

Contract Number: Contract FA8903-08-8766

Task Order: Task Order 0218

Installation: ______

Location ID: ______

Drilling Subcontractor: ______

Well ID: ______

Drilling Personnel: ______

Date: ______

Technician Name: ______

Drilling Method: ______

Other Amec Foster Wheeler Representatives: ______

Measurement Point (riser)
Elevation (ft msl): ______

Land Surface Elevation (ft): ______

Approximate Diameter
of Borehole (in): ______

Depth to Water (ft): ______
During Drilling: ______
Date: ______
Post Development: ______
Date: ______

Water added during
drilling (gal): ______

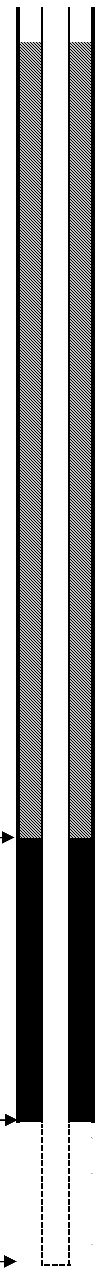
Water removed during
development (gal): ______

Borehole Yield (gpm): ______

Bottom of Overburden /
Top of Bedrock (ft): ______

Casing Depth (ft): ______

Bottom Depth (ft): ______



Surface Pad:
Dimensions: ______
Type: ______

Well Casing:
Manufacturer: ______
Type/Material: ______
Diameter (in): ______

Annular Seal (above BRx):
Manufacturer: ______
Type: ______
Installation Method: ______

Annular Seal (below BRx):
Manufacturer: ______
Type: ______
Installation Method: ______

Notes:

Technician Signature:

Depths and heights are referenced to ground surface unless specified TOC.
All elevations are referenced to MSL (NAVD 88).

Technician Name (print):

QA/QC'd by:

QA/QC Date:

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WELL DEVELOPMENT LOG

Project Name:	Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations	**Project Number:**	775290218
Contract:	Contract FA8903-08-8766	**Task Order:**	Task Order 0218
Installation:		**Sample Technician:**	
Well ID:		**Date:**	
Initial Depth to Water:		**Total Depth of Well:**	
Development Method:		**Depth to Water After Purging:**	
Pump Start Time:		**1 Casing Volume (gal):**	
Total Volume Purged (gal):		**3 Casing Volumes (gal):**	

Time	Intake Depth (feet)	Rate (gpm)	Water Level (feet)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)

Instruments (Manufacturer, Model, and Serial No.):

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

Technician Signature:

Notes:

Technician Name (print):

QA/QC'd by:

QA/QC Date:

SAMPLE COLLECTION LOG
FISH TISSUE

Project Name:	Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations	**Project Number:**	775290218
Contract:	Contract FA8903-08-8766	**Task Order:**	Task Order 0218
Installation:		**Date:**	
Location ID:		**Drainage/Location:**	
Northing:		**Air Temperature (°C):**	
Easting:		**Water Temperature (°C):**	
Water Body Description:		**Weather Conditons:**	
Sample Technician(s):		**Length of Stream Sampled for Specimen Collection (ft):**	

Sampling Technique(s): (check all that apply) ( ) BK electro ( ) Boat electro ( ) Hook/line ( ) Gill net ( ) Seine net ( ) Hand net ( ) Other:

Sample Organism Collected	**Length** (cm)	**Total Mass** (grams)	**Comments**

Location Sketch:

Sample ID:
Sample Date:
Sample Collection Time:
MS/MSD Collected:
Duplicate ID:
Analysis/Method(s):
Sample Container Type(s):
Preservative(s):

Equipment (Manufacturer, Model, and Serial No.):

Notes:

Technician Signature:

Technician Name (print)**:**

QA/QC'd by: **QA/QC Date:**

SAMPLE COLLECTION LOG
PORE WATER

Project Name:	Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations	**Project Number:**	775290218
Contract:	Contract FA8903-08-8766	**Task Order:**	Task Order 0218
Installation:		**Date:**	
Location ID:		**Surface Water Depth (ft):**	
Method of Purging:		**Water Level Depth - Inside (ft):**	
Surface Water Type:		**Water Level Depth - Outside (ft):**	
Northing:		**Easting:**	
Sample Technician(s):			

PORE WATER PARAMETERS

Time	Intake Depth (feet)	Rate (mL/min)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)

SURFACE WATER PARAMETERS

Time	Intake Depth (feet)	Rate (mL/min)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)

Location Sketch:

Sample ID:
Sample Date:
Sample Collection Time:
MS/MSD Collected:
Duplicate ID:
Sample Container Type(s):
Preservative(s):
Analysis/Method(s):
Sample Depth (ft):
Method of Sampling:
Water Quality (circle one): clear cloudy turbid other:

Instruments (Manufacturer, Model, and Serial No.):

Notes:

Technician Signature:

Technician Name (print):

QA/QC'd by: **QA/QC Date:**

SAMPLE COLLECTION LOG
SEDIMENT / SURFACE SOIL / SURFACE WATER

Project Name: Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations
Project Number: 775290218

Contract: Contract FA8903-08-8766
Task Order: Task Order 0218
Installation:
Date:
Location ID:
Sample Technician:
Northing:
Easting:

SEDIMENT SAMPLE

Description
NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

Sample Depth:
Sample ID:
MS/MSD Collected:
Sample Date:
Duplicate ID:
Sample Collection Time:
Sample Container Type(s):
Sample Collection Methods:
Preservative(s):
Analysis/Method(s):

SURFACE SOIL SAMPLE

Description
NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

Sample Depth:
Sample ID:
MS/MSD Collected:
Sample Date:
Duplicate ID:
Sample Collection Time:
Sample Container Type(s):
Sample Collection Methods:
Preservative(s):
Analysis/Method(s):

SURFACE WATER SAMPLE

Time	Intake Depth (feet)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)

Sample Depth:
Sample Date:
Sample ID:
Sample Collection Time:
MS/MSD Collected:
Sample Collection Methods:
Duplicate ID:
Surface Water Depth:
Sample Container Type(s):
Water Body and Water Quality Characteristics (circle all that apply)**:**
Preservative(s):
River Stream Pond Flowing Stagnant
Analysis/Method(s):
Clear Cloudy Turbid Other:

Location Sketch:

Instruments (Manufacturer, Model, and Serial No.):

Notes:

Technician Signature:

Technician Name (print)**:**

QA/QC'd by:
QA/QC Date:

SLUG TEST DATA FORM

Project Name:	Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations	**Project Number:**	775290218
Contract:	Contract FA8903-08-8766	**Task Order:**	Task Order 0218
Installation:		**Sample Technician:**	
Location ID:		**Date:**	
Static Water Level:		**Well Diameter (in):**	
Total Depth of Well:		**Boring Diameter (in):**	
Measuring Point:		**Slug Volume (gal.):**	
Measuring Point to Ground Surface (ft):			

Data Logger File ID	Test Method	Start Time	Start Depth (ft)	Start Time	End Depth (ft)	Comments

Instruments (Manufacturer, Model, and Serial No.):

Calculations:

Saturated well casing volume: V = Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

Additional Notes:

Technician Signature:

Technician Name (print):

QA/QC'd by: **QA/QC Date:**

PRIVATE AND PUBLIC WATER SUPPLY WELL SAMPLE COLLECTION LOG

Project Name: Site Investigation of Potential Perfluorinated Compound (PFC) Release Areas at Multiple BRAC Installations

Project Number: 775290218

Contract: Contract FA8903-08-8766

Task Order: Task Order 0218

Installation:

Date:

Location ID/Address:

Water System (circle one)**:** Private Well Public Water Supply

Technician 1:

Treatment Unit Installed (Y/N):

Technician 2:

Flow Meter Reading (before):

Field Parameters Collected?

Flow Meter Reading (after):

If No, Provide Explanation:

Pressure Tank Reading (psi):

Time	**Temp. (°C)** ±0.5°C	**pH (units)** ±0.1	**Specific Electrical Conductance (mS/cm)** ±3%	**DO (mg/L)** ±10%	**ORP (mV)** ±10%	**Turbidity (NTU)** ±10% and <10 NTU	**Comments/Observations During Purging (color, sediment, odor, etc.)**
Final Values:							

Sample Information

Sample ID	**Sample Date**	**Sample Time**	**Duplicate Collected**	**Location Description**

Preservative(s):

Sample Container Type(s):

Water Quality (circle one)**:** clear cloudy turbid other:

Analysis/Method(s):

Instruments (Manufacturer, Model, and Serial No.):

Notes:

Technician Signature:

Technician Name (print)**:**

QA/QC'd by:

QA/QC Date:

APPENDIX F

Final Inter-Laboratory Comparison Report

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