Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

FINAL REVISION 2
RADIOLOGICAL SCOPING SURVEYS WORK PLAN

Parcel F Structures

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

May 2019

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May 2019

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Acronyms and Abbreviations

α	sigma (variability)
^{90}Sr	strontium-90
^{137}Cs	cesium-137
^{226}Ra	radium-226
^{239}Pu	plutonium-239
ALARA	as low as reasonably achievable
AM	*Final Basewide Radiological Removal Action, Action Memorandum—Revision 2006, Hunters Point Shipyard, San Francisco, California*
AMS	APTIM Management System
APP/SSHP	*Accident Prevention Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*
APTIM	Aptim Federal Services, LLC
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
cm	centimeter
cm/sec	centimeter per second
cm^2	square centimeter
CQCP	contractor quality control plan
CSO	Caretaker Site Office
CTO	contract task order
dpm	disintegration per minute
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
GPS	global positioning system
HPNS	Hunters Point Naval Shipyard
HRA	*Final Historical Radiological Assessment Volume II, History and the Use of General Radioactive Materials, 1939-2003*
IL	investigation level
LLRW	low-level radioactive waste
m/s	meter per second
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*
MDA	minimum detectable activity
MDC	minimum detectable concentration
N	number
NaI	sodium iodide
NAVSEA	Naval Sea Systems Command
Navy	U.S. Department of the Navy
NRDL	Naval Radiological Defense Laboratory

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Acronyms and Abbreviations (continued)

PQCM	Project Quality Control Manager
PRSO	Project Radiation Safety Officer
QC	quality control
RASO	Radiological Affairs Support Office
RCT	radiological control technician
ROC	radionuclide of concern
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RPP	*Radiation Protection Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*
RWP	radiological work permit
RWQCB	California Regional Water Quality Control Board
SAP	sampling and analysis plan
SSHO	Site Safety and Health Officer
SU	survey unit
subpen	submarine pen
UFGS Section 01 35 26	*Unified Facilities Guide Specifications (UFGS) Section 01 35 26 Governmental Safety Requirements*
WMP	waste management plan
Work Plan	Radiological Scoping Surveys Work Plan

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1.0 INTRODUCTION

This Radiological Scoping Surveys Work Plan (Work Plan) presents the tasks and procedures that will be implemented by Aptim Federal Services, LLC (APTIM) during the radiological scoping surveys of the Parcel F structures (submarine pens and finger piers), located at Hunters Point Naval Shipyard (HPNS), San Francisco, California (Figure 1). The scoping surveys are being performed for the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command Southwest, under Contract No. N62473-17-D-0006, Contract Task Order (CTO) N62473-17-F-4550. Base Realignment and Closure Program Management Office West will manage the work elements under this CTO.

Based on the radiological operational history described in the *Final Historical Radiological Assessment Volume II, History and the Use of General Radioactive Materials, 1939-2003* (HRA; Naval Sea Systems Command [NAVSEA], 2004), the Navy determined that low-level radioactive contamination is potentially present at the submarine pens and the finger piers. This decision was presented in the *Final Basewide Radiological Removal Action, Action Memorandum—Revision 2006, Hunters Point Shipyard, San Francisco, California* (AM; Navy, 2006). The purpose of the AM was to document the Navy's decision to perform time-critical removal actions at areas throughout HPNS that could contain localized radioactive contamination and substantially eliminate identified exposure pathways to surrounding populations and nearby ecosystems.

The Navy identified the applicable or relevant and appropriate requirements for the HPNS removal actions, which were presented in Appendix A of the AM (Navy, 2006). The cleanup goals for localized radioactive contamination at HPNS presented in the AM were derived in consultation with federal and state regulators to meet the most conservative requirements at the time the AM was being written.

The HRA (NAVSEA, 2004) lists cesium-137 (^{137}Cs), plutonium-239 (^{239}Pu), radium-226 (^{226}Ra), and strontium-90 (^{90}Sr) as the radionuclides of concern (ROCs) for the Parcel F structures (Table 1). The radiological release criteria for each ROC are also provided in Table 1. For alpha measurements, the most restrictive release criterion for alpha-emitting ROCs is 100 disintegrations per minute (dpm)/100 square centimeters (cm^2) for ^{226}Ra and ^{239}Pu. For beta measurements, the most restrictive release criterion for beta-emitting ROCs is 1,000 dpm/100 cm^2 for ^{90}Sr.

The objective of this Work Plan is to describe radiological scoping surveys designed to provide results with sufficient quantity and quality to meet the requirements of a final status survey. The data will be presented in reports and used to support future site decisions for Parcel F structures. The Parcel F structures include the submarine pens (Drydocks 5, 6, and 7 and associated Ship Berths 61, 62, 63, and 64; Figure 2) and the finger piers (Finger Piers 1, 2, and 3 and associated Ship Berths 23 through 28, 30 through 35, and 37 through 42; Figure 3).

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1.1 Project Scope

The scope of the planned activities consists of the following elements:

- Develop the Work Plan and associated appendices
- Conduct radiological scoping surveys of the Parcel F structures (Figures 2 and 3)
- Prepare Parcel F scoping survey reports

1.2 Site Safety

Field activities will be conducted in accordance with the *Accident Prevention Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California* (APP/SSHP; APTIM, 2017a). Applicable federal and California Occupational Safety and Health Administration regulations and permit requirements will be followed, as well as the *Safety and Health Requirements Manual EM 385-1-1* (U.S. Army Corps of Engineers, 2014) and *Unified Facilities Guide Specifications (UFGS) Section 01 35 26 Governmental Safety Requirements* (UFGS Section 01 35 26; Naval Facilities Engineering Command, 2015).

1.3 Radiation Protection Program

The *Radiation Protection Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California* (RPP; APTIM, 2017b) defines the requirements for radiological protection support work performed by APTIM at HPNS. An overview of the performance of radiological hazard analysis and controls, analysis of smears, internal and external dosimetry, and other matters regarding radiation protection is presented in the RPP (APTIM, 2017b). For radiological activities, APTIM will invoke U.S. Nuclear Regulatory Commission License 20-31340-01 and California State Radiological License 7889-07 to perform this work at HPNS. APTIM will also establish areas of control under a Memorandum of Understanding with the HPNS low-level radioactive waste Brokering Company and any other Navy contractors as required. The intent of the Memorandum of Understanding is to outline the general applicability and responsibilities of each entity as applicable to corresponding work scope and license compliance parameters.

APTIM's policy is that radiological work, including work with radioactive materials or ionizing radiation, be purposeful and performed in a manner that protects workers, members of the general public, and the environment. Exposures to ionizing radiation and releases of radioactive material shall be managed to reduce individual and collective doses to workers and the public and ensure that exposure is as low as reasonably achievable (ALARA). Work involving radiological hazards may not begin unless that work can be performed in a safe manner, compliant with rules and regulations. Moreover, APTIM endorses and applies ALARA principles. The ALARA principle is integrated in activities described in this Work Plan and will be implemented during the course of the work carried out under this Work Plan.

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Project participants with the intent to enter a posted Restricted Area must successfully complete site-specific radiation worker training. The participants must also be briefed on the RPP (APTIM, 2017b), and sign acknowledgement that the participant has read and understands the requirements.

All employees working at the site have authorization to stop work if an unsafe condition exists or a safety procedure is being disregarded in accordance with *APTIM Management System* (AMS), AMS-710-05-PR-00400, "Stop Work Authority" (APTIM, 2017c).

1.4 Work Plan Organization

This Work Plan consists of 10 sections and provides descriptions of the specific activities involved in the implementation of the survey work. This Work Plan is organized as follows:

- Section 1.0, "Introduction"—Section 1.0 provides an introduction, project scope and schedule, site safety, radiological controls, and the Work Plan organization.
- Section 2.0, "Site Conditions and Background"—Section 2.0 presents the site location, description and history, and the nature and extent of contamination.
- Section 3.0, "Regulatory Framework"—Section 3.0 describes the regulatory process, project objectives, and anticipated waste streams.
- Section 4.0, "Project Requirements"—Section 4.0 describes the required supporting project documents.
- Section 5.0, "Survey Design"—Section 5.0 describes the process for survey design and data quality objectives (DQOs).
- Section 6.0, "Pre-Field Work Activities"—Section 6.0 describes permitting and notification requirements, meetings, mobilization, and site preparation activities.
- Section 7.0, "Scoping Surveys Field Work"—Section 7.0 describes field investigation activities, site restoration, decontamination, waste management, and demobilization activities.
- Section 8.0, "Project Management Plan"—Section 8.0 describes the key project personnel, document control, meetings and reports, and the project schedule.
- Section 9.0, "Reporting Requirements"—Section 9.0 describes the reporting requirements.
- Section 10.0, "References"—Section 10.0 includes a list of documents used to compile this Work Plan.

Appendices A through E—The Sampling and Analysis Plan (SAP), Contractor Quality Control Plan (CQCP), Waste Management Plan (WMP), the gamma scan minimum detectable concentration (MDC) basis, and responses to comments are included as Appendices A, B, C, D, and E, respectively.

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2.0 SITE CONDITIONS AND BACKGROUND

This section presents the site location, site description and history, and the nature and extent of contamination.

2.1 Site Location

The HPNS is located in southeastern San Francisco on a peninsula that extends east into the San Francisco Bay (Figure 1). The HPNS consists of 866 acres: 420 acres on land and 446 acres under water in the San Francisco Bay. Parcel F comprises approximately 446 acres offshore of HPNS.

The Parcel F structures include the submarine pens and the finger piers. The submarine pens (Drydocks 5, 6, and 7 and associated Ship Berths 61, 62, 63, and 64) are located in Parcel F and extend from Parcel B-1 (Figure 2). The finger piers (Finger Piers 1, 2, and 3 and associated Ship Berths 23 through 28, 30 through 35, and 37 through 42) are located in Parcel F and extend from Parcel D-1 (Figure 3). The Parcel F structures extend a few feet inland from the water edge and include concrete structures, utility pads, vaults, and other infrastructure (e.g., open and closed manholes, buildings on the finger piers, and other debris).

2.2 Site Description and History

Submarine pen Drydocks 5, 6 and 7 and associated Ship Berths 61, 62, 63, and 64 were built in 1944 for submarine repair, and were also capable of housing destroyers and other relatively small vessels. Drydocks 5 and 7 are each approximately 420 feet long by 60 feet wide, and Drydock 6 is approximately 420 feet long by 75 feet wide. The drydocks were each equipped with a gate (caisson) that was hinged at the bottom that flapped down to allow the vessel to enter. Each drydock was dewatered by four 20,000 gallons per minute pumps. Two pumps were located at each side of the San Francisco Bay end of the dock (NAVSEA, 2004). Historical drawings show a suction tunnel running across the drydock between the two sets of pumps. Drydocks 5 and 7 could be dewatered in one hour with no ship in the dock using all pumps at full capacity. Drydock 6, due to its larger size, required approximately 1 hour and 20 minutes to dewater. The pumps are not currently visible at the site and are presumed to have been removed. The docks were flooded by means of two 3-foot hydraulically operated flooding valves located on each side of the San Francisco Bay end of the dock. Flooding times were 45 minutes for Drydocks 5 and 7 and one hour for Drydock 6. There are no utility drawings available for the submarine pens (subpens).

The following radiological operations were performed at Drydocks 5, 6, and 7 and associated Ship Berths 61, 62, 63, and 64:

- Decontamination of Operation Crossroads ships in Drydock 6, potential decontamination of Operation Crossroads ships in Drydock 5 and Drydock 7

- Ship repair (submarines)
- Naval Nuclear Propulsion Program operations in Drydock 6

The following radiological operations were performed at Finger Piers 1, 2, and 3 and associated Ship Berths 23 through 28, 30 through 35, and 37 through 42:

- Berthing of Operation Crossroads ships
- Berthing of YGN-73 radioactive waste disposal barge
- Berthing of Naval Radiological Defense Laboratory (NRDL) experimental barges and YAG-39 and YAG-40 (ships used to support and study the effects of nuclear and atomic weapons tests)

Radiological operations generally performed at HPNS that could impact the submarine pens and finger piers included the use of generally licensed radioactive material, including handling and refurbishment of radioluminescent devices. Other activities involving radioactive material included gamma radiography, and calibration of radiation detection instruments. There are no records indicating that wastes, including radioactive wastes, were stored at either the submarine pens or the finger piers.

In 2012, the Navy performed a removal action that included Ship Berths 61 and 64 in the submarine pens. The objective of the removal action was to remove radiologically impacted over-water structures that were dilapidated, dropping debris into the San Francisco Bay, and the debris that presented hazards to navigation in the San Francisco Bay (ERS Joint Venture, 2012). Radioactive material was not encountered during the course of the removal action, and no radioactive waste was generated.

2.3 Nature and Extent of Contamination

A history of Navy radiological operations at HPNS is provided in the HRA (NAVSEA, 2004). Radioluminescent devices were used on ships and in shipyards to provide markers that could be seen under low-light conditions. These radioluminescent devices included ^{226}Ra or ^{90}Sr as a source of radioactivity to generate light using these devices. There is a low probability that intact radioluminescent devices could still be present at the submarine pens and the finger piers. However, it is more likely traces of radioactivity from damaged, discarded, or lost devices could be present on surfaces associated with the Parcel F structures, although the probability of residual radioactivity from radioluminescent devices is still low.

Drydocks and ship berths were decontaminated and surveyed following maintenance and decontamination of radiologically impacted ships. Sandblast material was removed and disposed of as described in Section 6.4.1 of the HRA (NAVSEA, 2004). After removal of the sand, the drydock floor was vigorously washed and the water pumped into the harbor. The drydocks were surveyed and met the criteria for release. ROCs from nuclear and atomic weapons tests would include a mixture of fission

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products, activations products, and actinides. ^{137}Cs and ^{239}Pu were selected as ROCs most likely to be present and most likely to be detected as contamination at HPNS. Radioactivity from contaminated ships is most likely to occur where contaminated ship surfaces could come into contact with drydocks or piers. Surveys of the drydocks following decontamination operations failed to identify areas of elevated radioactivity, so the probability of residual radioactivity from contaminated ships at the submarine pens or finger piers is low.

Radioactive wastes from NRDL and ship decontamination activities were loaded on barges at HPNS and transported for disposal in the ocean. Radioactive wastes included sandblasting residue from ship decontamination activities, as well as waste from NRDL laboratories and experiments (NAVSEA, 2004). Expected radiological waste constituents include a mixture of fission products, activation products, and actinides. ^{137}Cs and ^{239}Pu were selected as representative ROCs. Radioactive wastes were typically sealed in drums or other packages for transport, and may have been staged on piers or alongside ship berths prior to loading the waste onto the barges. The potential for residual radioactivity at the submarine pens and piers from leaking waste packages is low. The most likely location for residual radioactivity would be horizontal surfaces adjacent to ship berths where the waste packages could be staged prior to loading on the YGN-73 barge for disposal. Residual radioactivity also could have migrated from horizontal surfaces of the submarine pens and finger piers to subsurface areas such as manholes, grates, and access ports.

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3.0 REGULATORY FRAMEWORK

In 1989, the U.S. Environmental Protection Agency (EPA) identified HPNS as a National Priorities List site. As a result, the Navy is conducting environmental work in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) (Title 42 United States Code Sections 9601 to 9675) at a number of sites at HPNS. As the lead agency, the Navy is working with EPA Region 9 and the California Department of Toxic Substances Control (DTSC) and the California Regional Water Quality Control Board (RWQCB) to develop and implement the remedial scope in this Work Plan. The Navy coordinates activities at HPNS with the regulatory agencies under the terms of a Federal Facilities Agreement. The Federal Facilities Agreement was prepared in 1990, revised in 1991, and signed by representatives of the Navy, EPA, DTSC, and the RWQCB in 1992. The Navy, EPA, DTSC, and RWQCB representatives are collectively referred to as the Base Realignment and Closure Cleanup Team for HPNS.

3.1 Regulatory Process

This Navy is directing this work under the U.S. Department of Defense Installation Restoration Program in accordance with the requirements of the CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan. This survey work will be performed in accordance with the AM (Navy, 2006). The work will be conducted in accordance with Section 121(e) of CERCLA (42 United States Code, Section 9621[e]), as amended, which states that no federal, state, or local permits shall be required for the portion of any removal or remedial action conducted entirely on site. Because the work under this Work Plan is executed to support a removal action and will be conducted entirely on site, permits are not required for this work. However, all substantive requirements will be met.

3.2 Project Objectives

The objectives for this action are to implement the AM (Navy, 2006) and protect public health and welfare and the environment, which are consistent with the National Oil and Hazardous Substances Pollution Contingency Plan requirements in Title 40 CFR, Part 300.415(b)(2). This action includes performing scoping surveys of the Parcel F structures and identifying radioactive contamination that exceed the release criteria presented in Table 1.

3.3 Anticipated Waste Streams

Several waste streams are anticipated to be generated during site activities. Non-radiological waste that are anticipated include, but are not limited to, the following:

- Refuse and debris
- Personal protective equipment

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Low-level radioactive waste (LLRW) or low-level mixed waste that is anticipated include, but are not limited to, the following:

- Discrete radiological point sources
- Radiologically contaminated soil/sediment
- Refuse and debris
- Personal protective equipment
- Material and equipment used during the course of work

Waste management activities are described in the WMP provided in Appendix C of this Work Plan. The WMP has been prepared to address management, transportation, and disposal of the aforementioned waste streams. Radioactive waste, including any identified mixed waste, will be properly stored on site pending disposal by the HPNS Radiological Waste Broker under the direction of the Navy.

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4.0 PROJECT REQUIREMENTS

Required project plans, including radiological work permits (RWPs), are discussed in this section.

4.1 Accident Prevention Plan/Site Safety and Health Plan

The APP/SSHP (APTIM, 2017a) was submitted under a separate cover. The APP/SSHP was prepared to support fieldwork in accordance with the *Safety and Health Requirements Manual EM 385-1-1* (U.S. Army Corps of Engineers, 2014) and UFGS Section 01 35 26 (Naval Facilities Engineering Command, 2015).

4.2 Radiation Protection Plan

The RPP (APTIM,2017b) was prepared under a separate cover. The RPP was prepared to support work performed by APTIM at radiologically impacted sites at HPNS included under this CTO. The RPP document requirements and standard operating procedures to ensure qualified personnel, proper radiological controls, and approved standard operating procedures are used to perform radiological work at the site.

4.3 Radiological Work Permits

The RWP serves as a tool in identifying radiological hazards for project tasks to be performed and for specifying hazard mitigation and control measures necessary to protect workers from the radiological hazards, including personal protective equipment required for the task(s). The RWPs will be generated in accordance with the RPP (APTIM, 2017b). Personnel assigned to site work will be required to read and sign the RWP acknowledging that they understand the requirements of the RWP prior to beginning work. The RWPs identify the requirements for entering, exiting, and conducting work in radiological areas.

4.4 Sampling and Analysis Plan

The Sampling and Analysis Plan (SAP) is included as Appendix A to this Work Plan. The SAP includes sampling methods, procedures, and quality control (QC)/quality assurance requirements to be followed during the execution of this CTO. The SAP was prepared to address the sampling associated with the gamma scanning, alpha/beta surveys, and sampling to be performed at site.

4.5 Contractor Quality Control Plan

The CQCP was prepared in accordance with UFGS Section 45 00.00 20 (Naval Facilities Engineering Command, 2017). This plan is included as Appendix B.

4.6 Waste Management Plan

A WMP was prepared to allow for proper storage, characterization, and disposal of liquid and solid waste generated during the field activities. This plan addresses management, anticipated stockpiling,

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handling/transportation, and disposal of the waste streams derived during the fieldwork. The WMP is included as Appendix C. APTIM will not dispose of radioactive waste. Radioactive material, if any, that is identified during field activities will be collected, segregated, and stored in appropriate containers per the RPP (APTIM, 2017b) for subsequent packaging and disposal by a certified waste broker under the direction of the Navy LLRW Disposal Program.

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5.0 SURVEY DESIGN

The objective of the radiological scoping surveys is to characterize potential residual radioactivity of the Parcel F structures. A combination of scan surveys, static measurements at systematic and biased locations, and measurements of removable radioactivity at static measurement locations will be performed.

5.1 Classification and Survey Units

In accordance with the HRA findings (NAVSEA, 2004), which state the current potential for contaminated media including soil, groundwater, structures, drainage systems and surrounding air are low or none, the surveys of Parcel F structures are consistent with Class 2 areas as described in a *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (MARSSIM) framework (EPA et al., 2000). Class 2 areas are limited to a size between 2,000 and 10,000 square meters and meet the following criteria: (1) impacted; (2) low to moderate potential for delivering a dose above the release criterion; and (3) low to moderate potential for small areas of elevated activity. This scoping survey has been designed such that if contamination is not found, the scoping survey may be presented as a FSS to achieve unrestricted release.

The Parcel F submarine pens consist of three Class 2 survey units (SUs) (Figure 2), and the finger piers consist of three Class 2 SUs (Figure 3). SU locations, classifications, and descriptions are included in Table 2.

If radiological contamination is discovered during the survey, the Parcel F submarine pens and/or finger piers exceeding the release criteria listed in Table 1 will be re-surveyed as Class 1 areas. If no radiological contamination is discovered, no further investigation will be performed and the radiological survey data will be presented in reports and used to support future site decision for the Parcel F structures.

5.2 Radionuclides of Concern

As determined in the HRA, the ROCs for the Parcel F structures are ^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr (Table 1).

5.3 Reference Areas

The background reference area is a geographical area from which representative radioactivity measurements are performed for comparison with measurements performed in an impacted area. The reference area is an area that should have similar physical, chemical, radiological, and biological characteristics as the impacted area(s) being investigated, but that has not been identified as impacted.

5.3.1 Sitewide Soil Background Area

Reference area soil samples were obtained at the Building 526 reference area (Figure 1). Twenty samples were systematically collected from this area for reference area purposes. All 20 samples were sent to a U.S. Department of Defense Environmental Laboratory Accreditation Program accredited off-site laboratory (TestAmerica St. Louis) for analysis by gamma spectroscopy and use as reference area definitive data. Ten percent of the samples (two samples total) were also analyzed for ^{90}Sr and ^{239}Pu. Background activity for ^{226}Ra, based on the mean of the greater of the reported activity or method detection limit, was determined to be 0.633 picocuries per gram, placing the release criterion at 1.633 picocuries per gram of ^{226}Ra for final definitive data. The reference area gamma spectroscopy and ^{90}Sr results from the U.S. Department of Defense Environmental Laboratory Accreditation Program accredited off-site laboratory (TestAmerica St. Louis) are summarized in Table 3. If a new background dataset is collected and approved for Navy use, which may establish background concentrations for ROCs, that background dataset may be used in place of the existing dataset.

5.3.2 Concrete Background Area

The reference area behind Building 810 (Figure 1) will be used to collect gamma instrument-specific background levels. Reference data will be collected in similar matrix (i.e., concrete pad). If needed, additional reference areas may be established with the approval of the Navy. The same survey methods and equipment that will be used for conducting a survey area will be used for the background area data collection. Gamma scanning and static measurements collected from the reference area will be used for comparison to the survey data, as needed. Scan and static data will also be collected with the RS-700 system to establish background data for the spectral analysis process. The IL for the alpha/beta scanning will be based on the release criteria established in the AM (Navy, 2006) and presented in Table 1. Alpha/beta material-specific backgrounds will be established for each instrument based on measurements performed in the reference area.

5.3.3 Survey Investigation Levels

Gamma instrument-specific investigation levels (ILs) will be calculated after survey area gamma scans are completed. The ILs for each instrument (i.e., RS-700 system and 3-inch by 3-inch sodium iodide [NaI] detector) will be established as the mean of the survey data plus 3 standard deviations.

5.4 Data Quality Objectives

DQOs are qualitative and quantitative statements developed to define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. These outputs are used to develop a data collection design that meets all performance criteria and other design requirements and constraints. EPA has specified a seven-step process to develop DQOs (EPA, 2006) which was adapted for use in MARSSIM (EPA et al., 2000). The DQOs for this project are summarized in the following subsections.

5.4.1 Step One—State the Problem

The HRA (NAVSEA, 2004) identifies the Parcel F submarine pens and finger piers structures as radiologically impacted. Therefore, scoping surveys need to be completed.

5.4.2 Step Two—Identify the Decision

The decision to be made is as follows: "Are levels of residual radioactivity present at the Parcel F structures that would prevent unrestricted release?"

The following alternative actions will result from the resolution of the principle study question:

- If residual radioactivity is found during the radiological surveys at levels that would prevent unrestricted release of the site, then the Navy will be notified of the presence of residual radioactivity to determine the appropriate next steps for further investigation and the areas will be re-surveyed as Class 1 areas.
- If residual radioactivity is not found at levels that would prevent unrestricted release of the site during the radiological surveys, then no further investigation will be performed and the radiological survey data will be presented in reports and used to support future site decisions for the Parcel F structures.

5.4.3 Step Three—Identify Inputs into the Decision

Radiological surveys will include

- Surface gamma scanning surveys for 100 percent for accessible surfaces of the submarine pens and finger piers
- Surface alpha/beta scanning surveys for 25 percent for accessible surfaces of the submarine pens and finger piers
- Static measurements for alpha/beta at a statistically determined number of systematic locations to estimate the average level of residual radioactivity
- Static measurements of alpha/beta or gamma activity at biased locations (as appropriate) to investigate survey results exceeding project ILs
- Measurements of removable alpha/beta activity collected at locations based on the highest static measurements of alpha/beta activity

In addition, solid samples of specified materials may be collected to investigate sources of elevated count rates, if required.

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5.4.4 Step Four—Define the Study Boundaries

The spatial boundaries for this study are the Parcel F submarine pens (Figure 2) and the Parcel F finger piers (Figure 3). The vertical boundary of the project area extends from the top of the drydock, berth, or pier to the low tide line. The horizontal boundary is defined by the concrete surfaces forming the submarine pens and finger piers.

5.4.5 Step Five—Develop a Decision Rule

If the results of the survey are consistent with the release criteria (Table 1), the radiological survey data will be presented in reports and used to support future decisions for the Parcel F structures.

If the results of the survey exceed the screening criteria, the site will be further investigated as described in the decision rules.

- The IL for gamma scan measurements is the average of gamma scan measurements for a similar material in an appropriate background area plus three standard deviations. If a gamma scan survey result exceeds the IL, that location will be included in the surface area covered by the alpha/beta scanning survey. The IL for gamma scan measurements will be determined separately for the RS-700 and gamma scintillator handheld radiation detection instruments.
- The IL for alpha/beta static measurements is 50 percent of the most conservative (i.e., lowest) release criteria provided in Table 1 for alpha and beta-emitting radionuclides. If an alpha or beta static count result exceeds the corresponding IL, the static count will be repeated to confirm the result. If the confirmatory result exceeds the corresponding IL, the APTIM Project Manager and the Project Radiation Safety Officer (PRSO) will be notified that an area of elevated alpha or beta activity has been identified. The APTIM Project Manager and/or the PRSO will notify the Navy.
- The IL for removable alpha or beta activity is the most conservative (i.e., lowest) release criteria provided in Table 1 for alpha and beta-emitting radionuclides. If a removable measurement result for alpha or beta exceeds the IL, a notification will be made to the APTIM PRSO. The APTIM Project Manager and/or the PRSO will notify the Navy.

5.4.6 Step Six—Specify Limits on Decision Errors

Limits on decision errors are set at 5 percent.

5.4.7 Step Seven—Optimize the Design for Obtaining Data

Operational details for the radiological survey process have been developed, as further discussed in Section 7.0 of this Work Plan. The theoretical assumptions are based on guidelines contained in MARSSIM (EPA et al., 2000).

5.5 Survey Instrumentation

Commercially available radiation detection and measurement instrumentation will be selected based on reliable operation, detection sensitivity, operating characteristics, and expected performance in the field. Radiological survey instruments suitable for the physical and environmental conditions at the site have been selected and are provided in Table 4. The instruments and measurement methods selected are suitable for detection of project ROCs (^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr) with sensitivity (i.e., detection limits) that are below applicable survey criteria. Instrument capabilities will be verified by the PRSO.

APTIM operational procedures are included in the RPP and will be used for all field instruments to verify the equipment is operating properly and used correctly in the field to produce accurate and reliable data. At a minimum, calibrations of radiation detection instruments will be performed annually and after major repairs. Field instrument checks will verify instrument response and will be performed at the beginning and end of each day of use. Calibration will be performed by a qualified vendor with National Institute of Standards and Technology traceable sources. If the field instrument checks reveal the instrument is outside established response tolerances, the instrument will be marked out of service. If necessary, the instrument will be returned to the manufacturer for immediate repair and servicing. Surveys performed with an instrument that fails post or pre-use operational (background and/or source response) checks will be evaluated by the APTIM PRSO for re-performance of the survey with another equivalent instrument. At a minimum, calibration records will contain the following information:

- Instrument name and identification number (e.g., model and serial number)
- Manufacturer
- Date of calibration
- Calibration due date
- Name of company and person performing the calibration
- Calibration points
- Results of the calibration
- Calibration source documentation (serial number, certification, radionuclides, etc.)

5.5.1 Instrument Setup and Quality Control

Prior to initial instrument use, a minimum of 10 measurements will be collected using a source representative of the radiation types and energies of interest. A minimum of 10 one-minute measurements will be collected with the source removed to determine the instrument's expected response to ambient background. Background will be monitored qualitatively to assess daily variations that may have impact instrument MDC calculations. From the initial source measurements, the mean of the observed count rate will be calculated. The acceptance criterion will be ± 20 percent of the mean of the initial source counts. Source checks will be monitored using a control chart, with control limits set at

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± 20 percent of the average count rate. For the alpha/beta smear counter, the acceptance criterion for each channel will set at ± 2 or 3 standard deviations from the mean, as follows: If an alpha/beta counting system channel falls outside 2 standard deviations of the mean but is within 3 standard deviations of the mean, the source check will be repeated. A Chi-square test will also be performed according to procedure to maintain QC compliance for Ludlum Model 2929/3030 (smear counter) and Ludlum Model 2360 ratemeter/scaler (direct measurement).

5.5.2 Gamma Instrumentation

Gamma surface scans will be performed using the RS-700 as a towed array. A 3-inch by 3-inch NaI detector will be used for areas that are not accessible to the RS-700.

The RS-700 consists of an RSI RS-701 integrated controller and data acquisition system, a digital gamma ray spectrometer/multi-channel analyzer, a data controller, two RSX-1 4-liter (256 cubic inch) NaI gamma scintillation detectors, an internal global positioning system (GPS), and an external high-resolution Trimble Pro XH GPS receiver. The system is operated using the RS-700 RSI "RadAssist" software, which displays real-time data collection, both as a NaI spectrum as well as the count rates. Radiation and location information are collected by the system at a very high data transfer rate (nominally one data point per second), and stored in an uncorruptible data file for real-time feedback and data validation/post-processing. The system operator receives real-time feedback using waterfall plots of total response and geo-referenced mapping of relative radiation concentrations.

The RS-700 may also be used to assess follow-up locations, using a 1-minute or greater static count and spectral analysis to compare the activity at a specific point to background. In this case, the net spectrum will be plotted and the critical levels assessed for ROC-specific energy ranges to determine if there is any activity present above background. Critical levels, as defined in the MARSSIM Section 6.7.1, represent thresholds above which net counts are statistically greater than background (EPA et al., 2000). If RS-700 static measurements identify any elevated locations, biased samples may be collected.

The handheld gamma scan equipment consists of a Ludlum Model 44-20 3-inch by 3-inch NaI gamma scintillation detector coupled with a Ludlum Model 2221 ratemeter/scaler, or equivalent. Position correlation of the gamma scan results is provided by a high-resolution GPS receiver.

Static measurements, if required as discussed in Section 5.6, will be collected using a Ludlum Model 44-20 3-inch by 3-inch NaI gamma scintillation detector coupled with a Ludlum Model 2221 ratemeter/scaler, or equivalent, handheld instrument.

5.5.3 Gamma Surface Scan Minimum Detectable Concentration

The gamma surface scan MDC was determined for identifying intact deck markers containing ^{226}Ra or ^{90}Sr attached to the surface being investigated (Appendix D). The assumptions used to calculate the gamma surface scan MDC are the same for the RS-700 and the 3-inch by 3-inch NaI scintillation

detector. Deck markers are assumed to have an active area of 7/8-inch with a 3/8-inch plastic cover. The scan speed for the RS-700 is 1 meter per second (m/s) or less with the detector suspended 10 centimeters (cm) (4 inches) above the surface being investigated. The minimum detectable activity (MDA) for a ^{226}Ra deck marker on the surface of the Parcel F structures is well below that experienced when scanning soil for low-level radiological objects buried beneath the surface.

The scan speed for the 3-inch by 3-inch NaI detector is 0.5 m/s with the detector suspended 15 cm (6 inches) above the surface being investigated. The gamma scan MDA for a ^{226}Ra deck marker on the surface is well below that experienced when scanning soil for low level radiological objects buried beneath the surface.

5.5.4 Alpha and Beta Instrumentation

Measurements of total and removable alpha and beta radiation will be performed over 25 percent of accessible surface area as part of this survey. Total alpha and beta radiation will be measured using scans and static measurements using a Ludlum 43-37 gas proportional detector connected to a Ludlum Model 2360 ratemeter/scaler, or equivalent. Removable alpha and beta radiation will be measured using smears counted using a Ludlum Model 2929 sample counter, or equivalent. The sample counter uses a dual phosphor detector for radiation detector.

5.5.5 Alpha and Beta Surface Scan Minimum Detectable Concentration

The scan speed for detecting alpha radiation at the release criterion for ^{226}Ra of 100 dpm/100 cm^2 was calculated using the guidance from MARSSIM Appendix J (EPA et al., 2000) supplemented with additional information from Radiological Affairs Support Office (RASO) (RASO, 2013). The scan speed using an instrument efficiency with the detector on contact with the surface is 4 seconds, or approximately 1 centimeter per second (cm/sec). Using a lower instrument efficiency for a detector raised off the surface allowing the detector to move over the surface results in a scan speed on the order of 0.25 cm/sec., or 3 seconds per cm.

Scanning at 0.25 cm/sec is not logistically practical. Therefore, a series of static counts will be performed to provide alpha and beta surface scan measurements. The static counts will provide the equivalent detection efficiency to scanning at 0.25 cm/sec. The detector will be positioned in contact with the surface to be surveyed to provide the maximum instrument efficiency. A preset count time of 6 seconds (0.1 minutes) will be used for the count time, which is slightly greater than the minimum required count time of 4 seconds calculated for alpha activity at 100 dpm/100 cm^2. Once the static count is completed, the results are recorded and the detector re-positioned adjacent to the first count position, providing 100 percent coverage with the adjacent counts.

The minimum detectable net count for alpha was calculated as 2.6 counts in 6 seconds. This number was rounded up to 3 counts in 6 seconds. The minimum detectable net count in 6 seconds for beta was calculated as 21.3 and was rounded up to 22 counts in 6 seconds. This means that an alpha count of 3

counts or more above background in 6 seconds indicates the potential for residual alpha radioactivity exceeding the release criteria. A beta count of 22 or more counts above background in 6 seconds indicates the potential for residual beta radioactivity exceeding the release criteria. Converting these numbers into activity units for the Ludlum Model 43-37 gas proportional detector, the scan MDC for alpha is 86 dpm/100 cm^2 and the scan MDC for beta is 473 dpm/100 cm^2. Both values are less than the corresponding release criteria listed in Table 1; therefore the series of 6-second static scans meets the objectives of the survey. Instrument characteristics for the Ludlum Model 43-37, including background and total instrument efficiency, are provided in Table 5.

5.5.6 Alpha Beta Static Minimum Detectable Concentration

Integrated static alpha and beta activity measurements will be performed using a Ludlum Model 43-37 gas proportional detector during scans. A Ludlum Model 43-68 gas proportional detector may be used in areas inaccessible to the large area detector. The *a priori* MDCs for the investigation of the Parcel F structures were determined using the following equation, which is used to calculate instrument MDC in units of dpm/100 cm^2 when the background and sample are calculated for the same time interval:

$$MDC = \frac{3 + 4.65\sqrt{R_B T_B}}{\varepsilon_i \varepsilon_s \frac{W_A}{100} T_B}$$

Where:
3+4.65=constant factor provided in MARSSIM
R_B=background count rate in counts per minute
T_B=background count time in minutes
ε_i=instrument efficiency in counts per particle
ε_s=contaminated surface efficiency in particles per disintegration
W_A=active area of the detector in cm^2

Two-minute static measurements will be performed when using the Ludlum Model 43-37. Based on the backgrounds and efficiencies experienced using the Ludlum Model 43-37, the *a priori* MDC for alpha is 21.5 dpm/100cm^2 and for beta is 184 dpm/100cm^2. Five-minute static measurements will be performed when using the Ludlum Model 43-68. Based on the backgrounds and efficiencies experienced using the Ludlum Model 43-68, the *a priori* MDC for alpha is 32 dpm/100cm^2 and for beta is 202 dpm/100cm^2.This achieves sufficient detection to meet the release criteria shown in Table 1 and the ILs identified in the DQOs. Table 5 presents the static measurement sensitivity assumptions.

5.6 Gamma Count Rate Surveys

The gamma count rate survey of surface areas is performed in two stages. The first stage is a gamma count rate scan conducted over 100 percent of the accessible area using the RS-700 system or a Ludlum Model 44-20 and Ludlum Model 2221 (or equivalent) handheld instrument in areas inaccessible to the RS-700 system, consistent with the requirements for a MARSSIM survey (EPA et al., 2000). The data

collected during the gamma scan are evaluated and if all readings are below the instrument specific gamma scan IL, the second stage is not required.

If the count rate exceeds the instrument specific gamma scan IL, the second stage is an additional survey and possible material sampling at the location and adjacent area where the count rate exceeded the scan instrument specific scan IL and nearby areas. Biased gamma static measurements will be collected as part of the second stage of the survey.

Static measurements will consist of reacquiring the location of the elevated gamma count rate and conducting a 1-minute gamma static count using a Ludlum Model 44-20 3-inch by 3-inch NaI gamma scintillation detector coupled with a Ludlum Model 2221 ratemeter/scaler, or equivalent, handheld instrument. A high-resolution GPS receiver will record all gamma scan, static, and biased locations. The RS-700 has an internal GPS system, which displays real-time data collection. An additional GPS receiver will be used to verify locations of interest using handheld meter Ludlum Model 2221 coupled with Ludlum Model 44-20 NaI detector for the static and biased locations. The nearby area will be resurveyed to assess if the elevated gamma scan reading is due to a point source or distributed radioactive material. If the gamma static (1 minute) count is less than the instrument specific static IL and there is no evidence of a point source, further survey investigation is not required.

If the gamma static measurements are below the instrument specific IL, but there is a cluster of elevated gamma scan readings that exceed the gamma scan instrument specific IL, biased sample(s), depending on the size of the area, may be collected to determine the nature and extent of contamination present.

The RS-700 may also be used to assess follow-up locations, using a 1-minute or greater static count and spectral analysis to compare the activity at a specific point to background. In this case, the net spectrum will be plotted and the critical levels assessed for ROC-specific energy ranges to determine if there is any activity present above background. Critical levels, as defined in the MARSSIM Section 6.7.1, represent thresholds above which net counts are statistically greater than background (EPA et al., 2000). If RS-700 static measurements identify any elevated locations, biased samples may be collected.

If the static gamma count rate is less than the instrument specific static IL and there is no evidence of a point source or distributed source or the RS-700 spectral analysis does not identify any locations statistically above background, no further action is required. If radiological contamination is indicated, it will be addressed as described in Section 5.8.

5.7 Alpha and Beta Surveys

Alpha and beta scanning surveys will be performed on 25 percent of the accessible areas, and static measurements will be collected for the 54 systematic locations and based on the biased locations throughout the SUs by using Ludlum Model 2360.

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5.7.1 Alpha and Beta Scan Measurements

As discussed in Section 5.5.5, scanning at a speed slow enough to meet RASO guidance for conducting alpha scans for radium (0.25 cm/sec) is difficult to perform in the field. For this project, six-second static counts will be performed to cover the necessary area (25 percent of accessible surfaces). This measurement will achieve the same level of detection as slow scanning.

Alpha and beta static scans will be performed over 25 percent of the area of each SU. Preference will be given to potential contamination concentration areas such as berthing locations, concrete joints and cracks, and drainage locations. This survey area will also include accessible edges of all penetrations through the finger piers (including manholes, grates, access ports, etc.). Locations that exceeded the gamma scan IL will be included in these scans.

5.7.2 Alpha and Beta Static Measurements

The survey design requires the performance and evaluation of data from static measurements performed at systematic locations across each SU. Fifty-four static measurements will be collected at systematic locations within each SU. The static measurements will be two minutes when using the Ludlum Model 43-37 and five minutes when using the Ludlum Model 43-68, as discussed in Section 5.5.6. The systematic locations will be selected through the use of a map and a random starting point. Any location that exceeds the IL will be marked with paint and further investigated.

5.7.3 Number of Alpha and Beta Measurements

The lower bound of the gray region was set equal to the most conservative release criterion for alpha activity, 100 dpm/100 cm^2, and beta activity, 1,000 dpm/100 cm^2.

The lower bound of the gray region was set equal to the estimated average alpha activity for concrete in the reference area, 40 dpm/100 cm^2, and average beta activity for concrete in the reference area, 400 dpm/100 cm^2. These estimates are based on twice the static MDC for the Ludlum Model 43-37 gas flow proportional counter probe detector, rounded to one significant digit. Concrete is expected to have the highest reference area concentration of any material in the Parcel F structures, and these estimates are expected to be higher than the actual values determined during surveys of the reference area.

The variability (σ) of alpha activity in the survey area was set equal to the estimated average alpha and beta activity for concrete in the reference area to design the survey.

The tolerable decision error rate for Type I and Type II decision errors was set equal to 0.05 (see DQOs, Section 5.4).

The relative shift was calculated as 1.5 for both alpha and beta static measurements per MARSSIM Section 5.5.2.2 as follows:

Relative shift for alpha measurements:

$$\frac{\Delta}{\sigma} = \frac{UBGR - LBGR}{\sigma} = \frac{100 - 40}{40} = 1.5$$

Where:
Δ/σ = relative shift
UBGR=upper bound of the gray region
LBGR=lower bound of the gray region
σ=variability in radionuclide concentrations or activity levels

Relative shift for beta measurements:

$$\frac{\Delta}{\sigma} = \frac{UBGR - LBGR}{\sigma} = \frac{1{,}000 - 400}{400} = 1.5$$

Where:
Δ/σ = relative shift
UBGR=upper bound of the gray region
LBGR=lower bound of the gray region
σ=variability in radionuclide concentrations or activity levels

MARSSIM Table 5.3 lists a minimum of 18 data points for a survey design with a relative shift of 1.5, Type I error rate of 0.05, and Type II error rate of 0.05. Although a minimum of 18 static alpha and beta measurements is determined using this approach, additional static measurements are necessary to meet the RASO guidance to increase the density of static measurements by a factor of 3 when basing the alpha detection probability on the 300 dpm/100 cm^2 hotspot limit. Fifty-four alpha/beta static measurements will be collected per SU. In addition, collection of static measurements at this frequency will provide a high degree of confidence that the surveyed surfaces are fully characterized. The assumptions regarding the number of measurements will be evaluated during the field effort and additional static measurements will be collected as required.

5.8 Remediation Approach and Radiological Object Management

Any time a radioactive anomaly is confirmed during radiological surveys, the location will be marked or flagged and GPS/grid coordinates will be recorded. The field survey team or the data group analyzing collected field information will notify the PRSO. Routine findings will be reported on the daily radiological site report provided to RASO and the Navy Remedial Project Manager (RPM). APTIM will report anomalies confirmed to be radioactive material related to historical Navy activities to RASO and the RPM.

6.0 PRE-FIELD WORK ACTIVITIES

Pre-field work activities are discussed in the following subsections.

6.1 Permitting and Notification

APTIM will obtain all necessary authorizations from the HPNS Caretaker Site Office (CSO) and the Resident Officer in Charge of Construction (ROICC) for performing the work at the Parcel F structures. Prior to initiation of field activities for the submarine pens and finger piers, APTIM will notify the Navy RPM, ROICC, CSO, University of California- San Francisco personnel, appropriate fire department personnel, and HPNS security as to the nature of the anticipated work.

Notifications will be made by APTIM to California Department of Public Health and the U.S. Nuclear Regulatory Commission at least 14 days prior to initiation of activities involving the radiological materials licenses. Additional notifications required by regulatory agencies for specific activities conducted under this Work Plan will be addressed in the corresponding subsections and appendices of the Work Plan, and in the APP/SSHP (APTIM, 2017a).

6.2 Pre-Construction and Mutual Understanding Meeting

A pre-construction and mutual understanding meeting will be held prior to mobilization of equipment and personnel. The purpose of the meeting will be to discuss project-specific topics, roles, and responsibilities of all project personnel, project schedule, health and safety concerns, and other topics that require discussions before field mobilization. The pre-construction meeting will be attended by representatives of the following:

- Navy (RPM, RASO, ROICC, CSO, others as applicable)
- APTIM (Project Manager, Site Construction Manager, Project Quality Control Manager [PQCM], PRSO and Site Safety and Health Officer [SSHO])
- Subcontractors as appropriate

6.3 Construction Quality Control Meetings

A contractor QC meeting will be held on a weekly basis throughout the course of fieldwork. At a minimum, the ROICC and the PQCM will attend this meeting. The Navy RPM, RASO, APTIM site personnel, subcontractors and vendor representatives, and Navy subcontractor personnel will also attend as appropriate.

6.4 Health and Safety Meetings

Daily tailgate safety meetings will be held before starting work. Field staff, including subcontractors, will attend these meetings and sign a tailgate safety meeting form. The meetings will be held by the SSHO,

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or his or her qualified designee, and will cover various safety issues. Any subcontractor, inspector, agency, or Navy personnel that visit the site during the course of the day will be required to review and sign the tailgate form prior to entering the work site.

6.5 Mobilization

Mobilization activities will include site preparation, movement of equipment and materials to the site, and orientation and training of field personnel. Site-specific training will include radiological safety awareness. At least two weeks prior to mobilization, the appropriate Navy personnel, including the Navy RPM, ROICC and CSO, will be notified regarding the planned schedule for mobilization and site scoping activities. APTIM personnel and subcontractors will acquire badges by the San Francisco Redevelopment Agency during mobilization.

Upon receipt of the appropriate records and authorizations, field personnel, temporary facilities, and required construction materials will be mobilized to the jobsite. The temporary facilities will include restroom(s), hand washing station(s), security fencing, and one or more secure storage (conex) boxes for short and long-term storage of materials, if needed.

6.6 Site Preparation

Site preparation activities are discussed in the following subsections.

6.6.1 Temporary Construction Facilities

Work performed in or near roadways will be coordinated with the Construction Manager, local tenants, and other site users to implement appropriate traffic control and road closures as needed for site personnel safety. Temporary facilities to be mobilized to the site will include restroom(s), hand washing station(s), security fencing, and one or more secure storage (conex) boxes for short and long-term storage of materials, if needed. A project sign and safety sign will be erected at the site.

6.6.2 Field Observations and Photographic Documentation

Field observations will be recorded in the project logbooks and daily reports. Photographs of the site will be collected during field operations. Electronic versions of the photographs will be sorted by date and accompanied by a Project Photographic Log providing the date, location, and a description of the activities shown in each photo will be developed and kept in the electronic project file.

Prior to beginning radiological surveys of the Parcel F structures, a Professional Engineer will visually inspect and structurally assess the subpens and finger piers. The expected loads include personnel and radiological equipment, including the RS-700 system attached to an all-terrain vehicle for the drive over gamma scanning. No heavy equipment or passenger vehicles will be driven on the subpens and piers.

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6.6.3 Material Handling and Storage Areas

Radioactive waste will be minimized by compliance with contamination control work practices combined with survey practices. Radiological areas and postings are further described in the RPP (APTIM; 2017b). No radiologically controlled area is planned for this work effort. If discrete sources or areas of elevated radioactivity requiring additional radiological posting are found during the radiological scoping surveys, the APTIM PRSO will be immediately notified by the RCTs. The PRSO will then notify the Navy. The APTIM PRSO will oversee discrete object extraction, packaging, characterization and transport at the direction of the Navy. Any additional radiological posting required for this work effort will be coordinated through the APTIM PRSO, including development of any required RWPs.

If a radiologically controlled area is established as part of this work effort, field records will be maintained for waste generation activities. Field data records or daily reports will be signed and dated by the person entering the data. At a minimum, the following information will be recorded:

- Description of waste-generating activities
- Location of waste generation (including depth, if applicable)
- Type and volume of waste
- Date and time of generation
- Description of waste sampling
- Name of designee at time of generation
- Photographs of anomalies
- Radiological survey data
- Radiological dose readings on contact and at 30 cm from the waste container

6.7 Traffic Control

Traffic impacts are expected to be minimal during the field work. Traffic control is not required during this work effort for the Parcel F structures because the structures are located within fenced areas and are not located near roads. A sufficient area for parking will be provided to all passenger vehicles to support the work effort. On-street parking will be prohibited for all vehicles associated with the field work activities to maintain normal access and clear lanes.

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7.0 FIELD WORK

This section describes the specific field work activities and procedures.

7.1 Radiological Scoping Survey of Submarine Pens and Finger Piers

The objective of the radiological scoping survey is to measure levels of residual radioactivity to support future site decisions for the Parcel F structures. A combination of scan surveys, static measurements at systematic and biased locations, and measurements of removable radioactivity at static measurement locations will be performed.

7.1.1 Gamma Scan Surveys

Gamma scan surveys will be performed to identify areas of elevated gamma radioactivity that could result from residual radioactivity from radioluminescent devices or other sources of gamma radiation. Areas of elevated gamma activity will be included in the areas covered by the alpha and beta scan surveys.

The gamma scan surveys will be performed for 100 percent of the accessible areas for SUs 1 through 6 using the RS-700 or a Ludlum Model 44-20 3-inch by 3-inch NaI gamma scintillation detector coupled with a Ludlum Model 2221 ratemeter/scaler (or equivalent) handheld instrument in areas inaccessible to the RS-700. Figures 4 through 9 show the boundaries for each SU. Table 2 provides SU details and description.

Submarine pens Berths 62 and 63 are isolated areas and physically separated by water from the adjacent submarine pens (Photo 1).

The accessible edges of the Finger Pier manholes and metal grate areas will be accessed during the gamma scan surveys (see Photo 2).

Horizontal surfaces will be scanned using the RS-700 with the detector suspended 10 cm (4 inches) over the surface being investigated at a scan speed of 1 meter per second (m/s) or less. The scan MDC is provided in Appendix D.

For vertical surfaces of the drydocks and areas inaccessible to the RS-700, a Ludlum Model 44-20 3-inch by 3-inch NaI gamma scintillation detector coupled with a Ludlum Model 2221 ratemeter/scaler (or equivalent) will be used to perform the scan survey. The 3-inch by 3-inch NaI detector will be suspended 15 cm (6 inches) over the surface being investigated, moving at a speed of 0.5 m/s or less. Vertical surfaces greater than 6 feet may expose personnel to falls greater than 6 feet. Appropriate personal protective equipment and engineering controls will be used to perform the work safety as described in

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the APP/SSHP (APTIM, 2017a) and may include fall protection, personal flotation devices, and barriers. If practical, the detector will be suspended from a pole at a distance approximately 15 cm (6 inches) from the vertical surface. Using appropriate safety controls, the RCT will walk at a rate of 0.5 meters per second or less along the subpen, maintaining the detector at a consistent height while also maintaining a distance of approximately 15 cm (6 inches) from the vertical surface. The gamma count rate and the GPS position will be recorded. Once the entire length of the vertical surface has been surveyed, the detector will be lowered approximately 30 cm (12 inches) to continue the gamma scan of the vertical surface at the new height. This process will be repeated until the entire vertical surface has been scanned.

At a minimum, scan data will be processed as follows:

- The measurements will be plotted as color-coded filled contours for visual review and evaluation.
- The mean and standard deviation of each SU will be calculated.
- The location of the highest gamma count rate per SU will be determined.
- The difference between each data point and the average of all data points will be calculated and divided by the standard deviation of the SU measurement set. This will convert the measurements to multiples of the standard deviation above or below the average count rate of the SU (z-scores). The z-scores will be plotted as color-coded filled contours for visual review and evaluation, where the color-coding will be based on multiples of SU standard deviation.
- Areas exhibiting a z-score greater than three will be further investigated in comparison to the IL. The geospatial plot will also be visually inspected to identify anomalies in the distribution of measurement data.

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Photograph 1
Survey Unit 3 (Ship Berths 62 and 63)

7.1.2 Alpha and Beta Surveys

Alpha and beta surveys will include scans, static measurements, and smear measurements for Class 2 areas consistent with MARSSIM guidance (EPA, et.al, 2000) for Class 2 surveys. Alpha and beta static scans will be performed over 25 percent of the area of each SU. Debris will be relocated as necessary to complete these scans. Figures 4 through 9 shows the boundary for the SUs. The areas where the alpha/beta measurements will be performed may be adjusted as needed to include locations where the gamma scan results exceed the corresponding gamma IL.

Manholes, grates, and components of the suction and discharge system will be investigated during the survey of Drydocks 5, 6, and 7 and Finger Piers 1, 2, and 3. Each manhole will be opened and alpha/beta measurements will be collected to the extent practicable. Standing water has been observed in the manholes at low tide and may limit accessible surfaces. Alpha/beta scanning (as practicable), a minimum of one static measurement and one smear measurement will be collected from each accessible manhole. Accessible surfaces of discharge outlets located on the sidewalls of the drydocks will be investigated and surveyed. Alpha/beta scanning (as practicable), one static measurement and one smear measurement will be collected from each accessible outlet. The measurements may be biased to visible staining based on the direction and professional judgement of the PRSO. If the outlet impeller (or similar equipment) is safely accessible, alpha/beta scanning (as practicable), one static measurement, and a

smear sample will be collected from the impeller. If material is available, sediment samples will be collected and submitted to the off-site laboratory for analysis in accordance with Section 7.2 of this Work Plan. Other components of the discharge system (i.e., metal plates and piping) will be visually inspected in the field, and surveyed as practicable. This inspection may include cutting or sawing activities for accessing field-identified discharge piping, manhole covers locked or welded in place, or other plates or covers limiting access to areas requiring survey. Scans, static measurements, and smear measurements will be collected from accessible surfaces as practicable. Confined space entry and heavy lifts are not anticipated for this work; personnel will not enter manholes or other confined spaces.

The alpha/beta static measurements will be performed using portable contamination survey instruments specifically, the Ludlum Model 43-37 gas flow proportional "floor monitor" detector (or equivalent) coupled with a Ludlum Model 2360 scaler/ratemeter (or equivalent) (Table 4). If required, a Ludlum Model 43-68 gas flow proportional detector (or equivalent) small area detector may be used to perform static measurements in areas not accessible to the Ludlum Model 43-37 large area detector (Table 4). The scaler/ratemeter will be set to a two-minute count time when using the Ludlum Model 43-37 or a five-minute count time when using a Ludlum Model 43-68. At the start of each measurement, the RCT will position the detector, and begin the two-minute or five-minute count. At the completion of each two-minute or five-minute count (depending on the instrument used), the alpha and beta result will be recorded. The IL for the alpha and beta static measurements will be developed and used as described in the decision rules in Section 5.4 of this Work Plan. The release criteria were established from the AM (Navy, 2006) and are presented in Table 1.

Two-minute or five-minute (depending on the instrument used) static measurements will be collected at 54 systematic locations per SU as discussed in Section 5.7 of this Work Plan, and as part of investigations of scanning results exceeding the IL, as needed. Smears will be collected at each location where a total alpha and total beta static reading is taken. Smears may be qualitatively field checked to identify gross contamination with the Ludlum Model 2360 with a Ludlum Model 43-68 (or equivalent) detector. This will assist in identifying the extent of removable contamination. Smears will be quantitatively counted with a Ludlum Model 2929 or Ludlum Model 3030 sample counter located at the APTIM project office.

7.1.3 Sampling

Samples (sediment or material) may be collected as required to support the characterization of locations with identified elevated activity, based on the elevated results from the gamma scanning and/or alpha/beta survey (if any).

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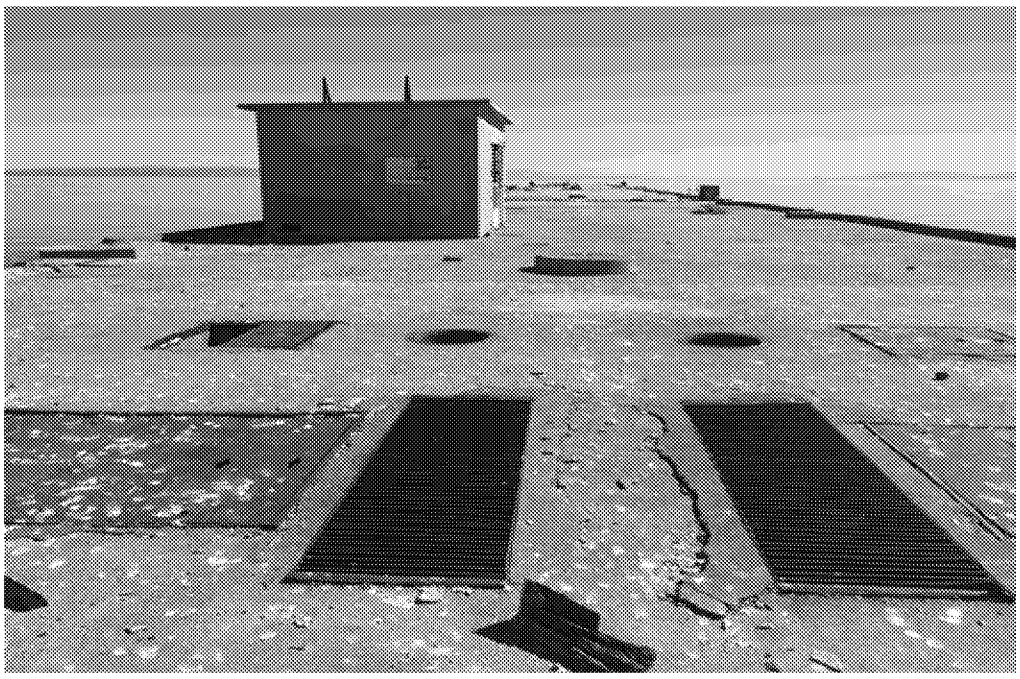

Photograph 2
Finger Pier Manholes and Buildings Structures

7.2 Radiological Analysis

Material samples, if required to further support the characterization of the finger piers and subpens, will be analyzed for ^{137}Cs and ^{226}Ra by gamma spectroscopy analysis and ^{239}Pu by alpha spectroscopy in accordance with the SAP (Appendix A to this Work Plan). Samples will also be analyzed for ^{90}Sr if there is a reason to suspect ^{90}Sr contamination (i.e., increased beta activity that is not attributed to another beta emitter as determined by laboratory analysis, the presence of ^{239}Pu, or the presence of ^{137}Cs). Gamma spectroscopy data will be reported by the off-site laboratory after an initial 7-day and following the 21-day ingrowth period. If the analytical results of the material indicate that any of the ROCs exceed their respective screening criterion (Table 1), the material is considered to be radiologically contaminated and may require additional remedial actions following consultation with the Navy.

7.3 Site Restoration

Restoration of Parcel F structures following the survey effort is not expected or required. Any surface sample locations (i.e., core borings) will be restored in kind with concrete patching to prevent further weathering/destruction of the area sampled.

7.4 Decontamination and Release of Equipment and Tools

Equipment and personnel exiting a work area will follow decontamination procedures presented in the RPP (APTIM, 2017b). Decontamination areas will be located near work boundary exits. The level of decontamination of equipment will be determined by the SSHO and PRSO. The need for and degree of

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decontamination will be based on the characteristics of the material within the work area and the potential for transporting contaminants outside of the work area.

7.5 Waste Management

A WMP was prepared to allow for proper storage, characterization, and disposal of liquid and solid waste generated during the field activities. Any investigation-derived waste will be managed in accordance with the WMP (Appendix C).

7.6 Demobilization

Demobilization will consist of surveying, decontaminating, and removing all equipment and materials, cleaning the project site, inspecting the site, and issuing a certification of completion. Demobilization activities will also involve collection and disposal of any contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate.

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8.0 PROJECT MANAGEMENT PLAN

The project management team will be responsible for all technical and administrative aspects of the site activities. Included among the team's responsibilities are the project schedule, staffing, data management, document control, project meetings, and reporting.

8.1 Key Project Personnel

Key personnel are provided in Table 6.

8.2 Document Control

APTIM's internal document control procedures will be followed for the duration of the project. Additional guidance provided by the Navy will be used for document control, particularly for matters relating to regulatory compliance. Management of internal and external correspondence will be administered at the home office in San Diego, California. Document control will include assigning alphanumeric codes to each submittal. Project files will be maintained in a secure, dry area at the field office.

8.3 Meetings and Reports

Project status/contractor QC meetings will be held weekly or biweekly (or at less frequent intervals if desired by the Navy) at the field office during the field construction activities. At a minimum, the ROICC and PQCM will attend this meeting. The Project Manager, Construction Manager, and other selected individuals will also attend these meetings with the CSO, ROICC, and RPM. All QC related documents and discussion are provided in the CQCP (Appendix B).

Daily reports will be prepared by the Construction Manager, PRSO, and the PQCM and submitted to the RPM, CSO, RASO, and ROICC. Weekly reports will be prepared by the Project Manager and submitted to the RPM. The weekly reports will include work completed by the end of each week and work that is planned for the following week.

8.4 Project Schedule

Figure 10 provides the current project schedule for Parcel F activities.

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9.0 REPORTING REQUIREMENTS

Upon completion of radiological survey activities, two separate reports will be prepared to document the results of the Parcel F structures investigation; one report for the submarine pens, and a second report for the finger piers. If no contamination is found, the survey reports will summarize the data to support future site decisions. If contamination is found, then the survey report will define the extent of contamination and provide recommendations for remediation of the structures.

Each survey report will include the following items:

- Site conditions and background
- Description of field methods and procedures
- Any variances from the Work Plan during the survey with an approved field change request
- Field activities
- Survey results
- Data evaluation results including data conversion, summary statistics, graphical data review (e.g., histograms, normal probability plots), and comparison to background reference area data
- Conclusions and recommendations
- References
- Applicable appendices

The appendices will include survey data, waste information, sampling and survey information, and other supporting information as appropriate.

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10.0 REFERENCES

Aptim Federal Services, LLC (APTIM) 2017a, *Accident Prevention Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*.

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ERS Joint Venture, 2012, *Final Removal Action Completion Summary Report, Pier Radiological Surveys and Removal, Hunters Point Naval Shipyard, San Francisco, California*.

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U.S. Environmental Protection Agency, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, Office of Environmental Information, EPA/240/B-06/001, Washington, D.C., February.

U.S. Environmental Protection Agency, U.S. Nuclear Regulatory Commission, and U.S. Department of Energy, 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, EPA 402-R-97-016, NUREG-1575, DOE/EH-0624, Revision 1, Washington, D.C.

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Figures

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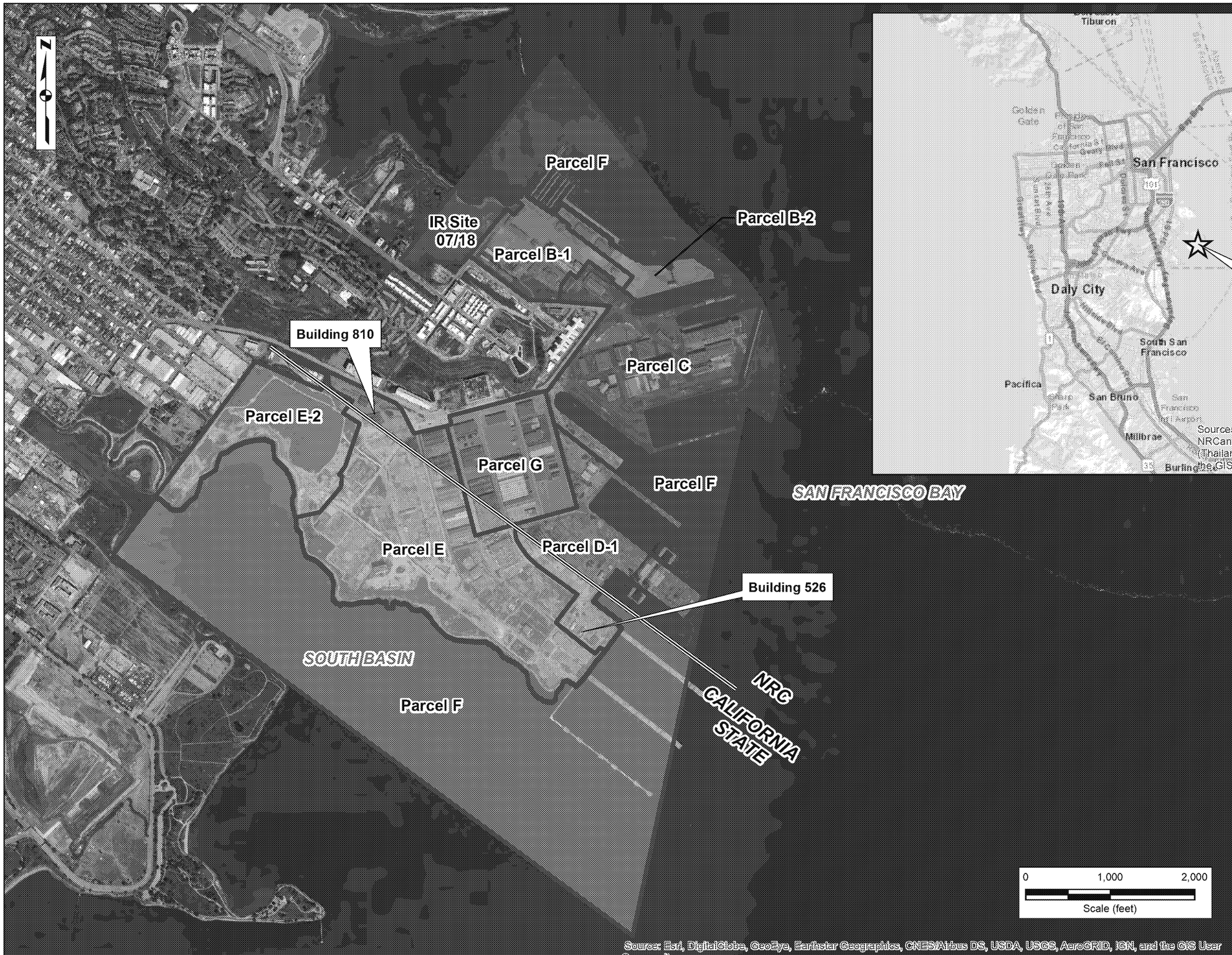
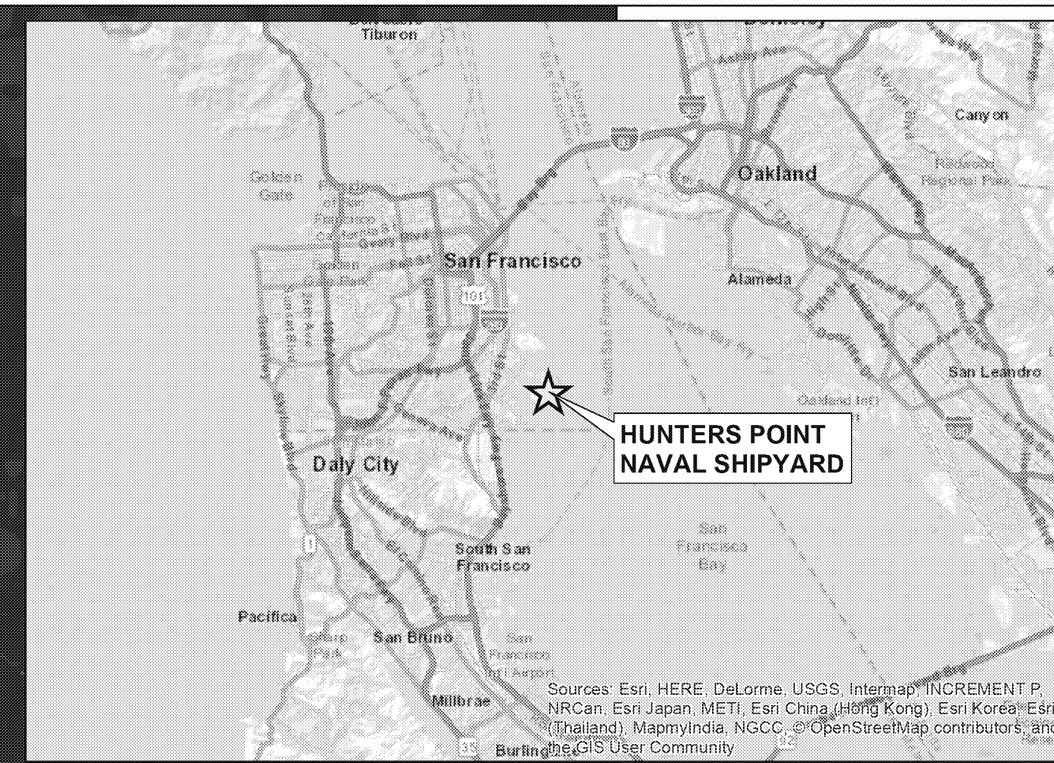




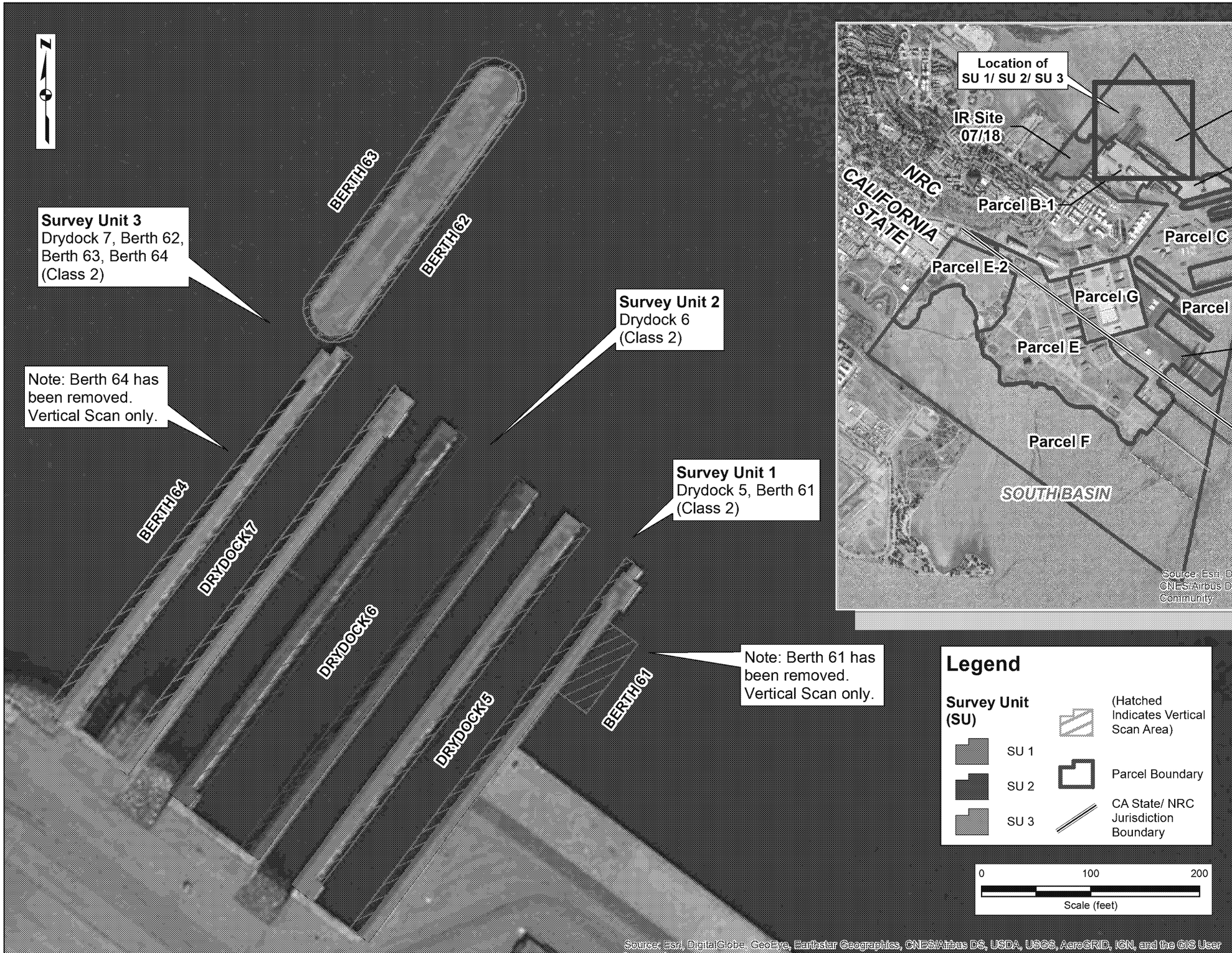
Legend

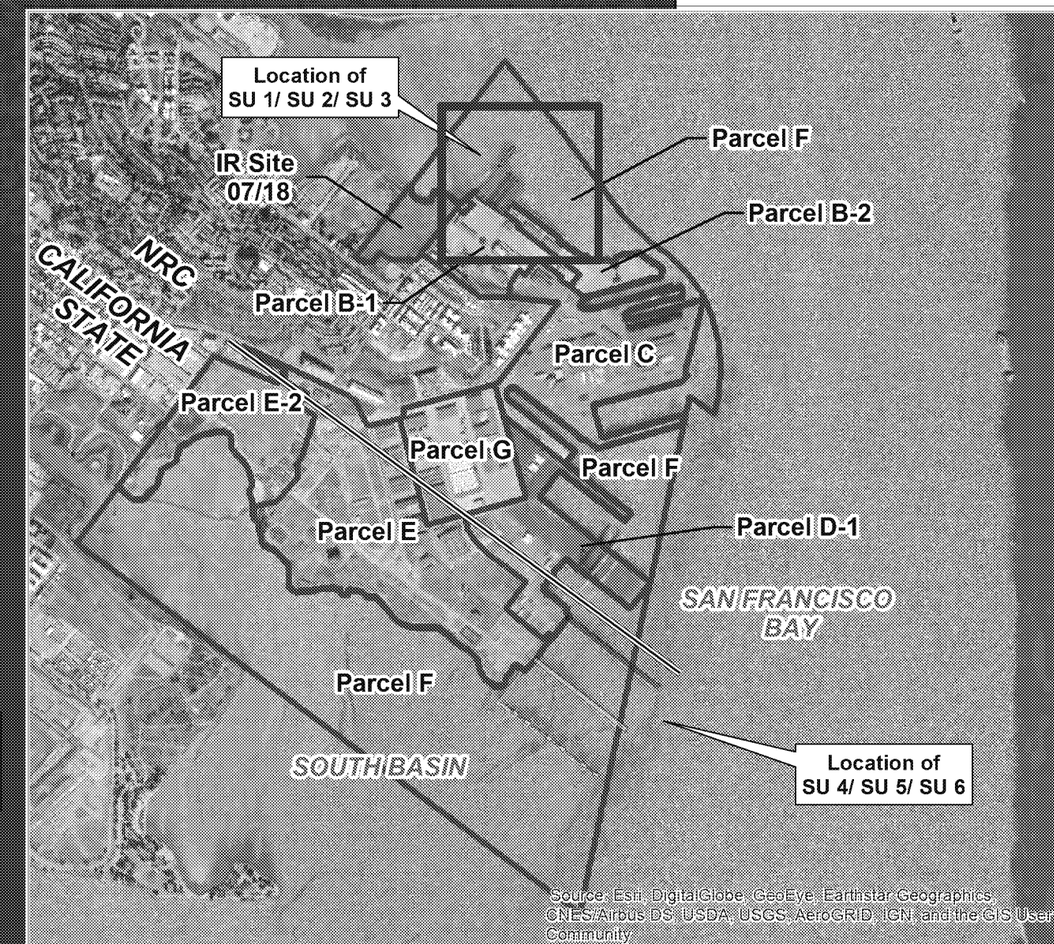
- Parcel Boundary
- CA State/ NRC Jurisdiction Boundary
- CA Jurisdiction
- NRC Jurisdiction

SITE LOCATION

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

10/2017	PROJECT No. R3-0016.01	FIGURE 1





Legend

Survey Unit (SU)

- SU 1
- SU 2
- SU 3

(Hatched Indicates Vertical Scan Area)

Parcel Boundary

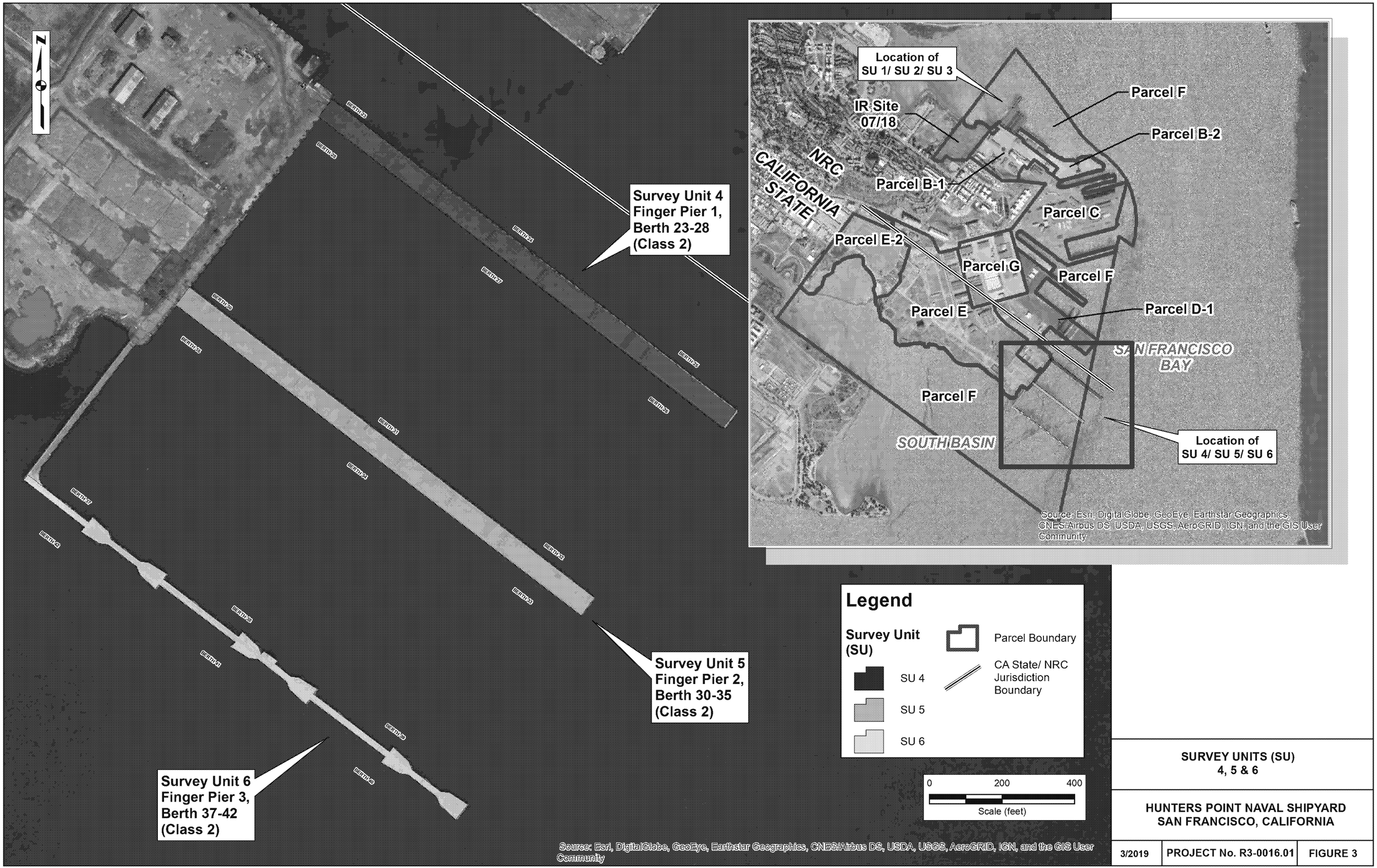
CA State/ NRC Jurisdiction Boundary

0 100 200
Scale (feet)

SURVEY UNITS (SU) 1, 2 & 3

HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA

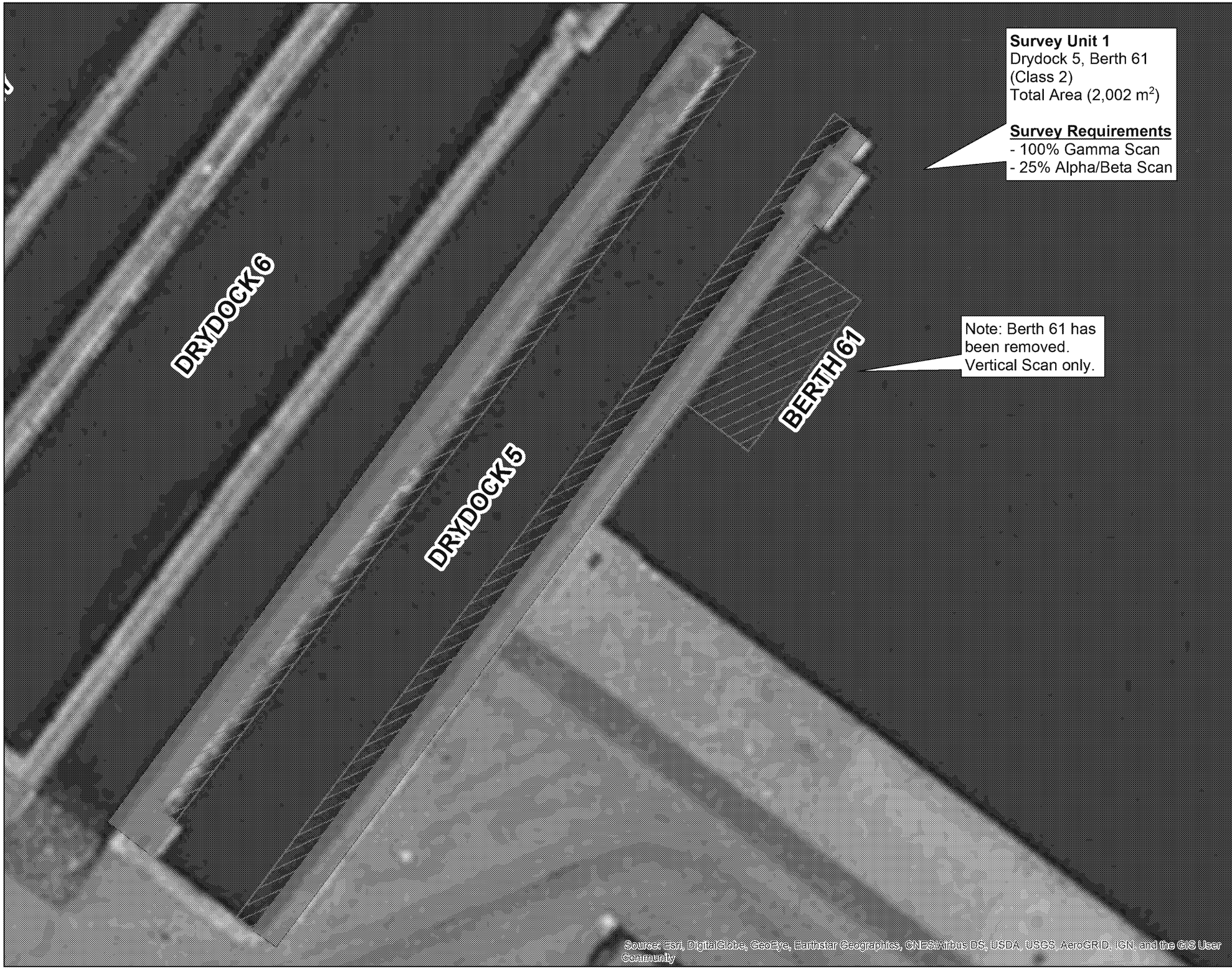
3/2019	PROJECT No. R3-0016.01	FIGURE 2



SURVEY UNITS (SU)
4, 5 & 6

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 3



N

Legend

Survey Unit (SU)

SU 1

(Hatched Indicates Vertical Scan Area)

0 40 80

Scale (feet)

SURVEY UNIT (SU) 1

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 4

N

Legend

Survey Unit (SU)

SU 2

(Hatched Indicates Vertical Scan Area)

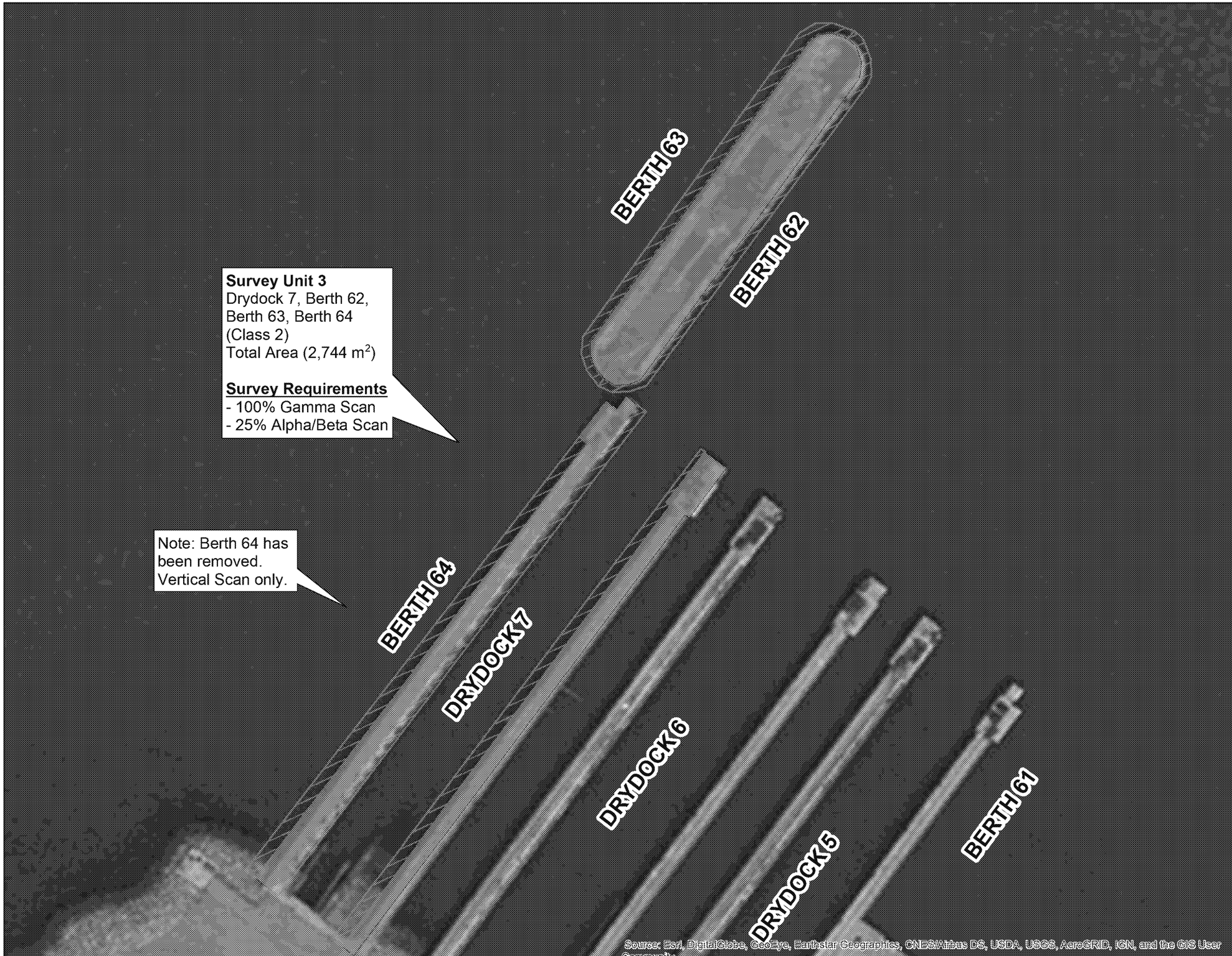
0 40 80

Scale (feet)

SURVEY UNIT (SU) 2

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 5



N

Legend

Survey Unit (SU)

SU 3

(Hatched Indicates Vertical Scan Area)

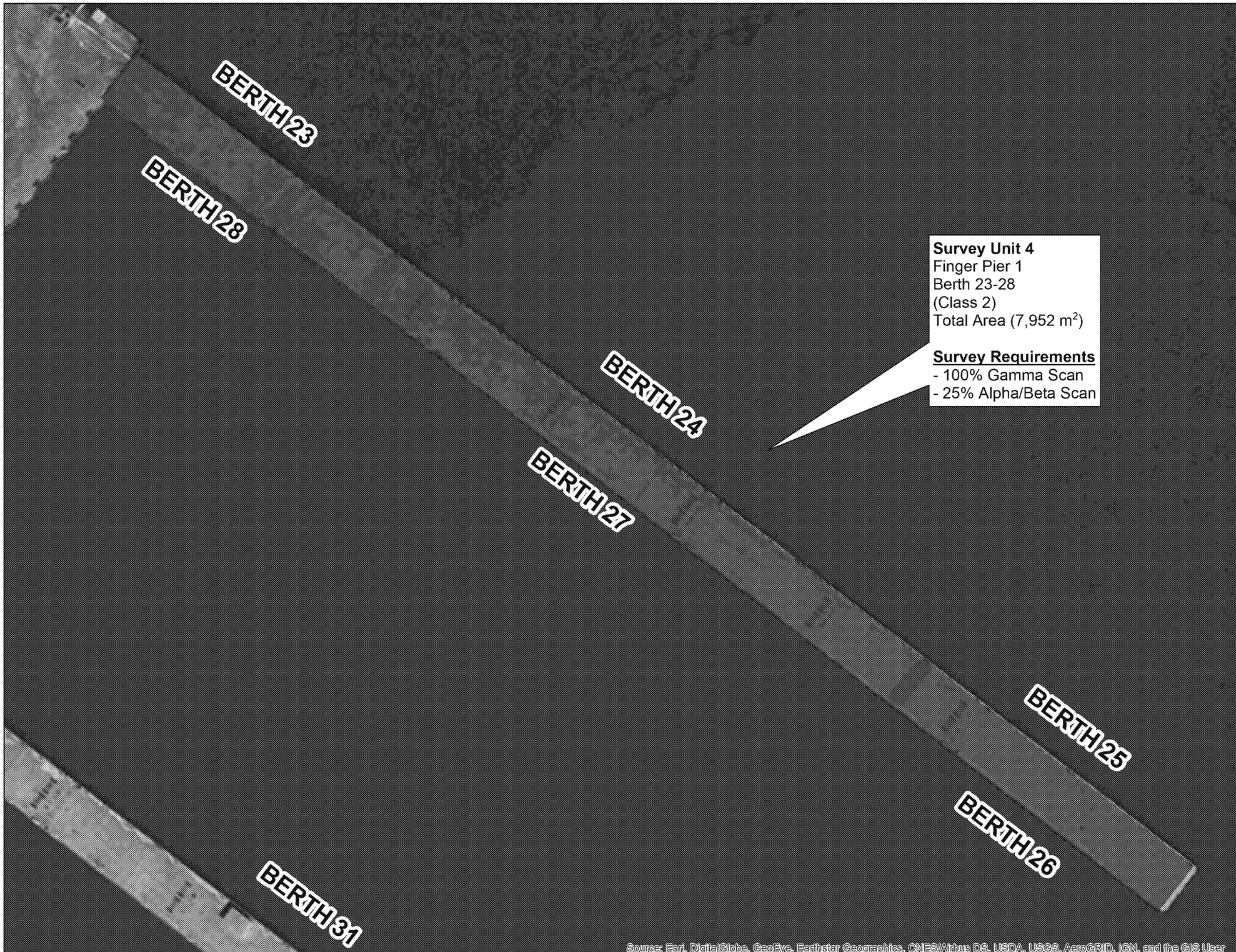
0 80 160

Scale (feet)

SURVEY UNIT (SU) 3

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 6



N

Legend

Survey Unit (SU)

SU 4

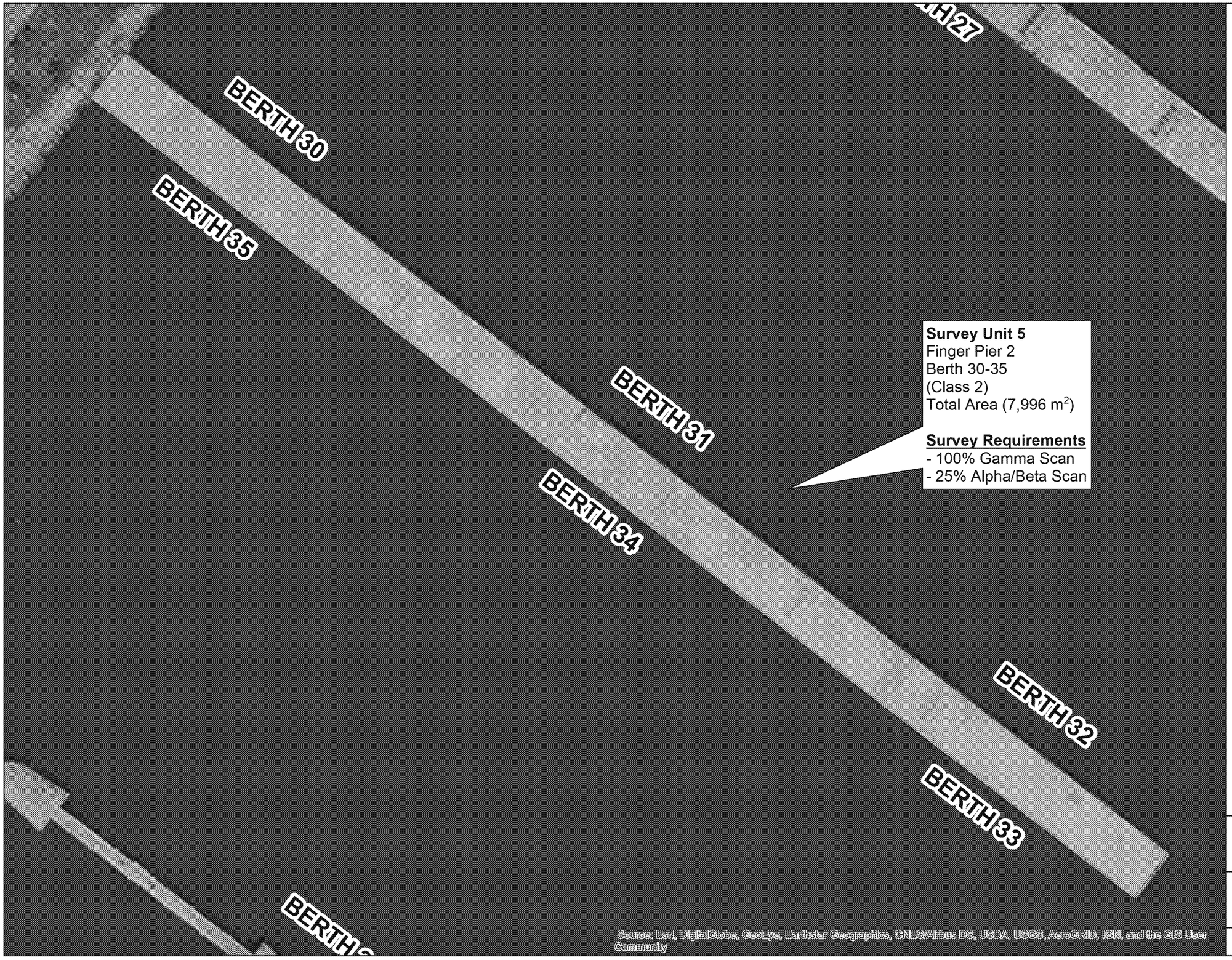
0 100 200

Scale (feet)

SURVEY UNIT (SU) 4

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 7



N

Legend

Survey Unit (SU)

SU 5

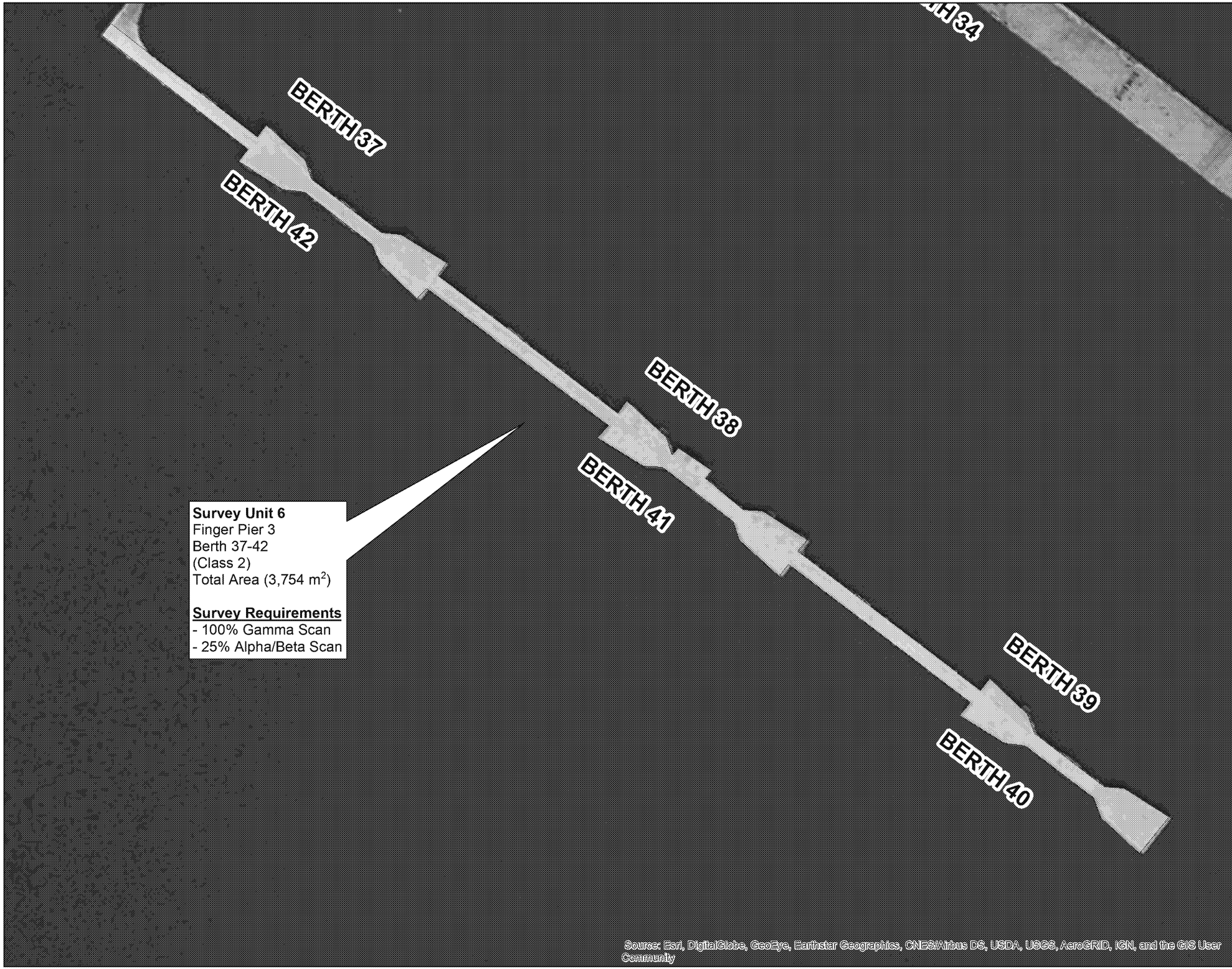
0 100 200

Scale (feet)

SURVEY UNIT (SU) 5

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 8



N

Legend

Survey Unit (SU)

SU 6

0 100 200

Scale (feet)

SURVEY UNIT (SU) 6

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 9

Tables

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Table 1
Radionuclides of Concern and Release Criteria

ROC	Half-Life	Radiations	Static Activity for alpha and beta ($dpm/100cm^2$)	Removable Activity for alpha and beta ($dpm/100cm^2$)	Soil [1] (pCi/g)
Ra-226	1,600 years	Alpha (α) /gamma (γ)	100	20	1.0
Cs-137	30.17 years	Beta (β-) /gamma (γ)	5,000	1,000	0.113
Pu-239	2.41×10^4 years	Alpha (α) /gamma (γ)	100	20	2.59
Sr-90	28.6 years	Beta (β-)	1,000	200	0.331

Notes:

Release criteria are to be applied according to Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) guidelines (EPA et al., 2000) as established in the Final Basewide Radiological Removal Action, Action Memorandum—Revision 2006, Hunters Point Shipyard, San Francisco, California (Navy, 2006).

[1] The project action limits are based on the U.S. Environmental Protection Agency preliminary remediation goals as cited in the Final Basewide Radiological Removal Action, Action Memorandum—Revision 2006, Hunters Point Shipyard, San Francisco, California (Navy, 2006) and are in addition to background values for these radionuclides.

Cs-137	*Cesium-137*
dpm/cm^2	*disintegration per minute/square centimeter*
EPA	*U.S. Environmental Protection Agency*
Navy	*U.S. Department of the Navy*
pCi/g	*picocurie per gram*
Pu-239	*Plutonium-239*
Ra-226	*Raduim-226*
ROC	*radionuclide of concern*
Sr-90	*Strontium-90*

Table 2
Survey Unit Designations for Parcel F Structures

Site Location	Survey Units	Site Location Detail	MARSSIM Classification	Gamma Scanning	Alpha/Beta Scanning	Survey Description
Submarine Pens	SU 1	Drydock 5/ Berth 61	Class 2	100%	25%	Survey of horizontal and vertical surfaces of Drydock 5 and vertical surfaces of Berth 61 (Figure 4)
	SU 2	Drydock 6				Survey of horizontal and vertical surfaces of Drydock 6 (Figure 5)
	SU 3	Drydock 7/ Berths 62, 63, and 64				Survey of horizontal and vertical surfaces of Drydock 7, Berths 62, 63, and vertical surfaces of Berth 64 (Figure 6)
Finger Piers	SU 4	Finger Pier 1 Berths 23 through 28	Class 2	100%	25%	Survey of horizontal surfaces of Finger Pier 1 (Figure 7)
	SU 5	Finger Pier 2 Berths 30 through 35				Survey of horizontal surfaces of Finger Pier 2 (Figure 8)
	SU 6	Finger Pier 3 Berths 37 through 42				Survey of horizontal surfaces of Finger Pier 3 (Figure 9)

Notes

The Final Historical Radiological Assessment Volume II, History of the Use of General Radioactive Materials, 1939–2003, Hunters Point Shipyard, San Francisco, California (HRA; Naval Sea Systems Command, 2004), HRA Section 8.3.7.2 states the current potential for contaminated media as low or none. As defined in the HRA, a low potential categorization for media contamination indicates that the contamination potential is remote. The Parcel F Submarine Pens and Finger Piers Class 2 areas are consistent with MARSSIM classification (EPA et al., 2000) where there is low to moderate potential for a dose above the release criterion, or in this case, low to moderate potential for radionuclide concentrations exceeding the release criteria listed in Table 1 of the Work Plan (October 2018).

EPA	*U.S. Environmental Protection Agency*
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*
SU	*survey unit*

Table 3
Radiological Soil Measurements—Background Reference Area—Release Criteria

	^{137}Cs			^{239}Pu			^{226}Ra			^{90}Sr		
Sample	Result[a]	Flag	MDL	Result	Flag	MDL	Result	Flag	MDL	Result	Flag	MDL
03A- BKGD- 001	0.073		0.041				0.822	A	0.918			
03A- BKGD- 002	0.041		0.040				0.877	A	0.881			
03A- BKGD- 003	0.007	A	0.022				-0.044	#A	0.722			
03A- BKGD- 004	0.059		0.041				0.261	A	0.863			
03A- BKGD- 005	0.026	A	0.046				0.429	A	1.030			
03A- BKGD- 006	0.078		0.037	0.007	U	0.015	0.849	A	0.929	0.002	U	0.250
03A- BKGD- 007	0.017	A	0.037				0.676	A	0.892			
03A- BKGD- 008	-0.002	#A	0.033				0.482	A	0.711			
03A- BKGD- 009	0.006	A	0.018				0.433	A	0.679			
03A- BKGD- 010	0.096		0.029				0.701	A	0.930			
03A- BKGD- 011	0.007	A	0.030				1.371		0.867			
03A- BKGD- 012	0.001	A	0.024				0.526	A	0.849			
03A- BKGD- 013	0.025	A	0.033				0.600	A	0.757			
03A- BKGD- 014	0.013	#A	0.017				0.656	A	0.674			
03A- BKGD- 015	0.101		0.028				0.747		0.660			
03A- BKGD- 016	0.035		0.033				1.069		0.868			
03A- BKGD- 017	0.041		0.038				0.655	A	1.050			
03A- BKGD- 018	0.054		0.025				0.245	A	0.727			
03A- BKGD- 019	0.031		0.022	-0.008	U	0.019	0.750		0.687	0.050	U	0.240
03A- BKGD- 020	0.028	A	0.041				0.557	A	0.862			
Project Release Criterion	0.113			2.590			1.633			0.331		
Average	0.037			-0.001			0.633			0.026		
Standard Dev	0.031			0.011			0.306			0.034		
Maximum	0.101			0.007			1.371			0.050		
Minimum	-0.002			-0.008			-0.044			0.002		

Table 3 (continued)
Radiological Soil Measurements—Background Reference Area—Release Criteria

Notes:

Release criteria are to be applied according to Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) guidelines (EPA et al., 2000) as established in the Final Basewide Radiological Removal Action, Action Memorandum—Revision 2006, Hunters Point Shipyard, San Francisco, California (Department of the Navy, 2006).

[a] Release criterion for radium-226 is 1 pCi/g above the average background (0.633 pCi/g), equal to 1.633 pCi/g.

#	*all peaks for activity calculation had bad shape*
^{90}Sr	*strontium-90*
^{137}Cs	*cesium-137*
^{226}Ra	*radium-226*
^{239}Pu	*plutonium-239*
A	*activity printed, but activity < MSA*
EPA	*U.S. Environmental Protection Agency*
MDL	*minimum detection limit*
pCi/g	*picocurie per gram*
U	*result is less than the sample detection limit*

Table 4
Field Survey Instrumentation

Measurement Type	Detector Type	Effective Detector Area and Window Density	Instrument Model	Detector Model
Dose Rate	NaI(Tl) scintillation	1-inch diameter x 1-inch length N/A	Ludlum 19 or Equivalent	N/A
Beta-Gamma	Geiger-Muller Survey Instrument	15 cm^2 0.3 mg/cm^2 mica	Ludlum 3 or Equivalent	Ludlum 44-9
Gamma	NaI(Tl) scintillation	3-inch x 3-inch length N/A	Ludlum 2221	Ludlum 44-20
Gamma	NaI(Tl) scintillation	4-inch x 4-inch x 16-inch length N/A	RS-700	RSX-1
Gamma	NaI Spectrometer (Nuclide Identification)	NA	Canberra Inspector 1000 or Equivalent	NA
Alpha/Beta Scan	Gas flow proportional	Floor Monitor Large Area (584 cm^2)	Ludlum 2360 or Equivalent	Ludlum 43-37
Alpha/Beta Static	Gas flow proportional	Large Area (584 cm^2)	Ludlum 2360 or Equivalent	Ludlum 43-37
Alpha/Beta Static	Gas flow proportional	Small Area (126 cm^2)	Ludlum 2360 or Equivalent	Ludlum 43-68
Alpha/Beta Swipes	Dual Phosphor scintillation	2-inch (5.1 cm) diameter 0.4 mg/cm^2	Ludlum 2929 or Equivalent	Ludlum 43-10-1

Notes:

cm	*centimeter*
cm^2	*square centimeter*
mg/cm^2	*milligram per square centimeter*
N/A	*Not Applicable*
NaI (Tl)	*sodium iodide (thallium-doped)*

Table 5
Scan and Static Measurement Sensitivity Assumptions

Model No.	Nuclide type	Background count rate (cpm) [a]	Background count time (min)	Sample count time (min)	Total Efficiency[b]	Detector active area (cm^2)	MDC (dpm/100 cm^2)
Alpha and Beta Surface Scan - Sequential 6-second Static Counts (Section 5.5.5)							
43-37	alpha	3.3	10	0.1	0.06	582	86
43-37	beta	601	10	0.1	0.08	582	473
Alpha and Beta Static Counts (Section 5.5.6)							
43-37	alpha	3.3	10	2	0.06	582	21.5
43-37	beta	601	10	2	0.08	582	184
43-68	alpha	1.2	10	5	0.07	126	32
43-68	beta	273	10	5	0.12	126	202

Notes:

(a) Background count rate based on experience with similar detectors.

(b) Total efficiency equals instrument efficiency times surface efficiency, the efficiencies provided are typical values for similar detectors.

cm^2	*square centimeter*
cpm	*count per minute*
dpm/cm^2	*disintegration per minute/square centimeter*
MDC	*minimum detectable concentration*
min	*minute*

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Table 6
Key Personnel

Agency	Contact	Project Title
NAVFAC SW 33000 Nixie Way, Building 50 San Diego, CA 92147	Leslie Howard 619.524.5903 leslie.howard.ctr@navy.mil	Navy Remedial Project Manager
NAVFAC SW 33000 Nixie Way, Building 50 San Diego, CA 92147	Sean-Ryan McCray 619.524.5322 seanryan.mccray@redhorsecorp.com	Navy Project Manager
Officer in Charge Naval Sea System Detachment Radiological Affairs Support Office ATTN: Matthew Liscio 160 Main Road Yorktown, Virginia 23691-5105	Matthew Liscio 757.887.4354 matthew.liscio@navy.mil	Navy Radiological Environmental Protection Manager
NAVFAC SW ROICC San Francisco Bay Area 950 W. Mall Square, Building 1, Suite 163 Alameda, CA 94501-7575	Shirley Ng 510.749.5939 (mobile) 510.521.8626 (office) shirley.ng@navy,mil	ROICC Project Engineer
NAVFAC SW CSO Hunters Point Naval Shipyard One Avenue of the Palms, Suite 161 San Francisco, CA 94130	Doug DeLong 415.743.4713 (office) 510.220.1894 (mobile) douglas.delong.ctr@navy.mil	CSO
U.S. Environmental Protection Agency, Region 9 75 Hawthorne Street (SFD-8-3) San Francisco, CA 94105	Lily Lee 415.947.4187 lee.lily@epa.gov	EPA RPM
California Department of Toxic Substances Control 700 Heinz Ave. Berkeley, CA 94710-2721	Nina Bacey 510.540.3480 juanita.bacey@dtsc.ca.gov	Cal/EPA DTSC RPM
California Department of Public Health Environmental Management Branch, MS 7402 1616 Capitol Ave Sacramento, CA 95899-7377	Sheetal Singh 916.449.5691 sheetal.singh@cdph.ca.gov	CDPH RPM
California Regional Water Quality Control Board, San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland, CA 94612	Tina Ures 510.622.2064 tina.ures@waterboards.ca.gov	RWQCB RPM
City and County of San Francisco Department of Public Health 1390 Market St., Suite 210 San Francisco, CA 94102	Amy Brownell 415.252.3967 amy.brownell@sfdph.org	San Francisco DPH RPM
Aptim Federal Services, LLC 1230 Columbia Street, Suite 600 San Diego, CA 92101	Lisa Bercik, PE 619.446.4508 (office) 619.213.3389 (mobile) lisa.bercik@aptim.com	Project Manager

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Table 6 (continued)
Key Personnel

Agency	Contact	Project Title
Aptim Federal Services, LLC 4005 Port Chicago Hwy, Suite 200 Concord, CA 94520	Sean Orman 628.231.8025 (mobile) sean.orman@aptim.com	Construction Manager
Aptim Federal Services, LLC 1230 Columbia Street, Suite 600 San Diego, CA 92101	Steve Massey 619.987.6557 (mobile) stephen.massey@aptim.com	Program QC Manager
Aptim Federal Services, LLC 4005 Port Chicago Hwy, Suite 200 Concord, CA 94520	Lee Laws 925.759.1787 (mobile) lee.laws@aptim.com	PQCM
Aptim Federal Services, LLC 6380 South Fiddler's Green Circle Greenwood Village, CO 80111	Amy Mangel 303.486.2560 (office) 419.350.9429 (mobile) amy.mangel@aptim.com	Technical Lead
Aptim Federal Services, LLC 4038 Masonboro Loop Road Wilmington, NC 28409	Raymond Schul 518.496.5533 (mobile) raymond.schul@aptim.com	Radiological Operations Manager
Aptim Federal Services, LLC 200 Fischer Avenue Former Hunters Point Naval Shipyard San Francisco, CA 94124	Randall Killpack 415.6714.2969 (office) 801.244.2394 (mobile) rose.condit@aptim.com	Project Radiation Safety Officer/License Authorized User
Aptim Federal Services, LLC 4005 Port Chicago Hwy, Suite 200 Concord, CA 94520	Rose Condit 925.288.2151 (office) rose.condit@aptim.com	Program Chemist
Aptim Federal Services, LLC 4005 Port Chicago Hwy, Suite 200 Concord, CA 94520	Eddie Kalombo 925.288.2342 (office) eddie.kalombo@aptim.com	Project Chemist
Aptim Federal Services, LLC 4005 Port Chicago Hwy, Suite 200 Concord, CA 94520	Mark Egan 925.579.4073 (mobile) mark.egan@aptim.com	SSHO
Aptim Federal Services, LLC 16380 U.S. Route 224 East, Suite 100 Findlay, OH 45840	David Mummert 419.429.5509 (office) 419.348.1544 (mobile) david.mummert@aptim.com	CIH

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Table 6 (continued)
Key Personnel

Notes:

Cal/EPA	*California Environmental Protection Agency*
CDPH	*California Department of Public Health*
CIH	*Certified Industrial Hygienist*
CSO	*Caretaker Site Office*
DPH	*Department of Public Health*
DTSC	*California Department of Toxic Substances Control*
EPA	*U.S. Environmental Protection Agency*
NAVFAC SW	*Naval Facilities Engineering Command, Southwest*
PQCM	*Project Quality Control Manager*
QC	*quality control*
ROICC	*Resident Officer in Charge of Construction*
RPM	*Remedial Project Manager*
RWQCB	*California Regional Water Quality Control Board, San Francisco Bay Region*
SSHO	*Site Safety and Health Officer*

Appendix A
Sampling and Analysis Plan
(dated April 2019)

SAP Worksheet #1: Title and Approval Page

Final Revision 2
SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)

April 2019

Radiological Work Tasks, Remedial Action, and Maintenance of Remedies
Task: Radiological Scoping Surveys
Parcel F Structures, Hunters Point Naval Shipyard
San Francisco, California

Prepared for:
Base Realignment and Closure
Program Management Office West
Naval Facilities Engineering Command Southwest
33000 Nixie Way, Building 50
San Diego, California 92147

Prepared by:
Aptim Federal Services, LLC
4005 Port Chicago Highway, Suite 200
Concord, California 94520-1120
925.288.9898

Prepared under:
Contract Number: N62473-17-D-0006
Contract Task Order: N6247317F4550
Document Control Number: APTM-0006-4550-0025.R2/F

Review Signatures: _____ April 8, 2019
Stephen Massey/Program QA Manager Date

Approval Signatures: WALKER.TERESIE.R.1515870071 Digitally signed by WALKER.TERESIE.R.1515870071 Date: 2019.05.22 07:09:05 -04'00' _____
Joe Arlauskas/NAVFAC SW QA Officer Date

EXECUTIVE SUMMARY

This Sampling and Analysis Plan (SAP) has been prepared by Aptim Federal Services, LLC (APTIM) to support radiological scoping surveys of the Parcel F structures (submarine pens and finger piers) located at Hunters Point Naval Shipyard, San Francisco, California (Figures 1, 2, and 3). Specifically, this SAP addresses tasks associated with large area gamma scans using the RS-700, gamma walkover surveys, and alpha/beta radiological scanning to support identification and removal of low-level radiological objects, and provide data to support future site decisions for the Parcel F structures. The Parcel F structures to be sampled under this SAP include the submarine pens (Drydocks 5, 6, and 7; associated Ship Berths 61, 62, 63, and 64; Finger Piers 1, 2, and 3; and associated Ship Berths 23 through 28, 30 through 35, and 37 through 42.)

In general, off-site sample analysis is not anticipated for this project. However, if discrete sources or radiological objects are identified, sampling may be conducted for off-site analysis to better identify the source of activity and to assist in planning removal action if necessary. These activities will be performed in accordance with the Radiological Scoping Surveys Work Plan and *Radiation Protection Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California* (APTIM, 2017a); the State of California Radioactive Materials License No. 7889-07; and the U.S. Nuclear Regulatory Commission License 20-31340-01 issued to APTIM. No chemical sampling is anticipated for this portion of the work scope.

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List of Attachments

Attachment 1 Field Forms
Attachment 2 Certifications and Analytical Standard Operating Procedures (will be provided in electronic copy only)

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List of Acronyms

%	percent
<	less than
>	greater than
±	plus or minus
≤	less than or equal to
≥	greater than or equal to
^{90}Sr	strontium-90
^{137}Cs	cesium-137
^{226}Ra	radium-226
^{239}Pu	plutonium-239
AM	*Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, California*
APTIM	Aptim Federal Services, LLC
BSC	background subtraction count
CCV	continuing calibration verification
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chain-of-custody
DER	duplicate error ratio
DL	detection limit
DLC	decision level concentration
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FWHM	full width at half maximum
H&S	health and safety
HRA	*Final Historical Radiological Assessment, History and the Use of General Radioactive Materials, 1939-2003*
HPNS	Hunters Point Naval Shipyard
ICAL	initial calibration
ICV	initial calibration verification
ID	identification
IL	investigation level
keV	kiloelectron volt
LCS	laboratory control sample
LOD	limit of detection

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List of Acronyms (continued)

MARLAP	*Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)*
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*
MS	matrix spike
MSD	matrix spike duplicate
NAVFAC SW	Naval Facilities Engineering Command Southwest
NAVSEA	Naval Sea Systems Command
Navy	U.S. Department of the Navy
NRDL	Naval Radiological Defense Laboratory
OSHA	Occupational Safety and Health Administration
pCi/g	picocurie per gram
PM	project manager
POC	point of contact
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QSM	*Quality Systems Manual for Environmental Laboratories*, Version 5.1
RASO	Radiological Affairs Support Office
ROC	radionuclide of concern
RPD	relative percent difference
RPM	Remedial Project Manager
RPP	*Radiation Protection Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*
RSO	Radiation Safety Officer
SAP	sampling and analysis plan
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
UFP-QAPP	*Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs*
Water Board	California Regional Water Quality Control Board

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SAP Worksheet #2: SAP Identifying Information

Site Name/Number:	**Radiological Scoping Surveys, Parcel F Structures, Hunters Point Naval Shipyard (HPNS)**
Contractor Name:	**Aptim Federal Services, LLC (APTIM)**
Contract Number:	**N62473-17-D-0006**
Contract Title:	**RADMAC II**
Work Assignment Number (optional):	**Contract Task Order N6247317F4550**

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the *Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs* (UFP-QAPP; U.S. Environmental Protection Agency [EPA], 2005) and *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, Office of Environmental Information* (EPA, 2001). With additional guidance from the following publications:

   - *Quality Systems Manual for Environmental Laboratories, Version 5.1* (QSM; U.S. Department of Defense [DoD], 2017)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006)
   - *Environmental Work Instruction 3EN2.1—Chemical Data Validation* (Naval Facilities Engineering Command Southwest [NAVFAC SW], 2001)
   - *Environmental Work Instruction EVR.2—Review, Approval, Revision, and Amendment of Sampling and Analysis Plans* (NAVFAC SW, 2011)
   - *Environmental Work Instruction EVR.4—Implementing and Maintaining the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Administrative Record and Compendium at NAVFAC Southwest* (NAVFAC SW, 2007)
   - *Environmental Work Instruction EVR.6—Environmental Data Management and Required Electronic Delivery Standards* (NAVFAC SW, 2005)

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

3. This is a project-specific SAP.

4. List dates of scoping sessions that were held: September 25, 2017 (Project Kick-Off Meeting)

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SAP Worksheet #2: SAP Identifying Information (continued)

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

Title	Date
No relevant documents available	

6. List organizational partners (stakeholders) and connection with lead organization:

Oversight by the California Department of Toxic Substances Control (DTSC)
Oversight by the California Department of Public Health (CDPH), Division of Drinking Water and Environmental Management
Oversight by the California Regional Water Quality Control Board (Water Board)
Oversight by the EPA

7. Lead organization

U.S. Department of the Navy (Navy)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

No worksheets omitted

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SAP Worksheet #2: SAP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	
2	Table of Contents; SAP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
Project Organization		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	
Project Planning/Problem Definition		
9	Project Planning Session Documentation (Including Data Needs Tables); Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background Site Maps (Historical and Present)	
11	Site-Specific Project Quality Objectives	
12	Measurement Performance Criteria Table	
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	
14	Summary of Project Tasks	
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	
18	Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table Sample Location Map(s)	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control (QC) Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	

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SAP Worksheet #2: SAP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain of Custody (COC) Form and Seal	
QC Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	
Data Management Tasks		
29	Project Documents and Records Table	
30	Analytical Services Table Analytical and Data Management SOPs	
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	
32	Assessment Findings and Corrective Action Responses Table	
33	Quality Assurance (QA) Management Reports Table	
D. Data Review		
34	Verification (Step I) Process Table	
35	Validation (Steps IIa and IIb) Process Table	
36	Validation (Steps IIa and IIb) Summary Table	
37	Usability Assessment	

Notes:
UFP-QAPP (EPA, 2005)

SAP Worksheet #3: Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Leslie Howard	Remedial Project Manager (RPM)	NAVFAC SW	619.524.5903 (office)	leslie.howard@navy.mil Base Realignment and Closure Program Management Office West 33000 Nixie Way, Bldg. 50 San Diego, California 92147
Sean-Ryan McCray	Navy Project Manager	NAVFAC SW	619.524.5322 (office)	sean-ryan.mccray.ctr@navy.mil Base Realignment and Closure Program Management Office West 33000 Nixie Way, Bldg. 50 San Diego, California 92147
Radiological Affairs Support Office (RASO) Environmental Protection Manager	Navy Radiological Environmental Protection Manager	RASO; Naval Sea System Command Detachment	757.887.4692 (office)	navsearasoadmin.fct@navy.mil Officer in Charge Naval Sea System Detachment Radiological Affairs Support Office 160 Main Road Yorktown, Virginia 23691-5105
Joe Arlauskas	Quality Assurance Officer (QAO)	NAVFAC SW	619.532.4125 (office)	joseph.arlauskas@navy.mil 1220 Pacific Highway San Diego, California, 92132
Sheetal Singh	CDPH RPM	CDPH	916.449.5691	sheetal.singh@cdph.ca.gov California Department of Public Health Environmental Management Branch 1616 Capitol Avenue, MS 7402 Sacramento, California 95814
Amy Brownell	San Francisco Department of Public Health RPM	San Francisco Department of Public Health	415.252.3967	amy.brownell@sfdph.org City and County of San Francisco Department of Public Health 1390 Market St., Suite 210 San Francisco, California 94102

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SAP Worksheet #3: Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Nina Bacey	DTSC RPM	DTSC	510.540.2480	juanita.bacey@dtsc.ca.gov California Department of Toxic Substances Control 700 Heinz Ave., Bldg. F, Suite 200 Berkeley, California 94710
Tina Ures	Water Board RPM	Water Board	510.622.2064	tina.ures@waterboards.ca.gov SF Bay Regional Water Quality Control Board, 1515 Clay Street, Suite 1400 Oakland, California 94612
Lily Lee	EPA RPM	EPA, Region 9	415.947.4187	lee.lily@epa.gov U.S. Environmental Protection Agency, Region 9 75 Hawthorne Street (SFD-8-3) San Francisco, California 94105
Ulrika Messer	Program Manager	APTIM	619.446.4529 (office)	ulrika.messer@aptim.com 1230 Columbia Street, Suite 600 San Diego, California 92101
Lisa Bercik	Project Manager (PM)	APTIM	619.446.4508 (office)	lisa.bercik@aptim.com 1230 Columbia Street, Suite 600 San Diego, California 92101
Rose Condit	Program Chemist	APTIM	925.288.2151 (office)	rose.condit@aptim.com 4005 Port Chicago Highway, Suite 200 Concord, California 94520
Eddie Kalombo	Project Chemist	APTIM	415.987.0760 (mobile)	eddie.kalombo@aptim.com 4005 Port Chicago Highway, Suite 200 Concord, California 94520
Steve Massey	Program QC Manager	APTIM	619.446.4522 (office)	stephen.massey@aptim.com 1230 Columbia Street, Suite 600 San Diego, California 92101

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SAP Worksheet #3: Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Raymond Schul	Radiological Operations Manager	APTIM	518.496.5533 (mobile)	raymond.schul@aptim.com 4038 Masonboro Loop Road Wilmington, North Carolina 28409
Randall Killpack	Project Radiation Safety Officer (RSO)/License Authorized User	APTIM	801.244.2394 (mobile)	randall.killpack@atpim.com 200 Fischer Avenue Former Hunters Point Naval Shipyard San Francisco, California 94124
Minh Chi	Project RSO Representative	APTIM	415.741.8299 (mobile)	minhsec.chi@aptim.com 200 Fischer Avenue Former Hunters Point Naval Shipyard San Francisco, California 94124
Rick Greene	Certified Health Physicist	APTIM	865.560.7819 (office)	rick.greene@aptim.com 4210 Cherahala Blvd Knoxville, Tennessee 37932
Amy Mangel	Technical Lead	APTIM	303.486.2560 (office)	amy.mangel@aptim.com 6380 South Fiddler's Green Circle Greenwood Village, Colorado 80111
Lee Laws	Project QC Manager	APTIM	925.759.1787 (mobile)	lee.laws@aptim.com 950 Avenue M, Building 570 San Francisco, California 94130

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SAP Worksheet #3: Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Bachir Badaoui	Site Radiation Safety Lead	Cabrera Services Inc.	916.897.1756 (mobile)	bbadaoui@cabreraservices.com 50 Founders Plaza, Suite 207 East Hartford, Connecticut 06108
Rhonda Ridenhower	Laboratory PM	Test America, St. Louis Laboratory	314.298.8566	Rhonda.Ridenhower@testamericainc.com 13715 Rider Trail North Earth City, Missouri 63045
Larry Duty Jeanne Peterson	Data Validation PM (copy of final SAP only)	E-Lab Consultants, LLC AQA, Inc	832.364.0173 702.368.3513	lduty@e-labdc.com jpeterson@aqainc.net

SAP Worksheet #4: Project Personnel Sign-Off Sheet

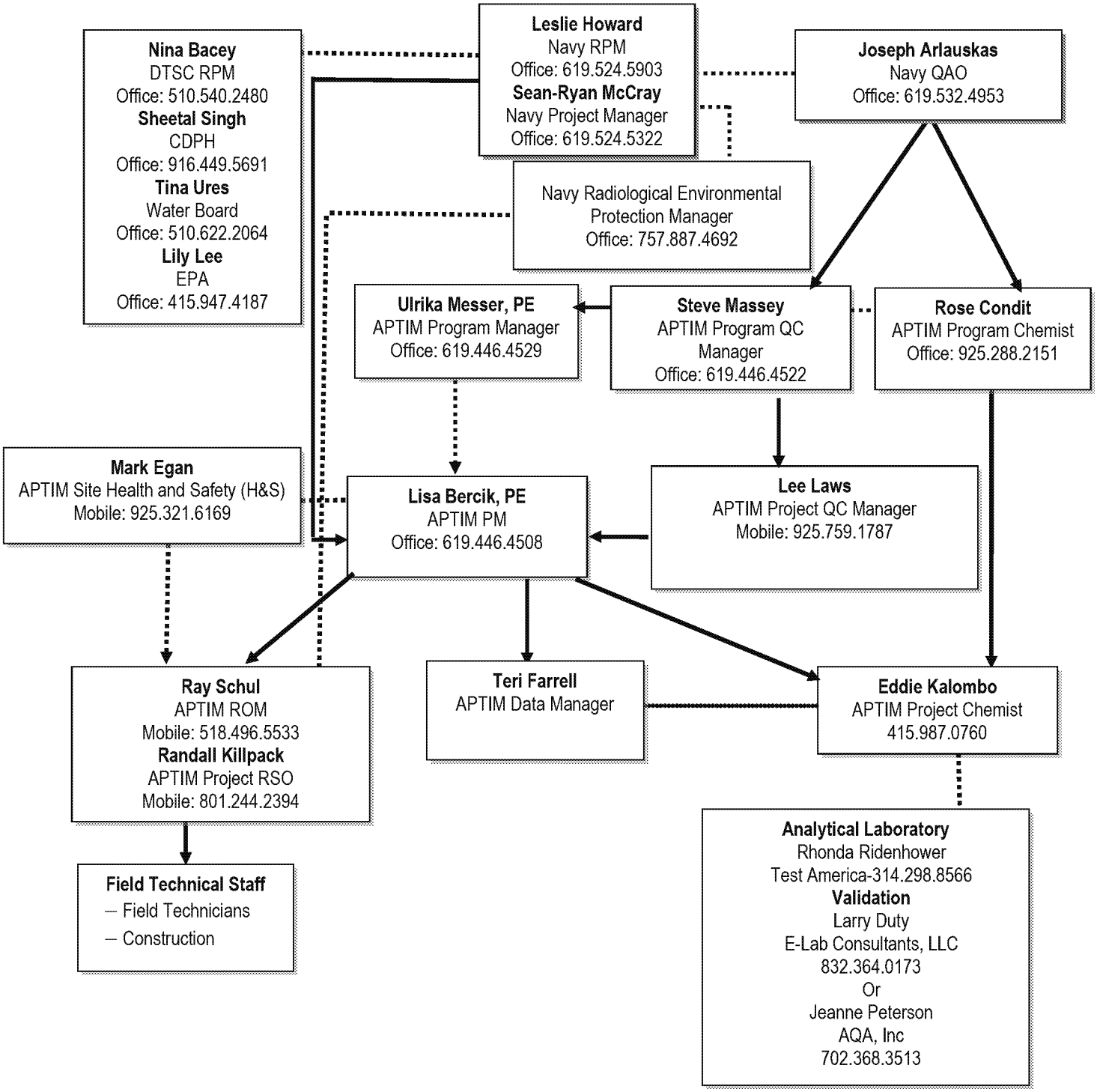
Name	Organization/Title/Role	Signature/Email Receipt	SAP Section Reviewed	Date SAP Read
Lisa Bercik	APTIM PM			
Eddie Kalombo	APTIM Project Chemist			
Lee Laws	APTIM Project QC Manager			
Rhonda Ridenhower	Test America PM			
Jeanne Peterson	AQA, Inc data validation project manager			
Larry Duty	E-Lab Consultants, LLC data validation project manager			

Note:

The signed SAP Worksheet #4 will be stored in the on-site project files, and then will be transferred to the APTIM Concord, California home office file storage at completion of fieldwork.

SAP Worksheet #5: Project Organization Chart

Lines of responsibility (solid lines) and lines of communication (dotted lines) are provided.



SAP Worksheet #6: Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Telephone Number	Procedure
Communication with regulators	Navy RPM Navy Project Manager	Leslie Howard Sean-Ryan McCray	619.524.5903 619.524.5322	Any significant corrective actions or changes to approved plans will be communicated to regulators by the Navy RPM within 72 hours via email and during regular field work updates, such (Base Realignment and Closure Cleanup Team meetings).
Point of Contact (POC) with the Navy RPM and RASO	PM	Lisa Bercik	619.446.4508	Materials and information about the project will be forwarded to the RPM by the PM within 72 hours or as soon as practical.
SAP Changes in the Field	Project Chemist or Program Chemist	Rose Condit Eddie Kalombo	925.288.2151 415.987.0760	The Project Chemist is responsible for documenting field changes related to sampling. The Project Chemist or Program Chemist is also responsible for generating SAP amendments as necessary for approval by the Navy QAO. The Project Chemist oversees the documentation, notification, and corrective actions associated with project management issues in writing. Due to the potential impact field changes and SAP amendments may have on the project, the Project Chemist is to be notified of such issues within 24 hours.
Sampling Quality Issues	Project or Program QC Manager Project or Program Chemist	Lee Laws, or, Steve Massey Eddie Kalombo or Rose Condit	925.759.1787 619.446.4522 415.987.0760 925.288.2151	In general, the Project Chemist is the POC for sampling and chemistry issues and the Project QC Manager is the POC for other quality issues. If quality issues are not resolved at the project level (in consultation with the PM, Project Site Superintendent, Technical Lead, etc.), then the issue will be elevated to the Program Chemist or Program QC Manager). The Program Chemist or designee will seek additional guidance or approval from the Navy QAO, if necessary. Upon resolution, the Project QC Manager or Project Chemist oversees the documentation, notification, and corrective actions associated with the QA issues in writing within five business days.

SAP Worksheet #6: Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number	Procedure
Sample Collection Issues	Project Chemist or Program Chemist	Eddie Kalombo or Rose Condit	415.987.0760 925.288.2151	The Project Chemist is the POC for sampling and chemistry issues. If sampling issues are not resolved at the project level (in consultation with the PM and other staff), then the issue will be elevated to the Program Chemist (Rose Condit) or Program QC Manager. The Program Chemist or Program QC Manager will seek additional guidance or approval from the Navy QAO, if necessary. Upon resolution, the Project Chemist oversees the documentation, notification, and corrective actions associated with the QA issues in writing. Due to the potential impact, sampling issues may have on the project the Project Chemist is to be notified of sampling issues within 24 hours.
Laboratory Reporting or Data Quality Issues	Program Chemist/ Data Manager	Rose Condit	925.288.2151	The Project Chemist is the POC for laboratory issues. The project Data Manager is the POC for electronic data deliverables (EDD). If laboratory issues are not resolved with the Project Chemist or Data Manager, then the issue will be elevated to the Program Chemist. If significant problems are identified from the laboratory that will impact the usability of the data, the Project Chemist should inform the PM, Navy RPM, and other parties as applicable within 24 hours of discovery or by the next business day. Upon resolution, the Project Chemist oversees the documentation, notification, and corrective actions associated with the laboratory issue in writing.
Stop Work Issues (Quality)	Navy QAO	Joe Arlauskas	619.532.4125	The Navy QAO is authorized to suspend project execution if QA requirements are not adequately followed. The Navy QAO will notify the Navy RPM and APTIM Program QC Manager if QC issues requiring stop work are identified. The APTIM Program QC Manager or Program Chemist, in consultation with the Task Order Manager and Navy RPM, will work with the Navy QAO to resolve QA issues and resume work. Upon resolution, the Project QC Manager oversees the documentation, notification, and corrective actions associated with site issues in writing within five business days.

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SAP Worksheet #6: Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Telephone Number	Procedure
Notification of Non-Usable Analytical Data	Program Chemist	Rose Condit	925.288.2151	If significant problems are identified by the laboratory or the project team that impact the usability of the data (i.e., the data is rejected or the data quality objectives are not met), the Program Chemist will notify the NAVFAC SW RPM and the NAVFAC SW QAO within 24 hours or the next business day.
Field Activity Issues	PM	Lisa Bercik	619.446.4508	The PM is the POC for project site activities such as scheduling, staffing, subcontractors, fieldwork, etc. The PM, in consultation with the Navy RPM, if necessary, will resolve project site issues. Upon resolution, the PM oversees the documentation, notification, and corrective actions associated with site issues in writing. The PM is to be notified of site issues within 24 hours.
H&S Issues	Site Safety and Health Officer (SSHO)	Mark Egan	925.321.6169	The Project SSHO is the POC for H&S issues. If H&S issues are not resolved at the project level (in consultation with the PM, Project Site Superintendent, Technical Lead, etc.), then the issue will be elevated to the Program SSHO. The Program SSHO or designee will seek additional guidance or approval from the Navy SSHO, if necessary. Upon resolution, the Project SSHO oversees the documentation, notification, and corrective actions associated with the issue in writing. Due to the potential seriousness of H&S issues, the SSHO is to be notified of H&S issues immediately.
Stop Work Issues (H&S)	SSHO APTIM Employees	Mark Egan	925.321.6169	Employees have the right and duty to stop work when conditions are unsafe, or when established safety procedures are being disregarded. Whenever an employee determines that workplace conditions present an immediate uncontrolled risk of injury or illness, immediate resolution with the appropriate supervisor shall be sought. Should the supervisor be unable or unwilling to correct the unsafe conditions, the employee is authorized and required to issue a Stop Work Order in accordance with APTIM Procedure AMS-710-05-PR-00400, “Stop Work Authority” (2017b). The specific activity or operation in question shall be discontinued until the issue is resolved.

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SAP Worksheet #7: Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibility
Leslie Howard Sean-Ryan McCray	Navy RPM Navy Project Manager	Navy	Manages governmental oversight of the project. Manages project funding and scope. Coordinates project documents review. Primary contact and liaison with regulatory agencies. Responsible for technical oversight of the project.
RASO Environmental Protection Manager	Navy Radiological Environmental Protection Manager	RASO	As deemed necessary by RASO/Base Realignment and Closure: Reviewing radiological laboratory data. Performing on-site reviews of all radiological site operations Reviewing final reports. Reviewing data for proposed radiological actions.
Lisa Bercik	PM	APTIM	Manages oversight of the project for APTIM. POC for communication with the Navy RPM and Navy contracts. Ensures that requirements of project contract are attained in a manner consistent with project plans. Oversees planning, execution, and conclusion of project activities. Manages project budgets and schedules. Develops work plans to address project scope of work. Prepares work plan variances, if necessary. Manages technical project elements.
Rose Condit	Program Chemist	APTIM	Reviews and approves this SAP; Guides the selection of subcontract analytical laboratories. Serves as a POC for the Navy QAO. Develops corrective action as required; Serves as a technical advisor to the project.

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SAP Worksheet #7: Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibility
Eddie Kalombo	Project Chemist	APTIM	Develops the project data quality objectives (DQO) and prepares this SAP. Selects qualified subcontract laboratories. Implements data QC procedures and audits field performance. Reviews laboratory data prior to use. Oversees third-party validation of laboratory data, if required. Reviews data validation report. Prepares the appropriate sections of the report summarizing the project sampling activities.
Randall Killpack	Project RSO	APTIM	Oversees overall radiological operations and documentation for the project. Acts as the Technical Lead for radiological data collection. Ensures that the Project Radiological Control Technicians have adequate training in sample collection. Receives and reviews QA laboratory sample data to ensure DQOs are met.
Lee Laws	Project QC Manager	APTIM	Develops the project QC objectives and prepares the QC Plan. Administers the QC Plan. Manages QC documentation and QC deliverables. Lists definable features of work. Conducts inspections (preparatory, initial, follow-up, completions).
Mark Egan	SSHO	APTIM	Develops and administers the Site Safety and Health Plan. Manages personnel and environmental monitoring. Coordinates preparation of job safety analyses. Selects appropriate personal protective equipment and facilitates daily safety meetings. Reviews essential H&S requirements with on-site personnel.
APTIM Field Technician	Field Technician (sampling)	APTIM	Performs sampling in accordance with approved SAP. Ensures that field QC samples are collected as specified in the SAP. Completes field documentation and implements field corrective actions as required. Must have Occupational Safety and Health Administration (OSHA) 40-hour Certification and 8-hour OSHA Refresher Certification as appropriate.

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SAP Worksheet #7: Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibility
Rhonda Ridenhower	Laboratory PM	Test America	Oversees proper analysis and reporting of project samples according to approved SAP. Manages communication between laboratory and APTIM Project Chemist. Ensures proper QA/QC procedures are followed during laboratory analysis.
Larry Duty Jeanne Peterson	Data Validation PM	E-Lab Consultants, LLC AQA, Inc	Performing data validation according to applicable methods and approved SAP Reviewing laboratory reports for compliance with applicable methods and approved SAP Applying validation qualifiers to analytical data Preparing data validation report

SAP Worksheet #8: Special Personnel Training Requirements Table

Field personnel will be required to have completed the OSHA 40-hour Hazardous Waste Operations and Emergency Response Standard Protection training, continued 8-hour Hazardous Waste Operations and Emergency Response, and submit to annual medical surveillance, as required by OSHA. The APTIM SSHO will be responsible for ensuring that training and/or certification is met and that qualified personnel are performing the work.

Project Function	Specialized Training—Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records and Certificates
On-Site Project Personnel	Title 49 Transportation Subpart H Function-specific Training	Radiological Controls Supervisor	Prior to start of fieldwork	On-Site Project Personnel	Radiological Controls Supervisor	APTIM Project Files
	Radiation Worker Training (see *Radiation Protection Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California* [RPP]; APTIM, 2017a)	APTIM Project RSO or designee	Prior to start of fieldwork	On-Site Project Personnel	APTIM SSHO	APTIM Project Files
Radiological Monitoring Personnel	Site-Specific Qualification	Radiological Controls Supervisor	Prior to start of fieldwork	Junior and Senior Radiological Controls Technicians	Radiological Controls Supervisor	APTIM Project Files

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SAP Worksheet #9: Project Scoping Session Participants Sheet

Project Name: Radiological Work Tasks, Remedial Action and Maintenance of Remedies Task: Basewide Radiological Support at Hunters Point Naval Shipyard

Projected Date(s) of Sampling: 2017–2020

PM: Lisa Bercik | **Site Location:** Hunters Point Naval Shipyard, San Francisco CA

Date of Session: September 25, 2017

Scoping Session Purpose: Project kick-off meeting

Name	Title	Affiliation	Phone #	Email Address	Project Role
Leslie Howard	RPM	Navy	619.524.5903	leslie.howard.ctr@navy.mil	RPM
Danielle Janda	Lead RPM	Navy	619.524.6041	danielle.janda@navy.mil	Lead RPM
Veronica Gonzales	RPM	Navy	619.524.5755	veronica.gonzales@navy.mil	RPM
Doug Delong	Caretaker Site Office	Navy	415.743.4713	douglas.delong.ctr@navy.mil	Caretaker Site Office
Shirley Ng	Resident Officer in Charge of Construction	Navy	510.521.8713	shirley.ng@navy.mil	Resident Officer in Charge of Construction
Lisa Bercik	PM	APTIM	619.446.4508	lisa.bercik@aptim.com	PM
Jim Click	Construction Manager	APTIM	303.345.8998	james.click@aptim.com	Construction Manager
Mike Ayala	Site Lead	APTIM	925.408.7121	mike.ayala@aptim.com	Site Lead
Mark Egan	SSHO	APTIM	925.579.4073	mark.egan@aptim.com	SSHO
Randall Killpack	Project RSO	APTIM	415.671.2969	randall.killpack@aptim.com	Project RSO
Barbara Matz	Alternate SSHO/Alternate Project QC Manager	APTIM	415.713.8482	barbara.matz@aptim.com	SSHO
Ray Schul	Program RSO	APTIM	518.496.5533	raymond.schul@aptim.com	Program RSO
Jim Langsted	Certified Health Physicist	APTIM	303.486.2513	jim.langsted@aptim.com	Certified Health Physicist
Jamie Egan	PM	APTIM	415.260.9803	jamie.egan@aptim.com	Assistant PM
Mark Vennemeyer	Project QC Manager	APTIM	925.579.4073	mark.vennemeyer@aptim.com	Project QC Manager

Comments/Decisions:	Project kick-off meeting for all Radiological Work Task at Hunters Point Naval Shipyard Items discussed included radiological project objectives, logistics, site access, RASO oversight and project schedule
Action Items/ Decisions:	None

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SAP Worksheet #10: Problem Definition

Based on the *Final Historical Radiological Assessment, History and the Use of General Radioactive Materials, 1939-2003* (HRA; Naval Sea Systems Command [NAVSEA], 2004), Parcel F structures including the submarine pens and finger piers are radiologically impacted (Figure 1). The objective of this work effort is to identify residual radioactivity or low-level radiological objects (e.g., deck markers) attached to surfaces of the submarine pens and finger piers. As a conservative measure, 100 percent gamma and 25 percent alpha/beta scanning will be performed for all accessible surface areas. If no residual radioactivity exceeding the project release criteria is found, the radiological survey data will be presented in reports and used to support future site decisions for the Parcel F structures.

10.1 SITE HISTORY AND DESCRIPTION

The HRA (NAVSEA, 2004) provides information on the historical use of radioactive materials at HPNS. As determined in the HRA, the radionuclides of concern (ROCs) for the Parcel F structures are cesium-137 (^{137}Cs), plutonium-239 (^{239}Pu), radium-226 (^{226}Ra), and strontium-90 (^{90}Sr).

10.2 SITE DESCRIPTION AND HISTORY

Drydocks 5, 6, and 7 and associated Ship Berths 61, 62, 63, and 64 (Figure 2) were built in 1944 for submarine repair, but were also capable of housing destroyers and other relatively small vessels. The drydocks are each approximately 420 feet by 60 feet, with a gate that is hinged at the bottom that flaps down to allow the vessel to enter. Each drydock was dewatered by four 20,000-gallon-per-minute pumps. Two pumps were located at each side of the San Francisco Bay end of the dock (NAVSEA, 2004). The following radiological operations were performed at Drydocks 5, 6, and 7 and associated Ship Berths 61, 62, 63, and 64:

- Decontamination of Operation Crossroads ships in Drydock 6, potential decontamination of Operation Crossroads ships in Drydock 5 and Drydock 7
- Ship repair (submarines)
- Naval Nuclear Propulsion Program operations in Drydock 6

The following radiological operations were performed at Finger Piers 1, 2, and 3 and associated Ship Berths 23 through 28, 30 through 35, and 37 through 42 (Figure 3):

- Berthing of Operation Crossroads ships
- Berthing of YGN-73 radioactive waste disposal barge

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- Berthing of Naval Radiological Defense Laboratory (NRDL) experimental barges and YAG-39 and YAG-40 (ships used to support and study the effects of nuclear and atomic weapons tests)

Radiological operations generally performed at HPNS that could impact the submarine pens and finger piers included the use of generally licensed radioactive material, including handling and refurbishment of radioluminescent devices. Other activities involving radioactive material included gamma radiography, and calibration of radiation detection instruments.

In 2012, the Navy performed a removal action that included Ship Berths 61 and 64 in the submarine pens. The objective of the removal action was to remove radiologically impacted overwater structures that were dilapidated, dropping debris into the San Francisco Bay, and the debris that presented hazards to navigation in the San Francisco Bay (ERS Joint Venture, 2012). Radioactive material was not encountered during the course of the removal action, and no radioactive waste was generated.

10.3 NATURE AND EXTENT OF CONTAMINATION

A history of Navy radiological operations at HPNS is provided in the HRA (NAVSEA, 2004). Radioluminescent devices were used on ships and in shipyards to provide markers that could be seen under low-light conditions. These radioluminescent devices included ^{226}Ra or ^{90}Sr as a source of radioactivity to generate light using these devices. The HRA describes the potential for contamination of Parcel F ships' berths as likely, meaning the sites were impacted by past historical radiological activities performed by the Navy. There is a low probability that intact radioluminescent devices could still be present at the submarine pens and the finger piers. However, it is more likely traces of radioactivity from damaged, discarded, or lost devices could be present on surfaces associated with the Parcel F structures, although the probability of residual radioactivity from radioluminescent devices is still low. Although the potential for contamination is conservatively classified as "likely" (due to historical activities), HRA Section 8.3.7.2 states the current potential for contaminated media including soil, groundwater, structures, drainage systems and surrounding air as low or none.

Drydocks and ship berths were decontaminated and surveyed following maintenance and decontamination of radiologically impacted ships. Sandblast material was removed and disposed of as described in Section 6.4.1 of the HRA (NAVSEA, 2004). After removal of the sand, the drydock floor was vigorously washed and the water pumped into the harbor. The drydocks were surveyed, and met the criteria for release. ROCs from nuclear and atomic weapons tests would include a mixture of fission products, activations products, and actinides. ^{137}Cs and ^{239}Pu were selected as ROCs most likely to be present and most likely to be detected as contamination at HPNS. Radioactivity from contaminated ships is most likely to occur where contaminated ship surfaces could come into contact with drydocks or piers. Surveys of the drydocks following

decontamination operations failed to identify areas of elevated radioactivity, so the probability of residual radioactivity from contaminated ships at the submarine pens or finger piers is low.

Radioactive wastes from NRDL and ship decontamination activities were loaded on barges at HPNS and transported for disposal in the ocean. Radioactive wastes included sandblasting residue from ship decontamination activities, as well as waste from NRDL laboratories and experiments (NAVSEA, 2004). Expected radiological waste constituents include a mixture of fission products, activation products, and actinides. ^{137}Cs and ^{239}Pu were selected as representative ROCs. Radioactive wastes were typically sealed in drums or other packages for transport, and may have been staged on piers or alongside ship berths prior to loading the waste onto the barges. The potential for residual radioactivity at the submarine pens and piers from leaking waste packages is low. The most likely location for residual radioactivity would be horizontal surfaces adjacent to ship berths where the waste packages could be staged prior to loading on the YGN-73 barge for disposal.

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

Step 1	Define the Problem that Necessitates the Study

Based on the HRA (NAVSEA, 2004), Parcel F structures including the submarine pens and finger piers are radiologically impacted. The objective of this work effort is to identify residual radioactivity and low-level radiological objects (e.g., deck markers) attached to surfaces at the submarine pens and finger piers. As a conservative measure, 100 percent gamma and 25 percent alpha/beta scanning will be performed for all accessible surface areas. If no residual radioactivity exceeding the project release criteria is found, the radiological survey data will be presented in reports and used to support future site decisions for the Parcel F structures.

Step 2	Identify the Goal of the Study

The study question is as follows:

- Are levels of residual radioactivity present at the Parcel F structures that would prevent unrestricted release?

The following alternative actions will result from the resolution of the principle study question:

- If residual radioactivity is found during the radiological surveys at levels that would prevent unrestricted release of the site, then the Navy will be notified of the presence of residual radioactivity to determine the appropriate next steps for further investigation and the areas will be re-surveyed as Class 1 areas.
- If residual radioactivity is not found at levels that would prevent unrestricted release of the site during the radiological surveys, then no further investigation will be performed and the radiological survey data will be presented in reports and used to support future site decisions for the Parcel F structures.

Step 3	Identify Information Inputs

The following data will be used to satisfy the goal of the study:

Radiological surveys will include the following:

- Surface gamma scanning surveys for 100 percent for accessible surfaces of the submarine pens and finger piers
- Surface alpha/beta scanning surveys for 25 percent for accessible surfaces of the submarine pens and finger piers
- Static measurements of alpha/beta activity at a statistically determined number of systematic locations to estimate the average level of residual radioactivity
- Static measurements of alpha/beta or gamma activity at biased locations to investigate scanning survey results exceeding project investigation levels (ILs) (if any)
- Measurements of removable alpha/beta activity will be collected at locations based on the highest static measurements of alpha/beta activity

No off-site laboratory analysis is planned for this project. However, samples may be collected to investigate discrete sources of elevated radioactivity, if required. If collected, samples will be analyzed primarily by gamma spectroscopy (EPA Method 901.1 or equivalent) for ^{137}Cs, ^{226}Ra and daughters, and other gamma emitting radionuclides. Other radionuclide-specific analyses will be performed as noted in subsequent worksheets.

Step 4	Define the Boundaries of the Study

The spatial boundaries for this study are the Parcel F submarine pens (Figure 2) and the Parcel F finger piers (Figure 3). The vertical boundary of the project area extends from the top of the drydock, berth, or pier to the low tide line. The horizontal boundary is defined by the concrete surfaces forming the submarine pens and finger piers.

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

Step 5	***Develop the Analytic Approach***

If the results of the survey are below or consistent with the release criteria (WS#15), the radiological survey data will be presented in reports and used to support future decisions for the Parcel F structures.

If the results of the survey exceed the screening criteria, the site will be further investigated as described in the decision rules.

- The IL for gamma scan measurements is the average of gamma scan measurements for a specific material in a specific survey unit plus three standard deviations. If a gamma scan survey result exceeds the IL, that location will be incorporated into the surface area covered by the alpha/beta scanning survey. The IL for gamma scan measurements will be determined separately using the RS-700 and gamma scintillator hand-held radiation detection instruments.
- The IL for alpha/beta static measurements is 50 percent of the most conservative (i.e., lowest) release criteria provided in Table 1 in the *Final Base-wide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, California* (AM; Navy, 2006) for alpha and beta emitting radionuclides. If an alpha or beta static count result exceeds the corresponding IL, the static count will be repeated to confirm the result. If the confirmatory result exceeds the corresponding IL, the APTIM PM and project radiation safety officer will be notified that an area of elevated alpha or beta activity has been identified.
- The IL for removable alpha or beta activity is the most conservative (i.e., lowest) release criteria provided in Table 1 in the AM (Navy, 2006) for alpha and beta emitting radionuclides. If a removable measurement result for alpha or beta exceeds the IL, a notification will be sent to the APTIM project radiation safety officer.

Step 6	***Specify Performance or Acceptance Criteria***

To limit uncertainty in the obtained environmental data, criteria for the precision, accuracy, representativeness, completeness, and comparability parameters and limit of detection (LOD) for the contaminants of concern have been developed. Measurement errors will be controlled by using appropriate sampling and analytical methods, and the laboratory errors will be controlled by adhering to the DoD QSM (2017), following established SOPs, and having the Project Chemist performing data review to verify laboratory processes. The field crews will review the SAP before sample collection to limit sample collection errors. The subcontract analytical laboratory will have a copy of this SAP and will adhere to DoD QSM (2017) guidance to limit measurement errors.

The *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (MARSSIM; EPA et al., 2000) guidelines will be used and a 95 percent confidence level for detecting radioactivity above the release criterion will be assumed with Type I and II errors limited to 5 percent.

Step 7	***Plan the Design for Obtaining Data***

The radiological survey design for this project is based on MARSSIM guidelines (EPA et al., 2000). Specific details regarding types of radiation measurements, instrument detection capabilities, quantities and locations of data to be collected and ILs are discussed in the Radiological Scoping Surveys Work Plan.

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SAP Worksheet #12: Measurement Performance Criteria Table—Field Quality Control Samples (Soil)

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Matrix Spikes (MS)	Not applicable				
Rinse Blanks	Not applicable				
Field Duplicates	None	Not applicable to structural materials and concrete	Not Applicable	Not Applicable	S&A

SAP Worksheet #13: Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
Existing site radiological data	*Final Historical Radiological Assessment, History and the Use of General Radioactive Materials, 1939-2003, Hunters Point Shipyard*	NAVSEA, 2004	Site scoping	None

SAP Worksheet #14: Summary of Project Tasks

14.1 SCOPE OF WORK

The scope of the planned remediation activities consists of the following elements:

- Conduct gamma survey of 100 percent of accessible surface areas of the submarine pens (Drydocks 5, 6, and 7 and associated Ship Berths 61, 62, 63, and 64) and three Finger Piers.
- Conduct gamma survey of 100 percent of accessible areas that are inaccessible to the RS-700 detectors using a 3-inch by 3-inch sodium iodide gamma scintillator hand-held radiation detection instrument.
- Perform alpha/beta survey of 25 percent of accessible surface areas of the submarine pens and finger piers consistent with MARSSIM guidance (EPA et al., 2000) or Class 2 surveys.
- Identify areas or locations of elevated radioactivity (e.g., deck markers that are readily distinguished from ambient background radioactivity).
- Discrete sources, if identified during the scanning, will be removed and documented. Additional surveys and sampling will be performed to document the removal of radioactivity associated with discrete radiation sources.
- Perform measurements of static and removable alpha/beta activity at a statistically determined number of systematic locations for each survey unit to estimate the average activity consistent with MARRSIM guidance (EPA et al., 2000) for Class 2 surveys.
- Perform measurements of static and removable alpha/beta activity at biased locations where the gamma and alpha/beta scan results exceed the IL.

14.2 SAMPLE COLLECTION METHODS AND PROCEDURES

The following subsections describe the sampling methods and procedures that will be used to collect samples for this project.

14.2.1 Solid Samples

If directed by the Navy, solid samples of concrete or similar materials may be collected to provide specific information concerning the nature and extent for areas of elevated residual radioactivity exceeding the release criteria. Sample collection methods will be determined based on the material being sampled and the location of the sample.

Structural material sampling may be conducted to supplement radiological surveys. Material samples for off-site radiological analysis will be collected using techniques most suitable to the material being sampled and analyses to be performed. Concrete or wood may be sampled using chips as discussed in this section.

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If concrete or wood debris requires sampling, chips of material for analysis will be obtained using hammers and chisels or other means to obtain near surface debris chips. Material samples for off-site radiological analysis will be collected using the general sampling technique described as follows:

1. Obtain decontaminated sampling (chisels, hammers, or other applicable equipment).
2. Put on a new (unused) pair of sampling gloves and other appropriate personal protective equipment.
3. Using chisels, saws, or hammers, reduce the material to small-size pieces for laboratory analysis. Collect the material pieces for radiological analysis into the appropriate sample containers.
4. Label, package, and prepare the samples for shipment to the laboratory.
5. Radiologically release sample containers from the radiological areas prior to shipment to the laboratory.

14.2.2 Equipment Decontamination

Sampling equipment decontamination is not anticipated for this project since disposable equipment will be used to collect samples if necessary.

14.3 ANALYTICAL REQUIREMENTS

Analytical methods will be performed according to the applicable EPA and DoD QSM (2017) QC requirements (e.g., initial calibrations [ICALs], continuing calibrations, tuning, reagent blanks, surrogates, replicates, and laboratory control sample [LCS]) as described in Worksheets #24 and #28.

14.4 QUALITY CONTROL TASKS

Samples will have appropriate associated QC samples, analyzed as method blanks and LCS, as described in Worksheet #28.

14.5 DATA RECORDING AND TRANSFER

This subsection details the requirements for data reporting and data package formats that will be provided by the laboratory.

14.5.1 Hard Copy Deliverables

Relevant raw data and documentation, including (but not limited to) logbooks, data sheets, electronic files, and final reports, will be maintained by the laboratory for at least 10 years. The laboratory will notify APTIM 30 days before disposal of any relevant laboratory records.

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The laboratory will provide data deliverable packages sufficient to perform validation at 90 percent Stage 2B (EPA Level 3 deliverable equivalent) and 10 percent Stage 3 (EPA Level 4 deliverable equivalent).

14.5.2 Electronic Deliverables

The laboratory EDD will be in Equis format (APTIM database format). The analytical laboratory will follow the requirements stated in the Laboratory Interface Document for the Analytical Laboratory EDD.

The laboratory will certify that the EDD and the hard copy reports are identical. Both the EDD and the hard copy will present results to two or three significant figures. Field information (e.g., date and time collected and sample identification) will be entered directly into the main database from the COC record or uploaded from electronic files generated in the field.

14.6 DATA MANAGEMENT

This subsection describes the data management procedures for data review, verification, reporting, and validation.

14.6.1 Data Reduction, Verification, and Reporting

Analytical data generated by the laboratory will be reviewed prior to reporting to ensure the validity of reported data. This internal laboratory data review process will consist of data reduction, three levels of documented review, and reporting. Review processes will be documented using appropriate checklist forms, or logbooks that will be signed and dated by the reviewer.

14.6.2 Data Reduction

Data reduction involves the mathematical or statistical calculations used by the laboratory to convert raw data to the reported data. The laboratory will perform reduction of analytical data as specified in each of the appropriate analytical methods and laboratory SOPs. For each method, raw data results will be recorded using method-specific forms or a standardized output from each of the various instruments.

Data calculations will be verified and initialed by personnel both generating and approving them. Raw and electronic data, notebook references, supporting documentation, and correspondence will be assembled, packaged, and stored for a minimum of 10 years for future use. Reports will be held client confidential. If the laboratory is unable to store project-related data for 10 years, then it is the responsibility of the laboratory to contact APTIM to make alternative arrangements.

14.6.3 Laboratory Data Verification and Review

The laboratory analyst who generates the analytical data will have the primary responsibility for the correctness and completeness of data. Each step of this verification and review process will

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involve the evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that data of known quality are generated consistently. Data generated and reduced will follow well-documented in-house protocols.

Level 1. Laboratory Technical (Peer) Data Review

Analysts will review the quality of their work based on an established set of guidelines, including the QC criteria established in each method, in this SAP, and as stated within the laboratory DoD QSM (2017). This review, at a minimum, will ensure that the following conditions have been met:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate SOPs have been followed.
- Calculations are verified.
- There are no data transposition errors.
- Analytical results are correct and complete.
- QC samples are within established control limits.
- Blanks and LCS are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.

Documentation is complete, for example, when any anomalies and holding times have been documented, and forms have been completed.

Level 2. Laboratory Technical Data Review

A supervisor or data review specialist whose function is to provide an independent review of data packages will perform this review. This review will also be conducted according to an established set of guidelines and will be structured to verify the following findings of the Level 1 data review:

- Appropriate laboratory SOPs have been followed.
- Calibration data are scientifically sound, appropriate to the method, and completely documented.
- QC samples are within established guidelines.
- Qualitative identification of contaminants is correct.

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- Manual integrations are justified and properly documented.
- Quantitative results and calculations are correct.
- Data are qualified correctly.
- Documentation is complete; for example, any anomalies and holding times have been documented, and appropriate forms have been completed.
- Data are ready for incorporation into the final report.
- The data package is complete and complies with contract requirements.

The Level 2 review will be structured so that calibration data and QC sample results are reviewed, and the analytical results from at least 10 percent of the samples are checked back to the sample preparation and analytical bench sheets. If no problems are found with the data package, the review will be considered complete.

If any problems are found with the data package, an additional 10 percent of the sample results will be checked back to the sample preparatory and analytical bench sheets. This cycle will then be repeated either until no errors are found in the checked data set, or until data have been checked. Errors and corrections noted will be documented.

Level 3. Laboratory Administrative Quality Assurance Data Review

The laboratory QA Manager will review 10 percent of data packages. This review should be similar to the review as provided in Level 2, except that it will provide a total overview of the data package to ensure its consistency and compliance with project requirements. Errors noted will be corrected and documented.

14.7 DATA VALIDATION

If radiological biased samples are collected, these sample results will be validated by a third-party validation company at 90 percent Stage 2B and 10 percent Stage 3. Data validation will be in accordance with the method requirements stated in the DoD QSM (2017), *Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)* (MARLAP; EPA et al., 2004), and the QC criteria specified in this SAP. Additional validation guidance from *ANSI/ANS-41.5-2012: Verification and Validation of Radiological Data for Use in Waste Management and Environmental Remediation* (American Nuclear Society, 2012) and the *National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2014) will be used as necessary

Data will be validated and flagged with the following data qualifiers:

- ***J qualifier*** denotes the analyte was positively identified, but the associated numerical value is estimated.
- ***U qualifier*** denotes the analyte was analyzed for, but not detected. The associated numerical value is at or below the reporting limit.
- ***R qualifier*** denotes the data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.

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SAP Worksheet #15.1: Reference Limits and Evaluation Table—Site Contaminants (Solid Matrix—Gamma Isotopes)

Analyte	CAS Number	Units	Project Action Limit[1]	Project Action Limit Reference	Project Quantitation Limit Goal	Laboratory-Specific		
						DLC[2]	LOD	DL
Actinium 228 (228Ac)	14331-83-0	pCi/g	NA	NA	NA	NA	NA	NA
Actinium-227 (227Ac)	14952-40-0	pCi/g	NA	NA	NA	NA	NA	NA
Bismuth-212 (212Bi)	14913-49-6	pCi/g	NA	NA	NA	NA	NA	NA
Bismuth-214(^{214}Bi)	14733-03-0	pCi/g	NA	NA	NA	NA	NA	NA
Cesium-137 (^{137}Cs)	10045-97-3	pCi/g	0.113	AM Release Criteria	0.07	0.07[2]	NA	NA
Cobalt-60 (^{60}Co)	10198-40-0	pCi/g	NA	NA	NA	NA	NA	NA
Lead-210 (^{210}Pb)	14255-04-0	pCi/g	NA	NA	NA	NA	NA	NA
Lead-212 (^{212}Pb)	15092-94-1	pCi/g	NA	NA	NA	NA	NA	NA
Lead-214 (^{214}Pb)	15067-28-4	pCi/g	NA	NA	NA	NA	NA	NA
Potassium-40 (^{40}K)	13966-00-2	pCi/g	NA	NA	NA	NA	NA	NA
Protactinium-231 (^{231}Pa)	15100-28-4	pCi/g	NA	NA	NA	NA	NA	NA
Radium-226 (^{226}Ra)	13982-63-3	pCi/g	1.0 above background[2]	AM Release Criteria	0.2	0.2[2]	NA	NA
Radium-228 (^{228}Ra)	15262-20-1	pCi/g	NA	NA	NA	NA	NA	NA
Thallium-208 (^{208}Tl)	14913-50-9	pCi/g	NA	NA	NA	NA	NA	NA
Thorium-228 (^{228}Th)	14274-82-9	pCi/g	NA	NA	NA	NA	NA	NA
Thorium-232 (^{232}Th)	7440-29-1	pCi/g	NA	NA	NA	NA	NA	NA
Thorium-234 (^{234}Th)	15065-10-8	pCi/g	NA	NA	NA	NA	NA	NA
Uranium-235 (^{235}U)	15117-96-1	pCi/g	NA	NA	NA	NA	NA	NA
Uranium-238 (^{238}U)	7440-61-1	pCi/g	NA	NA	NA	NA	NA	NA

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SAP Worksheet #15.1: Reference Limits and Evaluation Table—Site Contaminants (Solid Matrix—Gamma Isotopes) (continued)

Notes:

[1] The project action limits are based on EPA preliminary remediation goals as cited in the AM (Navy, 2006) and are in addition to background values for these radionuclides.

[2] ^{226}Ra background for definitive data is 0.633 picocurie per gram (pCi/g) for this project. If a new background dataset is collected and approved for Navy use, which may establish background concentrations for radionuclides of concern, that background dataset may be used in place of the existing background concentration.

[3] Decision level concentration (DLC) at or less than the value listed are goals for ^{137}Cs and ^{226}Ra for samples for this project. Project DLCs for radiological analyses are calculated on a sample specific basis and will vary. The values listed indicate a minimum DLC that will be achieved for the majority of samples, under normal analytical conditions. For samples reported as undetected (U-qualified), the DLC can be highly variable. For samples reported as undetected with positive results, if the DLC exceeds the release criteria, the laboratory will be requested to recount the samples to allow re-evaluation of the reported sample results.

DLC for other radionuclides analyzed by gamma spectroscopy are not required to be achieved unless specifically requested on the applicable COC.

DL	*detection limit*
NA	*not applicable, not an ROC for the site, but reported in the laboratory gamma spec standard list*

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SAP Worksheet #15.2: Reference Limits and Evaluation Table—Site Contaminants (Solid Matrix—Strontium-90)

Analyte	CAS Number	Units	Project Action Limit [1]	Project Action Limit Reference	Project Quantitation Limit Goal	Laboratory-Specific		
						DLC	LOD	DL
Total Strontium	7440-24-6	pCi/g	0.331	Release Criteria	0.16	0.16	NA	NA
Strontium-90 (^{90}Sr)	10098-97-2	pCi/g	0.331	Release Criteria	0.16	0.16	NA	NA

Notes:

Total strontium analysis will be performed first by the laboratory since strontium isotopes (not including ^{90}Sr) have decays away since activities involving radioactive material ceased at HPNS. If the total strontium result is less than the release criterion, a ^{90}Sr specific analysis is not required. If the total strontium result is above the release criterion, then a ^{90}Sr specific analysis will be performed.

[1] The project action limits are based on EPA preliminary remediation goals as cited in the AM (Navy, 2006) and are in addition to background values for these radionuclides.

DL — *detection limit*
NA — *not applicable*

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SAP Worksheet #15.3: Reference Limits and Evaluation Table—Site Contaminants (Solid Matrix—Alpha Isotopes)

Analyte	CAS Number	Units	Project Action Limit [1]	Project Action Limit Reference	Project Quantitation Limit Goal	Laboratory-Specific		
						DLC	LOD	DL
Plutonium-239/240	10-12-8	pCi/g	2.59	Release Criteria	0.10	0.10	NA	NA

Notes:

[1] The project action limit is based on EPA preliminary remediation goal as cited in the AM (Navy, 2006) and is in addition to the background value for this radionuclide.

DL *detection limit*
NA *not applicable*

SAP Worksheet #16: Project Schedule/Timeline Table

Activities	Organization	Dates		Deliverable
		Anticipated Date of Initiation	Anticipated Date of Completion	
Draft SAP Preparation	APTIM	November 2017	February 2018	Draft SAP
Navy BRAC/RASO SAP Review	Navy BRAC and RASO			Comments and responses
Navy QAO SAP Review	Navy QAO	December 2017	January 2018	Comments and responses, Navy chemist signature
Regulatory Review	EPA, DTSC, CDPH, City of San Francisco	February 2018	May 2018	Comments and responses, signature
Final SAP	Navy and regulatory agencies	June 2018	July 2018	Final SAP
Final Revision 1 SAP	Navy and regulatory agencies	August 2018	November 2018	Final Revision 1 SAP
Final Revision 2 SAP	Navy and regulatory agencies	November 2018	February 2019	Final Revision 2 SAP
Field Investigations	APTIM	March 2019	July 2019	None
Laboratory analyses, data validation and verification, and data management	TestAmerica, E-lab Consultants, AQA, Inc., APTIM	May 2019	June 2019	Analytical and data validation reports
Draft report preparation	APTIM	July 2019	August 2019	Draft reports
Navy BRAC/RASO report review	Navy BRAC and RASO	August 2019	October 2019	Comments and responses
Regulatory report review	EPA, DTSC, CDPH, City of San Francisco	October 2019	February 2020	Comments and responses
Report	Navy and regulatory agencies	February 2020	February 2020	Final report

Notes:

BRAC *Base Realignment and Closure*

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SAP Worksheet #17: Sampling Design and Rationale

Gamma surveys will be performed over 100 percent of the accessible surface of the Parcel F structures including the submarine pens and finger piers. Gamma surveys will be performed using the RS-700. In areas not accessible to the RS-700 such as the vertical surfaces along the submarine pens above the low tide line, gamma surveys will be performed using a handheld 3-inch by 3-inch sodium iodide radiological detector and suitable instrument (e.g., Ludlum Model 2221 ratemeter and Model 44-20 detector, or similar) coupled with the Global Positioning System.

Surveys consistent with MARSSIM guidance (EPA et al., 2000) for a Class 2 scoping survey will be performed. Alpha/beta scan measurements will be performed over 25 percent of the accessible surface of the Parcel F structures. Static and removable measurements of alpha/beta activity will be performed at biased locations to investigate scan survey results. Static and removable measurements of alpha/beta activity will be performed at systematic locations consistent with MARSSIM guidance for Class 2 scoping surveys.

17.1 BIASED RADIOLOGICAL SAMPLING

Samples will be collected as necessary and at the direction of the Navy to complete the investigation of the Parcel F structures in areas exhibiting discrete areas of elevated gamma count rate readings that exceed instrument-specific ILs and that are not attributable to naturally-occurring radioactivity.

If samples are submitted of off-site analysis, radiological data will be reported by the laboratory after an initial seven-day ingrowth period. If the analytical results of the soil indicate the ^{226}Ra concentration exceeds the screening criterion (1.633 pCi/g), or the criterion for ^{137}Cs (0.113 pCi/g), the soil is radiologically-impacted the results will be reported. If the analytical results indicate that the ^{226}Ra concentration is less than the screening criterion (1.633 pCi/g), the soil is not radiologically-impacted and, the samples will be recounted after a full 21-day ingrowth period and reported. If ^{90}Sr is detected above release criteria, then additional analysis for ^{239}Pu or other alpha emitters may be performed to confirm contamination. If the results following the full ingrowth are consistent with background and gamma count rate scanning and static measurements are below instrument-specific ILs, the radiological survey will be considered complete.

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SAP Worksheet #18: Sampling Locations and Methods/Standard Operating Procedures Requirements Table

Sampling Location	Purpose	Sample Identification (ID) Number	Matrix	Depth (feet below ground surface)	Analytical Group	Number of Samples	Sampling SOP Reference
Biased Locations	Biased radiological samples as needed to support field gamma survey	F-B-XXX	Structural material (concrete, wood, etc.)	Surface	Gamma spec (^{226}Ra,^{137}Cs) Total Strontium/^{90}Sr ^{239}Pu (*only analyzed if ^{90}Sr detected above release criteria*)	If necessary to support field gamma scan surveys	Worksheet #14

SAP Worksheet #19: Analytical Standard Operating Procedures Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ Reference	Sample Volume	Container	Preservation Requirements	Maximum Holding Time
Solid	Gamma Isotopes	EPA 901.1MOD	250 – 400 grams	One 250-mL poly/glass or tuna can	None	None
Solid	Total Strontium/ ^{90}Sr	EPA 905.0/Sr-02	250 – 400 grams	One 250-mL poly/glass or tuna can	None	None
Solid	^{239}Pu, alpha isotopic	U.S. Department of Energy (DOE) A-01-R	1 – 5 grams	One 250-mL poly/glass or tuna can	None	None

Notes:

mL *milliliter*

SAP Worksheet #20: Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Primary Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equipment Rinse Blanks	No. of Trip Blanks	Total No. of Samples to Laboratory
Solid	Gamma Isotopes Total Strontium ^{239}Pu	Collect as necessary to confirm to support surveys	None	None	None	None	None	To be determined based on gamma walkover survey results

Notes:

MSD *matrix spike duplicate*

SAP Worksheet #21: Project Sampling Standard Operating Procedures References Table

Reference Number	Title	Date, Revision and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
Worksheet #14	Chip Sampling	NA	APTIM	hammer, chisel, saw	Y	

Notes:

NA *not applicable*

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

Field Equipment	Calibration Verification Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Radiological controls portable instrument procedures are described in detail in the RPP (APTIM, 2017a) and work instructions					Project RSO or designee	Operation and use of portable instruments at HPNS (RPP [APTIM, 2017a]) Radiation Detection Instrumentation Work Instruction (AMS-710-07-WI-04014) [Attachment 2]

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SAP Worksheet #23: Analytical Standard Operating Procedures References Table

Laboratory SOP Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
ST-RD-0102	Gamma Vision Analysis,; 3/09/18	Definitive	Solids Gamma Isotopes (^{226}Ra and ^{137}Cs)	Gamma Spectrometer	TestAmerica	N
ST-RC-0025	Preparation of samples for gamma spectroscopy, 12/19/17	Definitive	Soil	Gamma Spectrometer	TestAmerica	N
ST-RD-0403	Low Background Gas Flow Proportional Counting System Analysis, 12/15/17	Definitive	Solids ^{90}Sr	Gas Flow Proportional Counter	TestAmerica	N
ST-RD-0210	Alpha Spectroscopy Analysis Revision 3/9/18	Definitive	Solids Alpha Isotopes	Alpha Spectrometer	TestAmerica	N
ST-RC-0058	Soil Sample preparation for Strontium-89, Strontium-90 and total strontium using extraction chromatography, 12/12/17	Definitive	Soil	Gas Flow Proportional Counter	TestAmerica	N

Notes:

[1]Portable document format copies of analytical SOPs will be provided in the Final SAP (Attachment 2).

SAP Worksheet #24.1: Analytical Instrument Calibration Table (Gamma Spectrometry)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
Gamma Spectrometry	ICAL	Prior to initial use, following repair or loss of control and upon incorporation of new or changed instrument settings (MARLAP [EPA et al., 2004] 18.5.6.2;)	Verify manufacturer's specifications for gamma peak resolution (MARLAP 18.5.6.2) Efficiency vs. energy for each geometry/matrix 95 percent (%) confidence limit of the fitted function: less than or equal to (≤) 8% over energy range (MARLAP 18.5.6.2) or peak energy difference is within 0.1 kiloelectron volt (keV) of reference energy for all points Peak full width at half maximum (FWHM) less than (<) 2.5 keV at 1,332 keV Energy vs. channel slope equation shall be linear and accurate to 0.5 keV	Correct problem, then repeat ICAL	Laboratory Manager/Analyst	ST-RD-0102
	ICAL verification (ICV)	After ICAL for energy/efficiency and prior to analysis of samples	Observed peaks of second source standard fall within plus or minus (±) 10% of ICAL value relative to energy, FWHM, and efficiency	Verify second source standard and repeat ICV to check for errors If that fails, identify and correct problem and repeat ICV or ICAL and ICV as appropriate	Laboratory Manager/Analyst	

SAP Worksheet #24.1: Analytical Instrument Calibration Table (Gamma Spectrometry) (continued)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
Gamma Spectrometry (continued)	Continuing calibration verification (CCV) (Daily Check)	Daily or prior to use When working with long count times or batch sequences that run more than a day, CCV is performed at the beginning and end of each analytical batch as long as it no longer than a week	Verify peak shift within tolerance limit; verify efficiency within control parameters; verify resolution in tolerance limit Response checks shall have a tolerance limit or control chart set at ± 3% or 3σ of the mean (MARLAP 18.5.6.2); or peak Energy/Efficiency: low, mid, and high energies within 10% of the ICAL value; FWHM: low, mid, and high energies within 10% of initial FWHM value	Correct problem, rerun CCV If that fails, then repeat ICAL Reanalyze samples since the last successful calibration verification	Laboratory Manager/Analyst	ST-RD-0102
	Background subtraction count (BSC) measurement (long count for subtracting background from blanks or test sources)	Immediately after ICAL and then performed on at least a monthly basis (MARLAP 18.5.6.2)	Statistical test of successive counts and count rates for identified background peaks show no significant difference (MARLAP 18.5.6.2)	Recount and check control chart for trends Determine cause, correct problem, re-establish BSC If background activity has changed, re-establish BSC and reanalyze or qualify impacted samples since last acceptable BSC	Laboratory Manager/Analyst	

SAP Worksheet #24.2: Analytical Instrument Calibration Table (Alpha Spectrometry)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
Alpha Spectrometry	ICAL	Prior to initial use, following repair or loss of control and upon incorporation of new or changed instrument settings (MARLAP 18.5.6.2; EPA et al., 2004)	Verify manufacturer's specifications for source efficiency (MARLAP); and two calibration peaks that are: 1) greater than or equal to (≥)700 keV apart; or 2) that bracket peaks to be determined Energy vs. channel slope equation <15 keV per channel Full Width –Half Maximum (FWHM) <100 keV for each peak used for calibration Minimum of 3,000 net counts in each peak	Correct problem, then repeat ICAL	Laboratory Manager/Analyst	ST-RD-0210
	ICV	After ICAL	Determine peak location, resolution, and radionuclide of interest/alpha peak efficiency (where counting efficiency is an analytical requirement) using at least two alpha peaks (MARLAP 18.5.6.3) Or Observed peak centroid falls within ±20 keV from reference energyfor each peak used in the initial energy calibration FWHM ≤100 keV and within ±20 keV of corresponding calibration peaks in initial energy calibration	Repeat ICV to check for error If that fails, identify and correct problem and repeat ICV or ICAL and ICV, as appropriate	Laboratory Manager/Analyst	

SAP Worksheet #24.2: Analytical Instrument Calibration Table (Alpha Spectrometry) (continued)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
Alpha Spectrometry (continued)	CCV (Pulsar Check)	Pulsar energy verification weekly, prior to analysis of samples Use either pulsar check or check source	Energy response check shall have a tolerance limit set at ± 3% or control chart set at ± 3σ (MARLAP 18.5.6.3) or observed peak centroid falls ≤20 keV from reference energy	Recount and check control chart for trends Determine cause, correct problem, and repeat CCV and associated samples since last successful CCV	Laboratory Manager/Analyst	ST-RD-0210
	CCV (Check Source)	Weekly source check verification prior to analysis of samples Use either pulsar check or check source	Response checks shall have a tolerance limit or control chart set at ± 3% or 3σ (MARLAP 18.5.6.3) or observed peak centroid falls within 20 keV from reference energy for each peak used in the initial energy calibration FWHM ≤100 keV and within 30 keV of corresponding calibration peaks in initial energy calibration	Recount and check control chart for trends Determine cause, correct problem, and repeat CCV and associated samples since last successful CCV	Laboratory Manager/Analyst	

SAP Worksheet #24.2: Analytical Instrument Calibration Table (Alpha Spectrometry) (continued)

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person(s) Responsible for Corrective Actions	SOP Reference
Alpha Spectrometry (continued)	BSC	Prior to initial use or after ICAL and monthly (MARLAP 18.5.6.3)	Within ±3σ of mean activity of recent BSCs for total radionuclide of interest for isotopes of interest (minimum of three BSC values)	Recount and check control chart for trends Determine cause, correct problem, re-establish BSC If background activity has changed, re-establish BSC and reanalyze or qualify impacted samples since last acceptable BSC	Laboratory Manager/Analyst	ST-RD-0210

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Gamma Spectroscopy	Efficiency check	CCV count	Multipoint	Daily	±3 standard deviations	Recount	Analyst/ Department Manager	ST-RD-0102
Gamma Spectrometer	1. Clean cave; fill dewar with nitrogen gas 2. QA check	1. Physical check 2. Background and source check	1. Physical check 2. Check deviation	1. Weekly 2. Daily	1. Acceptable background 2. Within 2 sigma of measured population	Recalibrate Instrument maintenance Consult with Technical Director	Analyst/ Department Manager	ST-RD-0102
Gas Flow Proportional Counting	1. Check counting gas and change when < 500 pounds per square inch. 2. QA check	1. Physical check 2. Background and source check	1. Physical check 2. Check deviation	1. Weekly 2. Daily	1. Acceptable background 2. Within 2 sigma of measured population	Recalibrate Instrument maintenance Consult with Technical Director	Analyst/ Department Manager	ST-RD-0403
	Efficiency check	CCV count	Multipoint	Daily	±3 standard deviations	Recount	Analyst/ Department Manager	ST-RD-0102

SAP Worksheet #26: Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): APTIM—Field Technician
Sample Packaging (Personnel/Organization): APTIM—Field Technician
Coordination of Shipment (Personnel/Organization): APTIM—Field Technician
Type of Shipment/Carrier: Laboratory Courier—UPS or FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization):TestAmerica (Sample Receiving)
Sample Custody and Storage (Personnel/Organization): TestAmerica (Sample Receiving)
Sample Preparation (Personnel/Organization): Subcontract Laboratory—TestAmerica Analytical Chemist
Sample Determinative Analysis (Personnel/Organization): Subcontract Laboratory—TestAmerica Analytical Chemist
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Shipped to laboratory the same day as collection if possible, if not possible to ship the same day; storage on site in cooler in locked building
Laboratory Sample Storage (No. of days from sample collection): Minimum three months TestAmerica
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 30 days—TestAmerica
Biological Sample Storage (No. of days from sample collection): Not applicable to this project
SAMPLE DISPOSAL
Personnel/Organization: TestAmerica
Number of Days from Analysis: Three months

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SAP Worksheet #27: Sample Custody Requirements Table

27.1 SAMPLE CUSTODY AND DOCUMENTATION

Sampling information will be recorded on a COC Form and in a permanently bound field logbook. Entries will be legible and recorded in indelible ink.

27.2 SAMPLE LABELING

Sample labels will be filled out with indelible ink and affixed to each sample container. Non-waterproof sample labels will be covered with clear tape. Sample containers will be placed in resealable plastic bags to protect the sample from moisture during transportation to the laboratory.

Each sample container will be labeled with the following, at a minimum:

- Sample identification number
- Sample collection date (month/day/year)
- Time of collection (24-hour clock)
- Project number
- Sampler's initials
- Analyses to be performed
- Preservation (if any)
- Location (i.e., site name)

27.3 CHAIN OF CUSTODY

An example COC Form is shown in Attachment 1. In addition to providing a custody exchange record for the samples, the COC Form serves as a formal request for sample analyses. The COC will be completed, signed, and distributed as follows:

- One copy retained by the sample coordinator for inclusion in the project files
- Original sent to the analytical laboratory with the sample shipment

After the laboratory receives the samples, the Sample Custodian will inventory each shipment before signing for it, and note on the original COC Form any discrepancy in the number of samples, temperature of the cooler, or broken samples. The Project Chemist will be notified immediately of any problems identified with shipped samples. The Project Chemist will, in turn, notify the Project QC Manager, and together they will determine the appropriate course of

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action. The Project Chemist will also notify the PM if the project budget and schedule may be impacted.

The laboratory will initiate an internal COC Form that will track the sample within the various areas of the laboratory. The relinquishing signature of the Sample Custodian and the custody acceptance signature of the laboratory personnel transfer custody of the sample. This procedure is followed each time a sample changes hands. The laboratory will archive the samples and maintain their custody as required by the contract, or until further notification from the Project Chemist, at which time the samples will either be returned to the project for disposal, or disposed by the laboratory.

27.4 SAMPLE PACKING AND SHIPMENT

After sample collection, sample labels will be affixed to each sample container. Each sample will be placed in a resealable plastic bag to keep the sample container and the label dry.

Sample containers from radiological areas will be screened in the field prior to shipping to the laboratory following Work Instruction WI-40113 of the RPP (APTIM, 2017a). The field exposure rate collected on the sample container is entered on the COC. Samples to be shipped by commercial carrier will be packed in a sample cooler lined with a plastic bag. Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage. Saturday deliveries will be coordinated with the laboratory.

If samples are picked up by a laboratory courier service, the COC Form will be completed and signed by the laboratory courier. The cooler will then be released to the courier for transportation to the laboratory.

If a commercial carrier is used, the COC Form will include the air bill number in the "Transfers Accepted By" column, and will be sealed in a resealable bag. The COC Form will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape, and two custody seals will be taped across the cooler lid. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping. The samples will then be shipped to the analytical laboratory. A copy of the courier air bill will be retained for documentation.

The shipping of samples to the analytical laboratory by land delivery services will be performed according to the U.S. Department of Transportation regulations. The International Air Transportation Association regulations will be adhered to when shipping samples by air courier services. Transportation methods will be selected to ensure that the samples arrive at the laboratory in time to permit testing according to established holding times and project schedules. No samples will be accepted by the receiving laboratory without a properly prepared COC Form and properly labeled and sealed shipping container(s).

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27.5 FIELD LOGBOOKS

A permanently bound field logbook with consecutively numbered pages will be assigned to this project. A sample collection log work sheet is provided in Attachment 1. Entries will be recorded in indelible ink. Corrections will be made following the procedure described in Section 27.6. At the end of each workday, the responsible sampler will sign the logbook pages, and any unused portions of a logbook page will be crossed-out, signed, and dated.

At a minimum, the logbook will contain the following information:

- Project name and location (on the front page of the log book)
- Date and time of collection for each sample (in the upper right corner of each page)
- Sample number
- Sample location (i.e., soil boring or sampling point)
- Sample type (i.e., soil and water)
- Composite or grab
- Composite type (the number of grab samples)
- Depth of sample
- Weather information (e.g., rain, sunny, approximate temperature)
- Containers used and requested analyses

In the graph paper portion of the field logbook, the sampler will fill in the following information:

- A map with sample locations (drawn or paste copy). Each sample location must be clearly identified on the map. Several sample locations may be presented on one map; however, the page with the map must be referred on each of the individual sample pages.
- Field analyses performed, including results, instrument checks, problems, and calibration records for field instruments.
- Descriptions of deviations from this SAP.
- Problems encountered and corrective action taken.
- Identification of field QC samples.
- List of QC activities.
- Verbal or written instructions from the Navy and APTIM Project QC Manager.

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The sampler will cross-out the unused portion and sign each page.

27.6 DOCUMENT CORRECTIONS

Changes or corrections on any project documentation will be made by crossing-out the item with a single line, initialing by the person performing the correction, and dating the correction. The original item, although erroneous, will remain legible beneath the cross-out. The new information will be written above the crossed-out item. Corrections will be written clearly and legibly with indelible ink.

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SAP Worksheet #28.1: Laboratory Quality Control Samples Table (Gamma Isotopes)

Matrix: Solid

Gamma Radionuclides

EPA 901.1M/SOP ST-RD-0102

QC Check	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator	Measurement Performance Criteria
Method Blank	One per analytical batch	|ZBlank |≤3 for blank subtracted (net) activity in radionuclides of interest (MARLAP 18.4.1; EPA et al., 2004) Or No analytes detected greater than (>) 2 times the blank combined standard uncertainty Blank result must not otherwise affect sample results	Recount the blank to confirm results, unless sample results are >5 times the blank activity Inspect method blank control chart for indication of significant bias If required, reprep and reanalyze method blank and samples processed with the contaminated blank	Laboratory Manager/Analyst	A means of assessing the existence and magnitude of contamination introduced via the analytical process	No analytes detected > 2 times the blank combined standard uncertainty. Blank result must not otherwise affect sample results
LCS	One per analytical batch	$\|Z_{LCS}\| \leq 3$. Investigate recurrent results with $\|Z_{LCS}\| \geq 2$ (MARLAP 18.4.3) Or Use in-house control chart limits of ± 3σ of the mean In-house control limits may not fall more than 25% from the known LCS value	Recount the LCS to confirm results Inspect LCS control chart for indication of significant bias If required, reprep and reanalyze the LCS and associated samples	Laboratory Manager/Analyst	Accuracy	In-house control chart limits of ± 3σ of the mean In-house control limits may not fall more than 25% from the known LCS value

SAP Worksheet #28.1: Laboratory Quality Control Samples Table (Gamma Isotopes) (continued)

Matrix: Solid

Gamma Radionuclides

EPA 901.1M/SOP ST-RD-0102

QC Check	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator	Measurement Performance Criteria
Sample Duplicate	One per analytical batch	|ZDup | ≤ 3. Investigate recurrent results with |ZDup|≥ 2 (MARLAP 18.4.1; EPA et al., 2004) Or the duplicate error ratio (DER) between the sample and the duplicate is <3; or the relative percent difference (RPD) is <25%	Check for lab error. Examine the project-specific requirements Contact the client as to additional measures to be taken	Laboratory Manager/ Analyst	Precision	The DER between the sample and the duplicate is <3; or the RPD is <25%

SAP Worksheet #28.2: Laboratory Quality Control Samples Table (Gas Flow Proportional Counting Isotopes)

Matrix: Solid

Beta Emitting Radionuclides

EPA 905/ST-RD-0403

QC Check	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator	Measurement Performance Criteria
Instrument Contamination Check	Daily or when working with long count times, before and after each analytical batch Check after counting high activity samples	Use a statistical test to determine a change in the background count rate value (MARLAP 18.5.6.4; EPA et al., 2004) Or within ±3σ of mean activity of recent BSCs (minimum of 3 BSCs)	Recount the background. If still out of control, locate and correct problem; reanalyze or qualify impacted samples since last acceptable instrument contamination check If background activity has changed, re-establish BSC and reanalyze samples	Laboratory Manager/ Analyst	A means of assessing the existence and magnitude of contamination introduced via the analytical process	Within ±3σ of mean activity of recent BSCs (minimum of three BSCs)
LCS	One per analytical batch	$\lvert Z_{LCS} \rvert \leq 3$. Investigate recurrent results with $\lvert Z_{LCS} \rvert \geq 2$ (MARLAP 18.4.3; EPA et al., 2004) Or use in-house control chart limits of ±3σ of the mean In-house control limits may not fall more than 25% from the known LCS value	Recount the LCS to confirm results. Inspect LCS control chart for indication of significant bias If required, reprep and reanalyze the LCS and associated samples	Laboratory Manager/ Analyst	Accuracy	$\lvert Z_{LCS} \rvert \leq 3$. Investigate recurrent results with $\lvert Z_{LCS} \rvert \geq 2$ Or Use in-house control chart limits of ±3σ of the mean not more than 25% from the known LCS value.

SAP Worksheet #28.2: Laboratory Quality Control Samples Table (Gas Flow Proportional Counting Isotopes) (continued)

Matrix: Solid

Beta Emitting Radionuclides

EPA 905/ST-RD-0403

QC Check	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator	Measurement Performance Criteria
MS	One per preparatory batch (MS not required when yield tracers are employed)	If activity of the MS > 5 times the unspiked sample, |ZMS |≤ 3 (MARLAP 18.4.3; EPA et al., 2004) Or within 60 – 140% recovery	Examine the project-specific requirements Contact the client as to additional measures to be taken	Laboratory Manager/ Analyst	Accuracy	If activity of the MS > 5 times the unspiked sample, |ZMS |≤ 3 (MARLAP 18.4.3) or Within 60 – 140% recovery
Sample Duplicate	One per analytical batch	|ZDup | ≤ 3. Investigate recurrent results with |ZDup|≥ 2 (MARLAP 18.4.1) Or the DER between the sample and the duplicate is <3; or the RPD is <25%.	Check for lab error. Examine the project-specific requirements Contact the client as to additional measures to be taken	Laboratory Manager/ Analyst	Precision	Act < 5*MDC, then RPD is 100% or less. If act > 5*MDC, then RPD is 25% or less or DER</=3

SAP Worksheet #28.3: Laboratory Quality Control Samples Table (Alpha Spectroscopy)

Matrix: Solid

Alpha Spectroscopy

DOE A-01-R MOD/SOP ST-RD-0210

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator	Measurement Performance Criteria
Method Blank	One per preparatory batch (MARLAP 18.4.1; EPA et al., 2004)	|ZBlank |≤ 3. Investigate recurrent results with |ZBlank| ≥ 2 (MARLAP 18.4.1) Or in-house control limits of ±3 σ of the mean	Recount the blank to confirm results. Inspect method blank control chart for indication of significant bias If required, reprep and reanalyze method blank and samples processed with the contaminated blank	Laboratory Manager/ Analyst	Accuracy	|ZBlank |≤ 3. Investigate recurrent results with |ZBlank| ≥ 2 Or In-house control limits of ±3 σ of the mean
LCS	1 per preparatory batch	$\|Z_{LCS}\|$ ≤ 3. Investigate recurrent results with $\|Z_{LCS}\|$ ≥ 2 (MARLAP 18.4.3) Or use in-house control chart limits of ± 3σ of the mean In-house control limits may not fall more than 25% from the known LCS value.	Recount the LCS to confirm results Inspect LCS control chart for indication of significant bias If required, reprep and reanalyze the LCS and associated samples	Laboratory Manager/ Analyst	Accuracy	Control chart limits of ± 3σ of the mean In-house control limits may not fall more than 25% from the known LCS value

SAP Worksheet #28.3: Laboratory Quality Control Samples Table (Alpha Spectroscopy) (continued)

Matrix: Solid

Alpha Spectroscopy

DOE A-01-R MOD/SOP ST-RD-0210

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Actions	Data Quality Indicator	Measurement Performance Criteria
MS	One per preparatory batch (MS not required when yield tracers are employed)	If activity of the MS > 5 times the unspiked sample, |ZMS |≤ 3 (MARLAP 18.4.3) Or within 60 – 140% recovery	Examine the project-specific requirements Contact the client as to additional measures to be taken	Laboratory Manager/ Analyst	Accuracy	If activity of the MS > 5 times the unspiked sample, |ZMS |≤ 3 (MARLAP 18.4.3) Or within 60 – 140% recovery
Tracers	Added to each sample as isotopic yield monitor	Isotopic yield within 30 – 110% FWHM < 100 keV and peak energy within ± 40 keV of known peak energy.	Reanalysis of sample, including sample preparation	Laboratory Manager/ Analyst	Accuracy	Isotopic yield within 30 – 110%
Sample Duplicate	One per analytical batch	|ZDup | ≤ 3. Investigate recurrent results with |ZDup|≥ 2 (MARLAP 18.4.1) Or the DER between the sample and the duplicate is <3; or the RPD is <25%	Check for lab error. Examine the project-specific requirements Contact the client as to additional measures to be taken	Laboratory Manager/ Analyst	Precision	RPD is 25% or less or DER</=3

SAP Worksheet #29: Project Documents and Records Table

Document	Where Maintained
Final Work Plan and SAP	APTIM project file (APTIM Concord, California office) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
Field notes/logbook	APTIM project file (APTIM Concord, California office) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
COC forms	APTIM project file (APTIM Concord, California office) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
Laboratory raw data package	APTIM project file (APTIM Concord, California office) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
Audit/assessment checklists/reports	APTIM project file (APTIM Concord, California office) and laboratory NAVFAC SW Environmental Restoration Program Record File for CERCLA sites
Corrective action forms/reports	APTIM project file (APTIM Concord, California office) and laboratory
Laboratory equipment calibration logs	APTIM project file (APTIM Concord, California office) and laboratory
Sample preparation logs	APTIM project file (APTIM Concord, California office) and laboratory
Run logs	APTIM project file (APTIM Concord, California office) and laboratory
Sample disposal records	APTIM project file (APTIM Concord, California office) and laboratory
Data validation reports and validated data	APTIM project file (APTIM Concord, California office) NAVFAC SW Environmental Restoration Program Record File for CERCLA sites

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SAP Worksheet #30: Analytical Services Table

Matrix	Analytical Group	Sample Locations/ ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory/Organization[1] (Name, Address, Contact, and Telephone No.)	Backup Laboratory (Name, Address, Contact, and Telephone No.)
Solid	Gamma Spec ^{90}Sr Alpha Spec	Radiological samples shown in Worksheet #18	All	7 to 28 calendar days	Test America St. Louis Laboratory Contact: Rhonda Ridenhower 13715 Rider Trail North Earth City, Missouri 63045 314.298.8566	None

Notes:

[1] Analytical laboratories performing analyses will be State of California and DoD Environmental Laboratory Accreditation Program-accredited laboratories.

SAP Worksheet #31: Planned Project Assessments Table

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
Laboratory Technical Systems Audit	If deemed necessary prior to start of sampling activities	External	APTIM	APTIM Project or Program Chemist	Laboratory QA Officer	Laboratory QA Officer	Laboratory QA Officer and APTIM Project Chemist
Initial Inspection/Preparatory Meeting	Prior to the start of sampling activities	Internal	APTIM	APTIM Project or Program Chemist	Project Chemist or Sample Technician	Project Chemist or Sample Technician	Program Chemist or QC Manager
Field audits	If deemed necessary or as needed as the project progresses	Internal	APTIM and/or Navy QAO	APTIM Project or Program Chemist	Project Chemist or Program Chemist	Project Chemist or Program Chemist	Project Chemist or Program Chemist
Field documentation review	At least once at the beginning of sampling activities and then as needed as the project progresses	Internal	APTIM	APTIM Program Chemist or Field QA Manager	APTIM PM; Field Sampling Technician or Project Chemist	APTIM PM; Field Sampling Technician or Project Chemist	APTIM Program Chemist or Field QA Manager

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SAP Worksheet #32: Assessment Findings and Corrective Action Responses

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	Timeframe for Response
Field Sampling Technical Systems Audit	Written Audit Report	Project PM	48 hours after audit	Email or letter	Field Technician, APTIM Project Chemist, APTIM Program Chemist	24 hours after notification
Off-Site Laboratory Audit (if performed for project)	Written Audit Report	Laboratory QA Manager, Laboratory PM (TestAmerica St. Louis)	5 days after audit	Corrective Action Plan	Field Technician, APTIM Project Chemist, APTIM Program Chemist	10 business days after receiving report
Laboratory Data Review Findings	Memorandum	Laboratory QA Manager, Laboratory PM (TestAmerica St. Louis)	48 hours after audit	Email or letter	Field Technician, APTIM Project Chemist, APTIM Program Chemist	3 days after notification

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SAP Worksheet #33: QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Sampling Technical System Audit Report	At least once at the beginning of sampling activities and then as needed as the project progresses	Within 24 hours of field sampling audit	APTIM QA Manager or APTIM Project Chemist	APTIM PM
Off-Site Laboratory Technical System Audit Report (if performed)	Prior to sample receipt at laboratory	Within 48 hours of on-site audit	APTIM Project Chemist or APTIM Program Chemist	Laboratory QA Manager, Laboratory PM
Data Review Report	After waste sample data reviewed by Project Chemist	As received from laboratory	APTIM Project Chemist or APTIM Program Chemist	APTIM PM
Final Project Report (if needed)	After completion of fieldwork	Project document delivery schedule is provided in the Work Plan	APTIM PM	Navy RPM and regulatory agencies (see distribution list)

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SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb[1]	Internal/External
COC forms	COC forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the COC Form should be initialed by the reviewer, a copy of the COC Form retained in the project file, and the original and remaining copies taped inside the cooler for shipment.	Field sampling team leader (APTIM) or Project Chemist	Step I	Internal
Sample Release Survey	Sample release field survey data are included on the COC form to the laboratory. The sample survey data are reviewed and approved prior to sample shipment.	Field radiological sampling team leader (APTIM) or Project Chemist	Step I	Internal
Sample receipt	The sample cooler will be checked for compliance with preservative, temperature and packaging requirements. Sample containers will be reviewed against the COC for agreement. Sample receipt will be documented by the laboratory on a login sheet and sample information will be entered into the Laboratory Information Management System.	Laboratory sample receiving and PM	Step I	External
Field notes/logbook	Field notes will be reviewed internally and placed in the project file upon project completion.	APTIM Project Chemist and Field QC Manager	Step I	Internal
Audit reports	Upon report completion, a copy of audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week, and at the completion of the site work, project file audit reports will be reviewed internally to ensure that appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the PM will be notified to ensure action is taken.	APTIM PM	Step I	Internal
Laboratory data packages	Laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. Received data packages will be verified by the APTIM Chemist and a third-party reviewer according to the data validation procedures specified in this SAP.	Laboratory PM and APTIM Project Chemist	Step I	Internal/External

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SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb[1]	Internal/External
EDD	EDDs will be verified internally by the subcontract laboratory for completeness and technical accuracy prior to submittal to APTIM. Received EDDs will be verified APTIM and/or the validation company against the hardcopy laboratory reports.	Laboratory, APTIM Chemist and a third-party data validation company	Step I	Internal/External
Sampling methods and procedures	Ensure that the required sampling methods were used to collect project samples, any field changes or deviations are noted in the field logbook. Review field sample collection logbooks for compliance with the approved SAP.	APTIM Project Chemist and Field QC Manager	Step IIa	Internal
Holding times	Ensure the samples were analyzed within the EPA holding times. If holding times were not met, verify that deviations were documented and proper notifications were made.	Laboratory PM	Step IIa	External
Analytes and project DLCs met	Ensure that the required list of analytes and that project-specific DLCs specified in this SAP are met and reported per project requirements.	Laboratory PM and Project Chemist	Step IIa	Internal/External
Hard copy data packages	Review data package for completeness.	Third-party validation company	Step IIb	External
Documentation of SAP QC sample results	Determine if SAP required QC samples were collected and met required control limits per SAP and DoD QSM (2017) requirements when applicable.	Third-party validation company	Step IIb	External
Radiological Analyses	If off-site laboratory analysis are performed, Review/validate laboratory data package for compliance with, DoD QSM (2017), MARLAP (2004), ANSI/ANS-41.5-2012 (American Nuclear Society, 2012), National Functional Guidelines (EPA 2014) and requirements in this approved SAP as applicable.	Third-party validation company	Step IIb	External

Notes:

[1] IIa = compliance with methods, procedures, and contracts (see Table 10, page 117, UFP-QAPP [EPA, 2005]).

IIb = comparison with measurement performance criteria in the SAP (see Table 11, page 118, UFP-QAPP [EPA, 2005]).

SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

VALIDATION OF LABORATORY DATA

Data validation is a systematic, independent process of reviewing a body of data to determine the analytical limitations of that data based on specific QC criteria. If off-site laboratory analyses are performed, a third-party data validation company will validate definitive-level project laboratory data for radiological samples at 90 percent Stage 2B and 10 percent Stage 3.

Data review and validation will be in accordance with the QA requirements and control limits specified in this project-specific Quality Assurance Project Plan and the following guidance, as appropriate to the analytical methods used:

- DoD QSM (2017)
- MARLAP (2004)
- *ANSI/ANS-41.5-2012: Verification and Validation of Radiological Data for Use in Waste Management and Environmental Remediation* (ANS, 2012)
- *National Functional Guidelines for Inorganic Superfund Data Review* (EPA, 2014)

The chemist or reviewer's professional judgment will be used to evaluate data quality when called for in the National Functional Guidelines. Professional judgment will also be used where no clear policy exists, or when there is conflicting guidance on how data should be qualified.

Stage 2B and Stage 3 Data Validation Criteria and Checklist

For a Stage 2B data validation effort, data quality is assessed by comparing the parameters listed below to the appropriate criteria (or limits) as specified in the project SAP, DoD QSM (2017), or by EPA method-specific requirements. If calculations for quantitation are verified, it is done on a limited basis requires raw data (Stage 3) in addition to the standard data forms normally present in a data package.

Data review/validation may include the following QC elements shown in the following example validation checklist (depending on the analysis being reviewed):

Pass/Fail QC Criteria	Review/Validation Criteria (Stage 2B and 3)
	Sample Receipt and Preservation
	Laboratory Method Blanks/Instrument Blanks
	Verify gross count rate less than 2,000 counts per second
	LCS/LCSD Recoveries
	RPD Evaluation
	Laboratory Sample Duplicate Evaluation

Pass/Fail QC Criteria	Review/Validation Criteria (Stage 2B and 3)
	ICAL verification
	2nd source and annual source verifications are within limits
	Weekly calibration checks (^{137}Cs) are within expected values
	Analyte quantitation (calculation check)—Stage 3 Validation only

SAP Worksheet #37: Usability Assessment

37.1 DATA QUALITY ASSESSMENT REPORT

Based on data validation/review, the Project Chemist or Project RSO will determine if the project DQOs have been met and will determine data usability. To reconcile the collected data with project DQOs and to establish and document data usability, the data will be reviewed against data quality indicators (Section 37.2).

A data usability assessment based on data quality indicators will be performed for every data set subjected to Class 3 validation (SAP Worksheet #34-36). If necessary, the Project Chemist will prepare a data quality assessment (DQA) report. The DQA report will cover the following topics:

- Implementation of sampling design and analysis according to the approved SAP (or sample completeness and representativeness)
- Proper frequency of field QC samples and the adequacy of field decontamination procedures
- Accuracy and precision of the data collected
- Data comparability, if appropriate
- Data usability for project decisions

The DQA report will be included in the final project report.

37.2 DATA QUALITY INDICATORS

This subsection defines the data quality indicators and their use for assessment of data quality.

37.2.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. The following equation illustrates the method for calculating the RPD to assess a method's precision:

$$\textit{Precision as RPD} = \frac{2 \times |\textit{Result-Duplicate Result}| \times 100\%}{\textit{Result} + \textit{Duplicate Result}}$$

The laboratory uses LCS/LCSD pairs to assess the precision of analytical procedures with one LCS/LCSD pair for every 20 samples. For radiochemical analyses, analytical precision will be calculated based on the sample and sample duplicate results.

The analytical laboratory will use DoD QSM (2017) acceptability limits for RPDs if available. If DoD limits are not available, then the laboratory will establish statistically based acceptability limits for RPDs for each method of analysis and sample matrix. The laboratory will review the

QC samples to ensure that internal QC data lie within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken.

The analytical laboratory will use DoD QSM (2017) control limits if available; otherwise, the laboratory will have statistically based acceptability limits for RPDs established for each method of analysis and sample matrix. The laboratory will review the QC samples to ensure that internal QC data lie within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken.

Due to the heterogeneous nature of site soil, field duplicates cannot be used to assess sampling precision; therefore, field duplicates will not be collected for this project.

37.2.2 Accuracy

Accuracy measures the bias of an analytical system by comparing the difference of a measurement with a reference value. The percent recovery of an analyte, which has been added to the environmental samples at a known concentration before extraction and analysis, provides a quantitation tool for analytical accuracy. The spiking solutions used for accuracy determinations are not used for instrument calibrations. The following equation illustrates how accuracy is evaluated:

$$\textit{Accuracy as percent recovery} = \frac{\textit{Spiked Sample Result-Sample Result x 100\%}}{\textit{Spiked Sample True Value}}$$

Percent recoveries for LCS and LCSD that are analyzed for every batch of up to 20 samples serve as a measure of analytical accuracy.

The laboratory will use DoD QSM (2017) control limits for accuracy if available. For analytes not specified in the QSM, the laboratory may use statistically based control limits that are developed for each method of organic analysis and sample matrix.

Control limits are defined as the mean recovery, plus or minus three standard deviations, of the 20 data points, with the warning limits set as the mean plus or minus two standard deviations. The laboratory will review the QC samples each analysis to ensure that internal QC data lie within the limits of acceptability. The laboratory will investigate any suspect trends and take appropriate corrective actions.

37.2.3 Representativeness

Unlike precision and accuracy, which can be expressed in quantitative terms, representativeness is a qualitative parameter. Representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or

an environmental condition. It is a qualitative parameter that depends on proper design of the sampling program.

Field personnel will be responsible for ensuring that samples are representative of field conditions by collecting and handling samples according to the approved site-specific SAP. Errors in sample collection, packaging, preservation, or COC procedures may result in samples being judged nonrepresentative and may form a basis for rejecting the data.

Data generated by the laboratory must be representative of the laboratory database of accuracy and precision measurements for analytes in different matrices. Laboratory procedures for sample preparation will ensure that aliquots used for analysis are representative of the whole sample.

37.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another, whether it was generated by a single laboratory or during inter-laboratory studies. The use of standardized field and analytical procedures ensures comparability of analytical data.

Sample collection and handling procedures will adhere to EPA-approved protocols. Laboratory procedures will follow standard analytical protocols, use standard units and standardized report formats, follow the calculations as referenced in the approved analytical methods, and use a standard statistical approach for QC measurements.

37.2.5 Completeness

Completeness is a measure of whether the data necessary to meet the project have been collected. For the data to be considered complete, they must meet acceptance criteria including accuracy and precision and other criteria specified for an analytical method. The data will be reviewed and/or validated to keep invalid data from being processed through data collection.

Completeness is evaluated using the following equation:

$$Completeness = \frac{Acceptable\ Results\ x\ 100\%}{Total\ Results}$$

The goal for completeness for QC parameters, except holding times, will be 90 percent. The goal for holding times will be 100 percent. If these goals are not achieved, the sources of nonconformances will be evaluated to determine whether resampling and reanalysis is necessary.

37.3 Sensitivity

Sensitivity is the capability of a method or instrument to measure target analyte responses. Sensitivity determines the minimum concentration or attribute that can be measured by a method

(method detection limit [DL]), by an instrument (instrument DL), or by a laboratory (LOD). The laboratory DLC, LOD, or DL will be sensitive enough to meet the project decision limits. Sensitivity may be affected by sample matrix factors such as interference of non-target analytes, sample materials, or sample dilution.

The DLC will be evaluated by the project team prior to sample analysis to determine if the laboratory is able to attain the required sensitivity for the project. The DLC will be evaluated after sample analysis to determine if there were any matrix effects, operator errors, or analytical process errors that interfered with the ability to compare the results to the project decision limits. The DLC will be used to determine if no detectable amounts of contaminants of concern are present. If no detectable amounts are reported and data are acceptable from the verification and validation, then the data are usable. If detectable amounts are reported and the verification and validation are acceptable, then the data are usable. If anomalies in sensitivity are present, the rationale for use or non-use of the affected samples will be discussed in the DQA report.

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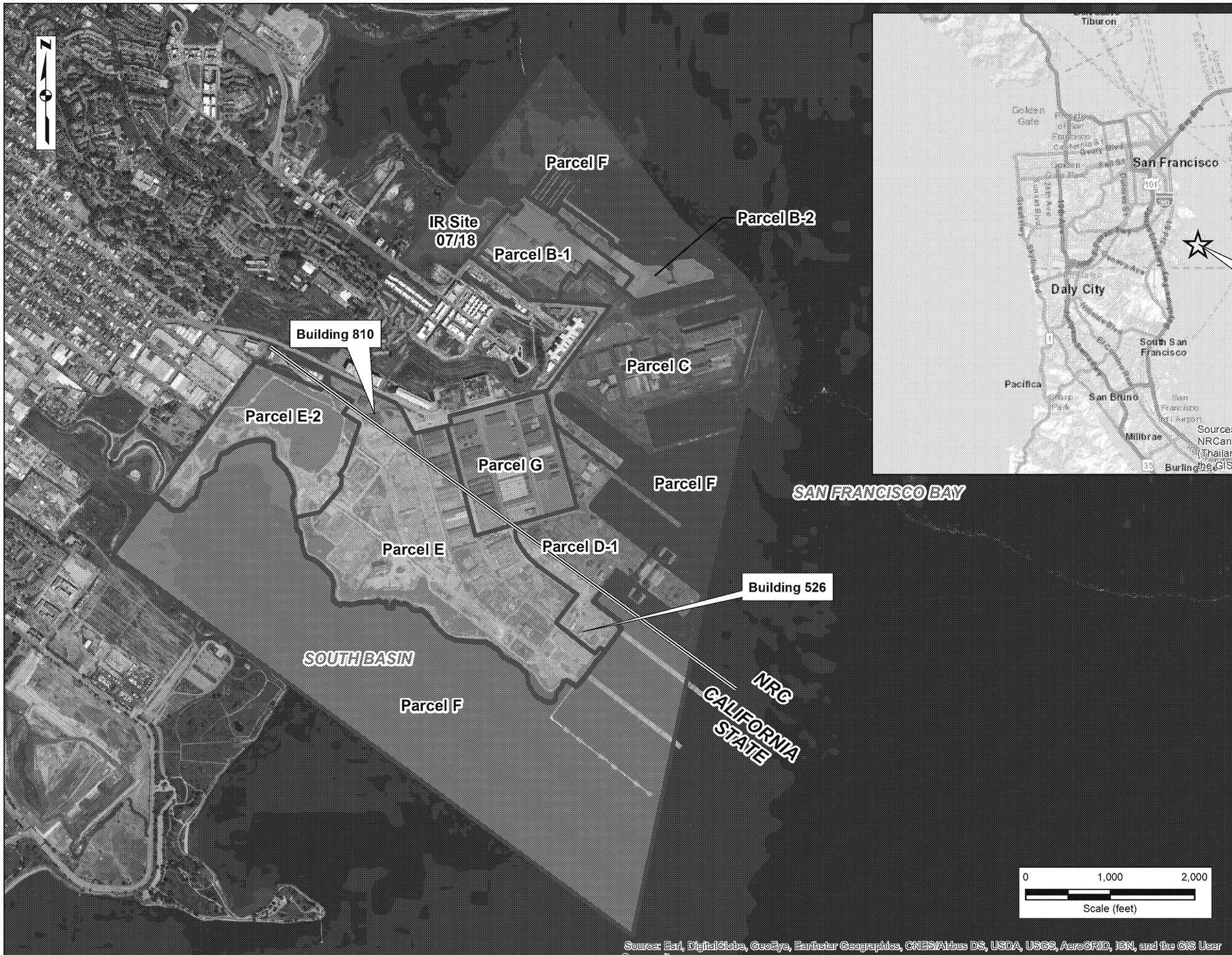
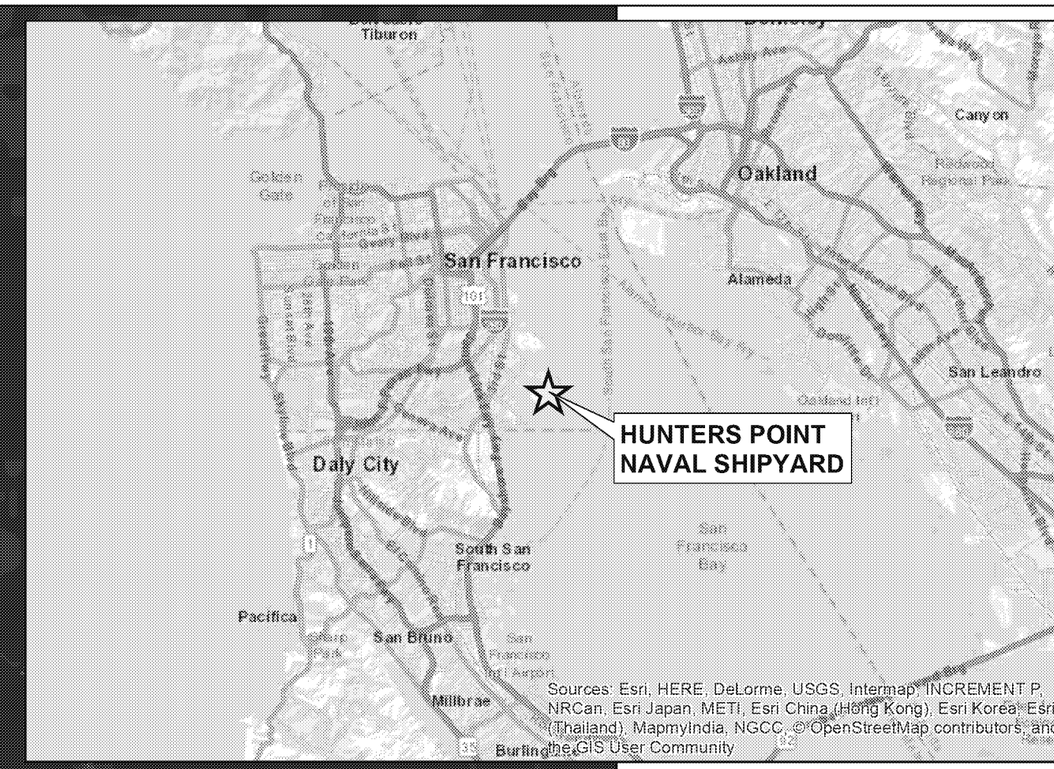
FIGURES





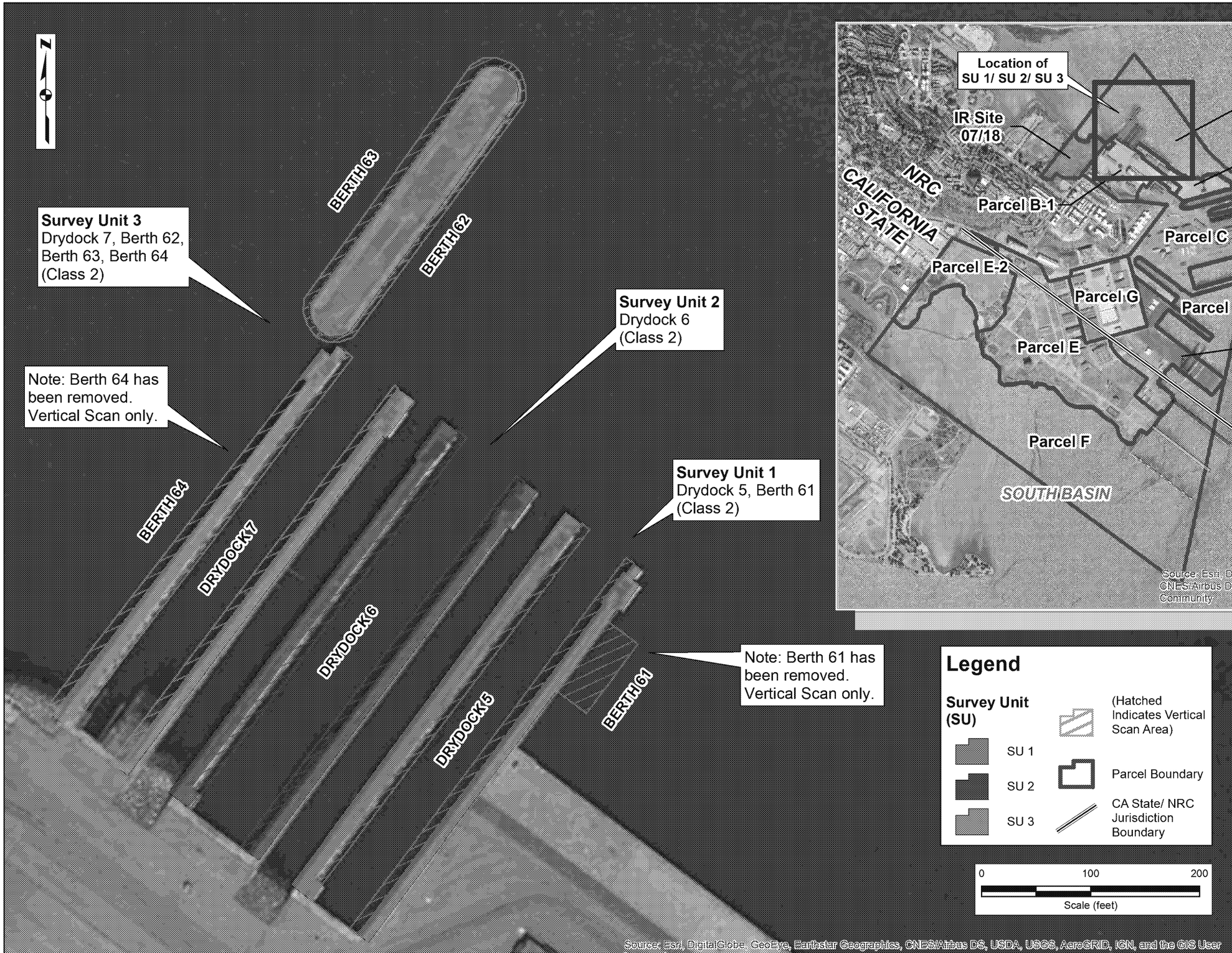
Legend

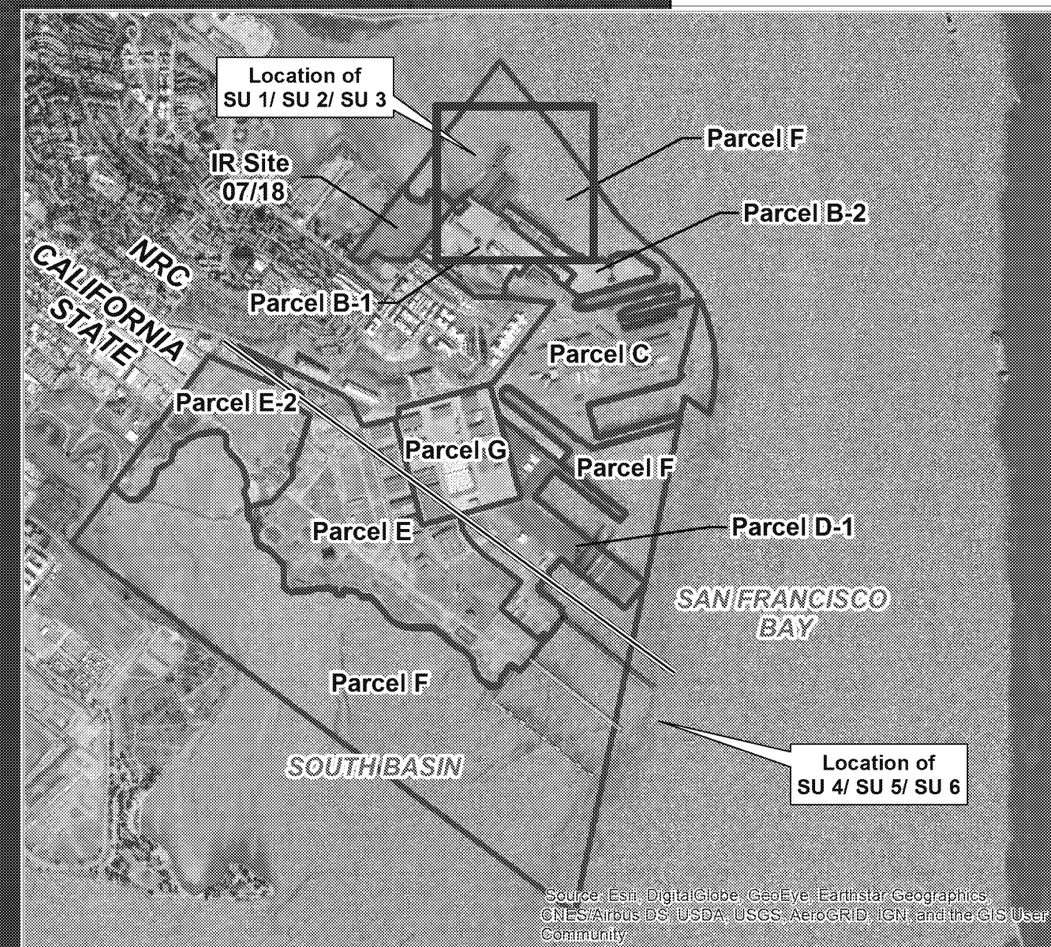
- Parcel Boundary
- CA State/ NRC Jurisdiction Boundary
- CA Jurisdiction
- NRC Jurisdiction

SITE LOCATION

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

10/2017	PROJECT No. R3-0016.01	FIGURE 1





Legend

Survey Unit (SU)

- SU 1
- SU 2
- SU 3

(Hatched Indicates Vertical Scan Area)

Parcel Boundary

CA State/ NRC Jurisdiction Boundary

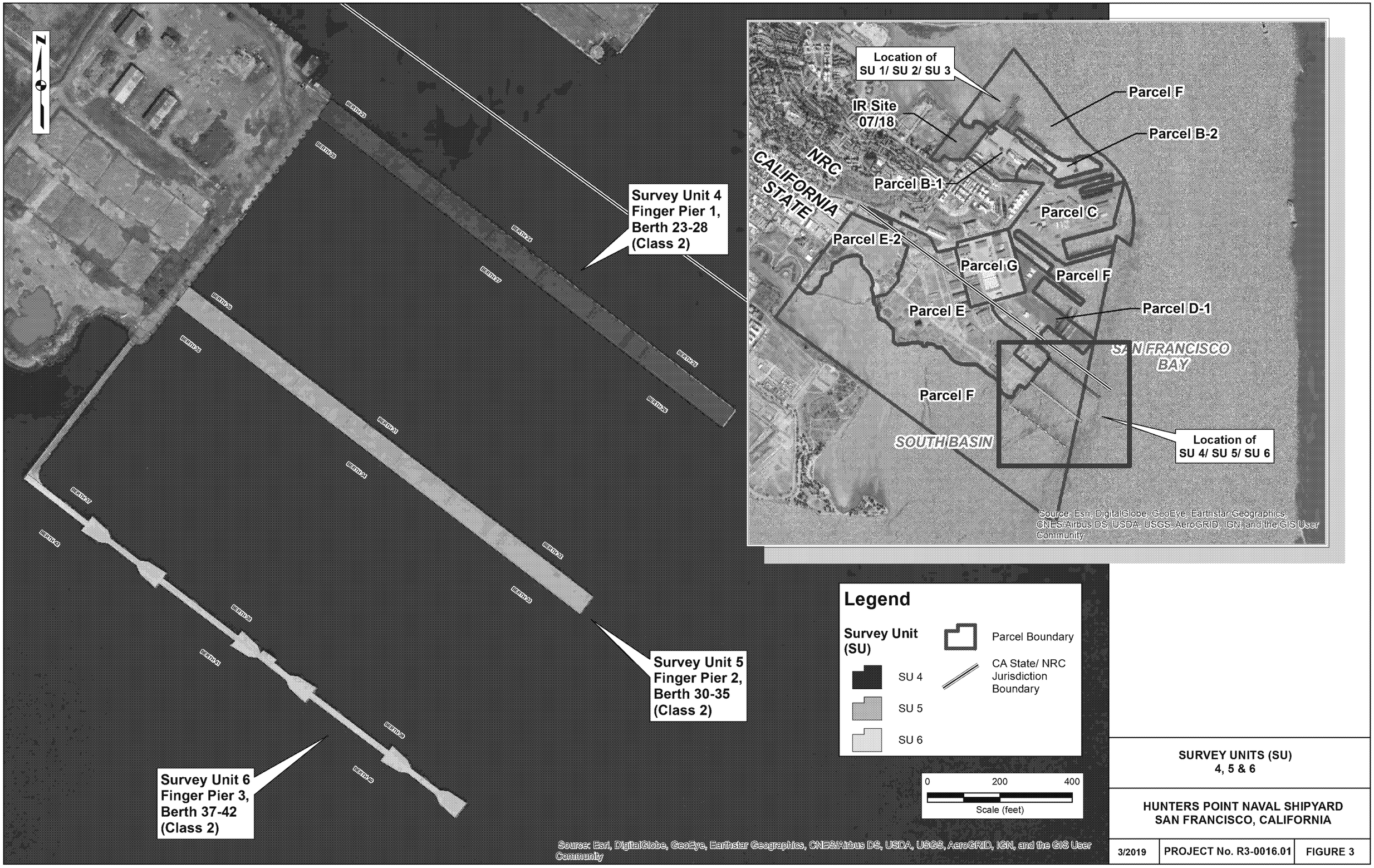
0 100 200

Scale (feet)

SURVEY UNITS (SU) 1, 2 & 3

HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 2



SURVEY UNITS (SU)
4, 5 & 6

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

3/2019	PROJECT No. R3-0016.01	FIGURE 3

Attachment 1
Field Forms

APTIM

CHAIN OF CUSTODY

Ref. Document # 501008-001

Page 1 of 1

APTIM Federal Services, LLC
4005 Port Chicago Hwy
Concord, CA 94520

Project Number: 501008
Project Name: Hunters Point Naval Shipyard - Parcel F
Project Location:
Purchase Order #:
Shipment/Pickup Date:
Waybill Number:
Lab Destination: TestAmerica (St. Louis Lab) 13715 Rider Trail North Earth City, MO 63045
Lab Contact Name / ph. #: Rhonda Ridenhower (314) 298-8566

Project Manager: (Name & phone #)

Send Report To:
Phone/Fax Number:
Address:
City:
Sampler's Name(s):

Sample ID Number	Sample Description	Collection Information: Date	Time	Method	Matrix	# of containers	Container Type	Gamma Spec (EPA 191.1 M) - (7 day in-growth preliminary results and full 21 day in growth for full gamma results)	Total Strontium (EPA 905 MOD)		Strontium 90 (EPA 905 MOD)			Dose Rate µR/Hr	
							Preservative (water)								
							Preservative (soil)	N/A	N/A		N/A				
				G	SO	1	16 oz. plastic jar	X	X		X				
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							
				G	SO	1	16 oz. plastic jar	X							

Special Instructions:

7 days ingrown draft and follow with 21 days final.
Analyze for Total Strontium as a screening step, and isotopic Sr-90 only if Total Strontium is above project action limit of 0.331 pCi/g.

☐ 24-hr
Standard TAT -10-day ☐ 3-day ☐ 10-day

Level Of QC Required: I II III Project Specific:

Relinquished By:	Date: / Time:	Received By:	Date: / Time:
Relinquished By:	Date: / Time:	Received By:	Date: / Time:
Relinquished By:	Date: / Time:	Received By:	Date: / Time:
Relinquished By:	Date: / Time:	Received By:	Date: / Time:

Method Codes C = Composite G = Grab

Matrix Codes
DW = Drinking Water SO =Soil
GW = Ground Water SL = Sludge
WW = Waste Water CP = Chip Samples
A = Air ABS=Asbestos, PO=Pipe Openning

APTIM

Aptim Federal Services LLC

DATE			
TIME	:		
PAGE	OF		
PROJECT NO.	**501008**		

SAMPLE COLLECTION LOG

PROJECT NAME **HPNS Parcel F**

SAMPLE NO. _____

SAMPLE LOCATION _____

SAMPLE TYPE ☐ Soil ☐ Water ☐ Air ☐ Other (give description)

COMPOSITE ☐ YES ☐ NO

COMPOSITE TYPE _____

DEPTH OF SAMPLE _____

WEATHER _____

MAP ON PAGE ☐

ANALYSES		CONTAINER AND AMOUNT COLLECTED
☐ PCBs	☐ PAHs	☐ 8 - OZ JARS
☐ Metals	☐ Sr90	☐ 4 - OZ JARS
☐ TPH	☐ Dioxin	☐ Encore
☐ Gamma Spec		☐ 16 - OZ JARS

COMMENTS:

PREPARED BY: _____

Attachment 2
Certifications and
Analytical Standard Operating Procedures

(will be provided in electronic copy only)

WORK INSTRUCTION

Work Instruction Title:	Radiation Detection Instrumentation	AMS Number:	AMS-710-07-WI-04014
Work Instruction Owner:	Federal Services HSE	Issuing Authority:	APTIM Quality Management

RADIATION DETECTION INSTRUMENTATION

INT	Issued for Interim Use	M. Hadacek & S. Lachney	7/30/2017
Rev	**Changes**	**Approved**	**Date**

1.0 PURPOSE

This work instruction provides the minimum requirements of the APTIM *Radiation Safety Program* (AMS-710-07-PR-04000) element "Radiation Detection Instrumentation". The principles, concepts, and requirements in this program document are to be used, as appropriate and necessary, to develop practices and work plans at work sites that receive, possess, use, transfer, or dispose of radioactive materials or sources of ionizing radiation that are governed by regulation.

2.0 APPLICATION

The work instruction is to be followed when developing a task- or site- specific Radiation Protection Plan (RPP) intended to support sites involving the potential for exposure to sources of occupational ionizing radiation.

3.0 REQUIREMENTS

The following personnel have responsibilities in this work instruction:

- Project/Program Radiation Safety Officer (PRSO)
- Director, Radiation Safety (DRS)

4.0 REFERENCES

ANSI N323A-1997	American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments. American National Standards Institute. Published by the Institute of Electrical and Electronics Engineers, Inc. New York, New York.
AMS-710-07-PR-04000	Radiation Safety Program
DOE	Occupational Radiation Protection. U.S. Department of Energy, Title 10 Code of Federal Regulations, Part 835, Subpart E, 835.401 – 835.405, Subpart F, 835.501 - 835.502, Subpart G, 835.601 – 835.606, Subpart L, 835.1101 – 835.1102, and Appendix E. Washington, D.C.
DOE	Radiation Protection Programs Guide. DOE G 441.1-1C. U.S. Department of Energy, Washington, D.C.
NRC	Standards for Protection Against Radiation. U.S. Nuclear Regulatory Commission, Title 10 Code of Federal Regulations, Part 20, 1004, and Subpart F, 20.1501 – 20.1502
Technical Report	Abelquist, E. W., W. S. Brown, G. F. Powers, A. M. Huffert. 1998. Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. U.S. Nuclear Regulatory Commission NUREG-1507. Washington, D.C.
Technical Report	Manufacturer's Instrument Technical and Users Manuals and Technical Reports

5.0 WORK INSTRUCTION

In accordance with APTIM *Radiation Safety Program* (AMS-710-07-PR-04000) the RPP shall document which radiation detection instruments are suitable for the required survey measurements. The PRSO shall develop and document a technical basis for verifying that the instruments used are appropriate for the radionuclides of concern and have sufficient sensitivity for the required measurements and monitoring for review and approval by the DRS. The information may be included or referenced in the task- or site-specific RPP.

Operating instructions and calibration and quality assurance procedures shall be maintained for each instrument and should be consistent with ANSI N323A. These requirements apply to both portable and fixed instruments.

5.1 Responsibilities

5.1.1 Project/Program Radiation Safety Officer (PRSO):

5.1.1.1 Periodically reviews the site procedure(s) for applicability and efficacy at least annually or when changing radiological conditions, instruments, project objectives, quality assurance/quality control (QA/QC) requirements, license, or regulatory changes warrant.

5.1.1.2 Establishes project and/or site-specific requirements for radiological survey and fixed instruments including the selection of parameters to be measured and specific instrumentation to be used.

5.1.1.3 Ensures that instrument surveys performed for the demonstration of compliance conform to the requirements of the RPP and applicable regulations.

5.1.1.4 Maintains an adequate inventory of functional, calibrated instruments including support equipment e.g., planchets, tools, and check sources.

5.1.1.5 Controls the use, storage and operation of all portable and fixed instruments.

5.1.1.6 Ensures that the calibration and operational checks of portable and fixed instruments are properly documented and conform to the requirements of this work instruction.

5.1.2 Director, Radiation Safety (DRS)

The DRS shall review and approve technical basis decisions addressing instrument sensitivity to detect the nuclides present at a fraction of the control levels.

5.2 Prerequisites

- Only personnel with appropriate, documented training shall issue or use radiation protection instruments. Training and documentation shall comply with 10 CFR 20.19 for NRC licensees and 10 CFR 835.103 and DOE G 441.1-1C for DOE Projects. Activities conducted under agreement state regulation shall have training compliant with those regulations. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites shall have training programs equivalent to those required by the appropriate regulatory group.
- Instruments and detectors shall be inspected for mechanical damage and shall be response tested prior to use.
- Instruments with mechanical damage or that do not pass the response test shall be removed from service and immediately tagged with a *Do Not Use* tag.
- Labels denoting current calibration shall be affixed to instruments in use.

5.3 Precautions and Limitation

- As Low as Reasonably Achievable (ALARA) practices shall be observed to minimize personnel exposure and the spread of contamination when using radiation protection instrumentation.
- Instruments removed from service for calibration, repair, or failure of a response test shall be physically segregated as practical from those instruments available for issue and shall be tagged or labelled to indicate their status.

- Portable survey instruments are susceptible to damage from physical and environmental stresses. Project procedures shall specify the environmental limits (e.g., temperature, humidity, etc.) for each instrument as specified by the manufacturer, if restrictive.
- Instruments will have been surveyed for contamination and decontaminated as necessary, prior to returning to the issue location.
- QA/QC requirements shall be established to include applicable calibration, daily response, and general operations acceptance criteria.
- Inspections, establishing acceptable ranges and daily performance checks shall only be performed by individuals trained and successfully tested on these tasks.

5.4 Characteristics, Accountability, Maintenance, and Calibration of Radiation Detection Instrumentation

5.4.1 Operating Characteristics

The PRSO shall ensure instrumentation is appropriate for the detection of the radionuclides of interest, including energy response, and that the expected Minimal Detectable Activity (MDA's) will meet project requirements. Operational characteristics should be verified with source testing once the instrumentation has been received and the results documented in a technical basis document. Any environmental limitations or special use conditions should be specified along with the required actions if those conditions are exceeded.

5.4.2 Receipt of Radiation Protection Instrumentation

Site-specific instrument procedure(s) shall define the requirements for placing radiation protection instruments in service in accordance with recommendations in Section 9.2.1 of ANSI N323A-1997 (ANSI, 1997).

The instrument may be used for 'information only', until:

- The required procedures have been written, reviewed, and approved.
- The calibration requirements have been satisfied.
- Successful passing of the general operations and source test in accordance with ANSI N323A-1997 (ANSI, 1997).

5.4.3 Performance Testing for Portable and Fixed Instruments

Site-specific instrument procedure(s) shall address the performance testing requirements before initial use, after maintenance that could affect performance, and periodically over the life of the Project to verify that they continue to meet the Project and or Site Measurement Quality Objectives. The site-specific instrument procedure(s) shall define the requirements for the testing and calibration of instruments. The testing and calibration of instruments should be performed under a group of controlled conditions called standard test conditions as described in Table 1 and Section 3.3 of ANSI N323A-1997 (ANSI, 1997).

5.4.4 Instrument Control and Accountability for Portable and Fixed Instruments

Site-specific instrument procedure(s) shall address the instrument accountability requirements including short-term and long-term use as appropriate, physical inventories by serial number, documentation and record keeping, and record disposition. Instrument issue and use should be limited to qualified personnel within the specified use parameters, including proper pre- and post-use checks, and required recordkeeping.

5.4.5 Maintenance for Portable and Fixed Instruments

Maintenance should be performed in accordance with the manufacturer's recommendations and preferably by the manufacturer. Recalibration shall be required following maintenance.

5.4.6 Pre-Calibration for Portable and Fixed Instruments

Instruments must be properly set-up, either at the work site or by the calibration service, in accordance with the instruction manuals prior to calibration. Set-up includes proper adjustment of high voltage, window settings, response time, battery checks, instrument zero, counting gas flow rate, and recording "as found" readings for the instrument. If the meter and detector are maintained as a set, ensure the proper detector is paired with the meter and that the cable is of the proper length. Check instruments for contamination and physical damage as well.

5.4.7 Calibration for Portable and Fixed Instruments

The PRSO shall ensure that the calibration frequency has been established for all instruments. Calibrations shall be performed using NIST traceable sources of the appropriate energy, source strength, and size for the intended use of the instrument. Source jigs shall be used to establish reproducible calibration geometries. Instrument scales to be calibrated shall be specified including whether at the low end, midpoint, or high end of the scale and the acceptance criteria. Specify the calibration data that must be recorded including as left conditions and alarm set points as appropriate. MDAs should be determined following calibration in accordance with NUREG-1507 (NRC, 1999).

5.4.8 Recordkeeping for Portable and Fixed Instruments

Accurate and complete records of instrument inventories, calibrations, repair history, and performance checks must be maintained. Information required on calibration labels must be specified.

5.4.9 Fixed Counting System General Requirements

The requirements for fixed counting systems are the same as described above and include the following requirements as well:

- Physical inspections.
- Counting gas requirements if appropriate.
- System set-up parameters.
- Range for background.
- Operational parameters.
- Performance testing and acceptable testing criteria.
- Appropriate response when instrument response is out of range.
- Sample counting operations, establishing required MDAs or Minimum Detectable Contamination (MDC's).
- Safety precautions.
- Record keeping requirements including data package and data verification and validation.

6.0 TERMINOLOGY

Term (Acronym)	***Definition***
ALARA	As Low As Reasonably Achievable
CERCLA	Comprehensive Environmental Response, Compensation, and

Term (Acronym)	***Definition***
	Liability Act
CFR	Code of Federal Regulations
DOE	Department of Energy
DRS	Director, Radiation Safety
MDA	Minimal Detectable Activity
MDC	Minimum Detectable Contamination
NIST	National Institute of Standards and Technology, the national organization for establishing the quality standards for radiation sources used for instrument calibration.
PRSO	Project Radiation Safety Officer
QA/QC	Quality Assurance/Quality Control
RPP	Radiation Protection Plan

7.0 EXHIBITS

Exhibit 7.1 AMS-720-01-FM-00020 – Business Glossary

Exhibit 7.2 AMS-720-01-FM-00021 – Technical Glossary

CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

TestAmerica Laboratories – St. Louis Facility

13715 Rider Trail North
Earth City, Missouri 63045

has been assessed by ANAB and meets the requirements of international standard

ISO/IEC 17025:2005

and the

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V5.1.1)

while demonstrating technical competence in the field of

TESTING

Refer to the accompanying Scope of Accreditation for information regarding the types of activities to which this accreditation applies

L2305
Certificate Number

ANAB Approval

Certificate Valid Through: 04/06/2022
Version No. 003 Issued: 03/13/2019

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

ANSI National Accreditation Board

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 and U.S. DEPARTMENT OF DEFENSE (DoD) QUALITY SYSTEMS MANUAL FOR ENVIRONMENTAL LABORATORIES (DoD QSM V5.1.1)

TestAmerica Laboratories
St. Louis Facility
13715 Rider Trail North
Earth City, Missouri 63045
Marti Ward
314-298-8566

TESTING

Valid to: **April 6, 2022** Certificate Number: **L2305**

Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-AES	EPA 6010B/6010C/6010D	Aluminum
ICP-AES	EPA 6010B/6010C/6010D	Antimony
ICP-AES	EPA 6010B/6010C/6010D	Arsenic
ICP-AES	EPA 6010B/6010C/6010D	Barium
ICP-AES	EPA 6010B/6010C/6010D	Beryllium
ICP-AES	EPA 6010B/6010C/6010D	Bismuth
ICP-AES	EPA 6010B/6010C/6010D	Boron
ICP-AES	EPA 6010B/6010C/6010D	Cadmium
ICP-AES	EPA 6010B/6010C/6010D	Calcium
ICP-AES	EPA 6010B/6010C/6010D	Chromium
ICP-AES	EPA 6010B/6010C/6010D	Cobalt
ICP-AES	EPA 6010B/6010C/6010D	Copper
ICP-AES	EPA 6010B/6010C/6010D	Iron
ICP-AES	EPA 6010B/6010C/6010D	Lead
ICP-AES	EPA 6010B/6010C/6010D	Lithium
ICP-AES	EPA 6010B/6010C/6010D	Magnesium
ICP-AES	EPA 6010B/6010C/6010D	Manganese

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-AES	EPA 6010B/6010C/6010D	Molybdenum
ICP-AES	EPA 6010B/6010C/6010D	Nickel
ICP-AES	EPA 6010B/6010C/6010D	Phosphorus
ICP-AES	EPA 6010B/6010C/6010D	Potassium
ICP-AES	EPA 6010B/6010C/6010D	Selenium
ICP-AES	EPA 6010B/6010C/6010D	Silicon
ICP-AES	EPA 6010B/6010C/6010D	Silver
ICP-AES	EPA 6010B/6010C/6010D	Sodium
ICP-AES	EPA 6010B/6010C/6010D	Strontium
ICP-AES	EPA 6010B/6010C/6010D	Sulfur
ICP-AES	EPA 6010B/6010C/6010D	Thallium
ICP-AES	EPA 6010B/6010C/6010D	Thorium
ICP-AES	EPA 6010B/6010C/6010D	Tin
ICP-AES	EPA 6010B/6010C/6010D	Titanium
ICP-AES	EPA 6010B/6010C/6010D	Vanadium
ICP-AES	EPA 6010B/6010C/6010D	Zinc
GC/MS	EPA 8260B/8260C	Acetone
GC/MS	EPA 8260B/8260C	Acetonitrile
GC/MS	EPA 8260B/8260C	Acrolein
GC/MS	EPA 8260B/8260C	Acrylonitrile
GC/MS	EPA 8260B/8260C	Benzene
GC/MS	EPA 8260B/8260C	Benzyl chloride
GC/MS	EPA 8260B/8260C	Bromobenzene
GC/MS	EPA 8260B/8260C	Bromochloromethane
GC/MS	EPA 8260B/8260C	Bromodichloromethane
GC/MS	EPA 8260B/8260C	Bromoform
GC/MS	EPA 8260B/8260C	Bromomethane
GC/MS	EPA 8260B/8260C	n-Butanol
GC/MS	EPA 8260B/8260C	2-Butanone
GC/MS	EPA 8260B/8260C	n-Butylbenzene
GC/MS	EPA 8260B/8260C	sec-Butylbenzene
GC/MS	EPA 8260B/8260C	tert-Butylbenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/8260C	Carbon disulfide
GC/MS	EPA 8260B/8260C	Carbon tetrachloride
GC/MS	EPA 8260B/8260C	Chlorobenzene
GC/MS	EPA 8260B/8260C	2-Chloro-1,3-butadiene
GC/MS	EPA 8260B/8260C	Chlorodibromomethane
GC/MS	EPA 8260B/8260C	Chloroethane
GC/MS	EPA 8260B/8260C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/8260C	Chloroform
GC/MS	EPA 8260B/8260C	Chloromethane
GC/MS	EPA 8260B/8260C	Allyl chloride
GC/MS	EPA 8260B/8260C	2-Chlorotoluene
GC/MS	EPA 8260B/8260C	4-Chlorotoluene
GC/MS	EPA 8260B/8260C	Cyclohexane
GC/MS	EPA 8260B/8260C	Cyclohexanone
GC/MS	EPA 8260B/8260C	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/8260C	1,2-Dibromoethane
GC/MS	EPA 8260B/8260C	Dibromomethane
GC/MS	EPA 8260B/8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260B/8260C	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/8260C	Dichlorodifluoromethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethane
GC/MS	EPA 8260B/8260C	1,2-Dichloroethane
GC/MS	EPA 8260B/8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	1,1-Dichloroethene
GC/MS	EPA 8260B/8260C	1,2-Dichloroethene (total)
GC/MS	EPA 8260B/8260C	1,2-Dichloropropane
GC/MS	EPA 8260B/8260C	1,3-Dichloropropane
GC/MS	EPA 8260B/8260C	2,2-Dichloropropane
GC/MS	EPA 8260B/8260C	cis-1,3-Dichloropropene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	1,1-Dichloropropene
GC/MS	EPA 8260B/8260C	1,2-Dichloro-1,1,2,2-tetrafluoroethane
GC/MS	EPA 8260B/8260C	Dimethyl disulfide
GC/MS	EPA 8260B/8260C	1,4-Dioxane
GC/MS	EPA 8260B/8260C	Ethyl acetate
GC/MS	EPA 8260B/8260C	Ethylbenzene
GC/MS	EPA 8260B/8260C	Ethyl ether
GC/MS	EPA 8260B/8260C	Ethyl methacrylate
GC/MS	EPA 8260B/8260C	Hexachlorobutadiene
GC/MS	EPA 8260B/8260C	n-Hexane
GC/MS	EPA 8260B/8260C	2-Hexanone
GC/MS	EPA 8260B/8260C	Iodomethane
GC/MS	EPA 8260B/8260C	Isobutanol
GC/MS	EPA 8260B/8260C	Isopropylbenzene
GC/MS	EPA 8260B/8260C	p-Isopropyltoluene
GC/MS	EPA 8260B/8260C	Methacrylonitrile
GC/MS	EPA 8260B/8260C	Methyl acetate
GC/MS	EPA 8260B/8260C	Methylcyclohexane
GC/MS	EPA 8260B/8260C	Methylene chloride
GC/MS	EPA 8260B/8260C	Methyl methacrylate
GC/MS	EPA 8260B/8260C	4-Methyl-2-pentanone
GC/MS	EPA 8260B/8260C	MTBE
GC/MS	EPA 8260B/8260C	Naphthalene
GC/MS	EPA 8260B/8260C	2-Nitropropane
GC/MS	EPA 8260B/8260C	Nonanal
GC/MS	EPA 8260B/8260C	Pentachloroethane
GC/MS	EPA 8260B/8260C	Propionitrile
GC/MS	EPA 8260B/8260C	n-Propylbenzene
GC/MS	EPA 8260B/8260C	Styrene
GC/MS	EPA 8260B/8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,2,2-Tetrachloroethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/8260C	Tetrachloroethene
GC/MS	EPA 8260B/8260C	Tetrahydrofuran
GC/MS	EPA 8260B/8260C	Toluene
GC/MS	EPA 8260B/8260C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260B/8260C	Trichloroethene
GC/MS	EPA 8260B/8260C	Trichlorofluoromethane
GC/MS	EPA 8260B/8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260B/8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/8260C	Vinyl acetate
GC/MS	EPA 8260B/8260C	Vinyl chloride
GC/MS	EPA 8260B/8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260B/8260C	o-Xylene
GC/MS	EPA 8260B/8260C	Xylenes (total)
GC/MS	EPA 8260B/8260C SIM	1,4-Dioxane
GC/MS	EPA 624	Acetone
GC/MS	EPA 624	Acetonitrile
GC/MS	EPA 624	Acrolein
GC/MS	EPA 624	Acrylonitrile
GC/MS	EPA 624	Benzene
GC/MS	EPA 624	Benzyl chloride
GC/MS	EPA 624	Bromobenzene
GC/MS	EPA 624	Bromochloromethane
GC/MS	EPA 624	Bromodichloromethane
GC/MS	EPA 624	Bromoform
GC/MS	EPA 624	Bromomethane
GC/MS	EPA 624	n-Butanol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624	2-Butanone
GC/MS	EPA 624	n-Butylbenzene
GC/MS	EPA 624	sec-Butylbenzene
GC/MS	EPA 624	tert-Butylbenzene
GC/MS	EPA 624	Carbon disulfide
GC/MS	EPA 624	Carbon tetrachloride
GC/MS	EPA 624	Chlorobenzene
GC/MS	EPA 624	2-Chloro-1,3-butadiene
GC/MS	EPA 624	Chlorodibromomethane
GC/MS	EPA 624	Chloroethane
GC/MS	EPA 624	2-Chloroethyl vinyl ether
GC/MS	EPA 624	Chloroform
GC/MS	EPA 624	Chloromethane
GC/MS	EPA 624	Allyl chloride
GC/MS	EPA 624	2-Chlorotoluene
GC/MS	EPA 624	4-Chlorotoluene
GC/MS	EPA 624	Cyclohexane
GC/MS	EPA 624	Cyclohexanone
GC/MS	EPA 624	1,2-Dibromo-3-chloropropane
GC/MS	EPA 624	1,2-Dibromoethane
GC/MS	EPA 624	Dibromomethane
GC/MS	EPA 624	1,2-Dichlorobenzene
GC/MS	EPA 624	1,3-Dichlorobenzene
GC/MS	EPA 624	1,4-Dichlorobenzene
GC/MS	EPA 624	trans-1,4-Dichloro-2-butene
GC/MS	EPA 624	Dichlorodifluoromethane
GC/MS	EPA 624	1,1-Dichloroethane
GC/MS	EPA 624	1,2-Dichloroethane
GC/MS	EPA 624	cis-1,2-Dichloroethene
GC/MS	EPA 624	trans-1,2-Dichloroethene
GC/MS	EPA 624	1,1-Dichloroethene
GC/MS	EPA 624	1,2-Dichloroethene (total)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624	1,2-Dichloropropane
GC/MS	EPA 624	1,3-Dichloropropane
GC/MS	EPA 624	2,2-Dichloropropane
GC/MS	EPA 624	cis-1,3-Dichloropropene
GC/MS	EPA 624	trans-1,3-Dichloropropene
GC/MS	EPA 624	1,1-Dichloropropene
GC/MS	EPA 624	1,2-Dichloro-1,1,2,2-tetrafluoroethane
GC/MS	EPA 624	Dimethyl disulfide
GC/MS	EPA 624	1,4-Dioxane
GC/MS	EPA 624	Ethyl acetate
GC/MS	EPA 624	Ethylbenzene
GC/MS	EPA 624	Ethyl ether
GC/MS	EPA 624	Ethyl methacrylate
GC/MS	EPA 624	Hexachlorobutadiene
GC/MS	EPA 624	n-Hexane
GC/MS	EPA 624	2-Hexanone
GC/MS	EPA 624	Iodomethane
GC/MS	EPA 624	Isobutanol
GC/MS	EPA 624	Isopropylbenzene
GC/MS	EPA 624	p-Isopropyltoluene
GC/MS	EPA 624	Methacrylonitrile
GC/MS	EPA 624	Methyl acetate
GC/MS	EPA 624	Methylcyclohexane
GC/MS	EPA 624	Methylene chloride
GC/MS	EPA 624	Methyl methacrylate
GC/MS	EPA 624	4-Methyl-2-pentanone
GC/MS	EPA 624	MTBE
GC/MS	EPA 624	Naphthalene
GC/MS	EPA 624	2-Nitropropane
GC/MS	EPA 624	Nonanal
GC/MS	EPA 624	Pentachloroethane
GC/MS	EPA 624	Propionitrile

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624	n-Propylbenzene
GC/MS	EPA 624	Styrene
GC/MS	EPA 624	1,1,1,2-Tetrachloroethane
GC/MS	EPA 624	1,1,2,2-Tetrachloroethane
GC/MS	EPA 624	Tetrachloroethene
GC/MS	EPA 624	Tetrahydrofuran
GC/MS	EPA 624	Toluene
GC/MS	EPA 624	1,3,5-Trichlorobenzene
GC/MS	EPA 624	1,2,3-Trichlorobenzene
GC/MS	EPA 624	1,2,4-Trichlorobenzene
GC/MS	EPA 624	1,1,1-Trichloroethane
GC/MS	EPA 624	1,1,2-Trichloroethane
GC/MS	EPA 624	Trichloroethene
GC/MS	EPA 624	Trichlorofluoromethane
GC/MS	EPA 624	1,2,3-Trichloropropane
GC/MS	EPA 624	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 624	1,2,4-Trimethylbenzene
GC/MS	EPA 624	1,3,5-Trimethylbenzene
GC/MS	EPA 624	Vinyl acetate
GC/MS	EPA 624	Vinyl chloride
GC/MS	EPA 624	m-Xylene & p-Xylene
GC/MS	EPA 624	o-Xylene
GC/MS	EPA 624	Xylenes (total)
GC-FID	EPA 8015B	Gasoline Range Organics
ICP-MS	EPA 6020/6020A/6020B	Aluminum
ICP-MS	EPA 6020/6020A/6020B	Antimony
ICP-MS	EPA 6020/6020A/6020B	Arsenic
ICP-MS	EPA 6020/6020A/6020B	Barium
ICP-MS	EPA 6020/6020A/6020B	Beryllium
ICP-MS	EPA 6020/6020A/6020B	Bismuth
ICP-MS	EPA 6020/6020A/6020B	Boron
ICP-MS	EPA 6020/6020A/6020B	Cadmium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020/6020A/6020B	Calcium
ICP-MS	EPA 6020/6020A/6020B	Cerium
ICP-MS	EPA 6020/6020A/6020B	Cesium
ICP-MS	EPA 6020/6020A/6020B	Chromium
ICP-MS	EPA 6020/6020A/6020B	Cobalt
ICP-MS	EPA 6020/6020A/6020B	Copper
ICP-MS	EPA 6020/6020A/6020B	Gold
ICP-MS	EPA 6020/6020A/6020B	Hafnium
ICP-MS	EPA 6020/6020A/6020B	Iron
ICP-MS	EPA 6020/6020A/6020B	Lanthanum
ICP-MS	EPA 6020/6020A/6020B	Lead
ICP-MS	EPA 6020/6020A/6020B	Lithium
ICP-MS	EPA 6020/6020A/6020B	Magnesium
ICP-MS	EPA 6020/6020A/6020B	Manganese
ICP-MS	EPA 6020/6020A/6020B	Molybdenum
ICP-MS	EPA 6020/6020A/6020B	Neodymium
ICP-MS	EPA 6020/6020A/6020B	Nickel
ICP-MS	EPA 6020/6020A/6020B	Niobium
ICP-MS	EPA 6020/6020A/6020B	Palladium
ICP-MS	EPA 6020/6020A/6020B	Phosphorus
ICP-MS	EPA 6020/6020A/6020B	Platinum
ICP-MS	EPA 6020/6020A/6020B	Potassium
ICP-MS	EPA 6020/6020A/6020B	Praseodymium
ICP-MS	EPA 6020/6020A/6020B	Rhenium
ICP-MS	EPA 6020/6020A/6020B	Rhodium
ICP-MS	EPA 6020/6020A/6020B	Ruthenium
ICP-MS	EPA 6020/6020A/6020B	Samarium
ICP-MS	EPA 6020/6020A/6020B	Selenium
ICP-MS	EPA 6020/6020A/6020B	Silver
ICP-MS	EPA 6020/6020A/6020B	Sodium
ICP-MS	EPA 6020/6020A/6020B	Strontium
ICP-MS	EPA 6020/6020A/6020B	Tantalum
ICP-MS	EPA 6020/6020A/6020B	Tellurium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020/6020A/6020B	Thallium
ICP-MS	EPA 6020/6020A/6020B	Thorium
ICP-MS	EPA 6020/6020A/6020B	Tin
ICP-MS	EPA 6020/6020A/6020B	Titanium
ICP-MS	EPA 6020/6020A/6020B	Tungsten
ICP-MS	EPA 6020/6020A/6020B	Uranium
ICP-MS	EPA 6020/6020A/6020B	Uranium 233
ICP-MS	EPA 6020/6020A/6020B	Uranium 234
ICP-MS	EPA 6020/6020A/6020B	Uranium 235
ICP-MS	EPA 6020/6020A/6020B	Uranium 236
ICP-MS	EPA 6020/6020A/6020B	Uranium 238
ICP-MS	EPA 6020/6020A/6020B	Vanadium
ICP-MS	EPA 6020/6020A/6020B	Yttrium
ICP-MS	EPA 6020/6020A/6020B	Zinc
ICP-MS	EPA 6020/6020A/6020B	Zirconium
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Bismuth
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium
ICP-MS	EPA 200.8	Cerium
ICP-MS	EPA 200.8	Cesium
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Gold
ICP-MS	EPA 200.8	Hafnium
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lanthanum

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Lithium
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Neodymium
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Niobium
ICP-MS	EPA 200.8	Palladium
ICP-MS	EPA 200.8	Phosphorus
ICP-MS	EPA 200.8	Platinum
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Praseodymium
ICP-MS	EPA 200.8	Rhenium
ICP-MS	EPA 200.8	Rhodium
ICP-MS	EPA 200.8	Ruthenium
ICP-MS	EPA 200.8	Samarium
ICP-MS	EPA 200.8	Selenium
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Strontium
ICP-MS	EPA 200.8	Tantalum
ICP-MS	EPA 200.8	Tellurium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Thorium
ICP-MS	EPA 200.8	Tin
ICP-MS	EPA 200.8	Titanium
ICP-MS	EPA 200.8	Tungsten
ICP-MS	EPA 200.8	Uranium
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Yttrium
ICP-MS	EPA 200.8	Zinc
ICP-MS	EPA 200.8	Zirconium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-AES	EPA 200.7	Aluminum
ICP-AES	EPA 200.7	Antimony
ICP-AES	EPA 200.7	Arsenic
ICP-AES	EPA 200.7	Barium
ICP-AES	EPA 200.7	Beryllium
ICP-AES	EPA 200.7	Bismuth
ICP-AES	EPA 200.7	Boron
ICP-AES	EPA 200.7	Cadmium
ICP-AES	EPA 200.7	Calcium
ICP-AES	EPA 200.7	Chromium
ICP-AES	EPA 200.7	Cobalt
ICP-AES	EPA 200.7	Copper
ICP-AES	EPA 200.7	Iron
ICP-AES	EPA 200.7	Lead
ICP-AES	EPA 200.7	Lithium
ICP-AES	EPA 200.7	Magnesium
ICP-AES	EPA 200.7	Manganese
ICP-AES	EPA 200.7	Molybdenum
ICP-AES	EPA 200.7	Nickel
ICP-AES	EPA 200.7	Phosphorus
ICP-AES	EPA 200.7	Potassium
ICP-AES	EPA 200.7	Selenium
ICP-AES	EPA 200.7	Silicon
ICP-AES	EPA 200.7	Silver
ICP-AES	EPA 200.7	Sodium
ICP-AES	EPA 200.7	Strontium
ICP-AES	EPA 200.7	Sulfur
ICP-AES	EPA 200.7	Thallium
ICP-AES	EPA 200.7	Thorium
ICP-AES	EPA 200.7	Tin
ICP-AES	EPA 200.7	Titanium
ICP-AES	EPA 200.7	Vanadium
ICP-AES	EPA 200.7	Zinc

Non-Potable Water		
Technology	**Method**	**Analyte**
CVAA	EPA 245.1/ 7470A	Mercury
Colorimetric	EPA 9010C EPA 9012A/9012B	Cyanide
Ion Chromatrography	EPA 300.0/9056/9056A	Bromide
Ion Chromatrography	EPA 300.0/9056/9056A	Chloride
Ion Chromatrography	EPA 300.0/9056/9056A	Fluoride
Ion Chromatrography	EPA 300.0/9056/9056A	Nitrate
Ion Chromatrography	EPA 300.0/9056/9056A	Nitrite
Ion Chromatrography	EPA 300.0/9056/9056A	Sulfate
Ion Chromatrography	EPA 300.0/9056/9056A	Ortho-phosphate
Ion Chromatrography	EPA 300.0/9056/9056A	Iodide
Gravimetric	SM 2540B -2011 SM 2540C -2011 SM 2540D -2011	Solids
Probe	EPA 9040B/C EPA 150.1 SM 4500-H+ B -2011	pH
Titration	SM 2320B EPA 310.1	Alkalinity
Titration	EPA 9030B EPA 9034/9034A	Sulfide
Penske-Martin	EPA 1010/1010A	Ignitability
Colormetric	EPA 353.1	nitrate/Nitrite
Colormetric	EPA 350.1	Ammonia
Colorimetric	EPA 410.4	COD
Colorimetric	EPA 365.2	Total Phosphorus
TOC Analyzer	EPA 9060A	TOC
Colormetric	EPA 7196A	Hex Chromium
Gravimetric	EPA 1664A	Oil & Grease
Gravimetric	EPA 1664A	TPH
Probe	EPA 9050A	Conductivity
Gas Flow Proportional Counter	EPA 900.0 EPA 9310 SM 7110C	gross alpha/beta
Gas Flow Proportional Counter	ST-RC-0036 ST-RD-0403	Chlorine-36

Non-Potable Water		
Technology	**Method**	**Analyte**
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	Radium-226
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	total radium
Gas Flow Proportional Counter	EPA 904.0 EPA 9320	Radium-228
Gas Flow Proportional Counter	EPA 905.0 DOE HASL 300 Sr-02 DOE HASL 300 Sr-03	Strontium-90
Liquid Scintillation Counter	SM 7500-Rn B	Radon-222
Liquid Scintillation Counter	ST-RC-0079	Selenium-79
Liquid Scintillation Counter	EPA 906.0	Tritium
Liquid Scintillation Counter	Eichrom Technologies TCW01/TCS01	Tecnetium-99
Liquid Scintillation Counter	EERF C-01-C14	Carbon-14
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Gamma Emitters:
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 227 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Americium 241
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 124
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 125
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium-137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium/Lanthanum-140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 133
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Beryllium 7
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 211 eq Th-227

Non-Potable Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 207
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth-210M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Calcium-45
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 141
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 139
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 134
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 57
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 58
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 60
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 152
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 154
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 155
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Hafnium 181
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iodine 131
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iridium 192

Non-Potable Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iron 59
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lanthanum 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 210
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 211
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese-56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese 54
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Mercury 203
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 237
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 239
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 83
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 94
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 95
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Potassium 40
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 146
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 147
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 231

Non-Potable Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium (226)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 223 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 224
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Ruthenium 106
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Scandium 46
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 22
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 24
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Strontium 85
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thallium 208
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 230
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 232
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Tin 113
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 235
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 238

Non-Potable Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Vanadium-48
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Yttrium 88
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zinc 65
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zirconium 95
Alpha Spectroscopy	DOE HASL 300 A-01-R	Alpha spec analysis:
Alpha Spectroscopy	DOE HASL 300 A-01-R DOE HASL 300 U-02-RC	Isotopic Uranium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Thorium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Americium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Plutonium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Neptunium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Curium
Alpha Spectroscopy	ST-RC-0301	Radium-226
Liquid Scintillation Counter	Eichrom Technologies OTW01, OTS01	Lead-210
Alpha Spectroscopy	ST-RC-0210	Polonium-210
Liquid Scintillation Counter	Eichrom Technologies FEW01	Iron-55
Liquid Scintillation Counter	DOE RP-300	Nickel 59/63
Liquid Scintillation Counter	SM 7500-IB	Iodine-129
Extraction Chromatography	ST-RC-0058	Strontium-90
Preparation	**Method**	**Type**
Volatile Prep	EPA 5000	Sample Preparation for Volatile Organic Compounds
Organic prep/analysis	EPA 8000C	Determinative Chromatographic Separations
Acid Digestion (Aqueous samples)	EPA 3010A EPA 3005A	Acid Digestion for Metals (Aqueous samples)
Purge & Trap	EPA 5030C	Purge & Trap for Aqueous Volatile
TCLP Extraction	EPA 1311	TCLP Extraction
SPLP Extraction	EPA 1312	SPLP Extraction
CWET Extraction	CA Title 22	CWET Extraction

Drinking Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 200.8	Uranium
Alpha Spectroscopy	DOE HASL 300 U-02-RC	Isotopic Uranium
Gas Flow Proportional Counter	EPA 900.0 EPA 9310	Gross alpha/beta
Gas Flow Proportional Counter	SM 7110C	Gross alpha
Gas Flow Proportional Counter	ST-RC-0036 ST-RD-0403	Chlorine-36
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	Radium-226
Gas Flow Proportional Counter	EPA 904.0 EPA 9320	Radium-228
Gas Flow Proportional Counter	EPA 905.0 DOE HASL 300 Sr-02	Strontium-90
Liquid Scintillation Counter	SM 7500-Rn B	Radon-222
Liquid Scintillation Counter	ST-RC-0079	Selenium-79
Liquid Scintillation Counter	EPA 906.0	Tritium
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Gamma Emitters:
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 227 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Americium 241
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 124
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 125
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium-137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium/Lanthanum-140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 133

Drinking Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Beryllium 7
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 211 eq Th-227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 207
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth-210M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Calcium-45
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 141
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 139
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 134
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 57
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 58
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 60
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 152

Drinking Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 154
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 155
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Hafnium 181
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iodine 131
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iridium 192
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iron 59
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lanthanum 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 210
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 211
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese-56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese 54
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Mercury 203
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 237
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 239
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 83
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 94

Drinking Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 95
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Potassium 40
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 146
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 147
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium (226)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 223 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 224
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Ruthenium 106
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Scandium 46
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 22
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 24
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Strontium 85
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thallium 208

Drinking Water		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 230
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 232
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Tin 113
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 235
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 238
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Vanadium-48
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Yttrium 88
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zinc 65
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zirconium 95

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP-AES	EPA 6010B/6010C/6010D	Aluminum
ICP-AES	EPA 6010B/6010C/6010D	Antimony
ICP-AES	EPA 6010B/6010C/6010D	Arsenic
ICP-AES	EPA 6010B/6010C/6010D	Barium

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP-AES	EPA 6010B/6010C/6010D	Beryllium
ICP-AES	EPA 6010B/6010C/6010D	Bismuth
ICP-AES	EPA 6010B/6010C/6010D	Boron
ICP-AES	EPA 6010B/6010C/6010D	Cadmium
ICP-AES	EPA 6010B/6010C/6010D	Calcium
ICP-AES	EPA 6010B/6010C/6010D	Chromium
ICP-AES	EPA 6010B/6010C/6010D	Cobalt
ICP-AES	EPA 6010B/6010C/6010D	Copper
ICP-AES	EPA 6010B/6010C/6010D	Iron
ICP-AES	EPA 6010B/6010C/6010D	Lead
ICP-AES	EPA 6010B/6010C/6010D	Lithium
ICP-AES	EPA 6010B/6010C/6010D	Magnesium
ICP-AES	EPA 6010B/6010C/6010D	Manganese
ICP-AES	EPA 6010B/6010C/6010D	Molybdenum
ICP-AES	EPA 6010B/6010C/6010D	Nickel
ICP-AES	EPA 6010B/6010C/6010D	Phosphorus
ICP-AES	EPA 6010B/6010C/6010D	Potassium
ICP-AES	EPA 6010B/6010C/6010D	Selenium
ICP-AES	EPA 6010B/6010C/6010D	Silicon
ICP-AES	EPA 6010B/6010C/6010D	Silver
ICP-AES	EPA 6010B/6010C/6010D	Sodium
ICP-AES	EPA 6010B/6010C/6010D	Strontium
ICP-AES	EPA 6010B/6010C/6010D	Sulfur
ICP-AES	EPA 6010B/6010C/6010D	Thallium
ICP-AES	EPA 6010B/6010C/6010D	Thorium
ICP-AES	EPA 6010B/6010C/6010D	Tin
ICP-AES	EPA 6010B/6010C/6010D	Titanium
ICP-AES	EPA 6010B/6010C/6010D	Vanadium
ICP-AES	EPA 6010B/6010C/6010D	Zinc
GC/MS	EPA 8260B/8260C	Acetone
GC/MS	EPA 8260B/8260C	Acetonitrile
GC/MS	EPA 8260B/8260C	Acrolein
GC/MS	EPA 8260B/8260C	Acrylonitrile

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/8260C	Benzene
GC/MS	EPA 8260B/8260C	Benzyl chloride
GC/MS	EPA 8260B/8260C	Bromobenzene
GC/MS	EPA 8260B/8260C	Bromochloromethane
GC/MS	EPA 8260B/8260C	Bromodichloromethane
GC/MS	EPA 8260B/8260C	Bromoform
GC/MS	EPA 8260B/8260C	Bromomethane
GC/MS	EPA 8260B/8260C	n-Butanol
GC/MS	EPA 8260B/8260C	2-Butanone
GC/MS	EPA 8260B/8260C	n-Butylbenzene
GC/MS	EPA 8260B/8260C	sec-Butylbenzene
GC/MS	EPA 8260B/8260C	tert-Butylbenzene
GC/MS	EPA 8260B/8260C	Carbon disulfide
GC/MS	EPA 8260B/8260C	Carbon tetrachloride
GC/MS	EPA 8260B/8260C	Chlorobenzene
GC/MS	EPA 8260B/8260C	2-Chloro-1,3-butadiene
GC/MS	EPA 8260B/8260C	Chlorodibromomethane
GC/MS	EPA 8260B/8260C	Chloroethane
GC/MS	EPA 8260B/8260C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/8260C	Chloroform
GC/MS	EPA 8260B/8260C	Chloromethane
GC/MS	EPA 8260B/8260C	Allyl chloride
GC/MS	EPA 8260B/8260C	2-Chlorotoluene
GC/MS	EPA 8260B/8260C	4-Chlorotoluene
GC/MS	EPA 8260B/8260C	Cyclohexane
GC/MS	EPA 8260B/8260C	Cyclohexanone
GC/MS	EPA 8260B/8260C	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/8260C	1,2-Dibromoethane
GC/MS	EPA 8260B/8260C	Dibromomethane
GC/MS	EPA 8260B/8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260B/8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260B/8260C	trans-1,4-Dichloro-2-butene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/8260C	Dichlorodifluoromethane
GC/MS	EPA 8260B/8260C	1,1-Dichloroethane
GC/MS	EPA 8260B/8260C	1,2-Dichloroethane
GC/MS	EPA 8260B/8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/8260C	1,1-Dichloroethene
GC/MS	EPA 8260B/8260C	1,2-Dichloroethene (total)
GC/MS	EPA 8260B/8260C	1,2-Dichloropropane
GC/MS	EPA 8260B/8260C	1,3-Dichloropropane
GC/MS	EPA 8260B/8260C	2,2-Dichloropropane
GC/MS	EPA 8260B/8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260B/8260C	1,1-Dichloropropene
GC/MS	EPA 8260B/8260C	1,2-Dichloro-1,1,2,2-tetrafluoroethane
GC/MS	EPA 8260B/8260C	Dimethyl disulfide
GC/MS	EPA 8260B/8260C	1,4-Dioxane
GC/MS	EPA 8260B/8260C	Ethyl acetate
GC/MS	EPA 8260B/8260C	Ethylbenzene
GC/MS	EPA 8260B/8260C	Ethyl ether
GC/MS	EPA 8260B/8260C	Ethyl methacrylate
GC/MS	EPA 8260B/8260C	Hexachlorobutadiene
GC/MS	EPA 8260B/8260C	n-Hexane
GC/MS	EPA 8260B/8260C	2-Hexanone
GC/MS	EPA 8260B/8260C	Iodomethane
GC/MS	EPA 8260B/8260C	Isobutanol
GC/MS	EPA 8260B/8260C	Isopropylbenzene
GC/MS	EPA 8260B/8260C	p-Isopropyltoluene
GC/MS	EPA 8260B/8260C	Methacrylonitrile
GC/MS	EPA 8260B/8260C	Methyl acetate
GC/MS	EPA 8260B/8260C	Methylcyclohexane
GC/MS	EPA 8260B/8260C	Methylene chloride
GC/MS	EPA 8260B/8260C	Methyl methacrylate
GC/MS	EPA 8260B/8260C	4-Methyl-2-pentanone

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/8260C	MTBE
GC/MS	EPA 8260B/8260C	Naphthalene
GC/MS	EPA 8260B/8260C	2-Nitropropane
GC/MS	EPA 8260B/8260C	Nonanal
GC/MS	EPA 8260B/8260C	Pentachloroethane
GC/MS	EPA 8260B/8260C	Propionitrile
GC/MS	EPA 8260B/8260C	n-Propylbenzene
GC/MS	EPA 8260B/8260C	Styrene
GC/MS	EPA 8260B/8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/8260C	Tetrachloroethene
GC/MS	EPA 8260B/8260C	Tetrahydrofuran
GC/MS	EPA 8260B/8260C	Toluene
GC/MS	EPA 8260B/8260C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260B/8260C	Trichloroethene
GC/MS	EPA 8260B/8260C	Trichlorofluoromethane
GC/MS	EPA 8260B/8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260B/8260C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260B/8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/8260C	Vinyl acetate
GC/MS	EPA 8260B/8260C	Vinyl chloride
GC/MS	EPA 8260B/8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260B/8260C	o-Xylene
GC/MS	EPA 8260B/8260C	Xylenes (total)
GC-FID	EPA 8015B	Gasoline Range Organics
ICP-MS	EPA 6020/6020A/6020B	Aluminum
ICP-MS	EPA 6020/6020A/6020B	Antimony
ICP-MS	EPA 6020/6020A/6020B	Arsenic

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020/6020A/6020B	Barium
ICP-MS	EPA 6020/6020A/6020B	Beryllium
ICP-MS	EPA 6020/6020A/6020B	Bismuth
ICP-MS	EPA 6020/6020A/6020B	Boron
ICP-MS	EPA 6020/6020A/6020B	Cadmium
ICP-MS	EPA 6020/6020A/6020B	Calcium
ICP-MS	EPA 6020/6020A/6020B	Cerium
ICP-MS	EPA 6020/6020A/6020B	Cesium
ICP-MS	EPA 6020/6020A/6020B	Chromium
ICP-MS	EPA 6020/6020A/6020B	Cobalt
ICP-MS	EPA 6020/6020A/6020B	Copper
ICP-MS	EPA 6020/6020A/6020B	Gold
ICP-MS	EPA 6020/6020A/6020B	Hafnium
ICP-MS	EPA 6020/6020A/6020B	Iron
ICP-MS	EPA 6020/6020A/6020B	Lanthanum
ICP-MS	EPA 6020/6020A/6020B	Lead
ICP-MS	EPA 6020/6020A/6020B	Lithium
ICP-MS	EPA 6020/6020A/6020B	Magnesium
ICP-MS	EPA 6020/6020A/6020B	Manganese
ICP-MS	EPA 6020/6020A/6020B	Molybdenum
ICP-MS	EPA 6020/6020A/6020B	Neodymium
ICP-MS	EPA 6020/6020A/6020B	Nickel
ICP-MS	EPA 6020/6020A/6020B	Niobium
ICP-MS	EPA 6020/6020A/6020B	Palladium
ICP-MS	EPA 6020/6020A/6020B	Phosphorus
ICP-MS	EPA 6020/6020A/6020B	Platinum
ICP-MS	EPA 6020/6020A/6020B	Potassium
ICP-MS	EPA 6020/6020A/6020B	Praseodymium
ICP-MS	EPA 6020/6020A/6020B	Rhenium
ICP-MS	EPA 6020/6020A/6020B	Rhodium
ICP-MS	EPA 6020/6020A/6020B	Ruthenium
ICP-MS	EPA 6020/6020A/6020B	Samarium
ICP-MS	EPA 6020/6020A/6020B	Selenium

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020/6020A/6020B	Silver
ICP-MS	EPA 6020/6020A/6020B	Sodium
ICP-MS	EPA 6020/6020A/6020B	Strontium
ICP-MS	EPA 6020/6020A/6020B	Tantalum
ICP-MS	EPA 6020/6020A/6020B	Tellurium
ICP-MS	EPA 6020/6020A/6020B	Thallium
ICP-MS	EPA 6020/6020A/6020B	Thorium
ICP-MS	EPA 6020/6020A/6020B	Tin
ICP-MS	EPA 6020/6020A/6020B	Titanium
ICP-MS	EPA 6020/6020A/6020B	Tungsten
ICP-MS	EPA 6020/6020A/6020B	Uranium
ICP-MS	EPA 6020/6020A/6020B	Uranium 233
ICP-MS	EPA 6020/6020A/6020B	Uranium 234
ICP-MS	EPA 6020/6020A/6020B	Uranium 235
ICP-MS	EPA 6020/6020A/6020B	Uranium 236
ICP-MS	EPA 6020/6020A/6020B	Uranium 238
ICP-MS	EPA 6020/6020A/6020B	Vanadium
ICP-MS	EPA 6020/6020A/6020B	Yttrium
ICP-MS	EPA 6020/6020A/6020B	Zinc
ICP-MS	EPA 6020/6020A/6020B	Zirconium
CVAA	EPA 7471A/7471B	Mercury
Colormetric	EPA 9010C EPA 9012A/9012B	Cyanide
Ion Chromatrography	EPA 300.0/9056/9056A	Bromide
Ion Chromatrography	EPA 300.0/9056/9056A	Chloride
Ion Chromatrography	EPA 300.0/9056/9056A	Fluoride
Ion Chromatrography	EPA 300.0/9056/9056A	Nitrate
Ion Chromatrography	EPA 300.0/9056/9056A	Nitrite
Ion Chromatrography	EPA 300.0/9056/9056A	Sulfate
Ion Chromatrography	EPA 300.0/9056/9056A	Ortho-phosph
Ion Chromatrography	EPA 300.0/9056/9056A	Iodide
Probe	EPA 9045C/D	pH
Titration	SM 2320B EPA 310.1	Alkalinity

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Titration	EPA 9030B EPA 9034/9034A	Sulfide
Penske-Martin	EPA 1010/1010A	Ignitability
Colormetric	EPA 353.1	Nitrate/Nitrite
Colormetric	EPA 350.1	Ammonia
TOC Analyzer	EPA 9060A	TOC
Colormetric	EPA 7196A	Hex Chromium
Gravimetric	EPA 1664A	Oil & Grease
Gravimetric	EPA 1664A	TPH
Probe	EPA 9050A	Conductivity
Gas Flow Proportional Counter	EPA 900.0 EPA 9310	gross alpha/beta
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	Radium-226
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	total radium
Gas Flow Proportional Counter	EPA 904.0 EPA 9320	Radium-228
Gas Flow Proportional Counter	EPA 905.0 DOE HASL 300 Sr-02 DOE HASL 300 Sr-03	Strontium-90
Liquid Scintillation Counter	ST-RC-0079	Selenium-79
Liquid Scintillation Counter	EPA 906.0	Tritium
Liquid Scintillation Counter	EERF C-01-C14	Carbon-14
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Gamma Emitters:
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 227 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Americium 241
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 124
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 125
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium-137

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium/Lanthanum-140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 133
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Beryllium 7
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 211 eq Th-227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 207
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth-210M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Calcium-45
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 141
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 139
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 134
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 57
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 58
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 60
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 152
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 154

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 155
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Hafnium 181
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iodine 131
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iridium 192
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iron 59
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lanthanum 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 210
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 211
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese-56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese 54
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Mercury 203
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 237
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 239
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 83
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 94
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 95
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Potassium 40
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 146

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 147
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium (226)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 223 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 224
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Ruthenium 106
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Scandium 46
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 22
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 24
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Strontium 85
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thallium 208
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 230
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 232
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Tin 113

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 235
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 238
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Vanadium-48
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Yttrium 88
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zinc 65
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zirconium 95
Alpha Spectroscopy	DOE HASL 300 A-01-R	Alpha spec analysis:
Alpha Spectroscopy	DOE HASL 300 A-01-R DOE HASL 300 U-02-RC	Isotopic Uranium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Thorium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Americium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Plutonium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Neptunium
Alpha Spectroscopy	DOE HASL 300 A-01-R	Isotopic Curium
Alpha Spectroscopy	ST-RC-0301	Radium-226
Liquid Scintillation Counter	Eichrom Technologies OTW01, OTS01	Lead-210
Alpha Spectroscopy	Laboratory SOP ST-RC-0210	Polonium-210
Liquid Scintillation Counter	Eichrom Technologies FEW01	Iron-55
Liquid Scintillation Counter	DOE RP-300	Nickel 59/63
Liquid Scintillation Counter	SM 7500-IB	Iodine-129
Preparation	**Method**	**Type**
Volatile Prep	EPA 5000	Sample Preparation for Volatile Organic Compounds
Organic prep/analysis	EPA 8000C	Determinative Chromatographic Separations
Acid Digestion (Aqueous samples)	EPA 3010A	Acid Digestion for Metals (Aqueous samples)
Acid Digestion (solids)	EPA 3050B	Acid Digestion for Metals of Sedimtent/Soils
Purge & Trap	EPA 5030C	Purge & Trap for Aqueous Volatile Samples
Closed System Purge & Trap and Extraction for Volatiles	EPA 5035A	Closed System Purge & Trap and Extraction for Volatiles

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
TCLP Extraction	EPA 1311	TCLP Extraction
SPLP Extraction	EPA 1312	SPLP Extraction
CWET Extraction	CA Title 22	CWET Extraction
Alkaline Digestion	EPA 3060A	Alkaline Digestion for Hexavalent Chromium
Extraction Chromatography	Eichrom Technologies FEW01	Iron-55
Extraction Chromatography	ST-RC-0058	Strontium-90

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2305

Vice President

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

CERTIFICATE OF ENVIRONMENTAL ACCREDITATION

Is hereby granted to

TestAmerica St. Louis

13715 Rider Trail North

Earth City, MO 63045

Scope of the certificate is limited to the
"Fields of Testing"
which accompany this Certificate.

Continued accredited status depends on successful completion of on-site inspection, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **2886**

Expiration Date: **6/30/2019**

Effective Date: **7/1/2018**

Sacramento, California
subject to forfeiture or revocation

Christine Sotelo, Chief
Environmental Laboratory Accreditation Program

CALIFORNIA STATE
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
Accredited Fields of Testing

TestAmerica St. Louis

13715 Rider Trail North
Earth City, MO 63045
Phone: (314) 298-8566

Certificate No. 2886
Expiration Date 6/30/2019

Field of Testing: 106 - Radiochemistry of Drinking Water

106.010	001	Gross Alpha	EPA 900.0
106.010	002	Gross Beta	EPA 900.0
106.030	001	Radioactive Cesium	EPA 901.1
106.030	003	Gamma Emitters	EPA 901.1
106.050	001	Total Alpha Radium	EPA 903.0
106.050	002	Radium-226 (estimate)	EPA 903.0
106.060	001	Radium-228	EPA 904.0
106.070	003	Strontium-90	EPA 905.0
106.080	001	Tritium	EPA 906.0
106.220	001	Strontium-89, 90	DOE Sr-01
106.230	001	Isotopic Uranium	DOE U-02
106.270	001	Gross Alpha by Coprecipitation	SM7110 C

Field of Testing: 108 - Inorganic Chemistry of Wastewater

108.020	001	Conductivity	EPA 120.1
108.112	001	Boron	EPA 200.7
108.112	002	Calcium	EPA 200.7
108.112	004	Magnesium	EPA 200.7
108.112	005	Potassium	EPA 200.7
108.112	007	Sodium	EPA 200.7
108.113	001	Boron	EPA 200.8
108.113	002	Calcium	EPA 200.8
108.113	003	Magnesium	EPA 200.8
108.113	004	Potassium	EPA 200.8
108.113	006	Sodium	EPA 200.8
108.120	001	Bromide	EPA 300.0
108.120	002	Chloride	EPA 300.0
108.120	003	Fluoride	EPA 300.0
108.120	008	Sulfate	EPA 300.0
108.120	012	Nitrate (as N)	EPA 300.0
108.120	014	Nitrite (as N)	EPA 300.0
108.120	015	Phosphate, Ortho (as P)	EPA 300.0
108.183	001	Cyanide, Total	EPA 335.4
108.209	001	Ammonia (as N)	EPA 350.1
108.211	002	Kjeldahl Nitrogen, Total (as N)	EPA 351.2
108.323	001	Chemical Oxygen Demand	EPA 410.4
108.381	001	Oil and Grease	EPA 1664A
108.440	001	Residue, Total	SM2540B-1997
108.441	001	Residue, Filterable TDS	SM2540C-1997

As of 6/28/2018 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

108.442	001	Residue, Non-filterable TSS	SM2540D-1997
108.490	001	Hydrogen Ion (pH)	SM4500-H+ B-2000

Field of Testing: 109 - Toxic Chemical Elements of Wastewater

109.010	001	Aluminum	EPA 200.7
109.010	002	Antimony	EPA 200.7
109.010	003	Arsenic	EPA 200.7
109.010	004	Barium	EPA 200.7
109.010	005	Beryllium	EPA 200.7
109.010	006	Boron	EPA 200.7
109.010	007	Cadmium	EPA 200.7
109.010	009	Chromium	EPA 200.7
109.010	010	Cobalt	EPA 200.7
109.010	011	Copper	EPA 200.7
109.010	012	Iron	EPA 200.7
109.010	013	Lead	EPA 200.7
109.010	015	Manganese	EPA 200.7
109.010	016	Molybdenum	EPA 200.7
109.010	017	Nickel	EPA 200.7
109.010	019	Selenium	EPA 200.7
109.010	021	Silver	EPA 200.7
109.010	023	Thallium	EPA 200.7
109.010	024	Tin	EPA 200.7
109.010	025	Titanium	EPA 200.7
109.010	026	Vanadium	EPA 200.7
109.010	027	Zinc	EPA 200.7
109.020	001	Aluminum	EPA 200.8
109.020	002	Antimony	EPA 200.8
109.020	003	Arsenic	EPA 200.8
109.020	004	Barium	EPA 200.8
109.020	005	Beryllium	EPA 200.8
109.020	006	Cadmium	EPA 200.8
109.020	007	Chromium	EPA 200.8
109.020	008	Cobalt	EPA 200.8
109.020	009	Copper	EPA 200.8
109.020	010	Lead	EPA 200.8
109.020	011	Manganese	EPA 200.8
109.020	012	Molybdenum	EPA 200.8
109.020	013	Nickel	EPA 200.8
109.020	014	Selenium	EPA 200.8
109.020	015	Silver	EPA 200.8
109.020	016	Thallium	EPA 200.8
109.020	017	Vanadium	EPA 200.8
109.020	018	Zinc	EPA 200.8
109.020	021	Iron	EPA 200.8
109.020	022	Tin	EPA 200.8
109.020	023	Titanium	EPA 200.8
109.190	001	Mercury	EPA 245.1

Field of Testing: 110 - Volatile Organic Chemistry of Wastewater

110.040	000	Purgeable Organic Compounds	EPA 624

Field of Testing: 111 - Semi-volatile Organic Chemistry of Wastewater

111.100	000	Base/Neutral & Acid Organics	EPA 625
111.170	000	Organochlorine Pesticides and PCBs	EPA 608

Field of Testing: 112 - Radiochemistry of Wastewater

112.010	001	Gross Alpha	EPA 900.0
112.010	002	Gross Beta	EPA 900.0
112.020	001	Total Alpha Radium	EPA 903.0
112.140	001	Cesium	EPA 901.1
112.140	002	Gamma	EPA 901.1
112.160	001	Radium-228	EPA 904.0
112.170	001	Strontium	EPA 905.0
112.180	001	Tritium	EPA 906.0
112.510	001	Strontium	DOE Sr-02
112.520	001	Isotopic Uranium	DOE U-02

Field of Testing: 114 - Inorganic Chemistry of Hazardous Waste

114.010	001	Antimony	EPA 6010B
114.010	002	Arsenic	EPA 6010B
114.010	003	Barium	EPA 6010B
114.010	004	Beryllium	EPA 6010B
114.010	005	Cadmium	EPA 6010B
114.010	006	Chromium	EPA 6010B
114.010	007	Cobalt	EPA 6010B
114.010	008	Copper	EPA 6010B
114.010	009	Lead	EPA 6010B
114.010	010	Molybdenum	EPA 6010B
114.010	011	Nickel	EPA 6010B
114.010	012	Selenium	EPA 6010B
114.010	013	Silver	EPA 6010B
114.010	014	Thallium	EPA 6010B
114.010	015	Vanadium	EPA 6010B
114.010	016	Zinc	EPA 6010B
114.020	001	Antimony	EPA 6020
114.020	002	Arsenic	EPA 6020
114.020	003	Barium	EPA 6020
114.020	004	Beryllium	EPA 6020
114.020	005	Cadmium	EPA 6020
114.020	006	Chromium	EPA 6020
114.020	007	Cobalt	EPA 6020
114.020	008	Copper	EPA 6020
114.020	009	Lead	EPA 6020
114.020	010	Molybdenum	EPA 6020
114.020	011	Nickel	EPA 6020
114.020	012	Selenium	EPA 6020
114.020	013	Silver	EPA 6020

114.020	014	Thallium	EPA 6020	
114.020	015	Vanadium	EPA 6020	
114.020	016	Zinc	EPA 6020	
114.103	001	Chromium (VI)	EPA 7196A	
114.140	001	Mercury	EPA 7470A	Aqueous Only
114.141	001	Mercury	EPA 7471A	
114.221	001	Cyanide, Total	EPA 9012A	
114.240	001	Corrosivity - pH Determination	EPA 9040B	
114.241	001	Corrosivity - pH Determination	EPA 9045C	
114.250	001	Fluoride	EPA 9056	

Field of Testing: 115 - Extraction Test of Hazardous Waste

115.020	001	Toxicity Characteristic Leaching Procedure (TC	EPA 1311 (TCLP)	
115.021	001	TCLP Inorganics	EPA 1311 (TCLP)	
115.022	001	TCLP Extractables	EPA 1311 (TCLP)	
115.023	001	TCLP Volatiles	EPA 1311 (TCLP)	
115.030	001	Waste Extraction Test (WET)	CCR Chapter11, Article 5, Appendix II	
115.040	001	Synthetic Precipitation Leaching Procedure (S	EPA 1312 (SPLP)	

Field of Testing: 116 - Volatile Organic Chemistry of Hazardous Waste

116.030	001	Gasoline-range Organics	EPA 8015B	
116.080	000	Volatile Organic Compounds	EPA 8260B	

Field of Testing: 117 - Semi-volatile Organic Chemistry of Hazardous Waste

117.010	001	Diesel-range Total Petroleum Hydrocarbons	EPA 8015B	
117.110	000	Extractable Organics	EPA 8270C	
117.171	000	Nitroaromatics and Nitramines	EPA 8330A	
117.210	000	Organochlorine Pesticides	EPA 8081A	
117.220	000	PCBs	EPA 8082	

Field of Testing: 118 - Radiochemistry of Hazardous Waste

118.010	001	Gross Alpha	EPA 9310	
118.010	002	Gross Beta	EPA 9310	
118.020	001	Radium, Total	EPA 9315	
118.030	001	Radium-228	EPA 9320	
118.271	001	Strontium	DOE Sr-02	

Field of Testing: 120 - Physical Properties of Hazardous Waste

120.010	001	Ignitability	EPA 1010	
120.040	001	Reactive Cyanide	Section 7.3 SW-846	
120.050	001	Reactive Sulfide	Section 7.3 SW-846	
120.070	001	Corrosivity - pH Determination	EPA 9040B	
120.080	001	Corrosivity - pH Determination	EPA 9045C	

Title: PREPARATION OF SAMPLES FOR GAMMA SPECTROSCOPY [EPA 901.1 and DOE GA-01-R]

Approvals (Signature/Date):

Andrew Buettner 12-14-2017 Andrew Buettner — Date Operations Manager	Mike Ridenhower 12/14/17 Mike Ridenhower — Date Health & Safety Manager / Coordinator
Kristen Ely 12/14/17 Kristen Ely — Date Quality Assurance Manager	Elaine Wild 12/14/17 Elaine Wild — Date Laboratory Director

This SOP was previously identified as SOP No. ST-RC-0025 Rev. 16

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1.0 SCOPE AND APPLICATION

1.1 The purpose of this SOP is to provide detailed instructions for the preparation of samples which require gamma spectroscopy analysis.

1.2 This SOP describes methods for the preparation of samples of liquid, soil, vegetation, air filter, and core matrices prior to gamma spectroscopy analysis.

1.3 This SOP is based on EPA Method 901.1 and DOE Method GA-01-R.

1.4 The laboratory target analytes supported by this method, the reporting limits, and QC limits are maintained in the Laboratory Information Management System (LIMS).

2.0 SUMMARY OF METHOD

2.1 Samples are transferred to a standard geometry container for counting on the gamma detectors. High purity germanium (HPGe) gamma detectors are used to detect isotopes with gamma ray energies between 40 and 2000 KeV. Activity concentration is determined using commercially available gamma spectral analysis software. A sample matrix which can be mounted in one of the standard geometries may be analyzed for any of the isotopes included in the radionuclide reference library. Detection limits may be affected by the sample size. Gamma photon energies not identified in the reference library may be identified and evaluated manually.

3.0 DEFINITIONS

3.1 See the TestAmerica St. Louis Quality Assurance Manual (ST-QAM) for a glossary of common laboratory terms and data reporting qualifiers.

3.2 Replicate Analyses – Two or more analysis of the same sample whose independent measurements are used to determine the precision of equipments analytical procedure.

4.0 INTERFERENCES

4.1 Gamma energy emissions identified with scientifically measured probability by some radionuclides are documented by multiple sources. There are some discrepancies between reference sources and attempts are made to evaluate the reference data used in spectral analysis. Gamma emissions at discreet energy and probability are used to identify and quantify specific radionuclides in the sample. Gamma emissions which are completely absorbed by an HPGe detector form photo peaks which are used for identification and quantification of gamma emitting radionuclides. When two or more nuclides emit similar gamma energy the photo peaks cannot be resolved without using complex algorithms. These photo peaks in close proximity can interfere with the identification or quantification of a radionuclide. Knowing this the nuclide reference library, computer software and analyst training are used to minimize the possibility of interference and misidentification. It is not possible to eliminate all interferences and misidentification.

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to

follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

5.2.1 **Wear Kevlar or MAPA Blue-Grip gloves when using knives or sharp articles.**

5.3 PRIMARY MATERIALS USED

5.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. ***NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.*** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Nitric Acid	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Nitric acid can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1- Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			
TWA – Time Weighted Average			
STEL – Short Term Exposure Limit			

6.0 EQUIPMENT AND SUPPLIES

6.1 Balance, top loader

6.2 Blender

6.3 Food chopper/grinder

6.4 Knives appropriate for food preparation

6.5 Graduated cylinder

6.6 Filter disk, 47 millimeter diameter

6.7 Plastic Tape

6.8 Marinelli beakers of various sizes (500 mL and 1000 mL)

6.9 Petri dishes, 2-inch diameter

6.10 Can Sealer

6.11 Cans and lids (commonly referred to as tuna cans)

6.12 8 oz, straight sided polypropylene jars or equivalent; (used for 25 mL and 100 mL geometries)

6.13 Teflon® or glass beakers (250 mL, 400 mL)

6.14 Disposable digestion vessels

6.15 Muffle furnace (programmable)

6.16 TEXPEN®

6.17 Teflon® beaker covers

6.18 Watch glasses

7.0 STANDARDS AND REAGENTS

7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP ST-QA-0002.

7.2 DI Water

7.3 Nitric acid (16 N HNO_3) concentrated

7.3.1 Nitric acid (4 N HNO_3) – to an appropriately sized bottle containing 1500 mL of DI water; add 500 mL of 16 N HNO_3.

7.4 Hydrochloric acid (12 N HCL) – concentrated, 37.2%

7.5 Hydrofluoric acid (HF 48.52%) – concentrated

7.6 Radiacwash™ solution 10% - add 100 mL of Radiac to 1 L of water

7.7 Bleach solution 10% - add 100 mL of bleach to 1 L of water

7.8 Sodium Sulfate

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in ST-PM-0002.

8.2 Samples may be collected in glass or plastic containers.

8.3 Aqueous samples are preserved with nitric acid to a pH of less than 2, unless I-129 or I-131 is requested. Samples collected for I-129 or I-131 analysis are ***not preserved***.

8.3.1 The pH of aqueous samples is checked upon receipt by Sample Control, therefore, the pH does not require checking prior to analysis

8.3.1.1 Aqueous samples acidified upon receipt (designated by a label on the bottle) do require checking the pH prior to analysis.

8.4 Milk samples are not chemically preserved.

9.0 QUALITY CONTROL

9.1 **Batch**

9.1.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents. Where no preparation method exists (i.e. water sample volatile organics, water sample anion analysis) the batch is comprised of a maximum of 20 environmental samples which are analyzed together with the same process, lots of reagents and personnel.

9.1.2 Instrument conditions must be the same for all standards, samples and QC samples.

9.1.3 For this analysis, batch QC consists of a Method Blank (MB), a Laboratory Control Sample (LCS), and Sample Replicate.

9.1.3.1 A Sample Duplicate may be performed at the request of the client. See client requirements.

9.2 **Method Blank**

9.2.1 For **Water** and **Liquid** analyses, the method blank is comprised of DI water.

9.2.2 For **Soil** and **Solids** analyses, the method blank is comprised of sodium sulfate.

9.2.3 For Filter analyses, the method blank is comprised of a Petri dish.

9.2.4 A Method Blank must be prepared with every sample batch.

9.3 **Laboratory Control Sample**

9.3.1 An LCS is a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.3.2 The LCS is a purchased sealed source standard in the prescribed geometry for the sample analysis.

9.3.3 An LCS must be prepared with every sample batch.

9.4 **Sample Duplicate**

9.4.1 A sample duplicate is an additional aliquot of a field sample taken through the entire analytical process to demonstrate precision (a replicate analysis of the original sample counted on a different detector will be performed as the duplicate).

9.5 **Procedural Variations/ Nonconformance and Corrective Action**

9.5.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.

9.5.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.

9.6 **Decontamination of Tuna Can Sealer**

9.6.1 The sealer must be wiped down with 10% Radiacwash™ solution daily

9.6.1.1 Analyst must record the information in the daily logbook..

9.6.2 Sealer will be monitored for contamination as part of the monthly contamination survey, as per SOP ST-RP-0032

10.0 CALIBRATION AND STANDARDIZATION

10.1 The balance must be calibrated in accordance with ST-QA-0005.

10.2 For Gamma Spectroscopy calibration requirements, see ST-RD-0102.

11.0 PROCEDURE

11.1 Liquid Sample Preparation

11.1.1 Liquid samples shall be prepared as a 25 mL, 100 mL, 500 mL, or 1000 mL geometry.

11.1.2 Determine the proper geometry.

11.1.2.1 The volume of sample used depends on the amount required to meet the detection limits, the volume of sample supplied by the client, and whether the sample has very high activity. The sample volume may be reduced for high activity samples due to detector dead time considerations. Consult the count room supervisor or radiochemistry technical director, if the sample has high activity which may require such consideration.

11.1.3 Label the top of the container with the sample Id

11.1.4 Shake the sample to suspend any residue and to ensure that the sample is homogeneous.

11.1.5 Write sample information (i.e. ID #) on the container.

11.1.6 Measure the required sample volume (25, 100, 500 or 1000 mL) by comparing the sample to the reference container

11.1.6.1 Reference containers are pre-made geometries comprised of DI water measured volumetrically.

11.1.6.2 Ra-226 is best reported inferred from the Bi-214 daughter after a 21-day ingrowth to allow the Ra-226 progeny through the potentially volatile Rn-222 daughter to reach secular equilibrium. To ensure Rn-222 is not lost from the container or does not escape into the headspace of the container, a radium-specific geometry should be utilized (e.g. 0.5L or 1L Marinelli beaker) which contains minimal headspace and can be sealed to prevent loss of radon. If Ra-226 is reported inferred from Bi-214 without sufficient ingrowth or from a geometry which is not intended for this purpose (due possibly to insufficient sample available), a NCM should be written to be included in the case narrative of the report.

11.1.6.3 If the client does not provide sufficient sample, and the sample is near a larger geometry, rather than reducing the volume significantly it may be preferable to dilute an aqueous sample with DI water to the correct volume in order to achieve a lower MDC. Consultant Supervisor/Manager to determine which action is preferable.

11.1.6.3.1 If the sample is diluted the undiluted volume is recorded as the sample volume. The dilution is only for fitting the calibrated geometry.

11.1.7 Place the lid securely on the container.

11.1.7.1 Remove excess air from Marinelli.

11.1.7.2 If the density is suspected to be greater than 1.2 g/ mL or less than 0.98 g/mL, generate a NCM. To determine the density use form RAD-0075_Density.xls (include form with batch paper work if utilized) Attachment 1

11.1.8 Seal the lid using plastic electrical tape. Marinelli beakers are prone to leaking liquids; the tape is tightly wrapped around the lid and the beaker in three layers each overlapping the previous layer with half the width of the tape. Make sure there are no creases in the tape which will form a channel for leakage.

11.1.9 Inspect for leakage.

11.1.10 Generate a label and print proper paperwork then submit to count room for analysis by gamma spec.

11.2 Soil Sample Preparation

11.2.1 Soil samples for I-129 or I-131 analysis **are not dried and ground** but rather inserted into an appropriate calibrated geometry. Proceed to step 11.2.3.

11.2.2 Soil samples, which do not require I-129 or I-131 analyses, are prepared in accordance with SOP ST-RC-0003 or ST-RC-0014.

11.2.3 Soil samples shall be prepared as 230 mL sealed (tuna) can, 100 mL, or 25 mL, or 500 mL Marinelli (marnsoil) geometry based on the amount of available sample. In both the tuna can and marnsoil geometries, the soil should nearly fill the container.

11.2.3.1 For I-129 analysis only a 25 mL or 100 mL straight sided poly jar geometry may be used (check with count room analyst on which geometry I-129 is calibrated for and prep the sample using a matching geometry).

11.2.3.2 Ra-226 is best reported inferred from the Bi-214 daughter after a 21-day ingrowth to allow the Ra-226 progeny through the potentially volatile Rn-222 daughter to reach secular equilibrium. To ensure Rn-222 is not lost from the container or does not escape into the headspace of the container, a radium-specific geometry should be utilized (e.g. tuna can or 0.5L Marinelli beaker) which contains minimal headspace and can be sealed to prevent loss of radon. If Ra-226 is reported inferred from Bi-214 without sufficient ingrowth or from a geometry which is not intended for this purpose (due possibly to insufficient sample available), a NCM should be written to be included in the case narrative of the report.

11.2.4 Write sample information (i.e. ID #) on the sample container.

11.2.5 Pre-weigh the empty container (tare weight) and record weight in TALS and on the container lid.

11.2.6 Fill the container with the appropriate amount of sample as described below.

11.2.6.1 Fill tuna cans to the ridge mark with sample. If there is insufficient sample to fill the can to the ridge, reduce geometry size.

11.2.6.2 Fill 100 mL geometry to the level as denoted on the reference container. If there is insufficient sample to fill, reduce the geometry size.

11.2.6.2.1 A 100 mL "reference" bottle is marked with the appropriate fill level.

11.2.6.3 Fill 25 mL geometry to the level as denoted on the reference bottle. If there is insufficient sample to fill the 25 mL geometry, write a NCM stating insufficient sample provided for routine analysis.

11.2.6.3.1 A 25 mL "reference" container is marked with the appropriate fill level.

11.2.6.4 Fill 500 mL Marinelli beakers to the ridge mark just below the lid with sample. If there is insufficient sample to fill the marnsoil to the ridge, reduce geometry size.

11.2.7 Close the sample container securely.

11.2.8 Seal the container with plastic electrical tape. For tuna cans, seal with can sealer, wipe samples clean with paper towel and DI water.

11.2.9 Place the sample on the balance; record the weight of the sample on the gamma worksheet (total weight of container plus sample, minus the tare weight of the empty container).

11.2.10 Generate a label and proper paperwork then submit to count room for analysis by gamma spec.

11.3 Vegetation Sample Preparation (No digestion)

11.3.1 Vegetation samples may be prepared in an appropriate calibrated geometry counted directly as dried and chopped matrix or green unprocessed matrix (if directed to do so by the client or if I-131 or I-129 is to be reported).

11.3.1.1 Green unprocessed samples can be reported on a wet or dry basis, determined by client or Project Manager.

11.3.1.1.1 Vegetation samples **for I-129 or I-131 analysis are not dried** but rather inserted into an appropriate calibrated geometry.

11.3.1.1.2 Dry weight can be determined on sample(s) not dried by using the percent moisture.

11.3.1.2 Consult the client requirements, client requirement memorandums or the Supervisor/Manager to determine proper sample handling.

11.3.2 The sample shall be counted in a 500 mL Marinelli, 230 mL sealed (tuna can), 100 mL, or 25 mL geometry. The container is filled to the appropriate level with the sample.

11.3.2.1 I-129 analysis uses only a 25 mL or 100 mL straight sided poly jar geometry (check with count room analyst on which geometry I-129/I-131 is calibrated for and prep the sample using a matching geometry).

11.3.2.2 Ra-226 is best reported inferred from the Bi-214 daughter after a 21-day ingrowth to allow the Ra-226 progeny through the potentially volatile Rn-222 daughter to reach secular equilibrium. To ensure Rn-222 is not lost from the container or does not escape into the headspace of the container, a radium-specific geometry should be utilized (e.g. tuna can or 0.5L Marinelli beaker) which contains minimal headspace and can be sealed to prevent loss of radon. If Ra-226 is reported inferred from Bi-214 without sufficient ingrowth or from a geometry which is not intended for this purpose (due possibly to insufficient sample available), a NCM should be written to be included in the case narrative of the report.

11.3.3 Write sample information (i.e. ID #) on the container.

11.3.4 Pre-weigh the empty container and record weight in TALS and on lid of container.

11.3.5 Place sample in the tared container.

11.3.5.1 Compress the sample when filling a 500 mL Marinelli beaker

11.3.6 Place the sample on the balance; record the weight of the sample on the gamma worksheet (total weight of container plus sample minus the tare weight of the empty container).

11.3.6.1 Verify with the Project Manager if sample is to be reported on a wet or dry basis.

11.3.7 Close the sample container securely, seal with plastic electrical tape

11.3.8 Generate a label and print proper paperwork then submit to count room for analysis by gamma spec.

11.4 Vegetation Sample Preparation (with digestion)

11.4.1 Vegetation samples may be digested and then placed into a appropriate calibrated geometry and counted as a liquid matrix.

11.4.1.1 Green unprocessed samples can be reported on a wet or dry basis, determined by the client or project manager.

11.4.1.1.1 **Iodine isotopes (e.g. I-125, I-129 or I-131) cannot be prepared using digestion technique** due to volatility.

11.4.1.2 Consult the client requirements and Supervisor/Manager to determine proper handling.

11.4.2 Label an appropriate sized beaker with a TEXPEN® to ensure identification post muffling

11.4.3 Transfer sample into beaker and record the weight on the gamma worksheet

11.4.3.1 Check with the Project Manager to determine if sample is to be reported on a wet or dry basis.

11.4.4 Cover sample with 8 N HNO_3 and allow to sit overnight.

11.4.5 Place beaker on hot plate and gently heat so that sample does not splatter. Periodically stir sample

11.4.6 Wash down sides of the beaker with small amounts of 30% H_2O_2 and small amounts of 8M HNO3. Continue this process periodically as sample digests on hot plate.

11.4.7 Cook sample down to dryness.
11.4.7.1 Upon visual inspection if sample is orange in color, cover sample with 16M HNO_3 and continue to wet ash with 30% H_2O_2.
11.4.7.2 Repeat 11.4.7 and 11.4.7.1 until sample is light yellow or white in color.
11.4.8 Cover beaker with a watch glass and place into the muffle oven.
11.4.9 Heat at 600YC for a minimum of 4 hours to reduce the sample
11.4.10 Allow beakers to cool to room temperature before removing from the oven.
11.4.10.1 The sample may be wet ashed again if yellow color remains.
11.4.11 Reflux samples with enough of 4 N HNO_3 to cover sample for approximately 30 minutes, using a watch glass to cover the beaker.
11.4.12 Quantitatively transfer sample to a labeled digestion vessel or Teflon® beaker with a minimal amount of 4 N HNO_3.
11.4.13 Add 5 mL of 16 N HNO_3, 5 mL of 12 N HCl and 10 mL of concentrated HF
11.4.14 Bring sample to dryness
11.4.14.1 If using a digestion vessel, place in MOD Block
11.4.14.2 If using a Teflon® beaker, heat on a hotplate
11.4.15 Repeat steps 11.4.10 and 11.4.11
NOTE: The amount of acid will vary depending on the sample aliquot. When increasing the aliquot, increased acid will be required
11.4.16 Reflux the sample in 10 to 20 mL of 4 N HNO_3. Allow to reflux with a watch glass over the beaker for approximately 30 minutes to ensure samples goes into solution.
11.4.16.1 If sample does not go into solution additional digestions may be required (see Supervisor/Manager/Technical Director for guidance)
11.4.17 Label appropriate size container (25 or 100 mL)
11.4.18 Quantitatively transfer sample to container by rinsing with minimal amount of 4 N HNO_3
11.4.19 Bring to volume to match the reference container
11.4.20 Close the sample container lid securely and seal with plastic electrical tape.
11.4.21 Inspect for leakage.
11.4.22 Generate a label and print proper paperwork then submit to count room for analysis by gamma spec.

11.5 Air Filters/Swipes (no digestion)
11.5.1 Air filters may be counted as single filters or as composite filters.
11.5.1.1 Consult client requirements and Supervisor/Manager for instruction.
11.5.1.2 Air filters are reported as pCi/sample or pCi/g. The weight to the air filter is required if the reporting units is pCi/g.
11.5.2 Write sample information (i.e. ID#) on Petri dish.
11.5.3 Filters with reporting units of
11.5.3.1 pCi/g proceed to 11.5.4
11.5.3.2 pCi/sample proceed to 11.5.5
11.5.4 Pre-weigh empty Petri dish, record the weight in TALS and then on the lid of the Petri dish.
11.5.5 Load air filter(s) directly into Petri dish
11.5.6 Place lid on Petri dish, for pCi/g record the weight of the sample (container and sample weight, minus container weight) in TALS.
11.5.7 Secure the Petri dish lid with plastic electrical tape
11.5.8 Generate a label and print proper paperwork then submit to count room for analysis by gamma spec.

11.6 Air Filters/Swipes (with digestion)
11.6.1 Air filters are digested and counted as a liquid.
11.6.2 Label a 250 mL beaker with a TEXPEN® to ensure identification post muffling.
11.6.3 Place sample into beaker

11.6.4 Place sample beaker in muffle oven and cover with a watch glass.
11.6.5 Ramp air filters in muffle oven
11.6.5.1 Refer to ST-RC-004 for ramping settings
11.6.6 Allow beakers to cool to room temperature
11.6.7 Digest filter in accordance with sections 11.4.9 to 11.4.12
11.6.8 Label appropriate size container (25 to 100 mL)
11.6.9 Transfer sample to container with minimal amount of 4 N HNO_3.
11.6.10 Bring to volume using reference container as a guide
11.6.11 Place lid securely on the container
11.6.12 Seal the lid using plastic electrical tape
11.6.13 Inspect for leakage.
11.6.14 Generate a label and proper paperwork then submit to count room for analysis by gamma spec.

11.7 Core Samples
11.7.1 To obtain sample, cut Shelby tube or sample container into two pieces.
11.7.1.1 Using a rigid pipe cutter cut the tube completely through.
11.7.1.2 Using a wire saw, cut through the sample.
11.7.1.3 Cuts should be made at 2 inch intervals.
11.7.1.4 Remove sample from every other sliced section of the Shelby tube.
11.7.1.5 Dry and grind the sample as described in SOP ST-RC-0003.
11.7.2 Aliquot 500 g of sample
11.7.2.1 If less than 500 g of sample is available, contact Supervisor/Manager for instruction.
11.7.2.2 Soil samples shall be prepared as 200 mL sealed (tuna) can, 100 mL, or 25 mL, or 500 mL Marinelli (marnsoil) geometry based on the amount of available sample. In both the tuna can and marnsoil geometries, the soil should nearly fill the container.
11.7.3 Pre-weigh the empty container and record the weight on the container lid and in TALS
11.7.4 Writer sample information (i.e. ID#) on the sample container
11.7.5 Place the dried sample into the container for counting.
11.7.6 Weigh and record sample weight in TALS .
11.7.7 Secure the lid on the container with plastic electrical tape.
11.7.8 Generate a label and print proper paperwork then submit to count room for analysis by gamma spec.

11.8 Food: vegetables, produce, grain or animal feed:
11.8.1 Vegetables, produce and grain samples may be prepared in a 500 mL Marinelli beaker or 1 L Marinelli beaker geometry depending on the requested reporting limit. These matrices are counted directly as whole grain, chopped or blended produce or vegetable matrices **without drying** unless directed by the client to dry the matrix.
11.8.1.1 Consult the client requirements and Supervisor/Manager for instruction.
11.8.2 For vegetables and produce, prepare the sample by chopping with a knife on a cutting board or using a food processor.
11.8.3 Write sample information (i.e. ID #) on the appropriate container.
11.8.4 Pre-weigh the empty container and record weight on container and in TALS.
11.8.5 Place processed sample in the pre-weighed container.
11.8.6 Compress the sample when filling a 500 mL Marinelli beaker
11.8.7 Weigh sample and record the weight in TALS as WET weight in grams.
11.8.7.1 If the sample is dried, record the DRY weight.
11.8.8 Close the sample container securely, seal with plastic electrical tape.

11.8.9 Generate a label and print proper paperwork then submit to count room for analysis by gamma spec.

11.9 Food: meat and fish:

11.9.1 Meat and fish may be prepared in a 500 mL Marinelli beaker or 1 L Marinelli beaker geometry depending on the requested reporting limit. These matrices are counted directly **without drying.**

11.9.1.1 Consult the client requirements and Supervisor/Manager for instruction.

11.9.2 For meat and edible portions of fish, prepare the sample by chopping with a knife on a cutting board.

11.9.2.1 Fish sample are to be filleted prior to chopping.

11.9.2.2 For analysis of fish **when the whole fish is required to be analyzed**, remove the head with a knife and cut the fish into pieces of appropriate size to easily fit into the Marinelli beaker without air voids. Place the heads in the main portion of the Marinelli and surround it with pieces to eliminate air voids or spaces.

11.9.3 Write sample information (i.e. ID #) on the container.

11.9.4 Pre-weigh the empty container and record weight on container and in TALS.

11.9.5 Place processed sample in the pre-weighed container.

11.9.6 Compress the sample evacuating any space in the geometry when filling a Marinelli beaker

11.9.7 Weigh sample and record the weight in TALS as WET weight in grams.

11.9.8 Close the sample container securely, seal with plastic electrical tape.

11.9.9 Generate a label and print proper paperwork then submit to count room for analysis by gamma spec.

11.10 Store unused portions of sample in appropriately sized poly containers. Food and Vegetation samples are to be refrigerated.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 There are no calculations pertaining to this sample preparation procedure.

12.2 Commonly used calculations (e.g. % recovery and RPD) and standard instrument software calculations are given in the TestAmerica St. Louis ST-QAM. Specific analysis calculations are given in the applicable analysis SOP.

12.3 Percent Moisture: Mass of original sample minus mass of dried sample divided by mass of dried sample.

12.3.1 $$p = \frac{W - D}{D}$$

p = fraction of total evaporable moisture content of sample
W = mass of the original sample
D = mass of dried sample

12.4 Density: Sample weight divided by the volume of said sample weight

12.4.1 $$d = \frac{m}{v}$$

d = density
m = mass

v = volume

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 Data assessment does not pertain to this sample preparation procedure.

13.2 Samples requiring re-preparation are submitted to the preparation lab with a NCM detailing the issue. The NCM process is described in SOP: ST-QA-0036. Specific information is given in the applicable analysis SOP.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1 Method performance data, Reporting Limits, and QC acceptance limits, are maintained in the LIMS.

14.2 Demonstration of Capability

14.2.1 Initial and continuing demonstrations of capability requirements are established in ST-QAM.

14.3 Training Qualification

14.3.1 The Supervisor/Manager has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in ST-QAM.

14.4 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in ST-QAM

15.0 VALIDATION

15.1 Laboratory SOPs are based on standard reference EPA Methods that have been validated by the EPA and the lab is not required to perform validation for these methods. The requirements for lab demonstration of capability are included in ST-QAM. Lab validation data would be appropriate for performance based measurement systems or non-standard methods. TestAmerica St. Louis will include this information in the SOP when accreditation is sought for a performance based measurement system or non-standard method.

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where feasible, technological changes have been implemented minimizing the potential for pollution to the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

16.2 Waste Streams Produced by the Method

The following waste streams are produced when this method is carried out.

16.2.1 Acidic sample waste generated. All acidic waste will be accumulated in the appropriate waste accumulation container, labeled as Drum Type "A" or "B."

16.2.2 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the lab ware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM

meter, the lab ware will be collected in waste barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

17.1 Prescribed Procedures for Measurement of Radioactivity in Drinking Water Method EPA 901.1.

17.2 Department of Energy (DOE) Environmental Monitoring Laboratory (EML) HASL-300 Procedures Manual, GA-01-R.

17.3 TestAmerica St. Louis Quality Assurance Manual (ST-QAM), current revision.

17.4 TestAmerica Corporate Environmental Health and Safety Manual (CW-E-M-001) and St. Louis Facility Addendum (SOP ST-HS-0002), current revision.

17.5 Associated SOPs

- 17.5.1 ST-RC-0003, Drying and Grinding of Soil and Solid Samples
- 17.5.2 ST-RC-0004, Preparation of Soil, Sludge, and Filter Paper Samples for Radiochemical Analysis
- 17.5.3 ST-RC-0014, Bulk Drying and Grinding of Soil and Solid Samples
- 17.5.4 ST-RD-0102, Gamma Spectroscopy Analysis
- 17.5.5 ST-RP-0032, Instrumentation and Surveillance
- 17.5.6 ST-PM-0002, Sample Receipt and Chain of Custody
- 17.5.7 ST-QA-0002, Standard and Reagent Preparation
- 17.5.8 ST-QA-0036, Non-conformance Memorandum (NCM) process

18.0 CLARIFICATIONS, MODIFICATIONS TO THE REFERENCE METHOD

18.1 None.

19.0 CHANGES FROM PREVIOUS REVISION

19.1 No Changes, Annual Review
19.2 Rev 11:
- 19.2.1 Inserted instructions regarding requirements for checking the pH of samples upon receipt and or prior to analysis in section 8.3.1.
- 19.2.2 Updated when sample ID's should be written on the container in section 11.0.
- 19.2.3 Inserted instructions for generating container ID labels throughout section 11.0.
- 19.2.4 Updated when weighing and recording sample weights/mass should be documented in gamma worksheet in section 11.0.
- 19.2.5 Added instructions for properly cleaning tuna cans before storage in section 11.2.9.

19.3 Rev 12:
- 19.3.1 Extensive revision to entire procedure
- 19.3.2 Addition of attachment 1

19.4 Rev 13:
- 19.4.1 Added sodium sulfate to section 7.0.
- 19.4.2 Updated section 9.2 regarding the matrix of method blanks.

19.5 Rev 14:
- 19.5.1 Updated vegetation sample with and without digestion throughout section 11.3 and 11.4.

19.6 Rev. 15: (8/30/2013)
- 19.6.1 Grammatical corrections and removal of references to QuantIMS through out
- 19.6.2 Section 3, added definition of replicate analyses
- 19.6.3 Section 8, removal of 180 day holding time
- 19.6.4 Section 9, explained that replicate will be used as duplicate for this procedure
- 19.6.5 Section 9.6, added "record in daily logbook"
- 19.6.6 Deleted record tare weight on lid in section 11.1.2
- 19.6.7 Deleted record weight of sample (container and sample weight minus container weight) on lid in section 11.1.8 , 11.2.9, 11.3.6
- 19.6.8 Added record weight in TALS throughout SOP
- 19.6.9 Added print proper paperwork throughout SOP

19.7 Rev. 16: (01/16/2015)
- 19.7.1 Grammatical corrections through out
- 19.7.2 Updated section 11.0
- 19.7.3 Added SOP references to Section 17: ST-RC-0014, St-RP-0032

19.8 Annual Review – No Changes (01/26/2015)
19.9 Annual Review- minor, non-procedural updates made (12/20/2016)
19.10 Revision 17 (12/15/17 Tech Review M. Minier/T Romanko; QA Review M Ward)
- 19.10.1 Added information pertaining to prep for Radium-226 in Sections 11.1, 11.2 and 11.3

Attachment 1

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

DENSITY CORRECTION

Date: _____ **Digi Tube Lot #:** _____

Analyst: _____ **Balance ID:** _____

	Sample ID:	Container Wt (g)	Sample Volume (mL)	Sample + Container Wt (g)	Density (g/mL)	Original Sample Aliquot	Adjust Sample Aliquot
1							
2							
3							
4							
5							
6							

Instructions:
Record the weight of a Class A digi tube in "Container Wt(g)"; record the volume of the sample added to the digit tube in "Sample Volume (mL)"; record the sample and digi tube in "Sample + Container Wt(g)." "Original Sample Aliquot" is the full sample size used for the actual analysis.

This density is to be used for sample aliquot correction when a sample is suspected of density less than or greater than 1. Include this document with batch paperwork.

Review is to be completed by a peer (someone other than the analyst handling the samples).

Reviewed by: _____ Date: _____

\\slsvr01\QA\FORMS\ST-LOUIS RAD-0075 REV (0)

Title: SOIL SAMPLE PREPARATION FOR STRONTIUM-89, STRONTIUM-90 AND TOTAL STRONTIUM USING EXTRACTION CHROMATOGRAPHY

Approvals (Signature/Date):

Sarah Bemsen 12/01/17 Sarah Bemsen — Date Radiochemistry Prep Manager	12/7/17 Michael Ridenhower — Date Health & Safety Manager / Coordinator
12/8/17 Kristen Ely — Date Quality Assurance Manager	12/7/17 Elaine Wild — Date Laboratory Director

This SOP was previously identified as SOP No. ST-RC-0058 Rev. 3

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1.0 SCOPE AND APPLICATION

1.1 This SOP describes the process for sample preparation of strontium-89, strontium-90 and total strontium using extraction chromatography. This procedure is applicable in conjunction with soil pre-preparation procedures to perform strontium determinations in solid matrices.

1.2 This SOP is based on ASTM Method C1507-07.

1.3 The reporting limits and QC limits are maintained in the Laboratory Information Management System (LIMS).

2.0 SUMMARY OF METHOD

2.1 Strontium is isolated/separated by extraction chromatography. For soils, the strontium is transferred from the soil into a liquid matrix prior to loading on the extraction column/cartridge. Interferences from calcium and other radionuclides are effectively removed by the extraction column. The separated strontium is eluted off the column, evaporated to dryness onto a planchet, and weighed for chemical recovery determination. For reporting total strontium (or strontium-89), the planchet is beta counted soon after planchet preparation, For strontium-90 determination, the strontium nitrate with ingrown yttrium-90 is dissolved from the planchet and loaded back onto the extraction chromatography column. The yttrium-90 passes directly through the column, is evaporated to dryness on a planchet, and beta counted. Strontium-90 and total strontium are counted for beta particle activity by gas flow proportional counting (GFPC). The strontium-89 concentration is determined by difference.

3.0 DEFINITIONS

3.1 See the TestAmerica St. Louis Quality Assurance Manual (ST-QAM) for a glossary of common laboratory terms and data reporting qualifiers.

3.2 There are no specific definitions for this procedure.

4.0 INTERFERENCES

4.1 Samples which contain natural strontium cause inaccurate chemical yield determinations. For samples suspected to contain significant elemental strontium, the concentration should be determined by suitable means (e.g. ICP or ICP-MS), and the yield calculation appropriately corrected.

4.2 The extraction resin effectively removes most beta-emitting isotope interferences (e.g. Ba-140 and K-40) utilizing 8 M nitric acid load and rinse solutions. Certain tetravalent elements, if present, (e.g. uranium, plutonium, neptunium, cerium, and ruthenium) are effectively removed using a 3 M nitric acid – 0.05 M oxalic acid wash.

4.3 The extraction resin has limited capacity based upon the number of sites available to bind the strontium. The carrier should be limited to about 5 mg to avoid overloading the column, resulting in lowered chemical recoveries. Alternatively, cartridges could be stacked to increase the load capacity.

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to

follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, non-absorbent shoes are a minimum.

5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

5.2.1 None.

5.3 PRIMARY MATERIALS USED

5.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Nitric Acid	Corrosive Poison Oxidizer	2 ppm (TWA) 4 ppm (STEL)	Inhalation may cause coughing, choking, and irritation of the nose, throat, and respiratory tract. Skin contact can cause redness, pain, and severe skin burns. Concentrated solutions can stain the skin a yellow-brown color. Vapors are irritating to the eyes and contact may cause severe burns.
Oxalic Acid	Corrosive	1 mg/m3 (TWA) 2 mg/m3 (STEL)	Inhalation symptoms include severe irritation and burns of nose, throat, and respiratory tract. Ingestion symptoms include burns, nausea, severe gastroenteritis and vomiting. Skin contact causes severe irritation and burns. Oxalic Acid is an eye irritant.
Hydrochloric Acid	Poison Corrosive	5 ppm (ceiling)	Inhalation symptoms include coughing, choking, inflammation of the nose, throat, and upper respiratory tract. Skin contact can cause redness, pain, severe skin burns, and discoloration. Vapors are irritating to the eyes. Contact may cause severe burns.
Hydrofluoric Acid	Poison Corrosive	3 ppm (TWA)	Inhalation symptoms may include sore throat, coughing, labored breathing and lung congestion/inflammation. Skin contact may cause serious burns which are not immediately apparent or painful. Symptoms of eye contact include redness, pain, and blurred vision.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			
TWA – Time Weighted Average			
STEL – Short Term Exposure Limit			
Ceiling – At no time should this exposure limit be exceeded.			

6.0 EQUIPMENT AND SUPPLIES

6.1 Analytical Balance (capable of an appropriate precision as required by each measurement within this procedure)

6.2 Centrifuge and centrifuge tubes

6.3 Labware, quartz crucibles, glass and teflon beakers, various sizes, covers and watch glasses

6.4 Planchets

6.5 Digestion vessels

6.6 Syringes

6.7 Mod block

6.8 Hot plate

6.9 Desiccator

6.10 Strontium-specific extraction chromatography resin – Eichrom Technologies, Inc® Sr resin 2-mL pack cartridge.

6.11 Inductively Coupled Plasma (ICP) – Atomic Emission Spectroscope (or equivalent)

7.0 STANDARDS AND REAGENTS

7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP ST-QA-0002, current revision.

7.2 Deionized Water (DI)

7.3 Hydrochloric acid (12 M HCl) - concentrated, 37.2%.

7.4 ICP Rinse/Diluent (non-critical reagent)- Fill a container with approximately 1000 mL of DI water. Add approximately 200 mL of concentrated nitric acid, and approximately 200 mL of concentrated hydrochloric acid to the DI water. Dilute the volume up to approximately 4000 mL.

7.5 Nitric acid (16 N HNO_3) (69 – 71%) - concentrated HNO_3.

7.6 Nitric acid (8 M HNO_3)

7.6.1 Non critical concentration
7.6.2 In a marked 2L bottle, add approximately 1L of DI water. Then SLOWLY and CAREFULLY add approximately 1L of concentrated HNO3
7.6.3 Shake carefully to mix.

7.7 Nitric acid (4 M HNO_3)
7.7.1 Non critical concentration
7.7.2 In a marked 2.5L bottle, add approximately 1875 mL of DI water. Then SLOWLY and CAREFULLY add approximately 625 mL of concentrated HNO3.
7.7.3 Shake carefully to mix.

7.8 Nitric acid (0.05 M HNO_3)
7.8.1 Non critical concentration
7.8.2 Add approximately 800 mL of DI water to a 1L container. Add approximately 3mL of concentrated HNO3.
7.8.3 Dilute to approximately 1L with DI water.
7.8.4 Shake carefully to mix.

7.9 Nitric acid (3 M HNO_3)/oxalic acid (0.05 M $C_2H_2O_4$) solution
7.9.1 Non critical concentration
7.9.2 In a 1L container, disslove 6.3 g of oxalic acid dihydrate in approximately 700 mL of DI water.
7.9.3 Add approximately 190 mL of concentrated HNO3 with mixing.
7.9.4 Dilute to approximately 1 L with DI water.

7.10 Nitric acid (3 M HNO_3)/boric acid (0.25 M BH_3O_3) solution
- 7.10.1 Non critical concentration
- 7.10.2 In a 1L container, dissolve 15.5 g of boric acid in approximately 700 mL of DI water.
- 7.10.3 Add approximately 190 mL of concentrated HNO3 with mixing.
- 7.10.4 Dilute to approximately 1 L with DI water.

7.11 Hydrofluoric acid, concentrated (29 N HF)

7.12 Strontium carrier (5 mg/mL Sr)
- 7.12.1 Strontium solution (5 mg/mL, Sr) in a 1-L volumetric flask, dissolve 12.077 g of strontium nitrate in approximately 250 mLof DI water. With stirring, add 5 mL concentrated nitric acid. Dilute to a final volume of 1 L with DI water.

7.13 Strontium carrier (25 mg/mL Sr)
- 7.13.1 Strontium solution (25 mg/mL, Sr) in a 1-L volumetric flask, dissolve 60.385 g of strontium nitrate in approximately 750 mL of DI water. With stirring, add 5 mL concentrated nitric acid. Dilute to a final volume of 1 L with DI water.

7.14 Strontium carrier (standardized) 5 or 25 mg/mL, NIST traceable
- 7.14.1 If the strontium carrier is not already standardized, standardize the strontium carrier using the following procedure in triplicate:
  - 7.14.1.1 Weigh a cleaned planchet.
  - 7.14.1.2 Pipette 1 mL of strontium carrier solution into the planchet.
  - 7.14.1.3 Dry the planchet in a hood under a heat lamp or on a hot plate.
  - 7.14.1.4 Allow the planchet to cool in a dessicator and then reweigh.
  - 7.14.1.5 Average the 3 net residue weights and record the average as the average of the amount of the strontium nitrate in the carrier.
  - 7.14.1.6 Record gross and final weights in the Rad Standards Log. Assign a unique number to the solution.

7.15 Strontium-89, NIST traceable

7.16 Strontium-90, NIST traceable

8.0 SAMPLE COLLECTION, PRESERVATIVES AND STORAGE

8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in ST-PM-0002.

8.2 Samples may be collected in glass or plastic containers.

9.0 QUALITY CONTROL

9.1 **Batch**
- 9.1.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents. Where no preparation method exists (e.g. water sample volatile organics, water sample anion analysis) the batch is comprised of a maximum of 20 environmental samples which are analyzed together with the same process, lots of reagents and personnel.
- 9.1.2 Instrument conditions must be the same for all standards, samples and QC samples.

9.1.3 For this analysis, batch QC consists of a method blank, a Laboratory Control Sample (LCS), and Sample Duplicate (DU). In the event that there is insufficient sample to analyze a sample duplicate, an LCS Duplicate (LCSD) is prepared and analyzed.

9.1.4 Matrix Spike (MS) and Matrix Spike Duplicate (MSD) may be performed upon client request, and are noted in the Client Requirement Sheets and Log-in.

9.1.5 Samples having different QC codes, due to non-standard client specific QC requirements, must be batched separately in the LIMS. A method blank and LCS may be shared across QC codes provided the actual "sample batch" does not exceed 20 environmental samples. Duplicates (and MS/MSD if applicable) must be performed for each separate QC code.

9.2 **Method Blank**

9.2.1 A method blank is a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the procedure.

9.2.2 A method blank must be prepared with every sample batch.

9.2.3 For **soil** analyses, the method blank is comprised of DI water acidified with 2 mL nitric acid.

9.3 **Laboratory Control Sample**

9.3.1 An LCS is a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.3.2 An LCS must be prepared with every sample batch.

9.3.3 For **soil** analyses, the LCS is comprised of DI water with strontium-90.

9.3.3.1 For strontium-90 and/or total strontium, the LCS is fortified with strontium-90.

9.4 **Matrix Spike/Matrix Spike Duplicate**

9.4.1 A Matrix Spike (MS) is an aliquot of a field sample to which a known amount of target analyte(s) is added, and is processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.4.2 MS/MSD samples do not count towards the 20 environmental samples in a sample batch.

9.4.3 MS/MSD samples, when requested, must be performed with every sample batch and every LIMS batch.

9.5 **Sample Duplicate**

9.5.1 A Sample Duplicate is an additional aliquot of a field sample taken through the entire analytical process to demonstrate precision.

9.5.2 If there is insufficient sample to perform a Sample Duplicate, a duplicate LCS is analyzed. A NCM is written to document the insufficient volume and utilizing of an LCSD for demonstration of precision.

9.6 **Procedural Variations/ Nonconformance and Corrective Action**

9.6.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Balance and automatic pipetter calibrations must be checked daily when used. Refer to SOP ST-QA-0005, "Calibration and Verification Procedure for Thermometers, Balances, Weights and Pipettes."

10.2 See analytical SOP ST-RD-0403, "Daily Calibration Verification and Maintenance of the Low Background Gas Flow Proportional Counting System", for instrument calibration requirements.

11.0 PROCEDURE

11.1 Soil Samples

11.1.1 For soil samples, prepare sample as per SOP ST-RC-0003, "Drying and Grinding of Soil and Solid Samples."

11.1.2 Weigh up to 2.5 g of sample into a labeled crucible. Larger aliquots (up to 10 g) may be utilized, but acid volumes need to be adjusted accordingly. See your supervisor or technical director for instructions.

11.1.3 Place in oven at 600° and allow to muffle for 4 hours. Allow to cool.

11.1.4 Transfer the soil to a labeled 50 mL digestion tube. Rinse the crucible using 4 M HNO_3.

11.1.5 Add 5 mg strontium equivalent of standardized strontium carrier (either 0.2 mL of 25 mg/mL carrier or 1 mL of 5 mg/mL carrier) to samples and QC. Add spike to LCS and MS/MSD, if applicable.

11.1.5.1 For strontium-90 and/or total strontium, the LCS is fortified with strontium-90.

11.1.6 Carefully add 30 mL concenetrated nitric acid and 10 mL concentrated hydrochloric acid.

11.1.7 Digest in mod block at > 110° for 1-2 hours

11.1.8 Allow the solution to cool.

11.1.9 Transfer the solution/solids to a labeled centrifuge tube with minimal DI water and centrifuge. Carefully transfer the supernatant to a labeled beaker.

11.1.10 Add 10 mL of concentrated nitric acid to the solids remaing in the centrifuge tube and vortex to loosen the solids. Transfer the solids/solution to the original digestion tube. Rinse the tube with 10 mL concentrated nitric acid to ensure all the soil transfers and add to the digestion tube. Add 10 mL more nitric acid and 10 mL concentrated hydrochloric acid to the digestion tube.

11.1.11 Digest in mod block at > 110° for 1-2 hours.

11.1.12 Allow the solution to cool.

11.1.13 Transfer the solution/solids to a labeled centrifuge tube with minimal DI water and centrifuge. Carefully transfer/combine the supernatant with the supernatant from the first digestion.

11.1.14 For samples which are not expected to contain refractory strontium, proceed to step 11.1.15. The following steps are to be used for samples expected to contain refractory strontium or for which the client requires total dissolution.

11.1.14.1 Add 10 mL of concentrated nitric acid to the solids remaning in the centrifuge tube and vortex to loosen the solids. Transfer the solids/solution to a labeled teflon beaker.

11.1.14.2 Add 30 mL of concentrated hydrofluoric acid.

11.1.14.3 Cover the beaker and digest for several hours at low heat.

11.1.14.4 Remove the cover and evaporate to dryness.

11.1.14.5 If necessary to dissolve remaining residue, add 10 mL of concentrated nitric acid and 30 mL of concentrated hydrofluoric acid and repeat the digestion/evaporation steps above.

11.1.14.6 Add 15 mL 3 M nitric acid/0.25 M boric acid and evaporate to dryness.

11.1.14.7 Add 10 mL 8 M nitric acid, cover, and heat just to boiling for 5 minutes.

11.1.14.8 Cool, and then transfer the solids/solution to a centrifuge tube with minimal DI water and centrifuge. Carefully transfer/combine the supernatant with the supernatant from the initial digestions.

11.1.15 Carefully evaporate the combined supernatant to dryness.

11.1.16 Add 15 mL of 4 M nitric acid to the beaker and reflux for 10-15 minutes. Do not allow the volume to drop below 5 mL.

11.1.17 Transfer the solution to a labeled mod block tube.

11.1.18 Rinse the beaker with 5 mL of 4 M nitric acid. Transfer to the labeled mod block tube.

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11.1.19 Carefully reduce the volume to 10 mL. If the volume drops below 10 mL, but greater than 5 mL, bring up to 10 mL with DI water. If the volume drops below 5 mL, consult your supervisor or technical director for instruction.

11.2 Initial Column Loading/Eluting

11.2.1 Prepare a labeled 2 mL extraction cartridge with a reservior (e.g. syringe barrel) and waste container and condition with 5 mL of 8 M nitric acid on a vacuum box setup.

11.2.2 Transfer the 10 mL sample to the reservior and allow to load at 1 mL per minute (approximately 1 drop every 3 seconds).

11.2.3 Rinse the cartridge with 5 mL of 8 M nitric acid at approximately 3 mL per minute (approximately 1 drop every 1-2 sections).

11.2.4 Rinse the cartridge with 5 mL of 3 M nitric acid/0.05 M oxalic acid solution at approximately 3 mL per minute.

11.2.5 Rinse the cartridge with 5 mL of 8 M nitric acid at approximately 3 mL per minute.

11.2.5.1 **Note: Record in LIMS, the date/time of this step as the final strontium rinse, indicating the beginning of the yttrium-90 ingrowth ("T1").**

11.2.6 Remove the acid waste container (discard to acid waste) and replace with a labeled collection tube.

11.2.7 Elute the strontium from the column with 10 mL (use calibrated pipette to measure 10 mL if performing ICP metals analysis for chemical yield) of 0.05 M nitric acid at 1 mL per minute.

11.2.8 If performing ICP metals analysis for chemical yield, transfer 0.1 mL of the eluant from the collection tube into a labeled tube for metals analysis using a calibrated pipette. Dilute to 20 mL (add 19.9 mL) with 5% HNO_3/5% HCl ICP diluent obtained from the metals group. Submit the tube for metals analysis to the metals analyst. Bringing the volume up to 20 mL, represents a 2x dilution that will have to be accounted for when entering the ICP data into LIMS.

11.2.9 Evaporate the strontium eluant onto a cleand/pre-weighed planchet (tare weight should be recorded in LIMS) by adding small portions (3-5 mL) to the dish in a hood under a heat lamp or on a hot plate and allowing each portion to evaporate to near dryness between additions.

11.2.10 Evaporate completely to dryness, cool in a dessicator, and reweigh. Record the final gross weight in LIMS..

11.2.11 For total strontium or strontium-89 analysis, submit the prepared planchet(s) to the count room for analysis. Store in a dessicator until count is performed.

11.2.12 Save the labeled extraction cartridge and planchet if strontium-90 analysis is to be performed.

11.3 Yttrium-90 preparation

11.3.1 For strontium-90 analysis, hold the planchet and allow the yttrium-90 to ingrow for 7-14 days.

11.3.2 Condition the extraction cartridge from the initial strontium separation.

11.3.2.1 Prepare the labeled extraction cartridge saved from the initial strontium separation (or a new cartridge) with a reservoir (e.g. syringe barrel) and acid waste container on a vacuum box.

11.3.2.2 For a *new cartridge*, proceed to 11.3.2.4.

11.3.2.3 For a *reused cartridge*, rinse with 5 mL of 0.05 M nitric acid at 3 mL per minute. Note: the 0.05 M nitric acid removes Bi-210 that might be present due to Pb-210 from the sample tightly bound to the resin.

11.3.2.4 Condition the cartridge with 5 mL of 8 M nitric acid at 3 mL per minute.

11.3.2.5 Remove the acid waste container (discard acid waste) and replace with a labeled collection tube.

11.3.3 Dissolve the strontium nitrate residue from the planchet with up to 3 portions of 5 mL of warm 8 M nitric acid. This can be accomplished in a labeled 150 mL glass beaker or directly on the planchet.

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11.3.4 Load each 8 M nitric acid solution containing the dissolved residue onto the prepared cartridge at 1mL per minute. Allow each 5 mL portion to drain completely before adding the next portion.

11.3.5 Record in LIMS, the time of the last rinse as the stop time for the yttrium-90 ingrowth ("**T2**").

11.3.6 Evaporate the yttrium eluant onto a cleaned/pre-weighed planchet (tare weight should be recorded in LIMS) by adding small portions (3-5 mL) to the dish in a hood under a heat lamp or on a hot plate and allowing each portion to evaporate to near dryness between additions.

11.3.7 Evaporate completely to dryness, cool in a dessicator, and reweigh. Record the final gross weight in LIMS, to be used in the efficiency determination. The yttrium yield is assumed to be 100%.

11.3.8 Submit the prepared planchet(s) to the count room for analysis. Store in a dessicator until count is performed.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 There are no calculations pertaining to this sample preparation procedure.

12.2 Commonly used calculations (e.g. precent recovery and realtive precent difference "RPD") and standard instrument software calculations are given in the TestAmerica St. Louis QAM (ST-QAM). Specific analysis calculations are given in the applicable analysis SOP.

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 Data assessment does not pertain to this sample preparation procedure.

13.2 Samples requiring re-preparation are submitted to the preparation lab with a NCM detailing the issue. The NCM process is described in SOP: ST-QA-0036. Specific information is given in the applicable analysis SOP.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1. The requested limits (RL), minimum detectable amount (MDA) and QC limits are maintained in the Laboratory Information Management System (LIMS).

14.2. Demonstration of Capability

14.2.1. Initial and continuing demonstrations of capability requirements are established in ST-QAM.

14.3. Training Qualification

14.3.1. The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2. The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in ST-QAM.

14.4. Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in ST-QAM

15.0 VALIDATION

15.1 This method is based upon a published ASTM procedure which presents performance results for over 30 measurements made over 8 years using 16 different samples in duplicate from the Department of Energy – Environmental Measurements Laboratory – Quality Assurance Program. The laboratory has also validated this method using a MARLAP Level C type protocol for total strontium.

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in the Corporate Safety Manual for "Waste Management and Pollution Prevention."

16.2 Waste Streams Produced by the Method

16.2.1 The following waste streams are produced when this method is carried out.

16.2.1.1 Acidic sample waste generated. All acidic waste will be accumulated in the appropriate waste accumulation container, labeled as Drum Type "A" or "B".

16.2.1.2 Sample waste with a Basic pH is generated. All base waste will be accumulated in the appropriate waste accumulation container, labeled as Drum Type "A" or "B".

16.2.1.3 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the labware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM meter, the labware will be collected in waste barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

17.1 ASTM Method C1507-07, "Standard Test Method for Radiochemical Determination of Strontium-90 in Soil". Current edition approved June 1, 2007.

17.2 Eichrom Technologies, Inc., Analytical Procedure SRW01 ("Strontium-89/90 in Water"), February 2003.

17.3 TestAmerica Quality Assurance Manual (ST-QAM), current revision

17.4 TestAmerica Corporate Environmental Health and Safety Manual (CW-E-M-001) and St. Louis Facility Addendum (SOP ST-HS-0002), current revisions.

17.5 Associated SOPs (Current Revisions)

17.5.1 ST-RC-0002, Preparation of Stainless Steel Planchets for Radiochemistry Analyses
17.5.2 ST-RC-0003, Drying and Grinding of Soil and solid Samples
17.5.3 ST-RC-0004, Preparation of Soil, Sludge, Filter, Biota and Oil/Grease Samples for Radiochemical Analysis
17.5.4 ST-RC-5006, Decontamination of Laboratory Glassware. Labware and Equipment
17.5.5 ST-RD-0403, Daily Calibration Verification and Maintenance of the Low Background Gas Flow Proportional Counting System
17.5.6 ST-QA-0002, Standards and Reagent Preparation
17.5.7 ST-QA-0005, Calibration and Verification Procedure for Thermometers, Balances, Weights and Pipettes
17.5.8 ST-QA-0036, Non-conformance Memorandum (NCM) Process
17.5.9 ST-PM-0002, Sample Receipt and Chain of Custody

18.0 CLARIFICATIONS, MODIFICATIONS TO THE REFERENCE METHOD

18.1 Modifictions to method C1507-07:

18.1.1 The reference method is geared for 10 g sample aliquot. This SOP is scaled for smaller aliquot volumes as needed.

18.1.2 Total dissolution with HF is only performed for samples expected to contain refractory strontium or when required by the client.

18.1.3 A 3 M nitric acid/0.05 M oxalic acid rinse is used in the initial strontium portion of the procedure based upon extraction resin manufacturer (Eichrom Technologies, Inc) recommendation to remove possible interferences.

18.1.4 Based upon recommendation by Eichrom, boric acid is utilized following the HF digestion step to help destroy residual HF, which can interfere with the ensuing process.

19.0 CHANGES TO PREVIOUS REVISION

19.1 New procedure (no previous revision).

19.2 Rev. 1:

19.2.1 In section 11.2.8 updated the amounts needed to perform an ICP metals analysis for chemical yields.

19.3 Rev 2: (07/31/2014)

19.3.1 Grammatical errors fixed throughout SOP

19.3.2 Removed references to Quantims, replaced with LIMS

19.3.3 Updated text in Section 14

19.4 Annual Review – No Changes (04/04/2016)

19.5 Revision 3: (02/27/2017):

19.5.1 Updated section 5.0 – replaced MSDS with SDS

19.5.2 Updated section 7.0

19.5.2.1 DI water source

19.5.2.2 Clarified how to make reagents

19.5.3 Updated section 9

19.5.3.1 Updated abbreviation for sample duplicate to match LIMS

19.5.3.2 Removed duplicate paragraph from section 9.6

19.5.4 Updated section 11.0 – replaced Rad Capture with LIMS

20.0 Revision 4: (12/12/2017 Technical Review S. Bernsen/QA Review: M. Ward):

20.1 Updated section 7.4- added ICP Rinse/Diluent as a reagent.

20.2 Updated section 11.1.1- fixed the SOP from ST-RC-003 to ST-RC-0003.

20.3 Updated section 11.1.4- added 50 mL digestion tube

20.4 Updated section 11.2.2- added approximately 1 drop every 3 seconds.

20.5 Updated section 11.2.3- added approximately 1 drop every 1-2 seconds

20.6 Grammatical errors fixed

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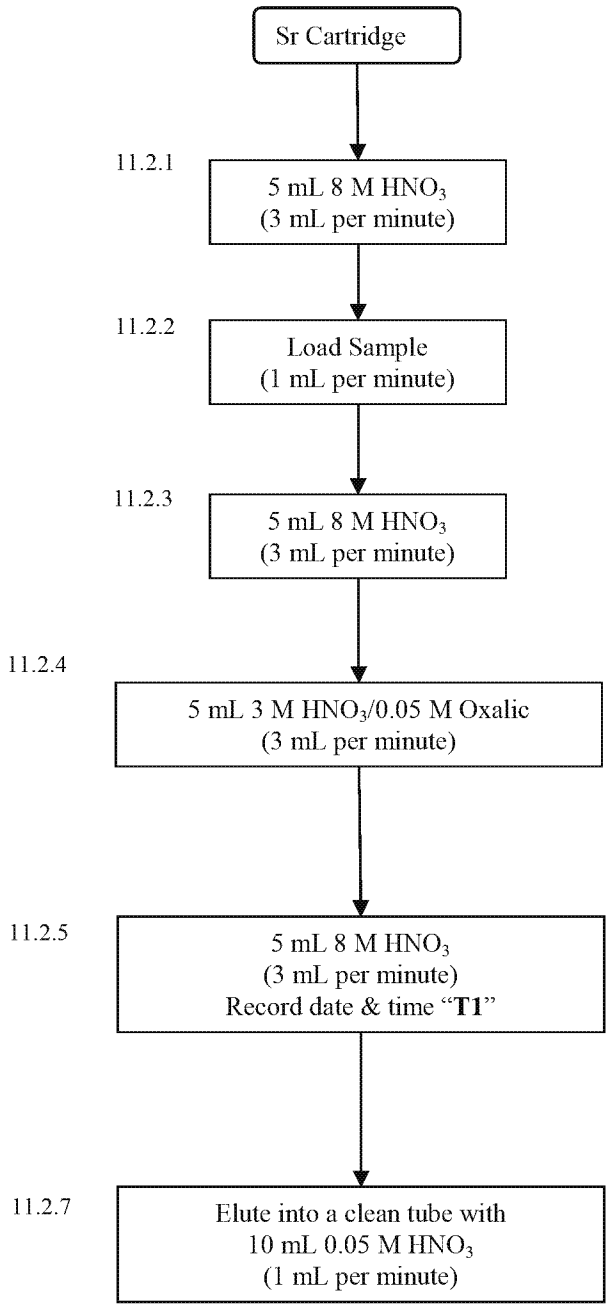
Strontium via Sr-Specific Resin



20.7

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Title: GAMMAVISION® ANALYSIS

Approvals (Signature/Date):

Rachel J. Mueller 3-7-18 Rachel Mueller Date Radiochemistry Count Room Manager	Michael Ridenhower 3/8/18 Michael Ridenhower Date Health & Safety Manager / Coordinator
Kristen Ely 3/8/18 Kristen Ely Date Quality Assurance Manager	For Jodie Carnes 3-8-18 Jodie Carnes Date Laboratory Director Andrew Buettner

This SOP was previously identified as SOP No. ST-RD-0102 Rev. 16

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1.0 SCOPE AND APPLICATION

1.1 This procedure applies to all germanium detectors and the computer assisted germanium spectroscopy analysis system.

1.2 Due to the nature of gamma spectroscopy, once the system is calibrated to a particular geometry a similar matrix may be run as long as it is prepared to match a calibrated geometry.

1.3 This SOP is based on EPA Method 901.1, DOE EML HASL 300 Method GA-01-R and ANSI N42.14-1999.

1.4 The requested limits (**RL**), minimum detectable amount (**MDA**) and QC limits are maintained in the Laboratory Information Management System (**LIMS**).

2.0 SUMMARY OF METHOD

2.1 This procedure provides detailed instructions for energy calibration, efficiency determination, quality control checks, background and sample counting of the germanium spectroscopy system.

3.0 DEFINITIONS

3.1 See the TestAmerica Quality Assurance Manual (ST-QAM) for a glossary of common laboratory terms and data reporting qualifiers.

4.0 INTERFERENCES

4.1 Germanium spectrometry has potential interference. Interferences are usually in the form of radionuclides with unresolved photon emissions. These interferences are limited by the careful design/construction of the gamma spectral identification and interference libraries.

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

6.0 EQUIPMENT AND SUPPLIES

6.1 Germanium spectroscopy system utilizing a computer based data acquisition system (GammaVision®-32).

6.2 GammaVision®-32 (know as GammaVision) is a comprehensive, all-in-one package, for the analysis of gamma-ray spectra acquired with HPGe detectors.

6.3 Global Value software is an optimization tool for automation, custom reporting, quality assurance and data management (GammaVision productivity add-on software).

7.0 REAGENTS AND STANDARDS

7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP ST-QA-0002.

7.2 Commercially prepared mixed gamma standards in reproducible geometries, with all appropriate NIST Source Certificate information.

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in ST-PM-0002. Samples may be collected in glass or plastic containers.

8.2 Aqueous samples are preserved with nitric acid to a pH of less than 2.

9.0 QUALITY CONTROL

9.1 See gamma preparation SOP (ST-RC-0025) for additional information regarding QC types, frequency and preparation.

9.2 **Batch**

9.2.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents.

9.2.2 Instrument conditions must be the same for all standards, samples and QC samples.

9.2.3 For this analysis, batch QC consists of a method blank, a Laboratory Control Sample, and Sample Duplicate.

9.3 **Method Blank (MB)**

9.3.1 A method blank must be counted with every sample batch.

9.3.1.1 For soils, a method blank is sodium sulfate filled in the specified geometry.

9.3.1.2 For waters, a method blank is DI water filled in the specified geometry.

9.3.1.3 For filters, a method blank is a blank petri dish.

9.4 **Laboratory Control Sample (LCS)**

9.4.1 A LCS must be counted with every sample batch.

9.4.1.1 For water, a purchased mixed nuclide source in the specified geometry.

9.4.1.2 For soil, a purchased mixed nuclide source in the specified geometry.

9.4.1.3 For filters, a purchased mixed nuclide source in a petri dish.

9.5 **Sample Duplicate**

9.5.1 A Sample Duplicate is a recounted field sample to demonstrate instrument precision, since there is no sample preparation (required to count on a different detector than the sample).

9.5.1.1 If requested, the laboratory may perform a Sample Duplicate which is an additional aliquot of a field sample.

9.6 **Procedural Variations/ Nonconformance and Corrective Action**

9.6.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.

9.6.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA Manager.

See SOP ST-QA-0036 for details regarding the NCM process.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Except in specific instances, it is NOT acceptable to remove points from a calibration curve. Points must never be removed solely for the purpose of meeting criteria. There must be a demonstrable reason to remove a point. Consult with the Supervisor or Technical Director for guidance. Examples of acceptable reasons for the removal of points include, but are not limited to:

- 10.1.1 A nuclide has decayed below acceptable count criteria due to short half-life
- 10.1.2 There is an apparent nuclide-specific issue associated with the purchased standard (e.g. all energy lines for a particular nuclide are low or high).

10.2 There are two types of Calibrations performed for Gamma: Energy and Efficiency

- 10.2.1 Energy Calibrations
  - 10.2.1.1 Frequency: the energy calibration is performed once per detector. The source is not geometry specific.
  - 10.2.1.2 A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include significant changes in instrument operating parameters, and major instrument maintenance (e.g. replacing the detector)
  - 10.2.1.3 Except in specific instances, it is NOT acceptable to remove points from a calibration curve for the purpose of meeting criteria. Refer to Section 10.1.
  - 10.2.1.4 Range: the energy range is determined by the sample matrix e.g. 46.54 to 1836.1 keV.
  - 10.2.1.5 Criteria:
    - 10.2.1.5.1 The curve should have, at minimum, eight calibration points used to determine the energy relationship of the calibration.
    - 10.2.1.5.2 The energy difference (delta Δ) should be within 0.05% for all calibration points or within 0.2 keV for the calibration points.
    - 10.2.1.5.3 The FWHM must be less than 3.0 keV at 1332 keV.
    - 10.2.1.5.4 FWHM difference (delta Δ) should be within 8% for all calibration points.
- 10.2.2 Efficiency Calibrations
  - 10.2.2.1 Frequency: the efficiency calibration is performed per geometry.
  - 10.2.2.2 A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include significant changes in instrument operating parameters, and major instrument maintenance (e.g. replacing the detector).
  - 10.2.2.3 Except in specific instances, it is NOT acceptable to remove points from a calibration curve for the purpose of meeting criteria. Refer to Section 10.1.
  - 10.2.2.4 Range: the energy range of the calibration is determined by the sample matrix e.g.. 46.54 to 1836.1 keV.
  - 10.2.2.5 Broad-Range Energy/Efficiency Curve Criteria:
    - 10.2.2.5.1 The curve should have at least eight points to determine the efficiency.
    - 10.2.2.5.2 The calibration source must have radionuclides that "bracket" the intended range of calibration.
    - 10.2.2.5.3 A minimum of 10,000 counts will be accumulated for each data point.
    - 10.2.2.5.4 The efficiency difference (delta Δ) should be within 8% of the true value for each point, except when utilizing the True Coincidence Correction (TCC) calibration. In the TCC calibration, the nuclides subjected to significant coincidence events (e.g. Cs-134, Y-88) will appear to be biased low and the lowest energy point (e.g. Pb-

210 at 46.5 keV) may have greater variance. This is to be expected, and the apparent bias is corrected in the samples for these nuclides through the TCC correction function of the software. After reprocessing the calibration count using the new TCC calibration, all points should fall within 8% of the true/expected value for each point.

10.3 Initial Calibration Verification (ICV) [Frequency: Once]

10.3.1 An initial calibration verification standard must be a different standard source than the one used for the initial calibration.

10.3.1.1 The ICV check does not include short half-life nuclides which may exist in the purchased standard. At a minimum, the ICV will always contain Am-241 (low), Cs-137 (medium) and Co-60 (high).

10.3.2 An ICV must be performed with every initial calibration.

10.3.3 The ICV percent recovery must be within ± 10% of the true value for each nuclide.

10.3.4 Not meeting this requirement may be indicative of serious system malfunction or inaccuracies in the standards used for the initial calibration curve or ICV standard. Corrective action must be taken (including reanalysis of the ICV, or analysis of a different ICV). Any decision to proceed with analysis of samples when the ICV is out-of-control must be taken with great care and in consultation with the QA department and the laboratory director. Any such action must be documented in an NCM.

10.4 Daily Checks

10.4.1 The detector **background** shall be checked each day that the germanium spectroscopy system is used. Limits are set at 2 sigma and 3 sigma.

10.4.1.1 <u>Bkgd Countrate (background count rate for entire spectrum)</u>

Tolerance (warning)	=	± 2 σ
Control (out)	=	± 3 σ

10.4.2 The instrument **Channel**, **Energy**, **FWHM** (resolution) and **Activity Difference** (efficiency) for a detector shall be checked each day the germanium spectroscopy system is used (using a check source that is non-geometry specific).

10.4.2.1 **Channel** – (low and high energy) is monitored for channel alignment. Limits are set around the target Channel.

10.4.2.1.1	QA-60	<u>Low Energy</u>		
		Tolerance (warning)	=	± 1 channel
		Control (out)	=	± 2 channels
10.4.2.1.2	QA-1332	<u>High Energy</u>		
		Tolerance (warning)	=	± 2 channels
		Control (out)	=	± 3 channels

10.4.2.2 **Energy** – (low and high energy) is monitored for energy alignment. Limits are set around a target energy.

10.4.2.2.1	QA-60	<u>Low Energy</u>		
		Tolerance (warning)	=	± 0.25 keV
		Control (out)	=	± 0.50 keV
10.4.2.2.2	QA-1332	<u>High Energy</u>		
		Tolerance (warning)	=	± 0.5 keV
		Control (out)	=	± 0.75 keV

10.4.2.3 Full-Width at the Half Maximum (**FWHM**) - (low, mid, and high energy) is monitored for peak shape There are no limits compared to a target FWHM. There are no lower limits (–) set for FWHM.

10.4.2.3.1	QA-60	<u>Low Energy</u>		
		Tolerance (warning)	=	+ 1.1
		Control (out)	=	+ 1.2
10.4.2.3.2	QA-662	<u>Mid Energy</u>		
		Tolerance (warning)	=	+ 1.7
		Control (out)	=	+ 1.8

10.4.2.3.3 QA-1332 High Energy

Tolerance (warning)	=	+ 2.2
Control (out)	=	+ 2.3

10.4.2.4 **Activity Difference** (low, mid, and high energy) – is monitored to check the percent difference between the source activity and the reported activity. Limits are set around the target activity.

10.4.2.4.1 QA-60/662/1332 Low/Mid/High Energy

Tolerance (warning)	=	± 4
Control (out)	=	± 5

10.4.3 If the daily check is outside of the control limits, it may be recounted or tagged out with red tag (or with an NCM). The Daily QC check may only be recounted once without corrective action.

10.4.3.1 If the out of control parameter is found acceptable for the rerun, the instrument can be used for the analysis of samples. ***Note***: *No corrective action is necessary for this situation since the uncertainty can be attributed to the stochastic uncertainty of decay process (statistics), uncertainty of the sources, or a known uncorrected trend.*

10.4.3.2 If the instrument fails to meet the acceptance criteria for the rerun, the instrument must be declared "Out of Service". The detector/instrument must be "tagged out". (See ST-QA-0036 for NCM details regarding tagging out of service).

10.4.3.3 If the QC check fails the following day for the same detector for the same specific parameter as the day before, the instrument must be declared "Out of Service". The detector/instrument must be "tagged out" until the detector can be evaluated and/or maintenance can be performed.

10.4.3.4 The analyst may want to:

10.4.3.4.1 Check the expiration date of the radioactive standard to confirm the material is current, for the isotopes being utilized.

10.4.3.4.2 Check source positioning and all instrument settings.

10.4.3.4.3 Check all cables for any apparent damage and confirm that all cables are routed to proper connectors and are in good working order.

10.4.3.4.4 The instrument may be returned to service once the malfunction has been corrected and the above acceptance criteria have been met. Corrective actions must be noted in the instrument maintenance log.

10.4.3.4.5 If a parameter has two successive values in the warning limits, the system will be examined for a trend and noted in the maintenance log. Decisions will be based upon the Data Quality Objectives (DQO) and the degree of the bias in relation to the parameter.

10.5 Background

10.5.1 Background subtraction spectrum shall be established for the germanium spectroscopy systems **monthly**, or when the background quality control check indicates an unacceptable change in the daily background parameters, or as needed per client requirements.

10.5.1.1 Backgrounds count for a minimum of 12 hours.

10.5.1.1.1 If a client project requires a longer count time, then the background must be performed at the longer time before initiating analysis.

10.5.1.2 Monthly Background limits are set at 2 sigma and 3 sigma.

10.5.1.2.1 Bkgd Countrate (background count rate for entire spectrum)

Tolerance (warning)	=	± 2 σ
Control (out)	=	± 3 σ

10.6 Calibration Software Handling

10.6.1 Gamma Detector System Energy and Shape Calibration

10.6.1.1 Acquire a spectrum from a calibration standard in the manual mode for an appropriate duration. Save the spectrum to the path "C:\User\Cal\Spectra\DetX\OriginalCountfileName.spc" where:

10.6.1.1.1 X = Detector Number
10.6.1.1.2 Analysis method
10.6.1.1.3 Select library
10.6.1.1.4 Enter correct sample data.
10.6.1.1.5 Enter correct conversion time.

10.6.1.2 Close all detectors windows in the current instance of gamma vision, then recall the appropriate calibration spectrum into the buffer window.

10.6.1.3 Select the menu "Analyze\Setting\Sample type…."

10.6.1.4 Select the browse button next to the "File" field and open the file. Click the "OK" button of the window to close it.

10.6.1.5 Recall the application Calibration File from the menu "Calibration \Recall Calibration…"

10.6.1.6 Select the menu "Calibrate\Calibration wizard…"

10.6.1.7 Select the option to create new energy calibrations. Select the next button.

10.6.1.8 On the energy calibration wizard page, select the file "DET_EnergyStandardMix Lib" or appropriate library for mixed gamma used the browser button if desired. Select the next button.

10.6.1.9 Select the next button to perform the energy, FWHM.

10.6.1.10 Select the edit energy button to review the energy.

10.6.1.10.1 Close the energy calibration sidebar window.

10.6.1.11 Select the save calibration button and save the calibration to "Cal\Energy\X_Energy.clb" where X is the detector.

10.6.1.12 Enter the calibration description in the format "X_ENERGY_GEOMETRY" where X is the detector number and Geometry is an appropriate geometry description when prompted. Select the Finish button to close the calibration wizard.

10.6.1.13 Print the calibration report from the menu "Calibrate \print calibration.

10.6.2 Gamma Detector System Efficiency Calibration

10.6.2.1 Acquire a spectrum from a calibration standard in the manual mode for an appropriate duration. Save the spectrum to the path "C:\User\Cal\Spectra\DetX\OriginalCountfileName.spc" where:

10.6.2.1.1 X = Detector Number
10.6.2.1.2 Analysis method
10.6.2.1.3 Select library
10.6.2.1.4 Enter correct sample data.
10.6.2.1.5 Enter correct conversion time.

10.6.2.2 Close all detector windows in the current instance of Gamma Vision, then recall the appropriate calibration spectrum into the buffer window.

10.6.2.3 Select the menu "Analyze\Setting\Sample Type".

10.6.2.4 Select the browse button next to the "File", field and open the file. Click the "OK" button at the bottom of the window to close it.

10.6.2.5 Recall the applicable calibration file from the menu "Calibration\Recall Calibration" (if the geometry file currently exists).

10.6.2.6 Select the menu "Calibrate\Calibration Wizard".

10.6.2.7 Select the option to create new energy and efficiency calibration. Select next button.

10.6.2.8 On the Energy Calibration Wizard page select the file "EnergyStandardMix Lib" or appropriate library for mixed gamma used the browser button if desired. Select the Next button.

10.6.2.9 On the Efficiency Calibration Wizard page, select library file, "DET_EfficiencyCalibration.Lib" for mixed gamma sources.

10.6.2.10 On the Efficiency Calibration Wizard page, select the appropriate Certification file from the directory.

10.6.2.11 Select the next button to perform the energy FWHM and efficiency calibration.

10.6.2.12 Select the Edit Energy button to review the energy and FWHM Calibration.

10.6.2.12.1 Close the Efficiency Calibration side window.

10.6.2.13 Select the save calibration button and save the calibration to Cal\X_Geometry.clb" where X is the detector and geometry is an appropriate geometry name.

10.6.2.14 Enter the calibration description in the format "x_Geometry_Source number_date counted" where X is the detector number and geometry is an appropriate geometry description when prompted. Select the finish button to close the calibration wizard.

10.6.2.15 Print calibration report from the menu "Calibrate\Print Calibration".

10.6.2.16 Select "Analyze", select "Entire spectrum in memory" and file print.

10.6.2.17 Close the spectrum Buffer window and save the spectrum when prompted.

10.6.3 Detector Long Background Counting

10.6.3.1 Remove any samples from the detector, clean the detector, close the shield lid and start acquisition.

10.6.3.2 Select detector 1 in global value quick Start.

10.6.3.3 Select Monthly Background PBC under Automation Groups.

10.6.3.4 Select Background PBC Long Count under Automation Jobs.

10.6.3.5 Login using name and password.

10.6.3.6 Select "OK", ensure detector cave is empty.

10.6.3.7 Repeat for each detector which background you would like to start.

10.6.3.8 After the background is complete it will save as a PBC file.

10.7 Evaluation of Controls for Trends

10.7.1 Identified controls shall be evaluated for trends at a minimum frequency of 1 month, but as often as deemed by analysts. The controls and trending rules are listed below (see appendix for list of trending rules).

10.7.1.1 Background FWHM, Centroid (by engergy), Efficiency

10.7.1.1.1 Trending Rules 2, 3 & 6

10.7.1.2 Source FWHM, Centroid (by engergy), Efficiency

10.7.1.2.1 Trending Rules 2, 3 & 6

11.0 PROCEDURE

11.1 Calibration Quality Control (**Daily Check**)

11.1.1 Place the calibration quality control sample on the detector, and start acquisition.

11.1.2 Select detector from global value quick sstart.

11.1.3 Select Quality Control under Automation Groups.

11.1.4 Select Daily Quality Control Check under Automation Jobs.

11.1.5 Login with user name and password.

11.1.6 Select "OK", ensure source is on detector.

11.1.7 Repeat for each detector.

11.1.8 Record in the instrument run log.

11.2 Background Quality Control (**Daily Background**)

11.2.1 Remove any samples from the detector, and start acquisition.

11.2.2 Select detector global value quick start.

11.2.3 Select quality control under automation groups.

11.2.4 Select daily background check under automation jobs.
11.2.5 Login with username and password.
11.2.6 Select "OK", ensure detector cave is empty.
11.2.7 Repeat for each detector.
11.2.8 Record in the instrument run log.

11.3 Sample Counting
11.3.1 Place the sample on the detector.
11.3.2 Select detector from global value quick start.
11.3.3 Select analyze samples under automation groups.
11.3.4 Select count sample under automation jobs.
11.3.5 Login with username and password.
11.3.6 Scan sample description from barcode report.
11.3.7 Select analysis method, sample type, geometry, library, correct date, count time, and continue.
11.3.8 Select "OK", ensure sample is on detector.
11.3.9 Record in the instrument run log.

11.4 Analysis/Analyte Specific Considerations
11.4.1 Analysis library
11.4.1.1 The analysis library, if supplied by the laboratory, should use nuclide energy lines and abundances from the table of isotopes edited by Gerhard Erdtmann and Werner Soyka.
11.4.1.2 The analysis library used should be representative of the types of analytes expected to be seen in the project samples.
11.4.1.3 The analysis library may be supplied by the client, defining their project-specific analytes, assumptions, energy lines, and abundances.
11.4.2 Ra-226 analysis using the nuclide's 185.99 keV peak
11.4.2.1 Ra-226 may be analyzed using the 3.28% abundant peak at 185.99 keV. This analysis may be performed using any geometry any time after preparation of the sample (including "0-day"). Ra-226 as a nuclide must be included in the analysis library with the abundance and energy listed.
11.4.2.1.1 Note: The 54% abundant 185.72 keV gamma ray emission of U-235 may produce a significant interference. This can produce high-bias to Ra-226 due to counts from the higher-abundant U-235 peak being mis-classified into the Ra-226 peak. However, there are circumstances where the opposite may occur (Ra-226 counts "lost" into the U-235 peak), producing a low bias. The client should be aware of the potential interferences.
11.4.3 Ra-226 inferred from Bi-214 after 21-days of ingrowth
11.4.3.1 Ra-226 may be inferred from the Bi-214 daughter after ingrowth in a sealed container devoid of headspace. This is the preferred means for determining Ra-226 by gamma spectrometry.
11.4.3.1.1 The ideal ingrowth period is 21-days (or longer), resulting in nearly complete secular equilibrium of the decay chain through Rn-222 down to the Bi-214 progeny. Other client-requested ingrowth periods (e.g. 14-days, 10-days, 7-days) may be used, but a NCM should be written stating the reported Ra-226 result may be low-biased due to the shorter ingrowth period.
11.4.3.1.2 The container should be reasonably well sealed to ensure gaseous Rn-222 does not escape the container.
11.4.3.1.3 The container (geometry) should not have significant headspace, into which Rn-222 could escape, ultimately resulting in a low bias. If such a geometry is used (e.g. due to limited aliquot provided by the client), a NCM should be written.

11.4.4 Other inferences:

11.4.5 Oftentimes nuclides, which may not have any reasonable gamma emissions, are reported based upon either shorter-lived daughters or a longer-lived parent, assuming secular equilibrium between the two. The half-life used for any decay corrections should be that of the longer-lived parent. Note: Such assumptions should be evaluated by the client as to appropriateness to their sample type. For example, Th-232 is often inferred from the Ra-228 daughter. While this is a good assumption for most soil samples, this is likely not a good assumption for an oil & gas flowback water. Common inferences ("re-maps") include:

input analyte	remapped to analyte
Ac-227	Th-227
Ac-228	Th-232
Ac-228	Ra-228
Ag-108m	Ag-108
Bi-214	Ra-226
Cs-137	Ba-137m
Pb-210	Po-210
Pb-210	Bi-210
Pb-212	Th-228
Pb-212	Ra-224
Rh-106	Ru-106
Sb-125	Te-125m
Th-227	Ra-223
Th-227	Ac-227
Th-227	Bi-211
Th-227	Pb-211
Th-231	U-235
Th-234	Pa-234
Th-234	U-238
U-235	Th-231

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Commonly used calculations (e.g. % recovery and RPD) and standard instrument software calculations are given in the TestAmerica St. Louis ST-QAM.

12.2 All calculations are performed in GammaVision-32 software; conversions are performed in RadCapture. Calculations are found in ST-QAM.

12.3 Other Detectable Radionuclides (ODRs - Identified as TICs in LIMS) when requested shall be evaluated when the activity to MDC ratio (Act/MDC) is above two (2) unless specified by the Client Requirement Memo (CRM) or by project notes in LIMS.

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 The data assessment and corrective action process is detailed through the LIMS Nonconformance Memorandum (NCM) process. The NCM process is described in SOP: ST-QA-0036.

13.2 Method Blank (**MB**)

13.2.1 Acceptance Criteria:

13.2.1.1 No target analytes may be present in the method blank above the requested reporting limit (RL). If no requested limit is assigned to the analyte(s), the activity to MDC ratio (Act/MDC) shall be below two (2). No further action would be required at that point.

13.2.1.2 Project specific requirements, if more stringent than our routine procedure (e.g. no target anlaytes present above ½ RL), will be noted on the Client Requirement Memo or in project notes in LIMS..

13.2.2 Corrective Action for Method Blanks not meeting acceptance criteria:

13.2.2.1 Method Blank Contamination – If the method blank exhibits activity above the limits/criteria (see Section 13.2.1), the affected analytes shall be evaluated to determine possible force fitted peak, or unsupported energy lines using the Gamma Vision™ raw data reports. If the contaminant is found to be unsupported, the analyst will narrate findings in an NCM.The blank may be re-counted once to confirm the activity. The recount can be used to report only the affected analyte(s); the original count can be used to report all unaffected analyte(s) if the analyst finds no additional error in the original count. If the re-counted MB activity exceeds the criteria/limit further evaluation will be performed and narrated accordingly. Note that certain analytes are common laboratory contaminants which require special narration.

13.3 Laboratory Control Sample (**LCS**)

13.3.1 Acceptance Criteria:

13.3.1.1 All control analytes must be within the specified control limits for accuracy (%Recovery) and precision (RPD).

13.3.2 Corrective Action for LCS not meeting acceptance criteria:

13.3.2.1 LCS Spike Recovery excursion (high) – The LCS may be re-counted once to confirm the result. If the re-counted LCS exceeds the control limit, samples that are non-detect may be reported with an NCM.

13.3.2.2 LCS Spike Recovery excursion (low) – The LCS may be re-counted once to confirm the result. If the low recovery is confirmed, the batch is recounted.

13.3.2.3 RPD/RER Duplicate excursion – The LCS is recounted if both RPD and RER exceed criteria.

13.4 Duplicate

13.4.1 Acceptance Criteria:

13.4.1.1 All control analytes must be within the specified control limits for precision (RPD), max. 40% RPD, RER < 1.

13.4.2 Corrective Action for Duplicate not meeting acceptance criteria:

13.4.2.1 RPD/RER Duplicate excursion – The sample is recounted if both RPD and RER exceed criteria.

13.5 Insufficient Sample

13.5.1 For any prescribed re-preparation corrective action, if there is insufficient sample to repeat the analysis a narrative comment stating such is included in the report narrative. The insufficient sample description is included in the LIMS NCM within the type

defining the excursion.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1 Method performance data, Reporting Limits, and QC acceptance limits, are documented in LIMS.

14.2 Demonstration of Capability

14.2.1 Initial and continuing demonstrations of capability requirements are established in the ST-QAM.

14.3 Training Qualification

14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2 The analyst must have successfully completed the initial demonstration of capability requirements prior to working independently. See requirements in the ST-QAM.

14.4 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in the ST-QAM.

15.0 VALIDATION

15.1 Laboratory SOPs are based on published methods (EPA, DOE, ASTM, Eichrom, Standard Methods) and do not require validation by the laboratory. The requirements for laboratory demonstration of capability are included in the ST-QAM. Laboratory validation data would be appropriate for performance based measurement systems, non-standard methods and significant modifications to published methods. Data from said validations is held in the QA department.

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Environmental Health and Safety Manual for "Waste Management and Pollution Prevention."

17.0 REFERENCES

17.1 Department of Energy (DOE) Environmental Monitoring Laboratory (EML) HASL-300 28th Edition, method GA-01-R, Gamma Radioassay
17.2 EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water Method 901.1
17.3 American National Standards Institute (ANSI) Accredited Standards Committee on Radiation Instrumentation, N42; ANSI N42.14-1999, American National Standard for Calibration and Use of Germanium Spectrometers for the Measurement of Gamma-Ray Emission Rates of Radionuclides
17.4 Ortec MCB Connections-32, Hardware Property Dialogs Manual, current version
17.5 MAESTRO–32, MCA Emulator, current version
17.6 GammaVision–32, Gamma-Ray Spectrum Analysis and MCA Emulator, current version
17.7 Master library Source: Gerhard Erdtmann, Werner Soyka
17.8 TestAmerica Quality Assurance Manual (ST-QAM), current revision

17.9 TestAmerica Corporate Environmental Health and Safety Manual (CW-E-M-001) and St. Louis Facility Addendum (SOP ST-HS-0002), current revisions.
17.10 TestAmerica Policy CA-T-P-0002, Selection of Calibration Points
17.11 Associated SOPs, Current Revision:
- 17.11.1 ST-RC-0003, Drying and Grinding of Soil and Solid Samples
- 17.11.2 ST-RC-0004, Preparation of Soil Samples for Radiochemical Analysis
- 17.11.3 ST-RC-0025, Preparation of Samples for Gamma Spectroscopy
- 17.11.4 ST-QA-0002, Standards and Reagent Preparation
- 17.11.5 ST-QA-0014, Evaluation of Analytical Accuracy and Precision Through the Use of Control Charts
- 17.11.6 ST-QA-0036, Non-Conformance Memorandum (NCM) Process

18.0 CLARIFICATIONS, MODIFICATIONS TO THE REFERENCE METHOD

18.1 None.

19.0 CHANGES FROM PREVIOUS REVISION

19.1 Annual Review, No Changes.
19.2 Revision 8:
- 19.2.1 Increased background count times from 12 to 36 hours in section 10.3.1.1.
- 19.2.2 Updated the procedure for detector long background counting in section 10.5 to reflect new software.
- 19.2.3 Updated daily calibration checks, daily background and sample counting procedures in section 11.0 to reflect new software.

19.3 Revision 9:
- 19.3.1 Replaced quartz sand with sodium sulfate to be used for soil method blanks in section 9.2.
- 19.3.2 Updated section 10.4 regarding instrument daily checks.
- 19.3.3 Updated data assessment and acceptance criteria in section 13.0
- 19.3.4 Updated section 9.0 regarding batch, method blank and laboratory control samples.
- 19.3.5 Updated the calibation points for an internal calibation in section 10.1.
- 19.3.6 Updated the percent recovery regarding the ICV in section 10.2.
- 19.3.7 Updated software storage file name throughout section 10.5.

19.4 Revision 10:
- 19.4.1 Updated references to QuantIMS through out
- 19.4.2 Update §10.1
- 19.4.3 Added §10.3 Annual Calibration Verification
- 19.4.4 Updated §10.4: 36 hour background changed to 12 hour and requirement to complete Attachment 2
- 19.4.5 Added Attachment 2, "Monthly Background Complete" example
- 19.4.6 Updated §13 references to Clouseau changed to LIMS
- 19.4.7 Added §17 reference to ANSI 42.14-1999

19.5 Revision 11:
- 19.5.1 Updated §1.4 with corrected termonolgy
- 19.5.2 Updated §6.0 software details
- 19.5.3 Additon/Update §10.0 major change in calibration
- 19.5.4 Updated §13.0 additional corrective action steps
- 19.5.5 Updated §15.0 with new verbiage

19.6 Revision 12: (04/16/2014)
- 19.6.1 Spelling and grammar corrections made throughout SOP.
- 19.6.2 Sections 10.2.3 and 10.2.5 had wording changed to common text.
- 19.6.3 Section 10.4.3.3 was updated to add 'for the same specific parameter as the day before' and 'until the detector can be evaluated and/or maintenance can be performed.'.

19.6.4 Section 10.5.1.2.1 was added to provide limits for monthly backgrounds, which were not previously provided.

19.6.5 Section 13.4.2 had 'LCS' changed to 'duplicate' since it is the duplicate section and LCS was incorrectly referenced.

19.7 Revision 13: (06/22/2015)

19.7.1 Section 10.5.1.1 was updated to say "Backgrounds count for a minimum of 12 hours" new wording.

19.7.2 Section 10.6.3.2 updated captialzation "global value quick".

19.7.3 Section 11.1.2 updated capitalization "global value quick start".

19.7.4 Section 111.3.2 updated capitalzation "global value".

19.7.5 Section 11.3.7 updated to say "and continue." new wording.

19.8 Revision 14: (05/23/2016)

19.8.1 Trending evaulation added to section 10

19.8.2 Appendix with trending rules added

19.9 Revision 15 (5/2/2017)

19.9.1 True Coincidence Correction (TCC) calibration.onformation added to Section 10.1

19.9.2 Trending Rules changed from 2,3,and 5 to 2,3,and 6

19.10 Revision 16 (12/12/2017) Technical Review: R. Mueller/QA Review: M Ward)

19.10.1 Section 10.1.2.55 changed/edited

19.10.2 Section 10.3 removed ACV mention; ACV is no longer performed

19.11 Revision 17 (3/9/2018) Technical Review: T. Romanko/Rachel Mueller / QA Review: M. Ward

19.11.1 Section 10.4.1.1.2 removed no longer utilized

19.11.2 Added Section 11.4: Analysis/Analyte Specific Considerations

19.11.3 Section 9.1 – fixed SOP reference

19.11.4 Added Section 10.1

19.11.5 Section 10.5.1.1.2 removed

19.11.6 Attachment 2 removed (Monthly Background Complete form); no longer posted

19.11.7 Added Section 12.3 – ODR information

19.11.8 Section 13.2 – added Method Blank criteria

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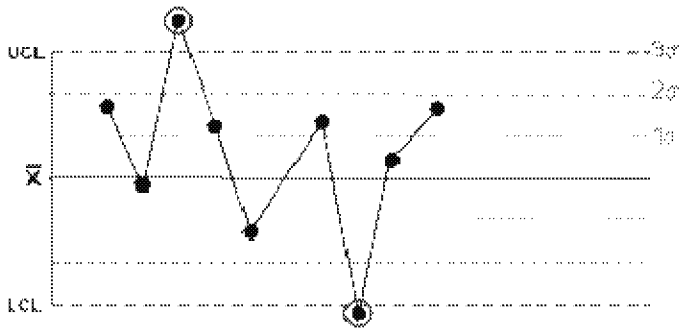
Appendix

Rule 1: One point is more than 3 standard deviations from the mean.

~ Simplest: Single point is considered out of control event

- Corrective action required



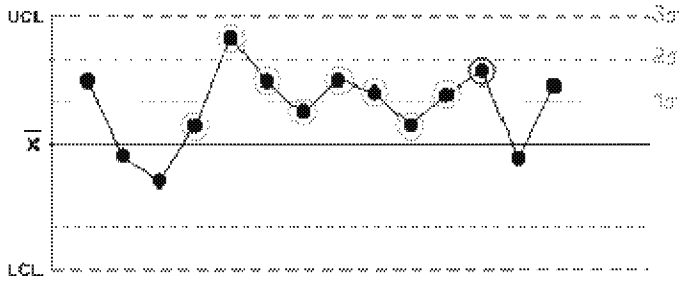
Rule 2: Seven (or defined 'n') points in a row are on the same side of the mean.

~ n = 7 warn trigger

- Mean shift: (same side of mean)

- Some prolonged bias exists.

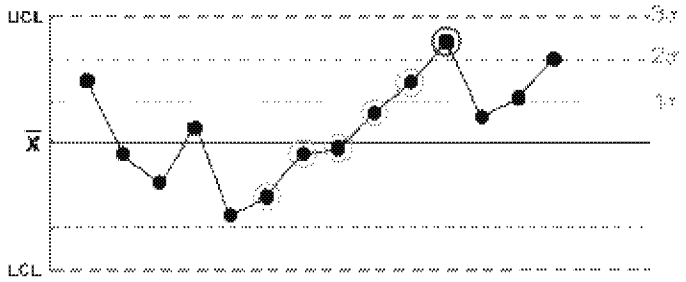
~ Corrective action recommended



Rule 3: Six (or more) points in a row are continually increasing (or decreasing).

- A trend exists.

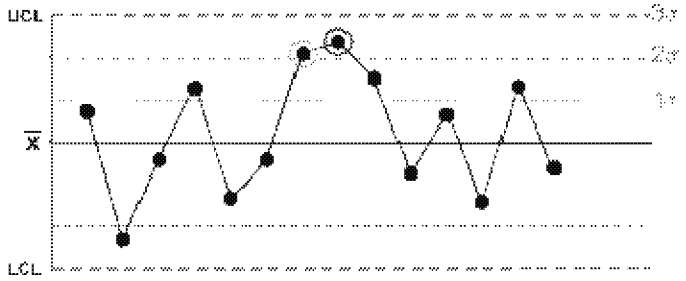
  ~ Corrective action recommended



Rule 5: Three out of three points in a row are more than 2 standard deviations from the mean in the same direction.

- There is a medium tendency for samples to be mediumly out of control.

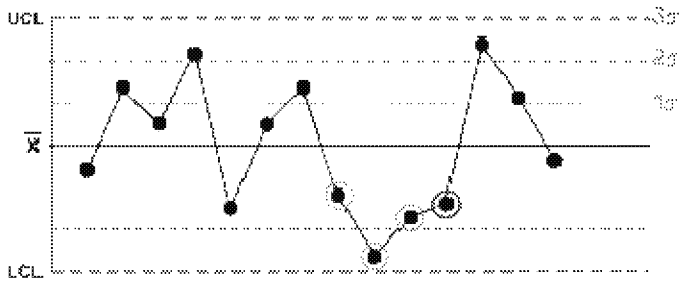
  ~ Investigate for preventive. May not be CAR



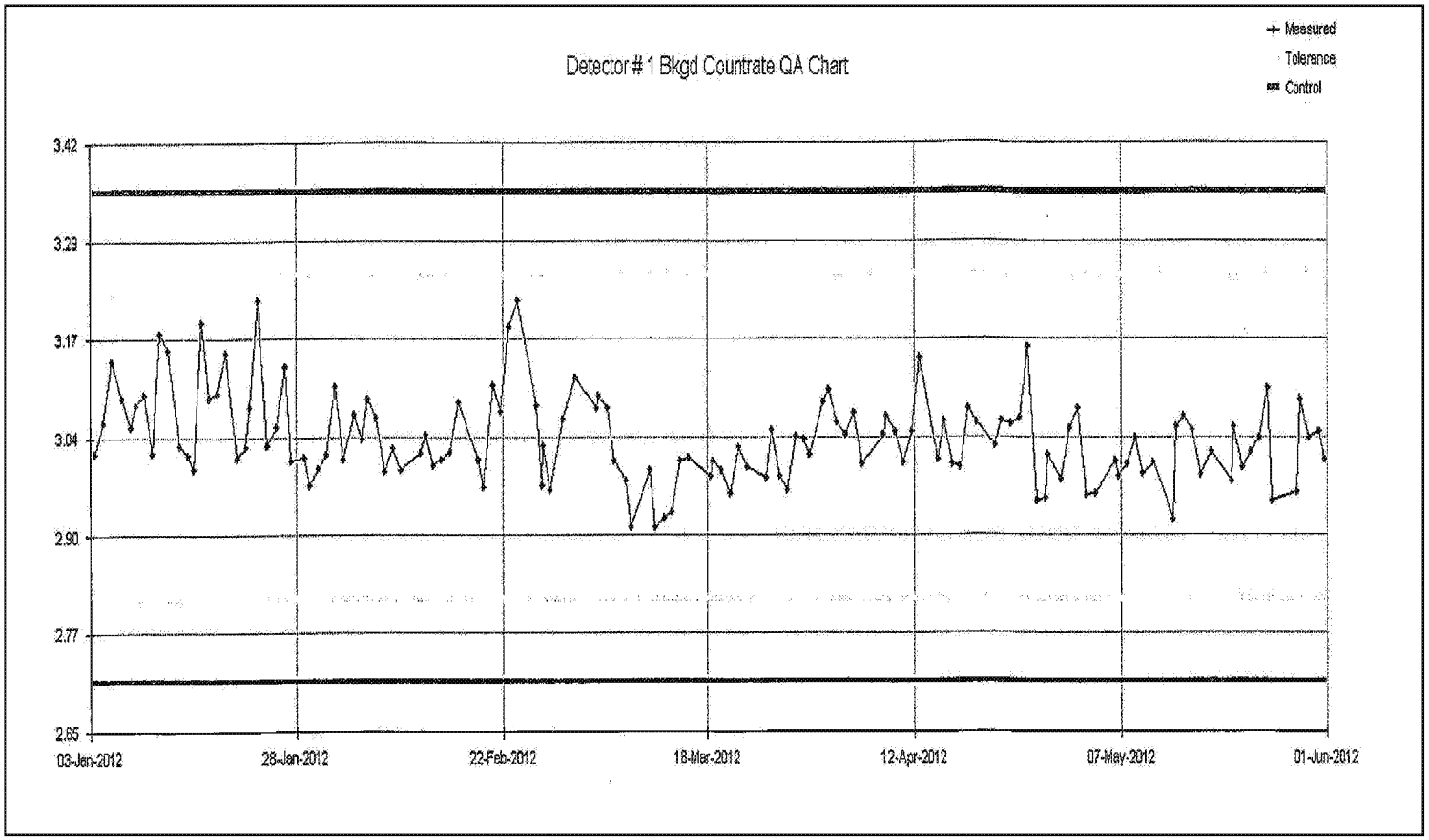
Rule 6: Four out of five points in a row are more than 1 standard deviation from the mean in the same direction.

- There is a strong tendency for samples to be slightly out of control.

  ~ No CAR, Statistical trend



Attachment 1



Title: ALPHA SPECTROSCOPY ANALYSIS [DOE HASL-300 A-01-R]

Approvals (Signature/Date):

3-8-18 Rachel Mueller — Date Radiochemistry Count Room Manager	3/8/18 Michael Ridenhower — Date Health & Safety Manager / Coordinator
3/9/18 Kristen Ely — Date Quality Assurance Manager	3-8-18 For Jodie Carnes — Date Laboratory Director Andrew Buettner

This SOP was previously identified as SOP No. ST-RD-0210 Rev. 14

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1.0 SCOPE AND APPLICATION

1.1 This procedure applies to alpha spectroscopy detectors and the computer assisted alpha spectroscopy analysis systems, using AlphaVision software.

1.2 This SOP is based on DOE method A-01-R

1.3 This SOP is applicable to both liquid and solid matrices.

1.4 The requested limits (RL), minimum detectable amount (MDA) and QC limits are maintained in the Laboratory Information Management System (LIMS).

2.0 SUMMARY OF METHOD

2.1 This SOP provides detailed instructions for energy calibration, efficiency determination, quality control checks, background and sample counting of the alpha spectroscopy system.

3.0 DEFINITIONS

3.1 See the TestAmerica St. Louis Quality Assurance Manual (ST-QAM) for glossary of common terms and data qualifiers.

3.2 Tracer – A known amount of ^{232}U, ^{242}Pu or ^{236}Pu, ^{243}Am, ^{209}Po, ^{244}Cm or ^{229}Th (depending on analyte(s) required) added to each sample to determine chemical yield. The tracer serves as an internal standard, which is used to calculate the activity of the target isotopes.

3.3 Region of Interest (ROI) – The keV range through which the target isotope peak signal responds.

3.4 keV - (kilo electron Volt) – electron volt is a unit of energy defined as the amount of energy gained (or lost) by the charge of a single electron moved across an electric potential difference of one volt.

3.5 Tailing – Tailing is a delayed return of a peak to chromatographic baseline or continuation of response beyond its normal response window (RT window, ROI) due to high concentration of the analyte or matrix interference.

3.6 AlphaVision – The Alpha Spectrometer data collection and processing software.

4.0 INTERFERENCES

4.1 Alpha spectrometry has many potential interferences. These are usually in the form of radionuclides with unresolved alpha emissions. Poorly resolved alpha peaks are often due to high alpha activity rates or attenuation of the alpha emissions.

4.2 Isotope peak responses, when sufficiently high, may tail into other isotope ROI. Th-229 tailing into the Th-230 region of interest is a recognized example. This interference is minimized by maintaining low activities of the Th-229 tracer and monitoring of the separation of the ROI for Th-229 and Th-230. The use of manual integration may be required.

4.3 Some isotopic elements are not distinguishable and are reported as an isotopic pair, unless specifically directed by the client not to do so. These pairs may be reported separately depending

on the client's DQO and the use-ability of the data. When reported separately, the narrative must describe the technical aspects of how the isotopic pair was divided.

4.3.1 Recognized Isotopic Pairs:

4.3.1.1 Plutonium-239/240
4.3.1.2 Uranium-235/236
4.3.1.3 Uranium-233/234
4.3.1.4 Curium-245/246
4.3.1.5 Curium-247/248

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS
None.

5.3 PRIMARY MATERIALS USED
None.

6.0 EQUIPMENT AND SUPPLIES

6.1 Alpha spectroscopy system utilizing a computer based data acquisition system.

6.1.1 Hardware – Octete Plus and Alpha Ensemble
6.1.2 Software – AlphaVision and Radcapture

7.0 REAGENTS AND STANDARDS

7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP ST-QA-0002, current revision.

7.2 Commercially prepared alpha standards for the isotopes Th-230, Pu-239 and Am-243.

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in ST-PM-0002.

9.0 QUALITY CONTROL

9.1 See actinide preparation SOPs for additional information regarding QC types, frequency and preparation

9.2 **Batch**

9.2.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and the same reagent lot(s).
9.2.2 Instrument conditions must be the same for all standards, samples and QC samples.
9.2.3 For this analysis, batch QC consists of a Method Blank (MB), a Laboratory Control Sample (LCS), and Sample Duplicate (Dup). In the event that there is insufficient sample to analyze a sample duplicate, a LCS Duplicate (LCSD) is prepared and analyzed.
9.2.3.1 Matrix Spike (MS) and Matrix Spike Duplicate (MSD) may be performed upon client request, and are noted in the Client Requirement Sheets and Log-in.

9.3 **Method Blank (MB)**
9.3.1 A method blank is a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure.
9.3.2 A method blank must be prepared with every sample batch.

9.4 **Laboratory Control Sample (LCS)**
9.4.1 A LCS is a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.
9.4.2 A LCS must be prepared with every sample batch.

9.5 **Matrix Spike (MS)**
9.5.1 A Matrix Spike is an aliquot of a field sample to which a known amount of target analyte(s) is added, and is processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.6 **Sample Duplicate (Dup)**
9.6.1 A Sample Duplicate is an additional aliquot of a field sample taken through the entire analytical process to demonstrate precision.

9.7 **Procedural Variations/ Nonconformance and Corrective Action**
9.7.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA, see SOP ST-QA-0036 for details regarding the NCM process.
9.7.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA, see SOP ST-QA-0036 for details regarding the NCM process.

10.0 INSTRUMENT SETUP, CALIBRATION, AND STANDARDIZATION

10.1 Initial instrument setup is performed when the instrument is first installed, when a detector or chamber is changed/replaced, when a chamber is returned from the manufacturer after servicing, or other such circumstances. The following steps should be taken to ensure proper setup. Steps may be accomplished either through hardware knobs/potentiometers or through software settings (depending upon the system hardware/software). See the hardware and/or software manual to determine further detailed instructions:
10.1.1 Set the conversion gain to 1024 channels.
10.1.2 Adjust the coarse and fine gain as well as the offset to adjust the location of the three peaks of the alpha source such that the lower energy peak (Th-230 at 4688 keV) falls into channel 176, the mid-energy peak (Pu-239 at 5155 keV) falls into channel 239, and the higher energy peak (Am-241 at 5486 keV) falls into channel 283. Note that this results in 107 channels between the low energy and high energy peaks (about 7.46 keV/channel with offset

of approximately 3375 keV). Ensure each peak is within 2 channels of the desired channel before beginning energy and efficiency calibrations.

10.1.2.1 Gain adjustment:

10.1.2.1.1 Turning the knob counter-clockwise decreases the gain (decrease the value in the fine gain for software adjustment), causing the spectrum peaks to move closer to each other (smaller keV/channel slope) and toward the lower energy.

10.1.2.1.2 Turning the knob clockwise increases the gain (increase the value in the fine gain for software adjustment), causing the spectrum peaks to spread apart (larger keV/channel slope) and toward higher energy.

10.1.2.2 Offset adjustment:

10.1.2.2.1 Increasing the offset moves the peak/spectra toward the the left (lower channel number) without altering the keV/channel (slope).

10.1.2.2.2 Decreasing the offset moves the peak/spectra toward the right (higher channel number) without altering the keV/channel (slope).

10.1.3 Adjust the pulser setting such that the pulser peak is centered at about channel 222 (approximately 5 MeV).

10.2 Calibrations

10.2.1 Energy calibrations shall be performed for the alpha spectroscopy systems <u>yearly</u>, or when a calibration quality control check indicates an unacceptable change in the energy calibration parameters.

10.2.1.1 Energy Calibrations shall be performed using at least three isotopes within the energy range of 3-6 MeV.

10.2.1.2 Typical isotopes used are Th-230, Pu-239, and Am-241. The energy vs. channel slope should be less than 15 keV per channel. The Full Width Half Maximum (FWHM) must be less than or equal to 100 keV for each peak. Final peak energy positions of all observed isotopes shall be within ± 2.5 channels (~20 keV) of expected channel/energy (see 10.1.2). The actual energy vs. channel and the equation with the slope is not calculated. Setting the peaks to within 2.5 channels of expected will ensure calculations utilizing fixed Regions of Interest (ROI) for each isotope will provide accurate results with minimal need for manual adjustment of ROI.

10.2.1.3 Routine pulser checks and continuing calibration verifications (see below) will help control/monitor for drift.

10.2.2 Efficiency calibrations (initial calibrations or IC) shall be established for the alpha spectroscopy systems <u>yearly</u>, or when a calibration quality control check indicates an unacceptable change in the efficiency calibration parameters.

10.2.2.1 A minimum of 3000 net counts must be collected for each peak in the calibration. Calibrated efficiency should fall between 20% and 32%. Values outside this range do not constitute a failure. However, if the calibrated efficiency does fall outside this range, an evaluation of the suitability of the detector for use should be performed and documented.

10.2.3 Initial calibration verifications (ICV) shall be performed utilizing an independent second source following the initial calibration.

10.2.3.1 A minimum of 2000 net counts must be collected for each peak in the ICV. The efficiency of the ICV must fall within 95%-105% of the initial calibration efficiency value. The Full Width Half Maximum (FWHM) must be less than or equal to 100 keV for each peak. Each peak must fall within 20 keV of the corresponding calibration peak in the initial calibration (IC).

10.2.3.2 A second level review will be perfomed before detectors are placed into service and will be noted as acceptable in the electronic monthly maintenance log.

10.3 Continuing Calibration Verification (CCV)

10.3.1 A continuing calibration verification shall be performed on a monthly basis.

10.3.1.1 A minimum of 2000 net counts must be collected for each peak in the CCV. The efficiency should fall within 95%-105% of the calibrated efficiency. The Full Width Half Maximum (FWHM) must be less than or equal to 100 keV for each peak. Each peak must fall within 30 keV of the corresponding calibration peak in the initial calibration (IC).

10.3.1.2 A second level review will be performed before detectors are placed into service and will be noted as accepable in the electronic monthly maintenance log.

10.4 Background subtraction spectrum (Initial Calibration Background or ICB) shall be established for the alpha spectroscopy systems monthly, or when the background quality control check indicates an unacceptable change in the daily background parameters.

10.5 Instrument Contamination Check (ICC) shall be performed weekly at minimum and after counting high activity samples (see section 11.9) . Must be a minimum four hour count duration.

10.6 Daily Checks (Pulsers)

10.6.1 Routine pulser quality control verifications are performed each day of use.

10.6.1.1 The pulser energy, peak centroid, peak resolution, peak area quality control for a detector shall be checked each day that the alpha spectroscopy system is used.

The limits for pulser centroid and pulser energy will be as below:

10.6.1.1.1 Gross counts must be within 5% of the average (20-point minimum) for each detector.

10.6.1.1.2 The peak resolution (FWHM) must fall within 10-20 keV.

10.6.1.1.3 The pulser centroid must fall within ± 5 channels of the average (20-point minimum) for each detector.

10.6.1.1.4 The pulser energy must fall within ± 40 keV of the average (20-point minimum) for each detector.

10.6.2 Routine calibration, background and pulser quality control parameters using the "Boundry" out-of-range test will be found unacceptable if the value is outside parameter tolerance.

10.6.2.1 The routine quality control check should be rerun to determine the statistical significance of the out of control parameter.

10.6.2.2 If the out of control parameter is found acceptable in the rerun, the investigation will be noted in the instrument maintenance log.

10.6.2.3 Check the integrity of the radioactive standard.

10.6.2.4 Check source positioning and all instrument settings.

10.6.2.5 Check all cables for any apparent damage and to confirm that all cables are routed to proper connectors and are in good working order.

10.6.3 If the instrument fails to meet the acceptance criteria, and the corrective actions above do not resolve the problem, the instrument must be "tagged" out of service (OOS) for the day see Attachment 1 for OOS tag example.

10.6.3.1 This is noted on the Alpha Spec Daily report (The report will display FAIL for criteria not met). The physical detector will be marked out of service with the date and initials of the analyst performing the daily check.

10.6.3.2 If a detector fails three consecutive days for the same criteria, the detector will be taken out of service until the problem is resolved. This is done by clicking on the detector in Alphavision. Right click on the detector, select detector properties, check the "out of service" box and fill in the description field briefly explaining the problem. Mark the detector with an OOS tag as a visual indicator of its status.

10.6.3.3 The instrument may be returned to service once the malfunction has been corrected and the above acceptance criteria have been met. Note any repairs in the maintenance log.

10.7 Calibration process in the Software

10.7.1 Alpha Detector System Energy and Efficiency Calibration (Initial Calibration- IC)

10.7.1.1 Print out the standards sheet for initial calibration (IC).
10.7.1.1.1 Location: \\STLFS01\Rad\alpha\Calibration_Sources
10.7.1.2 Load sources into the detector.
10.7.1.3 In the AlphaVision software, click on the Calibration icon.
10.7.1.4 Click on the detector to be calibrated.
10.7.1.5 Select Process and then select calibration from the dropdown menu.
10.7.1.5.1 The Calibration Explorer Window will appear.
10.7.1.6 In the General Window: scan the source name;AV(detector #)-date (with year month day format YYYYMMDD).
10.7.1.7 Choose the correct source template.
10.7.1.8 Click next.
10.7.1.9 In the Acquisition window, confirm count time of 140 minutes.
10.7.1.10 Click next.
10.7.1.11 In the Energy/Efficiency Calibration Window, confirm the correct source is used, and select which shelf the source is on. (This will be shelf 1) Make sure the 'Active' box is checked so the calibratoin is put in use immediately after calibration is processed.
10.7.1.12 Click next.
10.7.1.13 In the Report Window, select print on completion.
10.7.1.14 Click finish.
10.7.1.15 When count is complete, the Manual Energy and Efficiency Calibration Window will appear. In this window, select Calibration ROI, Click Calibrate, click Save.
10.7.1.16 Verify the efficiency is above 20% and below 32%.
10.7.1.17 Repeat for each detector.
10.7.1.18 Record the calibration in the Alpha Maintenance Log.

10.7.2 ICV Procedure

10.7.2.1 Print out the standards sheet for ICV.
10.7.2.1.1 Location: \\STLFS01\Rad\alpha\Calibration_Sources
10.7.2.2 Place the correct source into the detector.
10.7.2.3 In The AlphaVision software, click on the Calibration Icon.
10.7.2.4 Click on the detector to be calibrated.
10.7.2.5 Select Process and then select calibration from the dropdown menu.
10.7.2.6 The Calibration Explorer Window will appear.
10.7.2.7 In the General Window; scan the source name;AV(detector #)-date (with year month day format YYYYMMDD).
10.7.2.8 Choose the correct source template.
10.7.2.9 Click next.
10.7.2.10 In the Energy/Efficiency Calibration Window, confirm the correct source is used, and select which shelf the source is on. (This will be shelf 1).
10.7.2.11 Click next.
10.7.2.12 In the Report Window, select print on completion.
10.7.2.13 Click finish.
10.7.2.14 When the count is complete, the Manual Energy and Efficiency Calibration Window will appear. In this window, select Calibration ROI, click Calibrate and click Save.
10.7.2.15 Verify the efficiency is above 20% and below 32%.
10.7.2.16 Repeat for each detector.
10.7.2.17 Record the ICV in the Alpha Maintenance Log.
10.7.2.18 Open the AlphaVision Access database program in \\stlfs01\RAD\Alpha Tools\AV Tool (2003).mdb.
10.7.2.19 Select frm_QC_main from the form tab.
10.7.2.20 Enter date range.

10.7.2.21 Select system 1 for AlphaVision or system 2 for AlphaVision 1.
10.7.2.22 Select Get Cal Data.
10.7.2.23 Exit.
10.7.2.24 Select Check Ver to run the report and verify the ICV passes criteria.
10.7.2.25 For the Intitial Calibratin (IC), the detectors must have the box checked in the Cal Data window for that specific calibration and the previous year's IC must be unchecked and the 'do not use' box must be checked to ensure the correct calibration is being used.

10.7.3 CCV Procedure

10.7.3.1 Print out standards sheet for CCV on the network.
10.7.3.1.1 Location: \\STLFS01\Rad\alpha\Calibration_Sources
10.7.3.2 Load sources into the detectors.
10.7.3.3 In the AlphaVision software, click on the Calibration Icon.
10.7.3.4 Click on the detector to be calibrated.
10.7.3.5 Select process and then select calibration from the dropdown menu.
10.7.3.5.1 The Calibration Explorer Window will appear.
10.7.3.6 In the General Window; scan the source name;AV(detector #)-date (with year month day format YYYYMMDD).
10.7.3.7 Select correct source template.
10.7.3.8 Click Next.
10.7.3.9 In the Acquisition window, confirm count time of 60 mins.
10.7.3.10 Click Next.
10.7.3.11 In the Energy/Efficiency Calibration Window, confirm the correct source is used and select which shelf the source is on. (This will be shelf 1.)
10.7.3.12 Click next.
10.7.3.13 In the Report Window, select print on completion.
10.7.3.14 Click finish.
10.7.3.15 When the count is complete, the Manual Energy and Efficiency Calibration window will appear. In this window, select Calibration ROI, select Calibrate and Save.
10.7.3.16 Verify the efficiency is above 20% and below 32%.
10.7.3.17 Repeat for each detector.
10.7.3.18 Record the CCV in the Alpha Maintenace Log..
10.7.3.19 Open the AlphaVision Access database program in \\stlfs01\RAD\Alpha Tools\AV Tool (2003).mdb

10.7.3.20 Select frm_QC_Main from the form tab.
10.7.3.21 Enter date range.
10.7.3.22 Select system 1 for AlphaVision or system 2 for AlphaVision 1.
10.7.3.23 Select Get Cal Data.
10.7.3.24 Exit.
10.7.3.25 Select Check Ver to run the report and verify the CCV passes criteria.

10.7.4 Detector Background Process (ICB) (See Section 10.4)

10.7.4.1 Select the Batch Icon.
10.7.4.2 Select backgrounds from the Tool Bar.
10.7.4.3 Select Process.
10.7.4.3.1 This will open the General Window in Batch Wizard.
10.7.4.4 Name the background with month year format; MonthYYYY (e.g. January2015).
10.7.4.5 Select correct template (provided by analyst).
10.7.4.6 Click next.

10.7.4.7 In the Sample Window, add all detector names with the format: ICB;AV(detector)#.
10.7.4.8 Click next.
10.7.4.9 In the Acquisition Window, confirm count time is set at 960 minutes (or as long as the longest sample count time).
10.7.4.10 Click next.
10.7.4.11 In the Analysis Set Up Page, select Background Library and Background ROI, check the Use ROI box.
10.7.4.12 Click next.
10.7.4.13 In the Report Window, select print on completion.
10.7.4.14 Click finish.
10.7.4.15 The Detector Assignment worksheet will appear, assign detectors, and select start now.
10.7.4.16 Record the backgrounds in the instrument maintenance log.
10.7.4.17 The background spectrum will be processed by the software.
10.7.4.18 The detectors are identified by the color listed below corresponsing to the background counts

Counts in Region of Interest (i.e. Th230, Th232, U234, U238, Pu238, Pu239):

- 0-2 counts – Blue – Ultra Low Level
- 0-4 counts – Yellow – Intermediate Low Level
- 0-20 counts – Green – Low Level
- **Blue dot detectors – 0-20 counts- No Thorium samples can count on these detectors- Americium/Curium and Plutonium**

See Attachment 1 Detector Color Key

10.7.4.19 Detectors within each categorywith backgrounds above the counts listed are taken out of service for cleaning. A recount is allowed after the primary failure.
10.7.4.20 Detectors may also be removed from service when there is a visible peak present or at analyst judgment.
10.7.4.21 Backgrounds will be 2nd reviewed before placing into service and a notation of acceptable will be listed in the electronic monthly maintenance log.

10.8 Detector Cleaning (This should be done before starting Backgrounds- ICB)
10.8.1 Clean detector surface with ethanol and a clean cotton ball.
10.8.2 Clean the sample tray and place a clean background planchette on the tray.
10.8.2.1 A passing background count is required before returning the detector to service.

10.9 Nuclide Specific Detectors
10.9.1 Due to recoil from thorium isotopes, certain ROIs may build up background counts affecting isotopes such as Cm-244 and Pu-236. Analyses reporting such isotopes shall not be performed on detectors that count thorium samples (Blue Dot Detectors referenced in attachment 1).

10.10 Standard Verification Procedure
10.10.1 Receive manual batch from prep or a test job/batch logged in by QA through the LIMs.
10.10.2 Count for 960 minutes (make sure batch is set up correctly).
10.10.3 After count, open decay corrector (located in QA_Public\FORMS\RAD) to see if isotope you are verifying needs to be decay corrected. (if the isotope verifying is located in this spreadsheet, it needs to be decay corrected). Note, new activity on the prep sheet.

10.10.4 Open new spreadsheet verification folder (located in QA_Public\FORMS\RAD) and select master 3 or 6 point verification (depending on how many standards are made).
10.10.5 Enter calculated value from Decay Corrector (as True value) and value from the spectra print outs (activity on the spectra for the Isotope you are verifying).
10.10.6 Make sure units match.
10.10.7 Standard passes if the mean value is within 5% of certified (true) value, the 1.96 sigma value is within 10% of mean value and the standard reverification acceptablity evaluations are all yes.
10.10.8 Sign bottom of prep sheet and calculation page.
10.10.9 Give to prep supervisior.

10.11 Evaluation of Controls for Trends
10.11.1 Identified controls shall be evaluated for trends at a minimum frequency of 1 month, but as often as deemed by analysts. The controls and trending rules are listed below (see appendix for list of trending rules)
10.11.1.1 FWHM – Trending Rules 2, 3 & 6
10.11.1.2 Centroid (by Channel) – Trending Rules 2, 3 & 6
10.11.1.3 Efficiency – Trending Rules 2, 3 & 6

11.0 PROCEDURE

11.1 For sample preparation reference the applicable preparation SOP.

11.2 Initial Setup
11.2.1 Establish the normal instrument settings for all controls.
11.2.1.1 Detector specific high voltage settings and required polarity are listed in the method software settings.
11.2.2 Pulser quality controls shall be checked before each use of the instrument.

11.3 Counting Samples
11.3.1 In Radcapture, go to Utilities > Export>Choose 'Alphavision' or 'Alphavision1' depending on which instrument the samples were set up on>, enter batch # in the window that pops up, and click ok to export to Alphavision.
11.3.2 In Alphavision, go to Process, select Batch to open the Batch Wizard.
11.3.3 Choose Load from LIMS, and pick the batch.
11.3.4 Choose proper analysis by clicking on the correct isotope.
11.3.5 Select Next.
11.3.6 Click on blank, and then pick blank type (Uu blank, Pu Blank, etc…).
11.3.7 Click on LCS, and then pick LCS type with correct spike number. For amount, use the spike aliquot amount (0.1, 0.2 mL, 0.1326 g, etc) which is printed on the batch paper work.
11.3.8 Select Next.
11.3.9 Live time is count time. Enter correct count time for the batch, select next.
11.3.10 Select Nuclide Library, choose correct ROI and the specified tracer that is printed on the batch paper work.
11.3.11 Select next.
11.3.12 Select correct activity units (DPM, pCi, etc), select Activity concentration,

11.3.12.1 Always select TPU Sigma 1, add 5% systematic uncertainty and check the negative activity box. .
11.3.13 Select Next, two times.

11.3.14 Select Print on Completion.
11.3.15 Select Finish.
11.3.16 Click and drag correct detectors to the correct sample ID and select Start Now.
11.3.17 The spectrum will be processed by the software.
11.3.18 For DOE:
11.3.18.1 FWHM of each tracer peak shall be ≤ 100 keV
11.3.18.2 Tracer peak energy for each sample shall be within ± 50keV of the expected energy.
11.3.19 Backgrounds are checked after high activity samples r see section 11.4..

11.4 Samples with a count rate of greater than 1 CPS should be removed from the alpha counting system to prevent contamination of detector(s).
11.4.1 Alpha detectors exposed to samples with count rates greater than 1 CPS should be tagged out-of-service until an empty chamber check can be performed. To perform an empty chamber check, place a clean stainless steel disc in the chamber, establish vacuum, turn on bias and start acquisition. The duration of the background check measurement shall be of sufficient duration (i.e. at least as long as the sample count time) to quantify contamination that may impact routine sample measurements. Note this in the instrument and maintenance log.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Commonly used calculations (e.g. % recovery, RPD, uncertainty, MDC, tracer recovery) and standard instrument software calculations are given in the TestAmerica St. Louis QAM.

12.2 Isotope ROI and libraries are derived from the PCNudat master nuclide library:.

12.2.1 http://www.nndc.bnl.gov/nudat2/indx_dec.jsp

12.3 Any manual integration of a peak or group of peaks must be documented. In all instances where the data system report has been edited or where manual integration has been performed, the operator must clearly identify such edits or manual procedures. Reference SOP ST-QA-0040 for details.

12.4 Blank Population correction may be performed through RadCapture. An interference correction factor from a population of blank samples (min. 20) is entered into the RadCapture database for each isotope/ROI. Corrections should be applied to analyses with known interferences (i.e. thorium-230 interference from thorium-229 tracer) or by client request. When blank pop correction is desired, the analyst will check the "Blank Pop Batch" box during data import into RadCapture before generating an analysis report and uploading to TALs.

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 The data assessment and corrective action process is detailed through the LIMS Nonconformance Memorandum (NCM) module. The NCM process is described in SOP: ST-QA-0036.

13.2 Method Blank
13.2.1 Acceptance Criteria:
13.2.1.1 No target analytes may be present in the method blank above the requested limit.

13.2.1.2 Project specific requirements if more stringent than our routine procedure (e.g. no target anlaytes present above ½ RL), will be noted on the client requirements memorandum (CRM).

13.2.2 Corrective Action for Method Blanks not meeting acceptance criteria:

13.2.2.1 Method Blank Contamination – If the MB concentration exceeds the applicable criteria, the batch must be re-prepped unless the concentration of all associated samples is less than the RL or greater than five times the concentration found in the blank.

13.3 Laboratory Control Sample (LCS)

13.3.1 Acceptance Criteria:

13.3.1.1 All control analytes must be within the specified control limits for accuracy (%Recovery) and precision (RPD/RER).

13.3.2 Corrective Action for LCS not meeting acceptance criteria:

13.3.2.1 LCS Spike Recovery excursion (high) – Samples with results less than the RL may be reported with an NCM (unless prohibited by client requirements). Samples with detects for the isotopes with a high bias in the LCS are re-prepped and re-analyzed.

13.3.2.2 LCS Spike Recovery excursion (low) – The batch is re-prepped and re-analyzed for the affected isotope.

13.3.2.3 RPD/RER Duplicate excursion (Batch Precision) – For the RPD/RER, one or both must be with in acceptance limits. The RPD limit is 40% or less. The RER limit is 1 or less depending on the significant digits. Not meeting the criteria requires a reprep of the samples. If samples have a physical matrix issue (ie, nonhomogenous), results can be reported with an NCM. If samples fail RPD/RER criteria after the reprep and no matrix issue is observed sample may be reported with client approval and narrated in an NCM. If the sample(s) associated to the batch have activity below the RL, sample(s) may be reported with an NCM,

13.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

13.4.1 Analytes should be within control limits for accuracy (%Recovery) and precision (RPD/RER).

13.4.2 Corrective Action for MS/MSD not meeting acceptance criteria:

13.4.2.1 MS/MSD Spike Rec. excursion may not necessarily warrant corrective action other than narration. Investigate cause (i.e. high target isotopes) and NCM accordingly.

13.5 Sample Result Evaluation

13.5.1 Tracer recovery must be within specified limits. Tracer limits are 30% - 110% unless other wise specified by the client

13.5.2 Tracer/Carrier recovery (low) – Re-extract using a reduced volume or recount for maximum count time to achieve 400 tracer counts

13.5.2.1 Note: QSAS allows for reporting results as quantitative when tracer recoveries are below 30% if:

13.5.2.1.1 the relative uncertainty associated with the tracer recovery is less than 10% (2 sigma)

13.5.2.1.2 spectral resolution requirements are met and there are no indications of spectral interferences (resolution of <100 keV).

13.5.2.1.3 detection limit requirements have been met

13.5.3 Tracer/Carrier recovery (high) – If the Method Blank and LCS are **within limits**, contact a supervisor or manager for further instruction. If the Method Blank and/or LCS has **high recovery**, a reprep is required unless approval is given by the client.

13.5.3.1 Truncation to 100%: Truncation can be done at the clients discretion, or with approval from manager or technical director or based on sample history.

13.5.3.2 A sample tracer recovery outside QC limits may be accepted if the sample results are determined valid:

13.5.3.2.1 minimum number of tracer counts

13.5.3.2.2 level of uncertainty

13.5.3.2.3 client project requirements/approval

13.5.4 These expections will be documented using the NCM process. The NCM will narrate the conditions upon which the sample results were accepted with tracer recovery excursions.

13.5.5 The following occurances require a dilution to be performed:

13.5.5.1 Dilution level is determined by taking the highest gross counts divided by the count time divided by a factor of 2. (ie: 7200/180/2=1:20)

$$DL = GCts_{High} / t_{count} / 2$$

$$DL = Dilution\ Level$$

$$GCts_{High} = Highest\ Gross\ Counts$$

$$t_{count} = Count\ Time$$

13.5.5.1.1 Tailing – A peak is significantly tailing out side its region of interest (ROI)

13.5.5.1.2 The tracer recovery is low due the high activity of the sample

13.5.5.1.3 Peak Interference – A Peak is observed which is identified as an interference

13.6 Insufficient Sample

13.6.1 For any prescribed re-preparation corrective action, if there is insufficient sample to repeat the analysis an NCM is written and a narrative comment stating such is included in the report narrative.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1 Method performance data, Requested Limits, and QC acceptance limits, are maintained in the LIMS.

14.2 Demonstration of Capability

14.2.1 Initial and continuing demonstrations of capability requirements are established in ST-QAM.

14.3 Training Qualification

14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in ST-QAM.

14.1 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in ST-QAM.

15.0 VALIDATION

15.1 Laboratory SOPs are based on published methods (EPA, DOE, ASTM, Eichrom, Standard Methods) and do not require validation by the laboratory. The requirements for laboratory

demonstration of capability are included in the ST-QAM. Laboratory validation data would be appropriate for performance based measurement systems, non-standard methods and significant modifications to published methods. Data from said validations is held in the QA department.

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

16.2 Waste Streams Produced by the Method

16.2.1 The following waste streams are produced when this method is carried out.

16.2.1.1 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the lab ware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM meter, the lab ware will be collected in waste barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

17.1 Department of Energy (DOE) Environmental Measurement Laboratory (EML) HASL 300 28th Edition method A-01-R, Alpha Radioassay

17.2 AlphaVision-32, Alpha Particle Spectrum Acquistion and Analysis for Microsoft Windows and NT, Software Version 5.0 Installation, User Interface and Reference Guide, Ortec (latest version)

17.3 OCTETE Plus, Integrated Alpha-Spectroscopy System Hardware Operating Manual, 777720, Ortec (latest version)

17.4 MAESTRO-32, MCA Emulator for Microsoft Windows, A65-B32 Software User's Manual, 777800, Ortec (latest version)

17.5 U.S. Nuclear Regulatory Commission, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, Regulatory Guide 4.15.

17.6 "Quality Assurance Program Requirements for Nuclear Facilities", ANSI/ASME NQA-1 (latest edition).

17.7 TestAmerica, St. Louis Quality Assurance Manual, current revision

17.8 Corporate Environmental Health and Safety Manual (CW-E-M-001) and St. Louis Facility Addendum (SOP ST-HS-0002), current revisions.

17.9 Decay Radiation Datebase, Version of 5/8/2013; http://www.nndc.bnl.gov/nudat2/indx_dec.jsp

17.10 Associated SOPs, current revisions

17.10.1 ST-PM-0002, Chain of Custody

17.10.2 ST-QA-0002, Standard and Reagent Preparation

17.10.3 ST-QA-0014, Evaluation of Analytical Accuracy and Precision Through the Use of Control Charts

17.10.4 ST-QA-0036 Non-Conformance Memorandum (NCM) Procedure
17.10.5 ST-QA-0040, Manual Integration Procedure
17.10.6 ST-RC-0040, Total Alpha Emitting Isotopes of Radium
17.10.7 ST-RC-0238, Isotopic Uranium By Eichrom® Uteva Resin For Various Matrices
17.10.8 ST-RC-0210, Determination Of Polonium-210 By Alpha Spectrometry
17.10.9 ST-RC-0232, Isotopic Thorium And/Or Neptunium In Various Matrices By Eichrom® Teva Separation Resin
17.10.10 ST-RC-0240, Isotopic Americium, Curium, Plutionium, Thorium, And Uranium In Various Matrices By Eichrom® Separation Resin
17.10.11 ST-RC-0241, Americium, Plutonium, Curium, And Uranium In Various Matrices By Eichrom® Uteva And Tru Resins (With Vacuum Box System)
17.10.12 ST-RC-0242, Isotopic Thorium, Plutonium And Uranium In Various Matrices By Eichrom® Separation Resins
17.10.13 ST-RC-0246, Isotopic Americium, Curium, Uranium In Various Matrices By Eichrom® Separation Resins

18.0 MODIFICATIONS TO REFERENCE METHOD

18.1 Energy calibrations checks are performed monthly. Daily pulsar checks are performed in place of the weekly energy calibration checks.
18.2 Backgrounds are determined monthly rather weekly
18.3 CCV's are determined monthly rather that before and after each measurement.

19.0 CHANGES TO PREVIOUS REVISION

19.1 No Changes- Annual Review
19.2 Rev. 8:
- 19.2.1 Section 10 additions
  - 19.2.1.1 Addition of Instrument setup as §10.1
  - 19.2.1.2 Addition of Calibration Quality Control Check as §10.3
  - 19.2.1.3 Addition of calibration acceptance criteria

19.3 Rev. 9:
- 19.3.1 Section 10.5, addition of limits for pulser centroid and pulser energy

19.4 Rev. 10:
- 19.4.1 Section 10:
  - 19.4.1.1 2nd level review for ICV and CCV added to section 10
  - 19.4.1.2 1200 minute setting for acquisition window for special projects
  - 19.4.1.3 Upper control limits for long backgrounds
  - 19.4.1.4 Detector cleaning
- 19.4.2 Section 12: addition of ROI and library reference
- 19.4.3 Section 13: Occurances that require dilution
- 19.4.4 Addition of Attachement 1

19.5 Rev. 11: (8/21/13)
- 19.5.1 Grammatical corrections through out and removal of referencest to QuantIMS and Clouseau
- 19.5.2 Section 10, updated internal calibrations information in section and the calibration process in the lab software throughout
- 19.5.3 Section 10, added new standards verification procedure
- 19.5.4 Section 13, added corrective actions and equation for dilution level
- 19.5.5 Section 15, updated with new verbiage
- 19.5.6 Attachment 1 revised

19.5.7 Section 13,removed "See Clouseau NCM for Corrective Action"and added specfic Corrective Actions to the SOP
19.5.8 Section 18, added backgrounds will be done monthly and added CCV's will be done monthly.
19.5.9 Section 3, Added "keV" definition
19.5.10 Section 6, Added Hardware and Software specifics

19.6 Rev. 12: (4/24/15)
19.6.1 Section 10.2.1.1, added the energy vs. channel slope should be less than 15 keV per channel. The Full Width Half Maximum (FWHM) must be less than or equal to 100 keV for each peak. Changed 5 channels to 2.5 channels and 40 keV to 20 keV.
19.6.2 Section 10.2.2.1, added a minimum of 3000 net counts must be collected for each peak in the calibration.
19.6.3 Section 10.2.3.1, added a minimum of 2000 net counts must be collected for each peak in the ICV. Added the Full Width Half Maximum (FWHM) must be less than or equal to 100 keV for each peak. Each peak must fall within 20 keV of the corresponding calibraation peak in the initial calibration (IC).
19.6.4 Section 10.3.1.1, added The Full Width Half Maximum (FWHM) must be less than or equal to 100 keV for each peak. Each peak must fall within 20 keV of the corresponding calibraation peak in the initial calibration (IC).
19.6.5 Added section 10.5
19.6.6 Updated calibration identification in procedure

19.7 Rev. 13: (05/23/2016)
19.7.1 Section 10, removed red detector references
19.7.2 Removed Red Detectors from attachment
19.7.3 Trending evaluation added to section 10
19.7.4 Appendix with trending rules added

19.8 Revision 14 (5/2/17)
19.8.1 Updated hyperlinks throughout SOP.
19.8.2 Replaved all "Red" detectors with "Grren. Red detectors are no longer used.
19.8.3 Changed Trending Rules used from 2,3,and 5 to 2,3,and 6.

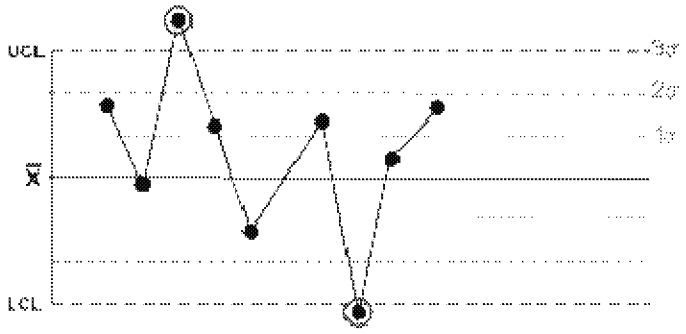
19.9 Revsion 15 (3/9/2018)
19.9.1 Grammar and referenced sections fixed throughout
19.9.2 Updated file locations throughout
19.9.3 Section 10.6.3.1- removed part about report generation, this is now done by LIMs
19.9.4 Section 10.7.2- fixed the formatting from previous revision- numbering was wrong causing referenced sections to be wrong.
19.9.5 10.7.3.18- removed redundancy
19.9.6 Section 10.7.4.18- removed re-categroization; we do not re-categroize monthly
19.9.7 Removed text thoughout referencing Quantims
19.9.8 Section 11.4.1- added/removed text to include reference to QSM 5.1
19.9.9 Section 12.4 added- Blank Population section
19.9.10 Section 13.3.2.3- added criteria
19.9.11 Section 13.5.3- removed reference to native correction, we do not do this for actinides methods.

Appendix

Rule 1: One point is more than 3 standard deviations from the mean.

~ Simplest: Single point is considered out of control event

- Corrective action required



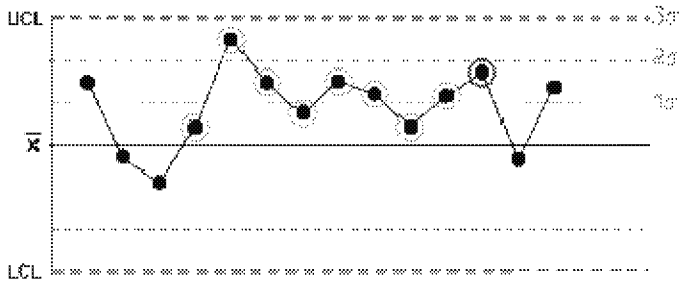
Rule 2: Seven (or defined 'n') points in a row are on the same side of the mean.

~ n = 7 warn trigger

- Mean shift: (same side of mean)

- Some prolonged bias exists.

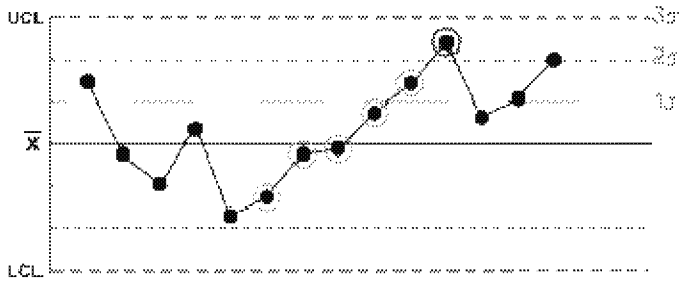
~ Corrective action recommended



Rule 3: Six (or more) points in a row are continually increasing (or decreasing).

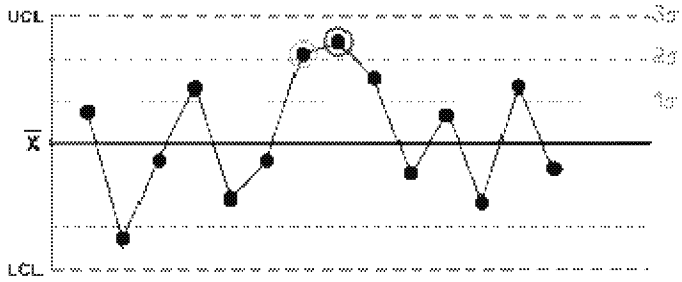
- A trend exists.

~ Corrective action recommended



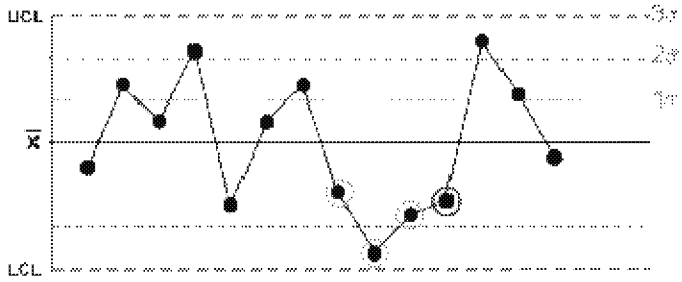
Rule 5: Three out of three points in a row are more than 2 standard deviations from the mean in the same direction.

- There is a medium tendency for samples to be mediumly out of control.
  - ~ Investigate for preventive. May not be CAR



Rule 6: Four out of five points in a row are more than 1 standard deviation from the mean in the same direction.

- There is a strong tendency for samples to be slightly out of control.
  - ~ No CAR, Statistical trend



Attachment 1

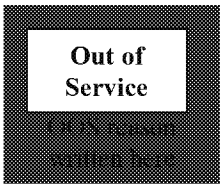
AlphaVision Detector Key

Green – Low Level 0-20 counts

Yellow – Intermediate Low Level 0 – 4 counts
Special Projects and QC samples (Method Blanks and Lab Control Samples) Only

Blue – Ultra Low Level (for Pu/Am/Np)
Special Projects Only

Blue Dot detectors – No Thorium (Am/Cm or Pu)



OOS Tag – Out of Service (OOS)

Title: LOW BACKGROUND GAS FLOW PROPORTIONAL COUNTING (GFPC) SYSTEM ANALYSIS

Approvals (Signature/Date):

Rachel Mueller 12-14-17 Rachel Mueller — Date Radiochemistry Count Room Manager	Michael Ridenhower 12/15/17 Michael Ridenhower — Date Health & Safety Manager / Coordinator
12/15/17 Kristen Ely — Date Quality Assurance Manager	Elaine Wild 12/15/17 Elaine Wild — Date Laboratory Director

This SOP was previously identified as SOP No. ST-RD-0403 Rev. 18

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1.0 SCOPE AND APPLICATION

1.1 This SOP is applicable to all Low Background Proportional Counting instruments. TestAmerica St. Louis performs radium-226/228, strontium-89/90, gross alpha/beta, neptunium-36 and chlorine 36.

1.2 This SOP is based on SW846 method 9310, 9315 and 9320; EPA methods 900.0, 903.0, 904.0, 905.0; and DOE EML HASL 300 method, Ba-01-R, Sr-02 and Sr-03-RC.

1.3 The SOP applies to GFPC analysis of liquid and solid matrices.

1.4 The requested limits (RL), minimum detectable amount (MDA) and QC limits are maintained in the Laboratory Information Management System (LIMS).

2.0 SUMMARY OF METHOD

2.1 This procedure provides instructions for the daily calibration and maintenance of the Low Background Proportional Counting instrumentation.

3.0 DEFINITIONS

3.1 See the TestAmerica St. Louis Quality Assurance Manual (ST-QAM) for a glossary of common terms and data qualifiers.

3.2 IQC - a computerized Quality Control Program where the counting results of Daily Radioactive check sources and Daily Background checks are entered and compared to statistical average data. A measurement within ± 3 standard deviations indicates the detector is operating within acceptable parameters.

3.3 αLL - discriminator setting indicating the alpha lower voltage limit.

3.4 Alpha Voltage Only - detector voltage capable of collecting ions created by alpha radiation only. Ion pairs created by beta radiation are not collected.

3.5 αUL - discriminator setting indicating the instruments alpha upper voltage limit.

3.6 βLL - discriminator setting indicating the beta lower voltage limit.

3.7 βUL - discriminator setting indicating the beta upper voltage limit.

3.8 Crosstalk - a measure of the amount of beta radiation that is collected in the alpha radiation channel; it is also a measure of alpha radiation collected in the beta channel.

3.9 Plateau - a point on a graph of count rate vs. detector bias voltage where further increases in bias will not result in an increase in measured counting rate.

3.10 LB4100 – LBPC (Low background Gas Flow Proportional Counting instrument).

4.0 INTERFERENCES

4.1 A detector contaminated with radioactive material will result in a high background and interfere with the correct measurement of a sample.

4.1.1 If a sample "times out" reaching 10,000 counts before the allotted time, and the sample count rate is 60 cpm or greater, then another daily background check is performed on that detector. If the detector background check is unacceptable, the detector is taken Out Of Service until action is taken to bring the background check within acceptable limits. If the chamber requires action to remove contamination and a new background check is acceptable, then a 30 minute empty chamber count should be performed to determine if a new long background needs to be performed on that detector.

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4.2 The actual counting efficiency for alpha radiation decreases greatly with a density > 6.0 mg/cm2. Therefore, the maximum acceptable mass density is typically 5 mg/cm2 or less that 100 mg for a 2" planchet.

4.3 For beta radiation, reliable data may be obtained counting samples with a density as high as 10 mg/cm2 or greater.

4.4 Sample thickness as well as moisture content may impact the alpha and/or beta results.

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum

5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS

5.2.1.1 None.

5.3 PRIMARY MATERIALS USED

5.3.1 The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Silver Nitrate	Poison Corrosive Oxidizer	$0.01^{g}/_{m3}$ (TWA) for silver, metal dust, and fume as Ag	Inhalation symptoms may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. Skin contact may cause redness, pain, and severe burning. Eye contact can cause blurred vision, redness, and pain.
Ammonium Hydroxide	Poison Corrosive	50 ppm (NH_3)	Inhalation symptoms may include irritation to the respiratory tract. Ingestion symptoms may include pain in the mouth, chest, and abdomen with coughing, vomiting, and collapse. Skin contact causes irritation and burns. Eye contact with vapors causes irritation.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			
TWA – Time Weighted Average			

6.0 EQUIPMENT AND SUPPLIES

6.1 Low Background Proportional Counter, equivalent to the Canberra/Oxford/Tennelec LB4100, or Protean MPC9604.

6.2 Gas mixture, 90% argon, 10% Methane
6.3 Blank planchets
6.4 PC based data acquisition system, IQC software
6.5 Centrifuge tubes
6.6 Centrifuge
6.7 Vortex
6.8 Pipettes, Eppendorf or equivalent
6.9 Pipette, disposable

7.0 STANDARDS AND REAGENTS

7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP ST-QA-0002, current revision

7.2 Radioactive sources to measure beta radiation,: Sr-90

7.3 Radioactive sources to measure alpha radiation: Am-241, Am-243, Th-230 and Ra-226

7.4 Deionized Water (DI).

7.5 Silver nitrate ($AgNO_3$), 0.5 N

7.6 Sodium chloride (NaCl), crystals

7.7 Sodium chloride (NaCl), 0.5 N

7.7.1 Add 50 mL of DI water to a 100 mL volumetric, add 5.84 g of NaCl, dilute to 100 mL, cap and shake to dissolve. Adjust volume to 100 mL with DI water.

7.8 Ammonium hydroxide (NH_4OH), concentrated, 28 N

7.9 Ammonium hydroxide (NH_4OH), 5 %

7.9.1 Add 25 mL of concentrated Ammonium Hydroxide to 475 mL of DI water. **CAUTION – Ammonium hydroxide is corrosive. Mist and vapor cause burns to every area of contact.**

7.10 Cl-36: At least four sodium chloride standards are prepared for calibration.

7.10.1 Add 10 mL of DI water to 4 centrifuge tubes.
7.10.2 Add 0.500 mL of 0.5 N sodium chloride carrier solutions to each centrifuge tube. Swirl to mix.
7.10.3 Add 2 drops of 5 % ammonium hydroxide solution, swirl to mix.
7.10.4 Add 12 mL of 0.5 N silver nitrate solution to each centrifuge tube.
7.10.5 Vortex for 30 seconds.
7.10.6 Centrifuge and decant supernate to waste.
7.10.7 Proceed to section 11.4, Planchet Preparation of Silver Chloride Precipitation of SOP ST-RC-0036.
7.10.8 Average the four weights for the sodium chloride carrier solution, record the standardized weight in the log book and on the bottle.
7.10.9 NOTE: It may be necessary to use more than 0.500 mL of carrier in some large water samples or calibrate a 4 N sodium chloride carrier solution. The efficiency of the detectors will have to be calculated using the heavier sodium chloride carrier solution.

7.10.10 Prepare four sodium chloride calibration samples as in Section 7.10 but add a known amount of Cl-36 to each tube before the sodium chloride carrier is added. Analyze samples by GFPC and determine detector efficiency as per Section 12, Data Analysis and Calculations.

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in ST-PM-0002.

8.2 See associated sample preparation SOPs ST-RC-0020, ST-RC -0021, ST-RC -0036, ST-RC -0040, ST-RC -0041and ST-RC -0050, for more detailed information.

9.0 QUALITY CONTROL

9.1 See actinide preparation SOPs for additional information regarding QC types, frequency and preparation.

9.2 **Batch**

9.2.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents.

9.2.2 Instrument conditions must be the same for all standards, samples and QC samples.

9.2.3 For this analysis, batch QC consists of a method blank (MB), a Laboratory Control Sample (LCS), and Matrix Spike (MS)/ Sample Duplicate (Dup). In the event that there is insufficient sample to analyze a sample duplicate, an LCS Duplicate (LCSD) is prepared and analyzed.

9.2.3.1 Matrix Spike (MS) and Matrix Spike Duplicate (MSD) may be performed upon client request, and are noted in the Client Requirement Sheets and Log-in.

9.3 **Method Blank (MB)**

9.3.1 A method blank is a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.3.2 A method blank must be prepared with every sample batch.

9.4 **Laboratory Control Sample (LCS)**

9.4.1 An LCS is a blank matrix spiked with a known amount of target analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.4.2 An LCS must be prepared with every sample batch.

9.5 **Matrix Spike**

9.5.1 A Matrix Spike is an aliquot of a field sample to which a known amount of target analyte(s) is added, and is processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

9.6 **Sample Duplicate**

9.6.1 A Sample Duplicate is an additional aliquot of a field sample, processed simultaneously with, and under the same conditions as, samples through all steps of the analytical process to demonstrate precision.

9.7 **Procedural Variations/ Nonconformance and Corrective Action**

9.7.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.

9.7.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Additional preventative maintenance can be found in ST-QA-0024.

10.2 Voltage Plateau Determination

10.2.1 **Frequency**:

10.2.1.1 Performed as a part of the Intial Calibration.

10.2.2 **Voltage Plateau Determination on Protean MPC 9604**

10.2.2.1 Place the Sr 90 source or sources in the detector drawer.

10.2.2.2 Select detector of interest on the computer screen.

10.2.2.3 Click Plateau under Count Method.

10.2.2.4 Set time to accumilate at least 10,000 counts for distributed Sr90 source.

10.2.2.5 Select A, B. C, D.

10.2.2.6 Click OK.

10.2.2.7 When count is complete select Plateau under instrument Specific.

10.2.2.8 Set Beta appropriate voltage with arrows </>. Evalulate and Print report.

10.2.3 **Criteria for Plateaus for Protean MPC 9604**

10.2.3.1 Acquire 40 data points in 30V increments beginning at 705V and ending at 1875V. Slope should be no more than 5%.

10.3 **Discriminator Settings**

10.3.1 **Frequency:**

10.3.1.1 Performed as a part of the Intial Calibration.

10.3.2 **Discrimator Settings on Protean MPC 9604**

10.3.2.1 Collect a minimum of 10,000 counts for each of Am-241, Th-230 and/or Po-210 sources

10.3.2.2 Calculate the percentage of crosstalk and compare the results to historical and expected values. Consult the Technical director if the values fall out of range.

10.4 **Initial Calibration (IC)**:

10.4.1 **Frequency**:

10.4.1.1 The Gas Flow Proportional Counter (GFPC) is calibrated initially and verified each year thereafter. Recalibration may be required if indicated during the operation of the instrument.

10.4.2 The specific calibration source preparations can be found in the file containing the previous calibration.

10.4.3 All nuclide sources shall be NIST traceable.

10.4.4 The efficiency calibration shall consist of at least seven mass attenuated calibration standards, unless a single point source efficiency is to be determined.

10.4.5 Alpha, Beta Ra226 - at least seven mass attenuated calibration standards

10.4.5.1 For gross alpha, use Th-230 in the nitrate form (spiked into varying amounts of salt solution, converted to nitrate) .

10.4.5.2 For Ra-226, use Ra-226 standard in sulfate form (co-precipitated with varying amounts of barium sulfate).

10.4.5.3 For gross beta, Sr-90, Total Beta Strontium, and Ra-228, use Sr-90/Y90 in the nitrate form (spiked into varying amounts of salt solution, converted to nitrate).

10.4.6 Air Filter – single point calibration

10.4.6.1 For alpha use Am-241

10.4.6.2 For beta use Sr-90

10.4.7 Cl-36 – Averaged 4 point calibration.

10.4.7.1 For Cl-36 use Cl-36

10.4.8 Np – Averaged 4 point calibration.

10.4.8.1 For Np use Am-243

10.4.9 The standards shall have enough activity to generate at least 10,000 counts in 90 minutes of count time for the most highly attenuated source. The count rate shall not exceed 5,000 counts per second.

10.4.9.1 For alpha and beta analysis, separate sets of calibration sources shall be prepared.

10.4.10 The mass attenuation is accomplished by utilization of a salt solution with comparable make up to the majority of samples seen in the laboratory.

10.4.10.1 Alternatively, the mass attenuation may be accomplished by using the same carrier solution used in a specific analysis.

10.4.11 Each standard shall be counted in every detector to be calibrated.

10.4.12 **IC Criteria:**

10.4.12.1 The efficiency of the detector (the dependent variable) shall be plotted on a single graph against the masses (the independent variable) for all data points.

10.4.12.2 The equation of the calibration curve shall be determined using polynomial functions and be included on the plot of the curve. The curve shall be continuous and smooth.

10.4.12.3 The degree of the polynomial shall not exceed three. The number of discreet source pairs shall be two more than the degree of the polynomial.

10.4.12.4 The percent difference of the measured efficiency and theoretical efficiency shall be calculated for all data points.

10.4.12.5 Points that are visual outliers or demonstrate less than 15 percent difference between the measured efficiency and theoretical efficiency may be removed at the analyst's discretion. Low residual mass sources and samples are difficult to plate with acceptable duplicate precision. Therefore, high outliers may not necessarily be removed from the calibration if they mimic live sample masses. In any case outliers above 15 percent shall be removed from the calibration curve. No more than 20 percent of the data points may be removed. Reasons for removal or inclusion of outliers shall be documented in the calibration narrative. Once outliers are removed, the percent difference between the measured efficiency and theoretical efficiency must be recalculated using the new polynomial coefficients generated from removal of data points. If outliers over 15 percent difference remain between the measured efficiency and theoretical efficiency the

Radiochemistry Manager/QA must be consulted before calibration may continue.

10.4.12.6 The coefficient of determination (r^2) shall be calculated and displayed on the plot with the equation of the trend line. An r^2 greater than or equal to 0.9 is required to proceed to counting of verification sources.

10.5 **Independent Calibration Verification (ICV)**

10.5.1 **Frequency**:

10.5.1.1 Performed with every intial calibration

10.5.2 GFPC initial calibrations must be verified by a second source standard.

10.5.3 The ICV standard is NIST traceable.

10.5.4 The ICV is counted to accumulate at least 5,000 counts.

10.5.5 **ICV Criteria**:

10.5.5.1 Prepare 3 verification sources varying in expected mass (low, medium and high) within the calibration range of the curve, unless a single point source is to be determined.

10.5.5.2 Alpha and Beta 3 sources

10.5.5.3 Ra226 Minimum of one source

10.5.5.4 Air Filter Minimum of one source

10.5.5.5 Cl-36 – Minimum of one source

10.5.5.6 Np- Minimum of one source

10.5.5.7 The source/standard used for the ICV shall be from an independent second source as defined within the laboratory Quality Assurance Manual."

10.5.9.7.1 Alternatively, verification source nuclides may consist of different nuclides than the calibration curve if it is customary to do so.

10.5.5.8 Count the secondary source in all detectors that were calibrated.

10.5.5.9 Calculate the results in terms of percentage recovery.

10.5.5.10 Calculate the mean results of all masses across each detector.

10.5.5.11 **Criteria:**

10.5.9.11.1 Individual points are within 30 percent of the true value

10.5.9.11.2 The mean result of all masses across all detectors is less than 10 percent.

10.5.9.11.3 If any detector fails the validation tests the Technical Director must be consulted to provide corrective action.

10.6 **Setting Performance Check Criteria After Calibration**

10.6.1 Twenty background check samples are counted and used to establish quality control limits for the daily background checks.

10.6.2 The limits for the background check sample will be established with five points from four months. Every month the oldest months points will be removed and points from the current month will be added.

10.6.3 Twenty alpha/beta check sources are counted after calibration and used to establish quality control limits for the daily source checks.

10.6.4 The limits for alpha/beta check sources will be a running average of the four months post calibration.

10.6.4.1 The limits are to be documented.

10.6.4.2 The limits will be re-established monthly at the following frequency

10.6.4.2.1.1 1st month – take first five data points from the new month and fifteen data points from the initial calibration.

10.6.4.2.1.2 2nd month – take first five points from new month, five from prior month and ten from initial calibration.

10.6.4.2.1.3 3rd month – take first five points from new month, five points each from the previous two months and five from the initial calibration.

10.6.4.2.1.4 4th month – take first five data points from new month and five points each from the previous three months.

10.6.4.3 Limits are set.

10.7 **Alpha to Beta Crosstalk Determination**

10.7.1 The mean mass is determined for each data point used to calculate the mass attenuation curve.

10.7.1.1 These curves are calculated and plotted and the percent of alpha into beta crosstalk is determined. This is done by dividing the beta counts per minute as observed in the beta channel from the alpha calibration source counts by the sum of the alpha and beta counts per minute.

10.7.1.2 The mean percent of alpha into beta is determined for each mass point by using the count data accumulated for two sets of alpha sources.

10.7.1.3 The crosstalk curve is plotted as mean crosstalk values relative to the mean mass for the two sets of data.

10.7.1.3.1.1 In this manner the crosstalk factor can be determined for any given mass.

10.7.1.4 The equation of the curve shall be determined using polynomial functions.

10.7.1.5 The coefficient of determination (R^2) shall be calculated and displayed on the plot as well as the equation for the trendline.

10.8 **Beta to Alpha Crosstalk Determination**

10.8.1 Since beta to alpha crosstalk does not vary across mass, a mean beta to alpha crosstalk correction factor is calculated.

10.8.2 The percent of beta into alpha is determined by dividing the alpha counts per minute as observed in the alpha channel from the beta calibration source counts by the sum of the alpha and beta counts per minute.

10.8.3 The mean percent of beta into alpha is determined for all mass points. The mean percent is insignificant in calculating results, therefore is not applied to the result calculation.

10.9 **Long Monthly Background (ICB)**

10.9.1 **Frequency**:

10.9.1.1 Monthly or whenever instrument conditions have significantly changed since the previous background was performed (e.g. detector replaced, etc.)

10.9.1.2 Minimum count time: 1000 minutes.

10.9.2 Wash the planchet holder and clean the drawers with a 20% radiac wash or ethyl alcohol.

10.9.2.1 Do not spray cleaner directly onto the drawers. Spray cleaner on a Kimwipe, a cotton ball, or paper towel and wipe out the drawers.

10.9.3 Check that instrument settings are as specified in 11.1.

10.9.4 **Orange, Protean, Purple and Blue Long Background Count Set-Up**

10.9.4.1 Select detector 0

10.9.4.2 Select 'source log'

10.9.4.3 Select 'ICB' by clicking on the file list arrow.

10.9.4.4 Ensure count time is set to 1000 minutes.
10.9.4.5 Select 'start'
10.9.4.6 Continue these steps with detectors 1-23.
10.9.4.7 Review the data for acceptance when the backgrounds are complete.

10.9.5 **Printing Orange, Protean, Purple and Blue Long Backgrounds**

10.9.5.1 Select 'Data
10.9.5.2 Select 'Source Count Data'
10.9.5.3 Select 'Source Name' ICB
10.9.5.4 Select 'This Range' and enter the date range that the Long Backgrounds (ICBs) were performed.
10.9.5.5 Select 'Refresh'
10.9.5.6 Select 'Source Count Summary' under Reports
10.9.5.7 Select 'Print'
10.9.5.8 Select 'Landscape' under Orientation
10.9.5.9 Select 'OK'

10.9.6 **Long Background Criteria:**

10.9.6.1 Long backgrounds are evaluated at ± 3 sigma.
10.9.6.2 The data report is evaluated per detector.
10.9.6.3 If a detector is above this limit, discard planchet.
10.9.6.4 Clean the planchet holder with radiac wash, ethyl alcohol or a detergent spray cleaner and dry thoroughly.
10.9.6.5 Place a clean planchet in the holder and repeat steps for that detector (s) only.
10.9.6.6 Perform a new background.
Note: The detector is tagged with an out of service tag noted with ICB and date. Detector is out of service until a successful background has been achieved.

10.10 Evaluation of Controls for Trends

10.10.1 Identified controls shall be evaluated for trends at a minimum frequency of 1 month, but as often as deemed by analysts. The controls and trending rules are listed below (see appendix for list of trending rules)

10.10.1.1 Alpha background counts – Trending Rules 2, 3 & 6
10.10.1.2 Alpha source counts – Trending Rules 2, 3 & 6
10.10.1.3 Beta background counts – Trending Rules 2, 3 & 6
10.10.1.4 Beta source counts – Trending Rules 2, 3 & 6

11.0 PROCEDURES

11.1 Initial Setup

11.1.1 Check the normal instrument settings for all controls as described below:

11.1.1.1 Tank Flow 8 psi
11.1.1.2 Flow Cells >/= 0.3 SCFH, the flow will vary, the target range is 0.15 to 0.20 SCFH.

11.1.2 The High Voltage is set as indicated in the Manuals for the LB4000/LB4100 located in the count room file cabinet. The Gas Flow Proportional counting system remains as set by the manufacturer and does not require adjustment.

11.1.3 If counting gas has just been turned on, allow a minimum purge time of 30 minutes prior to operation. Record gas tank changes on document on separate sheet.

11.2 Record date of Daily Background and Check Source Data in runlog logbook.

11.3 Maintenance

11.3.1 Change out the counting gas when the gauge reads under 500 psi. This usually occurs every 1 to 2 weeks. Record gas tank changes on separate sheet in maintenance log.

11.3.2 Allow gas to purge a minimum of 30 minutes prior to operation.

11.3.3 Background and checksource checks are required following a gas bottle change.

11.4 Data Acquisition: Daily Background Check and Source Check

11.4.1 **Daily Background Check**:

11.4.2 **<u>Orange, Protean, Purple and Blue</u> Instrument**:

11.4.2.1 Open each detector drawer. Place clean empty planchets into each sample holder and slowly insert each sample drawer into the instrument.

11.4.2.2 Select detector 0.

11.4.2.3 Select 'source log'.

11.4.2.4 Select or scan 'CCB' by clicking on the file list arrows for orange.

11.4.2.5 Select 'CCB' by clicking on the file list arrows for purple.

11.4.2.6 Select 'start'

11.4.2.7 Repeat these steps with detectors 1-23.

11.4.3 **Daily Background Criteria:**

11.4.3.1 Review the IQC report for each detector.

11.4.3.1.1 If a detector fails background criteria (3 sigma), clean the detector with radiac wash or ethyl alcohol and re-count.

11.4.3.1.2 Tag detector out of service with a Tag noted with "Bkg RC".

11.4.3.1.3 ,If detector fails Background re-count tag detector with an out of service tag noted with date to indicate that the detector is out of service for the day.

11.5 **Daily Source Check**

11.5.1 **<u>Orange, Protean, Purple and Blue</u> Instrument**:

11.5.1.1 Slowly open each detector drawer. Place alpha sources in sample holders of detectors 0-7. Place beta sources in sample holders of detectors 8-15. Slowly insert each drawer into the instrument.

11.5.1.2 Select detector 0.

11.5.1.3 Select 'source log'.

11.5.1.4 Select 'CCVA-"#";SA00.

11.5.1.5 Select 'start'

11.5.1.6 Repeat these steps for detectors 1-7 using the correlating detector number. For detectors 8-15 select 'CCVA-"#";SA08', CCVA-"#";SA09'', and so on for each correlating detector number.

11.5.1.7 Slowly open each detector drawer when counting is complete. Place beta sources in detectors 0-7 and place alpha sources in detectors 8-15.

11.5.1.8 Select detector 0.

11.5.1.9 Select 'CCVB-"#";SB00'.

11.5.1.10 Select 'start'.

11.5.1.11 Repeat these steps for detectors 1-7 using the correlating detector number. For detectors 8-15, select 'CCVB-"#";SB08', 'CCVB-"#";SB09' and so on for each correlating detector number.

11.5.1.12 Repeat steps 11.5.4.1 to 11.5.4.11 for detectors 16-23.

11.5.1.13 Remove sources from detector drawers when counting is complete.

11.5.1.14 Review the IQC report for each detecctor.

11.5.1.15 Limits +-3% (fail)

11.5.1.15.1 The indiviual loading samples will verify that detectors are in service.

11.5.2 **Daily Source Criteria:**

11.5.2.1 Review and save with your name and date on the IQC report for each detector.

11.5.2.1.1 If a detector fails criteria, re-count source.

11.5.2.1.2 If detector fails source re-count tag detector with a Red out of service tag noted with date to indicate that the detector is out of service for the day

11.5.3 **Daily check Criteria:**

11.5.3.1 Review and save with your name and date on the IQC report.

11.5.3.1.1 The indiviuals loading samples will verify that detectors are in-service prior to loading on them.

11.5.3.1.2 In addtioin Daily checks will be verified at 1st level review of Data.

11.5.3.1.3

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Commonly used calculations (e.g. % recovery and RPD) and standard instrument software calculations are given in the TestAmerica St. Louis ST-QAM.

12.2 Result calculations are performed by TestAmerica St. Louis' Rad Capture software program. These calculations are found in the TestAmerica St. Louis ST-QAM.

12.3 To calculate the efficiency of the detectors for Cl-36, divide the net counts determined of the spiked Sodium Chloride, by the known dpm of the Standard used.

$$\frac{Net\ Counts\ of\ Spiked\ Silver\ Chloride}{Known\ dpm\ of\ Cl-36\,(decay\ corrected\ to\ day\ counted)} = Efficiency$$

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

13.1 The data assessment and corrective action process is detailed through the LIMS Nonconformance Memorandum (NCM) process. The NCM process is described in SOP: ST-QA-0036.

13.2 Method Blank

13.2.1 Acceptance Criteria:

13.2.1.1 No target analytes may be present in the method blank above the reporting limit.

13.2.1.2 Project specific requirements if more stringent than our routine procedure (e.g. no target anlaytes present above ½ RL), will be noted on the client requirements sheet.

13.2.2 Corrective Action for Method Blanks not meeting acceptance criteria:

13.2.2.1 Method Blank Contamination – (e.g. reprep/reanalysis, narration). If the Method Blank concentration exceeds the applicable criteria, the batch must be re-prepped unless the concentration of all associated samples is less than the RL or greater than ten times the concentration found in the blank.

13.3 Laboratory Control Sample (LCS)

13.3.1 Acceptance Criteria:

13.3.1.1 All control analytes must be within the specified control limits for accuracy (%Recovery) and precision (RPD).

13.3.2 Corrective Action for LCS not meeting acceptance criteria:

13.3.2.1 LCS Spike Recovery excursion (high) – Samples with results less than the RL may be reported with an NCM (unless prohibited by client requirements). Samples with detects for the isotopes with a high bias in the LCS are re-prepped and re-analyzed..

13.3.2.2 LCS Spike Recovery excursion (low) the batch is re-prepped and re-analyzed for the affected isotope.

13.4 RPD/RER Duplicate excursion – For the RPD/RER One or both must be with in acceptance limits. The RPD limit is 40% or less. The RER limit is 1 or less depending on the significant digits. Not meeting the criteria requires a reprep of the samples. If samples have a physical matrix issue (ie, nonhomogenous), results can be reported with an NCM. If samples fail RPD/RER criteria after the reprep and no matrix issue is observed sample may be reported with client approval and narated in an NCM.

13.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

13.5.1 Analytes should be within control limits for accuracy (%Recovery) and precision (RPD).

13.5.2 Corrective Action for MS/MSD not meeting acceptance criteria:

13.5.2.1 MS/MSD Spike Rec. excursion may not necessarily warrant corrective action other than narration.

13.6 Sample Result Evaluation

13.6.1 Tracer/Carrier recovery must be within specified limits.

13.6.2 Tracer/Carrier recovery low– Samples must be reextracted. Exceptions can be made and results reported with approval from the technical director, manager, or client and approvpriate NCM included.

13.6.3 Tracer/Carrier recovery high

13.6.3.1 A sample tracer recovery outside QC limits may be accepted if the sample results are determined valid:

13.6.3.1.1 minimum number of tracer counts

13.6.3.1.2 level of uncertainty

13.6.3.1.3 client project requirements/approval

13.6.4 If the sample carrier recovery is significantly higher than normal, the native concentration in the sample of the carrier analyte may be present causing a high bias to the carrier recovery. This high bias to the carrier analyte would in turn cause a low bias to the samples result. The laboratory defines significant to be an additional 20% above the average LCS/MB carrier recovery (as determined from a population of LCS and MB data), with a maximum of 110%. The table below shows the limits determined for each

carrier analyte. The analyst should ensure that the carrier analysis is requested to determine native concentration for samples exceeding the limit.

Radium	Strontium	Chloride
110%	109%	109%

13.6.5 These expections will be documented using the NCM process. The NCM will narrate the conditions upon which the sample results were accepted with tracer recovery excursions.

13.7 Insufficient Sample

13.7.1 For any prescribed re-preparation corrective action, if there is insufficient sample to repeat the analysis a narrative comment stating such is included in the report narrative.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1 Method performance data, Reporting Limits, and QC acceptance limits, are given in LIMS.

14.2 Demonstration of Capability

14.2.1 Initial and continuing demonstrations of capability requirements are established in the ST-QAM.

14.3 Training Qualification

14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in the ST-QAM.

14.4 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in the ST-QAM.

15.0 VALIDATION

15.1 Laboratory SOPs are based on published methods (EPA, DOE, ASTM, Eichrom, Standard Methods) and do not require validation by the laboratory. The requirements for laboratory demonstration of capability are included in the ST-QAM. Laboratory validation data would be appropriate for performance based measurement systems, non-standard methods and significant modifications to published methods. Data from said validations is held in the QA department.

16.0 WASTE MANAGEMENT AND POLLUTION CONTROL

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

16.2 Waste Streams Produced by the Method

16.2.1 The following waste streams are produced when this method is carried out.

16.2.1.1 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the lab ware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM meter, the lab ware will be collected in waste

barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

17.1 ANSI N42.25-1997 – American National Standard Calibration and Usage of Alpha/Beta Proportional Counters

17.2 Department of Energy (DOE) Environmental Monitoring Laboratory (EML) HASL-300 Procedures Manual, method Ba-01-R, Beta Radioassay, Sr-02 Strontium 90, Sr-03-RC Strontium-90 in Environmental Samples.

17.3 Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Section 1, Method 900.0 Gross Alpha and Gross Beta Radiochemistry

17.4 Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Section 6, Method 903.0 Alpha-Emitting Radium Isotopes

17.5 Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Section 8, Method 904.0 Radium-228

17.6 Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Section 9, Method 905 Radioactive Strontium in Drinking Water

17.7 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 9310, Gross Alpha and Gross Beta

17.8 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 9315, Alpha-Emitting Radium Isotopes

17.9 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 9320, Radium-228

17.10 TestAmerica St. Louis Quality Assurance Manual, current revision

17.11 Corporate Environmental Health and Safety Manual (CW-E-M-001) and St. Louis Facility Addendum (SOP ST-HS-0002), current revisions

17.12 Associated SOPs, current revisions:

- 17.12.1 ST-PM-0002 "Sample Receipt and Chain of Custody"
- 17.12.2 ST-QA-0002, "Standards and Reagent Preparation."
- 17.12.3 ST-QA-0024, "Preventative Maintenance"
- 17.12.4 ST-QA-0036, "Non-Conformance Memorandum (NCM) Process"
- 17.12.5 ST-RC-0004, "Preparation of Soil, Sludge, Filter, Biota and Oil/Grease Samples for Radiochemical Analysis".
- 17.12.6 ST-RC-0020, "Determination of Gross Alpha/Beta Activity"
- 17.12.7 ST-RC-0021, "Gross Alpha Radition in Water using Copreciptation"
- 17.12.8 ST-RC-0036, "Determination of Chlorine-36 in Various Matrices by GFPC"
- 17.12.9 ST-RC-0040, 'Total Alpha Emitting Isotopes of Radium"
- 17.12.10 ST-RC-0041, "Radium-226 and Radium-228 by Chemical Separation Preparation"
- 17.12.11 ST-RC-0050, "Aqueous and Soil Sample Preparation for Strontium-89, Strontium-90, and Total Strontium"

18.0 MODIFICATIONS TO THE REFERENCE METHOD

18.1 Strontium-89 short half life makes it impractical to use as a calibration standard for both radium-228 analysis, as stated in EPA method 904 and SW method 9310, and strontium-89 analysis, as stated in EPA method 905. TestAmerica St. Louis uses a mixed strontium-90/yittrium-90 standard for its' GFPC beta calibration used in Gross Beta, strontium-90, strontium-89, and radium-228 analyses. TestAmerica St. Louis has selected the strontium-90/yittrium-90 standard because it produces a stable beta emission which can be reliably used for initial and continuing calibration. By using this standard mix, we have beta emissions at the lower and upper energetic spectrum whose average is in the middle of the beta range.

18.2 For Ra-228 analysis, TestAmerica St. Louis uses chemical separation techniques to eliminate other potential beta emitters.

18.3 TestAmerica St. Louis does not perform a direct strontium-89 analysis. TestAmerica St. Louis provides calculated results based on the difference between Total strontium and strontium-90.

19.0 CHANGES FROM PREVIOUS REVISION

19.1 Updated Section 10 to address voltage increase per step, plateau slope and QC check count requirements (5000 counts)

19.2 Rev. 11;
- 19.2.1 Added instument Purple throughout section 10 and 11.
- 19.2.2 Adjusted procedure steps throughout section 11.

19.3 Rev. 12,
- 19.3.1 Added Sr-02-RC and Sr-03-RC to sections 1.0 and 17.0.

19.4 Rev. 13:
- 19.4.1 Added Neptunium to scope in section 1.0.
- 19.4.2 Updated the Quality Control Program for counting daily rad checks and daily background checks in section 3.0.
- 19.4.3 Updated background count set-up, printing and entering protean data in section 10.8.

19.5 Rev. 14: (9/12/2013)
- 19.5.1 Removed references to Clouseau, SAC and QuantIMS
- 19.5.2 Section 5.0 added silver nitrate and ammonium hydroxide
- 19.5.3 Section 6.0 updated to include additional equipment
- 19.5.4 Section 7.0 updated to include addition reagents
- 19.5.5 Section 9.0 added reference to prep SOPs for additional information
- 19.5.6 Section 10.0 added sodium cloride standard preparation & reference to ST-QA-0024
- 19.5.7 Section 12.0 added Cl-36 detector efficiency calculation
- 19.5.8 Section 13.0 updated to include actual corrective actions and native concentration carrier requirements
- 19.5.9 Section 13.0 updated to include corrective actions
- 19.5.10 Section 17.0 added reference to ST-QA-0024

19.6 Rev. 15: (1/16/2015)
- 19.6.1 Added Section 7.10
- 19.6.2 Updated Section 9.6.1
- 19.6.3 Updated Section 10
- 19.6.4 Updated Section 11
- 19.6.5 Added ANSI N42.25-1997 reference to section 17

19.7 Rev. 16: (05/05/2015)
- 19.7.1 Section 11.3.3 added Background and checks are needed following a tank change.

19.8 Rev. 17: (05/23/2016)
- 19.8.1 Section 10, addition of trending of controls
- 19.8.2 Appendix created with trending rules

19.9 Revision 18 05/02/2017
- 19.9.1 Section 10.2 changes timefrom 5 minutes to "accumilate at least 10,000 counts" for distributed Sr90 source
- 19.9.2 Section 10.5 changed "single source" to "minimum of one source" for ICV/ACV
- 19.9.3 Section 10.9 – Added "Protean" source check instructions to those for "Orange" and "Purple" to combine all instruments. Added instrument "Blue" as well.
- 19.9.4 Section 11.3: added requirement to record gas tank changes on document on separate sheet
- 19.9.5 Updated SOPs in Section 17

19.10 Revision 19: (12/15/2017 (Tech Review: R. Mueller/J. Watson; QA Review: M. Ward))

19.10.1 Section 5: changed MSDS to SDS

19.10.2 Section 7:

19.10.2.1 Removed Ra-228 from beta calibration standard

19.10.2.2 Removed reference to Milli-Q system

19.10.3 Section 10.5.5 was removed to eliminate the need for ACV

19.10.4 Section 10.5.9 was revised to remove ACV

19.10.5 Section 18.0 removed- the lab changed the source for Ra-226 calibrations from Th-230 to Ra-226 and no note is needed to explain the use of a different analyte for calibration.

COMPANY CONFIDENTIAL AND PROPRIETARY

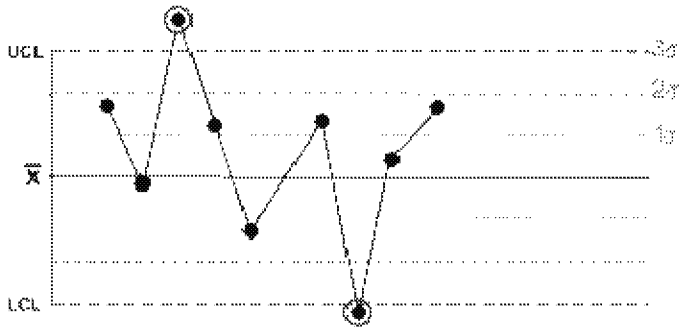
[THIS IS A CONTROLLED DOCUMENT. WHEN PRINTED IT BECOMES UNCONTROLLED]

Appendix

Rule 1: One point is more than 3 standard deviations from the mean.

~ Simplest: Single point is considered out of control event

- Corrective action required



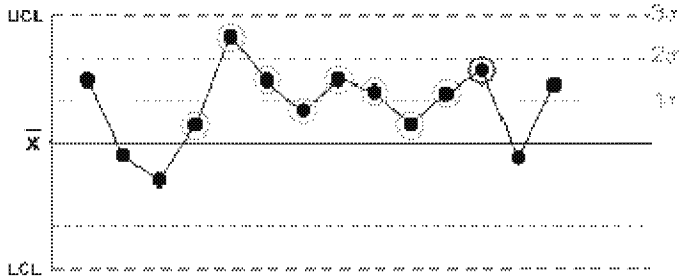
Rule 2: Seven (or defined 'n') points in a row are on the same side of the mean.

~ n = 7 warn trigger

- Mean shift: (same side of mean)

- Some prolonged bias exists.

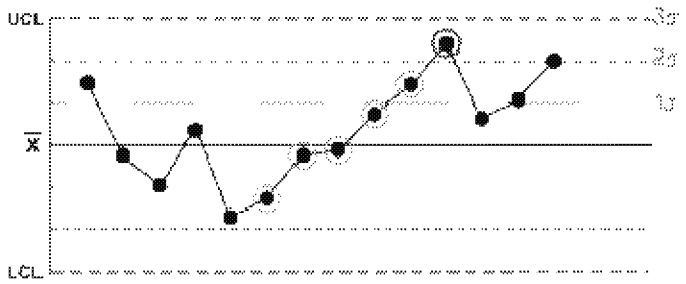
~ Corrective action recommended



Rule 3: Six (or more) points in a row are continually increasing (or decreasing).

- A trend exists.

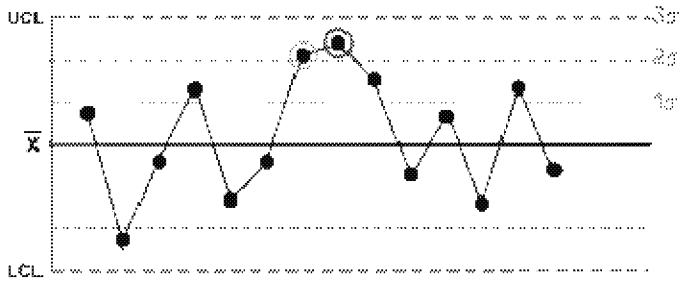
  ~ Corrective action recommended



Rule 5: Three out of three points in a row are more than 2 standard deviations from the mean in the same direction.

- There is a medium tendency for samples to be mediumly out of control.

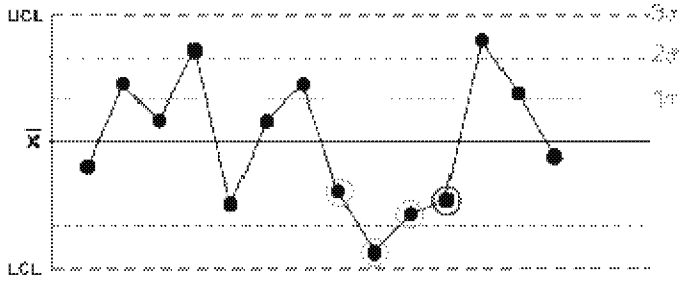
  ~ Investigate for preventive. May not be CAR



Rule 6: Four out of five points in a row are more than 1 standard deviation from the mean in the same direction.

- There is a strong tendency for samples to be slightly out of control.

  ~ No CAR, Statistical trend



Appendix B
Contractor Quality Control Plan

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Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

APPENDIX B

FINAL REVISION 2
CONTRACTOR QUALITY CONTROL PLAN

Parcel F Structures

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

May 2019

DCN: APTM-0006-4550-0025.R2/F

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

APPENDIX B

FINAL REVISION 2
CONTRACTOR QUALITY CONTROL PLAN

Parcel F Structures

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

May 2019

Prepared for:

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Contract Number: N62473-17-D-0006; Task Order: N6247317F4550
DCN: APTM-0006-4550-0025.R2/F

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

APPENDIX B

FINAL REVISION 2
CONTRACTOR QUALITY CONTROL PLAN

Parcel F Structures

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

May 2019

Approved By:	Steve Massey Program Quality Control Manager	May 24, 2019 Date
Approved By:	Lisa Bercik, PE, QSD, QSP Project Manager	May 24, 2019 Date

Contract Number: N62473-17-D-0006; Task Order: N6247317F4550
DCN: APTM-0006-4550-0025.R2/F

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Attachment 2 Project Quality Control Duties and Responsibilities
Attachment 3 Project Quality Control Manager Letter of Designation
Attachment 4 Alternate Project Quality Control Manager Letter of Designation
Attachment 5 Outside Organizations
Attachment 6 Submittal Register
Attachment 7 Testing Plan and Log
Attachment 8 Definable Features of Work Matrix
Attachment 9 Organization and Personnel Certifications
Attachment 10 Procedures (Procedures will be included if requirements for project-specific quality procedures arise as the project progresses)

Acronyms and Abbreviations

APP/SSHP	*Accident Prevention Plan/Site Safety and Health Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*
AMS	*APTIM Management System*
APTIM	Aptim Federal Services, LLC
COR	Contracting Officer Representative
CQC	contractor quality control
CTO	contract task order
DFOW	definable feature of work
KO	Contracting Officer
Navy	U.S. Department of the Navy
PM	project manager
QC	quality control
QCD	quality control directive
RPP	*Radiation Protection Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*
WP	work plan

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1.0 INTRODUCTION

Aptim Federal Services, LLC (APTIM) prepared this Contractor Quality Control (CQC) Plan under Contract No. N62473-17-D-0006, Contract Task Order (CTO) N6247317F4550 to describe the quality control (QC) actions that will be implemented during the radiological scoping surveys at Parcel F, Hunters Point Naval Shipyard, San Francisco, California. This CQC Plan will be used in conjunction with the following:

- *Corporate Quality Management Plan, Environmental Multiple Award Contract for Remediation of Radiological Contaminants (RADMAC II)* (CB&I Federal Services LLC, 2017), which includes quality control directives (QCDs)
- *APTIM Management System* (AMS; APTIM, 2017a)

Radiological activities will include radiological scoping surveys of the Parcel F structures (submarine pens and finger piers). Radiological work will be performed in accordance with U.S. Nuclear Regulatory Commission Radioactive Materials License 20-31340-01, and State of California Radioactive Materials License 7789-07 and associated procedures and work instructions. Radiological safety procedures and roles and responsibilities of the radiological organization are described in the *Radiation Protection Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California* (RPP; APTIM, 2017b).

This project-specific CQC Plan was developed to ensure project activities are conducted in a planned and controlled manner; the product of these activities conforms to contract requirements; and appropriate documentation exists to support each activity for which APTIM is responsible.

A Project QC Manager will be present at the work site to implement and manage the QC Program. The Project QC Manager will work closely with the Project Manager (PM) and with the U.S. Department of the Navy (Navy) quality assurance representatives to assure that the work is performed in compliance with specifications contained in the work plan (WP) and this CQC Plan. The Project QC Manager has the authority to stop work if contract requirements are not being met. In the event that the Project QC Manager is unavailable, an alternate QC Manager will assume this responsibility.

The Program QC Manager for this Navy contract is responsible for developing, maintaining, and enforcing the QC Program for the contract, and will work directly with the PM and the Project QC Manager to assure that all work is performed in compliance with the contract. The Program QC Manager will serve as an alternate contact for the Project QC Manager if questions arise regarding acceptability of materials or performance during the project.

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The PM reports to the Program Manager for the contract, who has the responsibility and authority to ensure that the work is performed according to the approved specifications and to the Navy's satisfaction.

Attachment 1 depicts APTIM's project organization for this CTO. Attachments 2 through 9 are documents from the QCDs tailored to this CTO, which will help achieve statement CTO objectives. If additional project-specific quality procedures are required as the project progresses, these procedures will be inserted into Attachment 10.

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2.0 QUALITY CONTROL ORGANIZATION

APTIM structured its corporate QC organization to support the Program Managers and PMs who have ultimate responsibility for the quality of services APTIM provides. The Program Managers and PMs are responsible for ensuring that personnel in their organizations understand the corporate and contract-specific QC programs and that their organizations' functions are set up and maintained effectively.

Quality issues are resolved at the lowest possible organizational level at each project site, to enable timely correction action development and implementation. Issues that cannot be satisfactorily resolved at the project level are elevated to and resolved at the corporate level.

APTIM's project organization chart, including QC personnel, is shown in Attachment 1. The figure illustrates the reporting and communication relationships between QC personnel, the APTIM field team, subcontractors, and Navy representatives. This structure provides the organizational freedom for personnel to identify and evaluate quality problems and discrepancies, provide recommended solutions, and ensure that appropriate corrective actions are taken.

The specific responsibilities and qualifications associated with each QC-related position are outlined in Attachment 2. The qualifications and experience of the proposed key appointees for this project are summarized in Attachments 3 and 4.

2.1 Quality Control Personnel and Qualifications

Key QC personnel for APTIM projects are assigned on the basis of appropriate experience and the determination that these individuals meet the contract and CTO-specific requirements. The Project QC Manager and Alternate Project QC Manager are appointed by the Program QC Manager. The following paragraphs identify the QC team for this CTO and highlight their responsibilities. Copies of appointees' resumes, certifications, and letters of designation are included in Attachments 3 and 4.

2.1.1 Project Quality Control Manager

The Project QC Manager, who reports directly to the Program QC Manager, will work closely with the PM, Radiation Safety Officer, Radiation Control Supervisor, and Navy QC representatives to assure that the work is performed in compliance with the specifications contained in the approved WP. The Project QC Manager has the authority to stop work if contract requirements are not being met. The Project QC Manager's responsibilities are listed in Attachment 2. In the event the Project QC Manager is unavailable, an Alternate Project QC Manager will assume this responsibility.

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2.1.2 Alternate Project Quality Control Manager

In the event the Project QC Manager is unavailable, an Alternate Project QC Manager will assume the QC responsibilities outlined in Attachment 2 and described in this CQC Plan. The Alternate Project QC Managers designated for this project are identified in Attachment 4.

The project team, including subcontractors, will use procedures in this subsection to ensure quality and achieve project objectives.

2.2 Quality Control Directives

The following QCDs apply to this CTO:

- QCD 1.0, "Project Quality Control Personnel Duties, Qualifications, and Authority"
- QCD 2.0, "Project Quality Control Plans"
- QCD 3.0, "Design Review"
- QCD 4.0, "Coordination and Mutual Understanding Meeting"
- QCD 5.0, "Project Quality Control Meetings"
- QCD 6.0, "Submittals"
- QCD 7.0, "Documentation"
- QCD 8.0, "Quality Control Certifications"
- QCD 9.0, "Three Phases of Control"
- QCD 10.0, "Completion Inspections"
- QCD 11.0, "Testing"
- QCD 12.0, "Corrective Action Requests and Non-compliance"
- QCD 13.0, "Rework"
- QCD 14.0, "Change Control"
- QCD 15.0, "Organization and Personnel Certifications Log"
- QCD 16.0, "Field Startup"
- QCD 17.0, "PM Turnover"
- QCD 18.0, "Training"
- QCD 19.0 "Quality Audits"
- QCD 20.0 "Quality Control for Geophysical Surveys"

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2.3 APTIM Quality Procedures

The following documents describe the administrative and technical requirements for uniform quality performance for this project. These procedures are developed, maintained, and hosted corporately within the AMS. Procedures can be accessed by any APTIM employee and will be provided to the government upon request (APTIM, 2017a).

- AMS-720-01-PR-00130, "Quality Management Organization" (supersedes EIP-Q-001, "Quality Organization")
- EIP-Q-002, "Stop Work Notice for Quality Related Issues" (no current AMS equivalent)
- AMS-720-01-PR-00120, "Project Quality Plans" (supersedes EIG-Q-003, "Project Quality Plan")
- AMS-720-02-PR-00480, "Receiving Inspection" (supersedes EIP-Q-004, "Receipt Inspection")
- AMS-720-01-PR-00230, "Construction Inspection Program" (supersedes EIP-Q-005, "Inspection")
- AMS-720-01-PR-00290, "Inspection and Test Plans" (supersedes EIP-Q-005, "Inspection" and EIP-Q-016, "Test Control")
- AMS-720-01-GL-00230, "Guidelines for Quality Surveillance Activities" (supersedes EIP-Q-006, "Surveillance")
- AMS-720-01-PR-00150, "Identification, Control, and Disposition of Nonconforming Product" (supersedes EIG-Q-007, "Nonconformance Reporting")
- AMS-720-01-PR-00170, "Corrective and Preventive Action" (supersedes EIG-Q-008, "Corrective Action")
- AMS-720-01-PR-00220, "Management System Audits" (supersedes EIG-Q-009, "Quality Audits")
- AMS-720-01-GL-00223, "Qualification and Assessment of Internal Audit Personnel" (supersedes EIP-Q-010, "Auditor and Lead Auditor Qualification Program")
- EIP-Q-014, "Management Assessment" (no current AMS equivalent)
- EIG-Q-015, "Quality Councils" (no current AMS equivalent)

Note: The QCDs take precedence over these procedures

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3.0 OUTSIDE ORGANIZATIONS

To manage subcontractors and vendors effectively, APTIM carefully selects and prequalifies each firm. APTIM continuously and aggressively manages subcontractor costs, schedule, safety, and quality performance. The pre-qualification process ensures that subcontractors bring the same focus on quality, cost control, schedule discipline, and commitment to customer satisfaction as APTIM. Once an award is made to a subcontractor, APTIM manages the quality of the subcontractor's performance through the three-phase inspection process outlined in Section 9.0.

Laboratories providing environmental analyses are accredited as noted in the Sampling and Analysis Plan prepared under this same contract for Parcel F (Appendix A of the WP).

Names and qualifications of subcontractors proposed for this project are summarized in Attachment 5. Subcontractors will be subject to APTIM QC procedures. Testing and inspection procedures will be monitored by APTIM as described in Section 5.0.

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4.0 SUBMITTAL PROCEDURES

Submittals will be managed by APTIM as required by contract. The Project QC Manager will review and approve items prior to submittal. The Project QC Manager will certify that submittals are in compliance with contract requirements. Radiological data will be reviewed by the Project Radiation Safety Officer or designee prior to submittal. Submittals are further discussed under QCD 6.0.

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5.0 TESTING

In addition to implementing the three phases of the control system to ensure the overall quality of each definable feature of work (DFOW), APTIM will make use of formal testing procedures where applicable, including tests performed by subcontractors and/or off-site laboratories, to ensure conformance to applicable specifications and verify that control measures are adequate to provide a finished product which conforms to contract requirements. The Project QC Manager will ensure that sampling and testing are managed and performed as required by contract.

5.1 Testing Plan and Log

If necessary, the Project QC Manager will use the Testing Plan and Log, contained in Attachment 7, to manage project testing. As tests are performed, the Project QC Manager will record on the log the date the test was performed and the date the test results were forwarded to the Contracting Officer (KO) or Contracting Officer Representative (COR) as applicable. The Project QC Manager will attach a copy of the updated log to the last Daily Contractor QC Report of each month. Chemical or radiological sampling and analyses are normally not included in the log, since requirements are implemented by the Sampling and Analysis Plan (Appendix A of the WP).

5.2 Testing and Documentation

APTIM will submit test reports, containing test results to the KO and/or COR as required by contract. Test reports will cite applicable contract requirements, tests or analytical procedures used, and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, APTIM will notify the KO and/or COR immediately. APTIM will submit the signed test reports, certifications, and other documentation to the KO and/or COR via the Project QC Manager. The Project QC Manager shall submit a summary report of field tests in the Daily Contractor QC Report. Testing is further discussed under QCD 11.0.

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6.0 REWORK ITEMS, NON-COMPLIANCES, AND CORRECTIVE ACTION REQUESTS

The Project QC Manager will review any instances where materials, equipment, or activities fail to meet the specified requirements, and will take appropriate action to prevent future occurrences.

6.1 Rework

A rework item is work that does not comply with the contract. There is no requirement to report a rework item that is corrected the same day it is discovered. All APTIM and subcontractor personnel will be responsible for identifying rework items and reporting them to the Project QC Manager. The Project QC Manager will coordinate with the Project Superintendent to ensure rework items are corrected in a timely manner. The Project QC Manager shall maintain a Rework Items List of work that does not comply with the contract, including those identified by the KO or his/her representative. The Project QC Manager will report identified and corrected items in the Daily Contractor QC Report and during Project QC Meetings and will attach a copy of the Rework Items List to the last Daily Contractor QC Report of each month. Rework items are further discussed under QCD 13.0.

6.2 Non-Compliances

The KO may also notify APTIM of any detected non-compliance with the contract. APTIM will take immediate corrective action after receipt of such notice. Such notice, when delivered to APTIM at the work site, shall be deemed sufficient for the purpose of notification. Non-compliances are further discussed under QCD 12.0.

6.3 Corrective Action Requests

APTIM will identify, track, and correct items, processes, and services that do not meet established requirements. Correction will focus on determining the cause of the deficiency and corrective actions will address the deficiency and prevent recurrence. Corrective Action Requests are further discussed under QCD 12.0.

6.4 Procedures for Tracking Laboratory Deficiencies

Laboratory testing requirements for radiological analyses and procedures for identifying and managing any deficiencies are addressed under the Sampling and Analysis Plan (Appendix A of the WP).

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7.0 DOCUMENTATION

A variety of documents will be developed at specified points or intervals during the course of this project to support the QC process. These items will be submitted to the government or maintained by APTIM and made available for review as required. QC-related project documentation may include:

- Testing plan and log
- Daily CQC reports
- Three-phase control inspection checklists (preparatory, initial, and follow-up)
- QC meeting minutes
- Rework items list
- Non-compliance/corrective action reports
- As-built drawings
- Material receipt inspections

Documentation is further discussed under QCD 7.0.

7.1 Daily Reports

APTIM shall submit reports for each day that work is performed as required by contract. Reports will be attached to the Daily Contractor QC Report. Reports may also be submitted on a weekly basis depending on the nature of work and with approval from the Navy. The reporting of work shall be identified by terminology consistent with the construction schedule. The "remarks" section of reports will include directions received, construction deficiencies and problems, QC problems, deviations from project plans, conflicts or errors in the drawings or specifications, field changes, instructions given and corrective actions taken, work progress and delays, safety hazards, meetings held, and visitors to the work site.

7.1.1 Daily Contractor Quality Control Report

The Project QC Manager is responsible for preparing and signing the Daily Contractor QC Report. Other QC, production, and health and safety documents may be attached to this report. The Project QC Manager will submit the report to the Navy by 10:00 AM the next working day after each day that work is performed and for every seven consecutive calendar days of no-work.

7.1.2 Daily Contractor Production Report

The Project Superintendent or designee is responsible for preparing and signing the Daily Contractor Production Report. The report will be attached to the Daily Contractor QC Report.

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7.1.3 Quality Control Specialist Report

If a QC Specialist is assigned, he/she shall prepare, sign, and date a report for each day that work is performed in his/her area of responsibility. This report shall include the same documentation requirements as are submitted with the Daily Contractor QC Report.

7.2 Quality Control Meeting Minutes

After the start of construction, the Project QC Manager will commence holding weekly QC meetings with the Site Superintendent, QC staff, and Site Safety and Health Officer. The Navy Remedial Project Manager/COR, Caretaker Site Office, Resident Officer in Charge of Construction, and Radiological Affairs Support Office may also attend these meetings as required.

As a minimum, the following will be accomplished at each QC meeting as needed:

- Review the minutes of the previous meeting
- Review the status of work, inspections, testing, rework, and submittals
- Review the work, inspections, and testing to be accomplished in the next two weeks and documentation required
- Resolve QC, production, and safety concerns
- Address items that may require revising the project plans
- Review the accident prevention plan and/or activity hazard analyses as necessary
- Review environmental requirements and procedures as necessary
- Review the following, as applicable
  - Waste Management Plan
  - Radiological Protection Plan
  - Status of training completion and progress

The Project QC Manager will prepare the minutes of the meetings and provide a copy to the COR within two working days after the meeting.

7.3 Quality Control Validation

APTIM shall maintain files of original documents in a home office, including project documents. Copies of project documents will also be filed in the field office. Project files include, but are not limited to, inspection reports and checklists, Testing Plan and Log, Rework Items List, and punch lists. Reports are required from the QC Specialists (if assigned) for each day that work is performed in their area of responsibility. QC Specialist reports shall include the same documentation requirements as the Daily Contractor QC Report for their area of responsibility. QC Specialist reports are to be prepared, signed,

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and dated by the QC Specialists and shall be attached to the Daily Contractor QC Report prepared for the same day.

7.4 As-Built Drawings

The Project QC Manager shall ensure the as-built drawings are kept current on a daily basis and marked to show deviations from the contract drawings identified with the appropriate modifying documentation. The Project QC Manager or QC Specialist assigned to that area of responsibility shall initial each revision. Upon completion of work, the Project QC Manager will certify the drawings, attesting to their accuracy, and ensure that they are submitted to the KO per QCD 8.0.

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8.0 DEFINABLE FEATURES OF WORK

A DFOW is a representative portion of work that is separate and distinct from any other stage of work. Three DFOWs have been identified for this project, as outlined in the following subsections and further described in the WP. Activities associated with the project will be conducted in accordance with the WP and Sampling and Analysis Plan (Appendix A of the WP); the *Accident Prevention Plan/Site Safety and Health Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California* (APP/SSHP; APTIM, 2017c); and the RPP (APTIM, 2017b) for this project, which provide specific methods and requirements for implementation of the DFOWs.

8.1 Definable Feature of Work 1: Radiological Surveys of Parcel F Structures

Class 2 *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (U.S. Environmental Protection Agency et al., 2000) surveys of the Parcel F submarine pens and finger piers will be completed. Per the CTO project work statement, the survey will include six Class 2 survey units, one survey unit for each pier and submarine pens. The scoping surveys have been designed so that if contamination is not found, the scoping survey may be presented as a final status survey to achieve unrestricted release.

The gamma scan surveys will be performed for 100 percent of the accessible areas using the RS-700 or a Ludlum Model 44-20 3-inch by 3-inch sodium iodide gamma scintillation detector coupled with a Ludlum Model 2221 ratemeter/scaler (or equivalent) handheld instrument in areas inaccessible to the RS-700, consistent with the requirements for a *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* survey (U.S. Environmental Protection Agency et al., 2000). The objective of the gamma scan surveys is to identify areas of elevated gamma radioactivity that could result from residual radioactivity from radioluminescent devices or other sources of gamma radiation. Areas of elevated gamma activity will be included in the areas covered by the alpha and beta scan surveys.

Alpha/beta static measurements and alpha/beta swipes will be collected over 25 percent of the accessible areas of the Parcel F structures. The alpha/beta static measurements will be performed using portable contamination survey instruments specifically, the Ludlum Model 43-37 gas flow proportional "floor monitor" detector or Ludlum Model 43-93 zinc sulfide/plastic scintillator detector (or equivalent) coupled with a Ludlum Model 2360 scaler/ratemeter (or equivalent). The scaler/ratemeter will be set to a two-minute count time. At the start of each measurement, the surveyor will position the detector, and begin the two-minute count. At the completion of each two-minute count, the alpha and beta result will be recorded. The IL for the static alpha and beta will be developed and used as described in the decision rules included in the WP. The release criteria were established in the *Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, California* (Navy, 2006).

Samples (sediment, wood, or concrete) may be collected as required to support the radiological scoping surveys.

8.2 Definable Feature of Work 2: Decontamination and Release of Equipment and Tools

Equipment and personnel exiting a work area will follow decontamination procedures presented in the APP/SSHP (APTIM, 2017c). Decontamination areas will be located near work boundary exits. The level of decontamination of equipment will be determined by the Site Health and Safety Officer and Project Radiation Safety Officer. The need for and degree of decontamination will be based on the characteristics of the material within the work area and the potential for transporting contaminants outside of the work area.

Visible dirt or debris will be removed from equipment with a brush and a Masslin wipe. The equipment and wipe will be surveyed to confirm the absence of activity above applicable control levels as described in the RPP (APTIM, 2017b) using the surface contamination criteria from the *Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, California* (Navy, 2006). Detectable levels of activity during decontamination above criteria will require immediate notification to the Navy for further direction.

8.3 Definable Feature of Work 3: Site Restoration/Demobilization

Restoration of Parcel F structures following the scoping survey effort is not expected or required. Any surface sample locations (i.e., core borings) will be restored in kind with concrete patching to prevent further weathering/destruction of the area sampled.

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9.0 THREE PHASES OF CONTROL

The Project QC Manager manages the three phases of control to adequately cover on-site and off-site DFOWs. The Project QC Manager may assign the Task Leader for DFOWs to other project personnel, including the Project Engineer, Project Geologist, Project Superintendent, QC Specialist, etc.

9.1 Preparatory Phase

The Project QC Manager shall notify the CO and/or COR, as applicable, at least two work days, two weeks for off-site work, in advance of each preparatory phase meeting. The assigned lead shown on the project DFOW Matrix will conduct the meeting. At a minimum, the Project QC Manager, QC staff, Project Superintendent, foreman, and Site Safety and Health Officer will attend. When a subcontractor will perform work, that subcontractor's superintendent shall attend.

9.1.1 Preparatory Phase Activities

The following will occur during the preparatory phase:

- Review each paragraph of the applicable specification sections.
- Review the contract drawings.
- Verify that field measurements are as indicated on construction and/or shop drawings before confirming product orders, in order to minimize waste due to excessive materials.
- Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.
- Review the Testing Plan and Log, and ensure that provisions have been made to provide the required QC testing.
- Examine the work area to ensure that the required preliminary work has been completed.
- Coordinate the schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- Examine the required materials, equipment, and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data.
- Discuss construction methods, construction tolerances, workmanship standards, and the approach that will be used to provide quality construction by planning ahead and identifying potential problems.

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- Review the APP/SSHP (APTIM, 2017c) and appropriate activity hazard analyses to ensure that applicable safety requirements are met and that required material safety data sheets are submitted.

Results of the preparatory phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report.

9.2 Initial Phase

The Project QC Manager shall notify the KO and/or COR at least two work days, two weeks for off-site work, in advance of each initial phase. The assigned lead shown on the project DFOW Matrix will perform the initial phase and he/she will observe the initial segment of the DFOW to ensure that the work complies with contract requirements. Results of the initial phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report. Attachments contain this report. The following will be performed:

- Establish the quality of workmanship required
- Resolve conflicts
- Ensure that testing is performed by the approved laboratory
- Check work procedures for compliance with the APP/SSHP (APTIM, 2017c) and the appropriate activity hazard analyses to ensure that applicable safety requirements are met

Results of the initial phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report.

9.3 Follow-up Phase

The assigned lead shown on the project DFOW Matrix will perform the follow-up phase for ongoing work daily, or more frequently as necessary, until the completion of the work. Results of the initial phase will be documented in the Inspection Report and attached to the Daily Contractor QC Report. The following will be performed:

- Ensure the work is in compliance with contract requirements
- Maintain the quality of workmanship required
- Ensure that testing is performed by the approved laboratory
- Ensure that rework items are being corrected
- Perform safety inspections

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9.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases will be conducted for a deficiency if the quality of ongoing work remains or becomes unacceptable; there are changes in the applicable QC organization; there are changes in the on-site production supervision or work crew; work is resumed after substantial period of inactivity; or other problems develop. The three phases of control are further discussed under QCD 9.0.

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10.0 COMPLETION INSPECTIONS

Project inspections that demonstrate completeness are described in this section. Inspections may include a punch-out inspection, pre-final inspection, and final acceptance inspection.

10.1 Punch-Out Inspection

The Project QC Manager will manage completion inspections. Near the completion of all work or to verify that statement of objectives or performance work statements are met, the Project QC Manager will ensure work is inspected and a punch list developed. Punch list items include items that do not conform to the approved drawings, specifications and contract, and remaining rework items. The punch list will indicate the estimated correction dates of these items. A copy of the punch list will be provided to the COR, if required by contract. The Project QC Manager will ensure corrected items are verified. Once this is accomplished, he/she will schedule a pre-final inspection.

10.2 Pre-Final Inspection

The Navy will perform a pre-final inspection to verify that fieldwork is complete. A Navy punch list may be developed as a result of this inspection. The Project QC Manager will ensure that the items on this list are corrected prior to notifying the Navy that a final inspection with the client can be scheduled. Any items noted during the preliminary-final inspection must be corrected in a timely manner and be accomplished before the contract completion date for the work.

10.3 Final Acceptance Inspection

If required by contract, the Project QC Manager will notify the KO and/or COR at least 14 calendar days prior to the date a final acceptance inspection can be held, stating that all items previously identified during the pre-final will be corrected and acceptable, along with any other unfinished contract work, by the date of the inspection. The Project QC Manager, Project Superintendent, and others deemed necessary will be present during the inspection with the Navy. If deficiencies remain or are identified during the inspection, the parties will agree on a course of action. Completion inspections are further discussed under QCD 10.0.

10.4 Inspection Documentation

Inspection records will be maintained by the Project QC Manager in accordance with QCD 7.0.

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11.0 REFERENCES

CB&I Federal Services LLC, 2017, *Corporate Quality Management Plan, Environmental Multiple Award Contract for Remediation of Radiological Contaminants (RADMAC II)*, May.

Aptim Federal Services, LLC (APTIM), 2017a, *APTIM Management System*.

APTIM, 2017b, Radiation Protection Plan, *Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*.

APTIM, 2017c, *Accident Prevention Plan/Site Safety and Health Plan, Radiological Work Tasks, Remedial Action and Maintenance of Remedies at Hunters Point Naval Shipyard, San Francisco, California*.

U.S. Department of the Navy (Navy), *Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, California*, April 21.

U.S. Environmental Protection Agency, U.S. Nuclear Regulatory Commission, and U.S. Department of Energy, 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* EPA 402-R-97-016, NUREG-1575, DOE/EH-0624, Revision 1, Washington, D.C.

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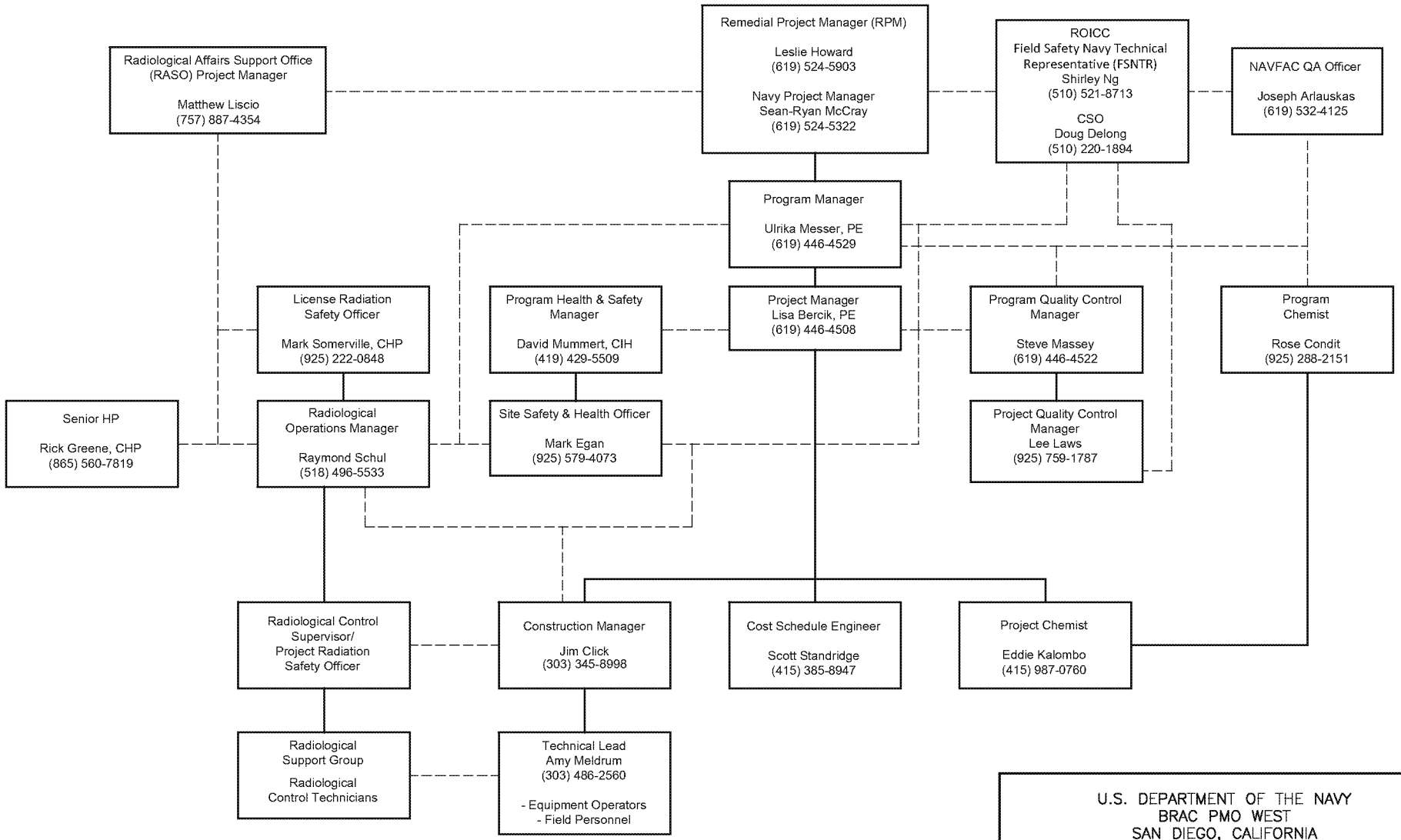
Attachment 1
Quality Control Organization Chart

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER	501008-A3
---	---	Concord	JWR	03/04/19						



LEGEND

- - - - - - - - LINES OF COMMUNICATION

———— LINES OF AUTHORITY

U.S. DEPARTMENT OF THE NAVY
BRAC PMO WEST
SAN DIEGO, CALIFORNIA

ATTACHMENT 1
ORGANIZATION CHART

PARCEL F – RADIOLOGICAL WORK TASKS, REMEDIAL ACTION, AND MAINTENANCE OF REMEDIES
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

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Attachment 2
Project Quality Control Duties and Responsibilities

Project Quality Control Duties and Responsibilities

Duty	Responsibility	QCD
Pre-Construction Phase		
Establish Personnel Requirements	PM	1.0
Review Personnel Resumes	PM	1.0
Assign Duties	PM	1.0, 2.0
Prepare Organization Chart	PQCM	1.0, 2.0
Prepare Letters of Designation	PQCM	1.0, 2.0
Review Plans and Designs	PM, PQCM	3.0, 7.0
Identify Subcontractors	PM	1.0, 2.0
Submit Laboratory Information	PQCM	1.0, 2.0
Attend Training	all	1.0
Prepare Submittal Register	PQCM	2.0, 6.0
Prepare Definable Features of Work Matrix	PQCM	2.0, 9.0
Prepare Testing Plan and Log	PQCM	2.0, 11.0
Prepare Rework Items List	PQCM	2.0, 13.0
Assemble Forms	PQCM	2.0
Assemble Personnel Certifications	PQCM	8.0, 15.0
Conduct Coordination and Mutual Understanding Meeting	PQCM	4.0
Construction Phase		
Ensure Construction Quality	PM	1.0, 14.0, 16.0, 17.0
Review Definable Features of Work	PQCM	9.0
Ensure Submittals Approved and Submitted	PQCM	3.0, 6.0, 7.0
Conduct Project QC Meetings	PQCM	5.0
Conduct Preparatory Meetings	PQCM	9.0
Conduct Preparatory Inspections	PQCM	9.0
Conduct Initial Inspections	PQCM	9.0
Conduct Follow-Up Inspections	PQCM	9.0
Conduct Completion Inspections	PQCM	10.0
Manage Corrective Action Requests	PQCM	12.0
Manage Rework Items	PQCM	13.0
Provide QC Certifications	PQCM	8.0

Notes:

The PQCM may assign the lead for inspections to the other project personnel: Task Lead, Project Site Superintendent, etc.

PM	*project manager*
PQCM	*project quality control manager*
QC	*quality control*
QCD	*quality control directive*

Attachment 3
Project Quality Control Manager
Letter of Designation

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CONTRACTOR QUALITY CONTROL PLAN—PARCEL F
Radiological Work Tasks, Remedial Action and Maintenance of Remedies
Hunters Point Naval Shipyard
San Francisco, California
Contract Number N62473-17-D-0006
Contract Task Order N6247317F4550

PROJECT QUALITY CONTROL MANAGER
LETTER OF DESIGNATION

May 2019

Mr. Lee Laws:

This letter will serve to assign you as the Aptim Federal Services, LLC Project Quality Control (QC) Manager for the above-captioned contract task order. In this capacity, you will report directly to me and will administer the established requirements of the contract and Project QC Plan. In the case where you are not able to perform the Project QC Manager's duties, Mr. Kevin O'Leary, Mr. Michael Lightner, Ms. Amy Meldrum will serve as your Alternate Project QC Manager. You will manage the three phases of control. You are authorized to stop work that is not in accordance with the contract and will exercise this authority consistent with Aptim Federal Services, LLC policies and procedures. You are authorized to approve submittals that have been certified by qualified submittal reviewers as identified in the organization chart for this task order and as necessary to ensure the quality of the work, and direct the removal and/or replacement of nonconforming materials or work.

Your Construction Quality Management certificate and resume are classified as Personal Identifiable Information and not included in the Project QC Plan. These records will be furnished to the government upon request.

If you have any questions or require additional information, please contact me at 619.446.4552.

Sincerely,

Aptim Federal Services, LLC

Stephen Massey
Program QC Manager

Attachment 4
Alternate Project Quality Control Manager Letter of Designation

CONTRACTOR QUALITY CONTROL PLAN—PARCEL F
Radiological Work Tasks, Remedial Action and Maintenance of Remedies
Hunters Point Naval Shipyard
San Francisco, California
Contract Number N62473-17-D-0006
Contract Task Order N6247317F4550

ALTERNATE PROJECT QUALITY CONTROL MANAGER
LETTER OF DESIGNATION

May 2019

Mr. Kevin O'Leary, Mr. Michael Lightner, Ms. Amy Meldrum:

This letter will serve to assign you as Aptim Federal Services, LLC Alternate Project Quality Control (QC) Manager for the above-captioned contract task order. In the case where the designated Project QC Manager, Mr. Lee Laws is unable to perform the Project QC Manager's duties, you will serve in that capacity with his responsibilities and authorities, report directly to me, and administer the established requirements of the contract and Project QC Plan. You will manage the three phases of control. You are authorized to stop work that is not in accordance with the contract and will exercise this authority consistent with Aptim Federal Services, LLC policies and procedures. You are granted the authority to approve submittals that have been certified by qualified submittal reviewers as identified in the organization chart for this task order and as necessary to ensure the quality of the work, and direct the removal and/or replacement of nonconforming materials or work. You are authorized to act as an alternate for two weeks at one time and not more than 30 workdays during a calendar year. In the case where it is believed that these time periods will be exceeded, you must notify me.

Your Construction Quality Management certificate and resume are classified as Personal Identifiable Information and not included in the Project QC Plan. These records will be furnished to the government upon request.

If you have any questions or require additional information, please contact me at 619.446.4552.

Sincerely,

Aptim Federal Services, LLC

Stephen Massey
Program QC Manager

Attachment 5
Outside Organizations

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Outside Organizations

Organization Name/Address/Phone	Description of Services
TestAmerica	Environmental Analytical Services
Cabrera Services, Inc.	Radiological technical support

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Attachment 6
Submittal Register

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SUBMITTAL REGISTER

CONTRACT NUMBER
N62473-17-D-0006
CTO N62473-17-F-4550

Title and Location: ***Radiological Work Tasks, Remedial Action and Maintenance of Remedies, Task: Radiological Scoping Surveys, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California***

Contractor
Aptim Federal Services LLC

Specification Section
Scope of Work

Transmittal No.	Item No.	Specification Paragraph No.	Description of Item Submitted	Type of Submittal									Classification		Reviewer	Contractor Schedule Dates			Contractor Action			Government Action		Remarks
				Data	Drawings	Instructions	Schedules	Statements	Reports	Certificates	Samples	Records	Information only	Government approved		Submit	Approval needed by	Material needed by	Code	Date	Submit to government	Code	Date	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
	001	Section 2.1.1	Copy of NRC and CA License and SOPs					X		X			X											
	002	Section 2.2.1	Kickoff Meeting Minutes					X						X	RPM									Within 10 days of meeting
	003	Section 2.1.1	Monthly Status Reports					X					X		RPM									
	004	Section 2.0	Internal Draft Work Plan, SAP, CQC Plan, WMP		X		X	X						X	RPM									
	005	Section 2.0	Draft Work Plan SAP, CQC Plan, WMP		X		X	X						X	RPM									
	006	Section 2.0	Final Work Plan		X		X	X						X	RPM									
	007	Section 2.3.2.4	Draft Radiological Protection Plan		X			X						X	RASO									
	008	Section 2.3.2.4	Final Radiological Protection Plan		X			X						X	RASO									
	009	Section 2.3.2.1	Draft APP/SSHP		X			X						X	Navy NMPHC									
	010	Section 2.3.2.1	Final APP/SSHP		X			X						X	Navy NMPHC									
	011	Section 2.5.5	Internal Draft Scoping Survey Report – Parcel F Submarine Pens	X	X			X	X			X		X	RPM									
	012	Section 2.5.5	Draft Scoping Survey Report – Parcel F Submarine Pens	X	X			X	X			X		X	RPM									

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SUBMITTAL REGISTER

CONTRACT NUMBER
N62473-17-D-0006
CTO N62473-17-F-4550

Title and Location: ***Radiological Work Tasks, Remedial Action and Maintenance of Remedies, Task: Radiological Scoping Surveys, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California***

Contractor
Aptim Federal Services LLC

Specification Section
Scope of Work

Transmittal No.	Item No.	Specification Paragraph No.	Description of Item Submitted	Type of Submittal									Classification		Reviewer	Contractor Schedule Dates			Contractor Action			Government Action		Remarks
				Data	Drawings	Instructions	Schedules	Statements	Reports	Certificates	Samples	Records	Information only	Government approved		Submit	Approval needed by	Material needed by	Code	Date	Submit to government	Code	Date	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
	013	Section 2.5.5	Draft Final Scoping Survey Report – Parcel F Submarine Pens	X	X			X	X			X		X	RPM									
	014	Section 2.5.5	Final Scoping Survey Report – Parcel F Submarine Pens	X	X			X	X			X		X	RPM									
	015	Section 2.5.5	Internal Draft Scoping Survey Report – Parcel F Finger Piers	X	X			X	X			X		X	RPM									
	016	Section 2.5.5	Draft Scoping Survey Report – Parcel F Finger Piers	X	X			X	X			X		X	RPM									
	017	Section 2.5.5	Draft Final Scoping Survey Report – Parcel F Finger Piers	X	X			X	X			X		X	RPM									
	018	Section 2.5.5	Final Scoping Survey Report – Parcel F Finger Piers	X	X			X	X			X		X	RPM									

Attachment 7
Testing Plan and Log

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Testing Plan and Log

Contract No. N62473-17-D-0006 Contract Task Order N6247317F4550			PARCEL F—Hunters Point Naval Shipyard San Francisco, California							Contractor APTIM	
Specification Section and Paragraph Number	Test Procedure	Test Name	Accredited/Approved Laboratory		Sampled By	Location of Test On Site or Off Site		Frequency of Test	Date Completed	Date Forwarded to Contracting Officer	Remarks
			Yes	No							
*											

Notes:

** Analytical testing requirements are provided in the Sampling and Analysis Plan (Appendix A of the Work Plan).*

APTIM *Aptim Federal Services, LLC*

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Attachment 8
Definable Features of Work Matrix

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Definable Features of Work Matrix
CONTRACTOR QUALITY CONTROL PLAN—PARCEL F
Radiological Work Tasks, Remedial Action and Maintenance of Remedies
Hunters Point Naval Shipyard
San Francisco, California
Contract Number N62473-17-D-0006
Contract Task Order N6247317F4550

Plan/ Specification Section	Schedule Cross Reference	Feature of Work	Task Lead	Preparatory	Initial	Follow-Up	Completion
Work Plan/7.1, 7.2	W.E. 4	Radiological Surveys of Parcel F Structures	Amy Meldrum	Lee Laws	Lee Laws	Amy Meldrum	Amy Meldrum
Work Plan/7.4	W.E. 4	Decontamination and Release of Equipment and Tools	Randall Killpack	Lee Laws	Lee Laws	Randall Killpack	Randall Killpack
Work Plan/7.3, 7.5, 7.6	W.E. 4	Site Restoration/Demobilization	Randall Killpack	Lee Laws	Lee Laws	Randall Killpack	Randall Killpack

Notes:

W.E. *work element*

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Attachment 9
Organization and Personnel Certifications

Organization and Personnel Certifications Log
Definable Features of Work Matrix
CONTRACTOR QUALITY CONTROL PLAN—PARCEL F
Radiological Work Tasks, Remedial Action and Maintenance of Remedies
Hunters Point Naval Shipyard
San Francisco, California
Contract Number N62473-17-D-0006
Contract Task Order N6247317F4550

Definable Feature of Work	Certification Requirement	Code	Organization	Individual	Verified by/Date Verified	Certificate Expires
All Project Tasks	40-Hour Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response, including 8-Hour Refresher, Radiological Worker Awareness Training	P	APTIM	(all personnel)		
Lab Analysis	U.S. Department of Defense Environmental Laboratory Accreditation Program	S				

Legend:

Column 1, Definable Feature of Work: Refer to Construction Quality Control Plan table for list of definable features of work. List in order.

Column 2, Certification Requirement: State the certification required for the subcontractor, supplier, and/or individual.

Column 3, Code: S = Certificate required for the firm, that is, subcontractor or supplier; P = certificate required for the person performing the work.

Column 4, Organization: Subcontractor or supplier organization name.

Column 5, Individual: Name of certified individual (note: if certification requirement only applies to the firm, note name of person who provided certificate).

Column 6, Verified By/Date Verified: APTIM individual who verified certificates for organization and/or individuals. Verification required no later than Preparatory Inspection.

Column 7, Certificate Expires: Note the certificate expiration date.

Notes:

This log will be included in the Construction Quality Control Plan as an appendix with Columns 1, 2, and 3 are filled in. Remaining columns will be completed when information becomes available.

APTIM *Aptim Federal Services, LLC*

Attachment 10
Procedures

(Procedures will be included if requirements for project-specific quality procedures arise as the project progresses)

Appendix C
Waste Management Plan

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Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

APPENDIX C

FINAL REVISION 2
WASTE MANAGEMENT PLAN

Parcel F Structures

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

May 2019

DCN: APTM-0006-4550-0025.R2/F

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

APPENDIX C

FINAL REVISION 2
WASTE MANAGEMENT PLAN

Parcel F Structures

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

May 2019

Prepared for:

Department of the Navy
Naval Facilities Engineering Command Southwest
BRAC PMO West
33000 Nixie Way, Bldg. 50
San Diego, CA 92147

Prepared by:

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Contract Number: N62473-17-D-0006; Task Order: N6247317F4550
DCN: APTM-0006-4550-0025.R2/F

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

APPENDIX C

FINAL REVISION 2
WASTE MANAGEMENT PLAN

Parcel F Structures

HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

May 2019

Lisa Bercik, PE, QSD, QSP
Project Manager

May 24, 2019
Date

Contract Number: N62473-17-D-0006; Task Order: N6247317F4550
DCN: APTM-0006-4550-0025.R2/F

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Acronyms and Abbreviations

APTIM	Aptim Federal Services, LLC
LLMW	low-level mixed waste
LLRW	low-level radiological waste
PPE	personal protective equipment
Navy	U.S. Department of the Navy
NRC	U.S Nuclear Regulatory Commission
T&D	transportation and disposal

1.0 INTRODUCTION

This Waste Management Plan was prepared and will be implemented by Aptim Federal Services, LLC (APTIM), under Contract No. N62473-17-D-0006, Contract Task Order N6247317F4550. This document is submitted as Appendix C of the Work Plan.

This Waste Management Plan describes the categories of waste and project management and engineering controls that APTIM will use to accumulate, transport, and dispose of waste generated at the site in a cost-effective, timely, and compliant manner. Section 2.0 includes a summary of the types of waste expected to be generated when providing radiological support to the contractor performing work in radiologically impacted areas. It also provides specific waste information and the Transportation and Disposal (T&D) Coordinator's associated responsibilities for each T&D activity.

2.0 WASTE CATEGORIES AND CLASSIFICATION

This section describes the types of waste anticipated to be generated during the Parcel F radiological scoping surveys.

The APTIM Site Superintendent will ensure waste from different sources are segregated by each individual source. The T&D Coordinator will then review available information and determine whether the waste from different sources can be commingled for both cost and handling efficiency. Table 1 includes information regarding waste accumulation methods and times.

2.1 Solid Waste

Site activities will consist of radiological surveys and are not expected to generate significant quantities of waste. Waste generated during these activities will either be radiological or non-radiological in nature (Table 2 and Table 3). Practical measures will be implemented to minimize the generation of low-level radiological waste (LLRW; materials that contain radionuclides at greater than Hunters Point Action Levels) or low-level mixed waste (LLMW; waste containing both LLRW and levels of chemicals triggering a hazardous waste designation).

Non-radiological waste that are anticipated include, but are not limited to, the following:

- Refuse and debris
- Personal protective equipment (PPE)

LLRW or LLMW that is anticipated include, but are not limited to, the following:

- Discrete radiological point sources
- Radiologically contaminated soil/sediment
- Refuse and debris
- PPE
- Material and equipment used during the course of work.

2.2 Liquid Waste

Liquid waste is not expected to be generated during Parcel F activities.

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3.0 TRANSPORTATION AND DISPOSAL ACTIVITIES

Non-radiological hazardous waste is not expected to be generated during Parcel F field activities. The following subsections address specific control and management practices for LLRW and LLMW. Waste characterization activities will include radiological screening of waste debris and other materials prior to final disposition. Surveys will follow APTIM's U.S. Nuclear Regulatory Commission (NRC) and/or California license procedures for free release. If classified as LLRW or LLMW, these wastes may be placed in containers provided by the U.S. Department of the Navy (Navy) LLRW waste broker. The Navy's LLRW waste broker will coordinate closely with the Navy's Radiological Affairs Support Office and be responsible for packaging, shipping, manifesting, and disposal of LLRW and LLMW.

3.1 Waste Classification

Radioactive waste will be classified as either LLRW or LLMW per NRC guidelines and/or disposal facility requirements. Waste characteristics, including the radionuclides present and their associated specific activity, will be measured using available standardized test methods such as those listed in Table 2.

3.2 Waste Accumulation and Storage

APTIM will segregate and accumulate wastes into the categories outlined in Table 2. The APTIM Site Superintendent will ensure wastes from different sources are segregated by each individual source. The APTIM T&D Coordinator will then review available information and determine whether the wastes from different sources can be commingled for both cost and handling efficiency.

Radiologically impacted soil and/or debris will be placed in covered and lined roll-off containers (or other suitable container) which will be provided by the Navy's LLRW waste broker. The Navy's LLRW waste broker will assign a unique identification number to each individual container and will supervise and manage the tracking and contents of each bin.

Attachment 1 provides the "Waste Inventory Log" that the APTIM Site Superintendent will use to track project waste. Attachment 2 provides the "Waste Storage Area Inspection Checklist" that the APTIM Site Superintendent will use to inspect each waste storage area on a weekly basis.

3.3 Labeling and Posting of Containers Containing Radioactive Waste

Each waste container containing LLRW will be labeled and placed in a designated radioactive material storage area. The waste container will be labeled with a "Caution—Radioactive Material" label. The label will also note the maximum surface radiation level (measured in microroentgen per hour). The waste inventories will be managed under APTIM's NRC license until it is transferred to the Navy's LLRW waste broker.

3.4 Waste Accumulation Areas

APTIM will implement, at a minimum, the following requirements for radioactive waste stored on site within a designated radiologically impacted area:

- Display an industry standard placard and barrier materials with wording that includes the following, "Caution, Radiologically Controlled Area, Radioactive Materials Area, RWP Required for Entry, Authorized Personnel Only" (written in English and Spanish), at each radiological storage area every 50 feet (or 15 meters). The signs will be legible.
- Aisle space will be maintained to allow for the unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment to any area of facility operation in an emergency.
- The areas will be secured to prevent unauthorized access to the material.
- The following emergency equipment will be located or available to personnel during active waste management activities at each accumulation area:
- A device, such as a telephone or a hand-held two-way radio, capable of summoning emergency assistance will be available.
- Portable fire extinguishers, fire control equipment, spill control equipment, and decontamination equipment will be available.

Filled containers generated during performance of this Work Plan will be stored at the site where they were generated until the contained material can be characterized for packaging and disposal by the waste broker.

3.5 Waste Minimization

To minimize the volume of waste streams generated during the project, the following general guidelines will be followed:

- Waste material will not be cross-contaminated unnecessarily.
- Work will be planned ahead.
- Material may be stored in large containers, but the smallest reasonable container will be used to transport the material to the location where it is needed.
- Cleaning and extra sampling supplies will be maintained outside any potentially contaminated area to keep them clean and to minimize additional waste generation.
- Mixing of detergents or decontamination solutions will be performed outside potentially contaminated areas.

- When decontaminating radioactively contaminated material, every effort should be made to minimize the generation of mixed waste.
- Drop cloths or other absorbent material will be used to contain small spills or leaks.
- Contaminated material will not be placed with clean material.
- Wooden pallets inside the exclusion zone will be covered with plastic.
- Material and equipment will be decontaminated and reused when practical.
- Volume reduction techniques will be used when practicable.
- Waste containers will be verified to ensure that they are solidly packed to minimize the number of containers.

3.6 Inspections

While waste accumulation areas will be informally inspected on a daily basis, formal inspections of radiological controlled areas under the APTIM NRC license will be inspected weekly. The Project Radiation Safety Officer or designee will conduct inspections. Inspections will be logged in a dedicated field notebook, and a weekly inspection checklist will be completed. The radiologically controlled areas will be inspected to ensure the following:

- The containers will be checked for good condition. If a container is not in good condition, the waste broker will be informed.
- The containers will be checked to ensure that they remain closed and secured at all times, except when adding or removing waste.
- The soil stockpiles will be checked to see they are properly identified/labeled and that their identification number is legible.
- The fence lines and gates will be checked for signs of break-ins or vandalism.

3.7 Waste Disposal

Radiological waste generated under this project will be disposed by the Navy's LLRW waste broker. These wastes may include the following:

- Debris, PPE, and soil classified as unsuitable for reuse as backfill, based on radiological analysis, will be directly loaded into bins and transferred to the Navy's LLRW waste broker for disposal. Bins will be provided by the Navy's LLRW waste broker.
- Non-hazardous debris and PPE not classified as radiologically impacted will be moved outside the radiologically controlled area following approval from Radiological Affairs Support Office.

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4.0 REFERENCES

California Code of Regulation, Title 22, Social Security, Division 4.5, "Environmental Health Standards for the Management of Hazardous Waste," Chapter 12, "Standards Applicable to Generators of Hazardous Waste," current.

Code of Federal Regulations, Title 40, Part 300, *National Oil and Hazardous Substances Pollution Contingency Plan*, U.S. Government Printing Office, Washington, D.C.

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Tables

Table 1
Waste Accumulation Methods and Times

Waste	Accumulation Method	Maximum Accumulation Times
LLRW	Temporary waste pile; roll-off container	Not applicable for nonhazardous; 90 days maximum for hazardous according to 22 CCR Section 66262.34
Refuse and debris	Temporary waste pile; roll-off container	Not applicable for nonhazardous
PPE and Visqueen®	Roll-off container; plastic bag	Not applicable for nonhazardous; 90 days maximum for hazardous according to 22 CCR Section 66262.34

Notes:

California Code of Regulation (CCR), Title 22, Social Security; Division 4.5, Environmental Health Standards for the Management of Hazardous Waste; Chapter 12, Standards Applicable to Generators of Hazardous Waste; current through April 10, 2009.

LLRW — *low-level radiological waste*
PPE — *personal protective equipment*

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Table 2
Waste Sample Types and Analyses

Waste	Sample Type	Analytical Methods
LLRW	Representative	Surface contamination and gamma scanning surveys Gamma spectroscopy for radium-226 and cesium-137 (EPA Method 901.1) Total strontium/strontium-90 (EPA Method 905.0/Sr-02) Plutonium-239 (DOE A-01-R) Other radionuclide-specific analyses as required
Refuse and debris	No sampling	N/A
PPE and Visqueen®	No sampling, PPE will be characterized based on associated materials	N/A

Notes:

California Code of Regulation (CCR), Title 22, Social Security; Division 4.5, Environmental Health Standards for the Management of Hazardous Waste; Chapter 12, Standards Applicable to Generators of Hazardous Waste; current through April 10, 2009.

DOE	*U.S. Department of Energy*
EPA	*U.S. Environmental Protection Agency*
LLRW	*low-level radiological waste*
N/A	*not applicable*
PPE	*personal protective equipment*

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Table 3
Preliminary Characterization and Classification

Waste Stream	EPA/DTSC Characterization	DOT Classification
LLRW or LLMW	Class A LLRW	Class 7 or not regulated
Refuse and debris	Nonhazardous	Non-regulated
PPE and Visqueen®	Nonhazardous	Not applicable

Notes:

DOT	*U.S. Department of Transportation.*
DTSC	*California Department of Toxic Substances Control*
EPA	*U.S. Environmental Protection Agency*
LLMW	*low-level mixed waste*
LLRW	*low-level radiological waste*
PPE	*personal protective equipment*

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Attachment 1
Waste Inventory Log

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WASTE INVENTORY LOG

Aptim Federal Services, LLC

Contract No. N62473-15-D-0811 | Task Order N6247317F4550

Hunters Point Naval Shipyard San Francisco, California

Date of Inventory Inspection: _____ Inspected by: _____

Manifest Number	Container Number	Container Type	Container Volume	Generation Date	Waste Description/ Originating Site	Date Removed from site

Attachment 2
Waste Storage Area Inspection Checklist

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Waste Storage Area Inspection Checklist

Inspected by:_____ Date:_____ Time: _____

	Yes	No	Corrective Action	Date Corrected
Area posted with appropriate hazard and cautionary signs				
Area free of spills?				
All liquids stored in proper secondary containment?				
Secondary containment basins free of liquids, snow and debris?				
Containers compatible with waste being stored?				
Containers properly sealed (lids on, rings in place, bins covered, etc.)?				
All containers properly labeled?				
Labels easily visible for inspection?				
Accumulation start dates present on labels?				
Accumulation start dates with storage time limit (e.g., 90 days)?				
Information on all labels legible not faded and all required information is present?				
Adequate aisle space for drums (minimum 22 inches)?				
Aisles and doorways free of obstructions?				
Containers free of leaks, dents or deterioration including structural defects and rusting?				
Adequate separation of incompatible materials?				
Tops of containers free of standing water?				
Stockpiles adequately covered?				

Notes: _____

Appendix D
Gamma Scan Minimum Detectable Concentration Basis

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Surface gamma scanning will be performed as part of the scoping survey of Parcel F structures. Scan surveys will be performed to identify areas of elevated gamma radiation that could result from potential contamination. The results of the surface gamma scan surveys will be used to identify locations of elevated gamma activity for additional investigation. This appendix describes the methods used to develop *a priori* scan minimum detectable concentrations (MDCs) for low-level radiological objects (LLROs) on the surface. This determination is used to support selection of instrumentation and measurement methods based on the project measurement quality objectives.

Two measurement systems will be used to perform surface gamma scan surveys for the Parcel F structures:

- A RS-700 scanning system operated as a towed array, and
- 3-inch by 3-inch thallium activated sodium iodide (3x3 NaI) detectors connected to a global positioning system (GPS).

Section 1 of the appendix discusses the field of view (FOV) for the Radiation Solutions Inc. (RSI) RS-700. Section 2 presents the assumptions and calculations for the RS-700 radium-226 (^{226}Ra) scan MDA for LLROs. Section 3 presents the assumptions and calculations for the 3x3 NaI scan ^{226}Ra MDA.

1.0 RS-700 Field of View

The objective of this case study was to map the capability of the RS-700 and determine its FOV. Using a certified radium source, the FOV has been determined to be 3.57 square meters (m^2) or a circle with a diameter of 2.13 meters (m). A copy of the calibration certificate for the radium source used for this determination is shown in Figure 1.

1.1 DESCRIPTION OF RS-700

The RS-700 consists of an RS-701 integrated controller and data acquisition system, a digital gamma ray spectrometer/multi-channel analyzer (MCA), a data controller, two RSX-256 4-liter (256 cubic inch) thallium activated sodium iodide [NaI(Tl)] gamma scintillation detectors, an internal GPS, and an external high-resolution Trimble Pro XH GPS receiver.

The system is operated using the RSI "RadAssist" software, which displays real-time data collection, both as a sodium iodide (NaI) spectrum as well as the count rates. The system collects gross gamma counts in 1,024 energy spectral divisions. For the purposes of this test, only the gross gamma counts at a location were evaluated.

1.2 EXPERIMENTAL METHOD

Two gamma scintillation detectors as employed in the towed array and wall RS-700 orientations were placed in the center of radial matrix. The radial matrix was designed with a series of concentric rings with each ring one foot apart extending out seven feet from the center. The rings were further divided into 12 sectors plus the four cardinal compass points. The sectors and points were labeled with letters (i.e., A through P) and the concentric circles were labeled with numbers corresponding to the distance from the center. For example, cell A0 indicates the source was placed directly under the detector and A1 indicates the source was placed one foot away from the detector.

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
GAMMA STANDARD SOURCE

Radionuclide:	Ra-226	**Customer:**	CABRERA SERVICES, INC.
Half-life:	1600 ± 7 years	**P.O. No.:**	06-064
Catalog No.:	EG-CUSTOM	**Reference Date:**	1-Sep-05 12:00 PST
Source No.:	1131-47-1	**Contained Radioactivity:** (Ra-226 only)	105.3 nCi 3896 Bq

Physical Description:

A. Capsule type:	Customer supplied canister (4.25" OD x 4.875" Ht)
B. Nature of active deposit:	Ra-226 distributed in 1.7 g/cc sand matrix
C. Active diameter/volume:	Approximately 800mL (1336 grams)
D. Backing:	Tin
E. Cover:	Tin

Radioimpurities:

None detected (daughters not in equilibrium as of 24-Aug-05)

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in µCi/g was determined using gamma ray spectrometry.

Peak energy used for integration:	186.0 keV
Branching ratio used:	0.0351 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 1.0 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.1 %
D. Total uncertainty at the 99% confidence level:	± 3.2 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from NCRP Report No. 58, 1985.
- This source has a working life of 5 years.

Daniel James Van Delsen — Quality Control

26-Aug-05 — Date

IPL Ref. No.: 1131-47

ISO 9001 CERTIFIED

Medical Imaging Laboratory
24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory
1800 North Keystone Street Burbank, California 91504

Figure 1. Radium Source Calibration Certificate

A National Institute of Standards and Technology (NIST) traceable radium source was placed on the grid cells and a one minute static measurement was collected. The radial matrix was 16 feet in diameter. Each row of data was calculated from all radial distance positions in a concentric ring. Figure 2 shows the layout for the experiment.

1.3 DATA RESULTS

A total of 124 one-minute static measurements were collected during this experiment. Two data sets were generated - one from each of the two detectors. The data were combined, and the combined data were evaluated and plotted using Surfer 8 software. A color-coded plot was used to identify elevated locations on the experimental grid. Table 1 provides a summary of the combined data set.

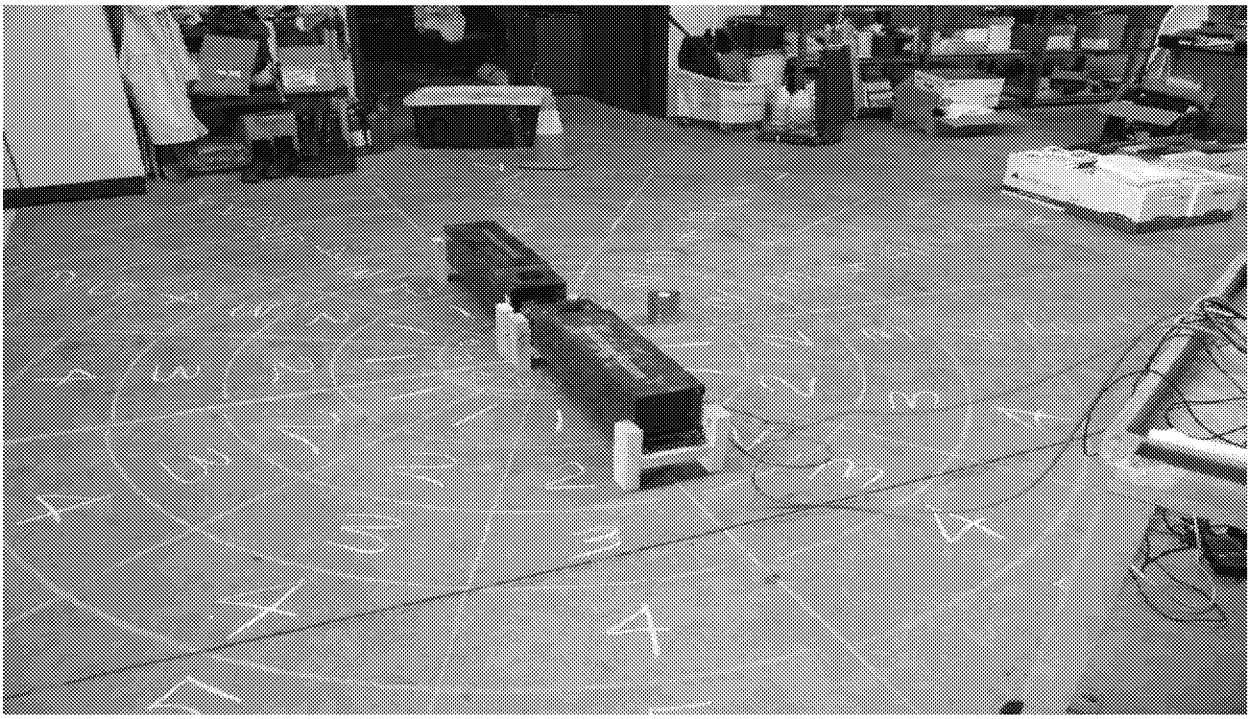

Figure 2. Radial Matrix Experimental Grid

Table 1. Data Summary

Sample Location	Detector 1 (cpm)	Detector 2 (cpm)	Combined (cpm)
A 00	134,917	123,771	258,688
A 01	119,753	114,464	234,217
A 02	121,543	118,050	239,593
A 03	116,464	112,693	229,157
A 04	115,664	111,675	227,339
A 05	114,870	110,943	225,813
A 06	115,280	111,505	226,785

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Table 1. Data Summary (Continued)

Sample Location	Detector 1 (cpm)	Detector 2 (cpm)	Combined (cpm)
A 07	114,972	111,252	226,224
B 00	127,230	130,523	257,753
B 01	127,401	127,429	254,830
B 02	120,476	118,817	239,293
B 03	115,358	112,504	227,862
B 04	114,478	111,598	226,076
B 05	114,652	112,735	227,387
B 06	114,859	110,957	225,816
B 07	113,843	111,349	225,192
C 00	124,338	138,935	263,273
C 01	124,763	135,889	260,652
C 02	119,674	120,944	240,618
C 03	114,797	114,516	229,313
C 04	114,567	113,629	228,196
C 05	114,430	112,212	226,642
C 06	114,738	111,095	225,833
C 07	114,229	111,646	225,875
D 00	123,438	152,351	275,789
D 01	122,519	152,924	275,443
D 02	118,573	121,965	240,538
D 03	114,078	116,178	230,256
D 04	114,578	112,727	227,305
D 05	114,418	111,735	226,153
D 06	114,357	111,532	225,889
D 07	114,261	110,909	225,170
E 00	123,755	159,945	283,700
E 01	121,620	152,222	273,842
E 02	118,927	122,087	241,014
E 03	113,907	116,325	230,232
E 04	113,798	112,079	225,877
E 05	113,568	112,085	225,653
E 06	113,776	111,361	225,137

Table 1. Data Summary (Continued)

Sample Location	Detector 1 (cpm)	Detector 2 (cpm)	Combined (cpm)
E 07	113,637	110,862	224,499
F 00	123,661	143,954	267,615
F 01	123,979	136,795	260,774
F 02	119,145	121,458	240,603
F 03	114,378	113,778	228,156
F 04	113,254	112,406	225,660
F 05	113,565	111,040	224,605
F 06	113,904	110,839	224,743
F 07	113,671	110,571	224,242
G 00	126,472	131,903	258,375
G 01	126,541	127,310	253,851
G 02	119,687	118,839	238,526
G 03	114,870	112,618	227,488
G 04	114,176	112,054	226,230
G 05	114,055	111,394	225,449
G 06	113,739	111,535	225,274
G 07	114,080	111,470	225,550
H 00	136,724	122,837	259,561
H 01	130,161	122,115	252,276
H 02	122,228	117,107	239,335
H 03	116,388	111,733	228,121
H 04	114,950	111,887	226,837
H 05	114,210	111,105	225,315
H 06	114,174	111,451	225,625
H 07	113,993	111,173	225,166
I 00	149,801	120,112	269,913
I 01	136,145	120,505	256,650
I 02	123,694	116,926	240,620
I 03	116,805	111,317	228,122
I 04	115,449	111,283	226,732
I 05	113,946	111,222	225,168
I 06	114,493	111,661	226,154

Table 1. Data Summary (Continued)

Sample Location	Detector 1 (cpm)	Detector 2 (cpm)	Combined (cpm)
I 07	114,134	110,172	224,306
J 00	169,660	119,066	288,726
J 01	149,020	119,327	268,347
J 02	124,212	116,452	240,664
J 03	117,668	111,179	228,847
J 04	115,146	110,974	226,120
J 05	114,560	111,150	225,710
J 06	114,211	110,487	224,698
J 07	114,318	111,233	225,551
K 00	161,417	118,459	279,876
K 01	147,493	119,469	266,962
K 02	133,822	110,965	244,787
K 03	117,890	111,244	229,134
K 04	115,650	110,577	226,227
K 05	114,577	110,416	224,993
K 06	114,264	111,025	225,289
K 07	114,132	110,806	224,938
L 00	145,674	120,993	266,667
L 01	141,622	120,829	262,451
L 02	123,846	116,844	240,690
L 03	116,943	111,023	227,966
L 04	115,138	111,183	226,321
L 05	114,659	111,178	225,837
L 06	114,925	110,962	225,887
L 07	114,207	110,827	225,034
M 01	126,235	122,762	248,997
M 02	124,635	121,166	245,801
M 03	124,016	119,901	243,917
M 04	123,266	119,567	242,833
M 05	122,489	119,017	241,506
M 06	122,274	119,461	241,735
M 07	121,819	119,489	241,308

Table 1. Data Summary (Continued)

Sample Location	Detector 1 (cpm)	Detector 2 (cpm)	Combined (cpm)
N 01	122,759	156,139	278,898
N 02	122,602	147,986	270,588
N 03	122,560	123,868	246,428
N 04	122,401	120,519	242,920
N 05	121,122	118,824	239,946
N 06	121,282	118,932	240,214
N 07	121,308	118,675	239,983
O 01	125,958	121,637	247,595
O 02	124,454	120,957	245,411
O 03	122,993	120,068	243,061
O 04	122,855	119,211	242,066
O 05	122,533	118,803	241,336
O 06	121,450	119,530	240,980
O 07	121,848	119,225	241,073
P 01	159,942	118,242	278,184
P 02	139,992	118,448	258,440
P 03	125,955	118,459	244,414
P 04	122,278	118,748	241,026
P 05	122,065	118,247	240,312
P 06	121,392	118,050	239,442
P 07	121,712	118,224	239,936

Figure 3 provides a graphical presentation of the data. A dip in the detection is indicated on the three-dimensional side view plot that was artificially created due to the fact that the detector mounting stands precluded the ability of placing the source at the exact 0,0 location.

1.4 FINDINGS

The combined detector gross counts were used to determine the effective detector FOV to simulate the data analysis used for field operations. The data demonstrate the RS-700 with the two detectors arranged in a line have a FOV for detecting the radium source of 3.57 m^2. The FOV is essentially equal in the lateral (side to side) and vertical (front to back) directions at 7.0 feet (2.13 m) diameter. The detector response is 82 percent of the source emission rate at the periphery of the FOV relative to 100 percent at the center. This compares well to the minimum detectable activity calculated using the Microshield® computer code (Grove Engineering) where the exposure rate 50 centimeters (cm) offset from the end of the detector was 82.6 percent of the exposure rate directly under the detector.

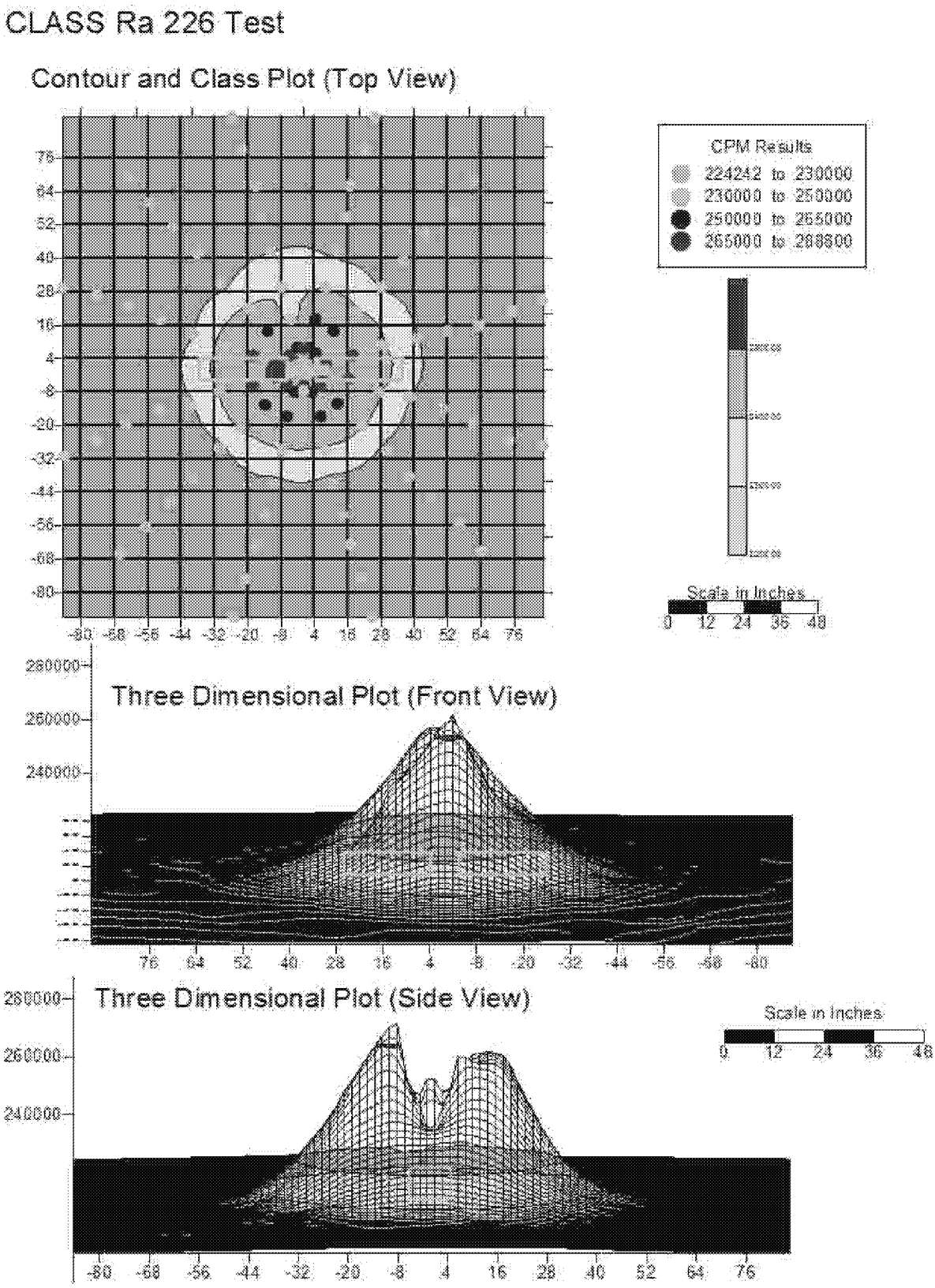

Figure 3. Graphical Data Display

2.0 RS-700 ^{226}RA SCAN MINIMUM DETECTABLE ACTIVITY FOR LLROs

2.1 INTRODUCTION

The RS-700 is used to scan for elevated concentrations of gamma emitting radionuclides. The assumptions, methodology, and calculation of the detector response for ^{226}Ra over soil areas anticipated at the project sites are described in this section. For this calculation, the center of the source is assumed to be 15 cm from the center to the detector (Figure 4) and the detector is suspended 10 cm above the ground. The calculations and methodologies used to determine the MDC follow the guidance contained in US Nuclear Regulatory Commission Regulation (NUREG)-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions,* Section 6.8.2 (USNRC, 1997).

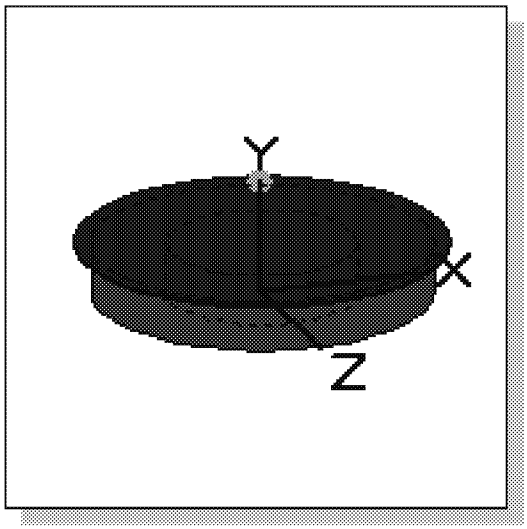

Figure 4. Source to Detector Geometry

For this calculation, the ^{226}Ra source is assumed to be a disk with a 2.22 cm radius (2-inch diameter) sealed in plastic. The scan sensitivity is important for identifying small isolated point sources of ^{226}Ra activity located on the ground surface. The surveys for this project will be performed using the RS-700 (two four-inch x four-inch x sixteen-inch NaI scintillation detectors—see Figure 5). Scans of the subject survey material will be accomplished at a maximum scan speed of 1.0 m/sec at a detector height of approximately 4 inches (10 cm) above the surface. Results will be tallied by counts within a one (1) second time interval.

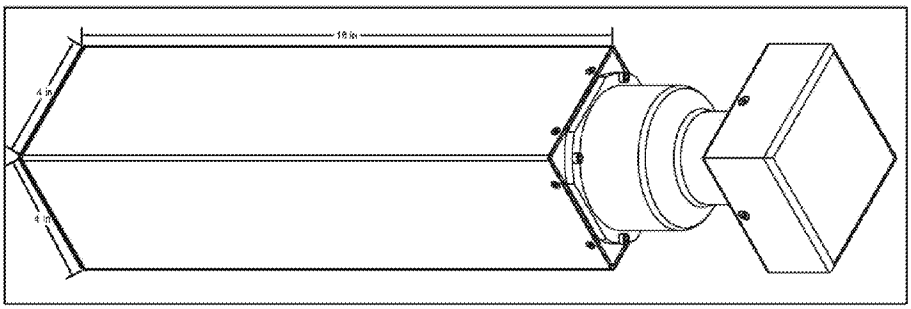

Figure 5. RSI-700 Detector Dimensions

The objective of this appendix is to calculate the scan sensitivity of the RS-700 NaI scintillation detection system utilized for gross gamma drive over and potentially wall surveys for ^{226}Ra LLROs.

2.2 SITE RADIOLOGICAL CONDITIONS

The Parcel F survey units to be surveyed consist of structures potentially contaminated with ^{226}Ra in small objects on the surface. Any ^{226}Ra present is assumed to be in secular equilibrium with decay products with half-lives less than 6 months.

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It has been assumed for detection calculations (as recommended by NUREG- 1507) that the contamination is present as a point source or small disk corresponding to the NUREG 1507 "hot spot" small area of elevated activity.

2.3 DESCRIPTION OF RS-700 SYSTEM

Surface scanning at the site will be performed using the RSI-700 mobile radiation detection system. The RSI-700 consists of an RSI-701 gamma ray spectrometer (MCA)/controller equipped with two RSX-1 4-liter (256 cubic inch) NaI gamma scintillation detectors. The detector dimensions are 4-inch by 4 inch by 16-inch long. The RSI-700 system is designed to measure and record radiation measurements from a moving platform and incorporates a GPS receiver such that detector position is integrally stored with the radiological information.

Surveys will be performed by traveling along the path of a survey area in rows equal to the width of the RS-700 FOV. The coverage goal is 100 percent for Class 2 survey units.

For drive over surveys the tow vehicle will be driven at a target speed of 1.0 meter per second (m/sec) or slower. At this speed, the residence time of the detector over a small area of elevated contamination will be 0.5 second. The system is operated using RSI's 'RadAssist" software, which shows real-time data collection, both as a NaI spectra as well as the count rates, in units of counts per second (cps), from the programmed ROIs. If used in the wall scan orientation, the scan speed for the RS-700 will be 0.5 m/sec or slower.

2.4 SCAN MDA FOR LLRO - CALCULATION AND METHODOLOGY

The methodology used to determine the NaI scintillation detector scan MDA was based on NUREG-1507, Section 6.8.2. Factors included in this analysis were the surveyor scan efficiency, index of sensitivity, the natural background of the surveyed area, scan rate, detector to source geometry, and energy and yield of gamma emissions.

Microshield® was used to model the presence of a deck marker containing 5 microcuries of ^{226}Ra on a concrete surface. The active area of the disk was assumed to be a disk with a radius of 2.22 cm, covered with a 3/8-inch thick plastic cover. The deck marker was assumed to be located directly between the two detectors, 15 cm from the end of the detector, and assumed to be the worst-case positioning of the deck marker. The detector was suspended 10 cm (4 inches) above the surface being scanned. The uncontaminated soil cover thickness was assumed to have zero thickness (the deck marker was located on the surface). There was a 0.051 cm aluminum shield surrounded by approximately 0.125 inches of carbon fiber and 1.25 inches of rigid foam, "Poron" foam and felt wrap surrounding the NaI detectors. The carbon shield was assumed to be 0.5 cm to account for the rigid, "poron", and felt layers. The thin aluminum wrapper was also considered as part of the 0.5 cm of carbon to complete the model source term. The assumed density of soil is 1.6 grams per cubic centimeter (g/cm^3). This model is consistent with the NUREG-1507 methodology and provides for a count rate to exposure rate ratio (counts per minute/microroentgen per hour [cpm/μR/hr]) to be calculated.

The following sections provide tabulated data based upon the NUREG-1507 methodology as applied toward the RX-700 NaI scintillation detectors used in this survey. The dose point is offset 15 cm from the contaminated disk in the center of the detector. Additional details and discussion describing the NUREG analysis methodology are described in that publication.

2.4.1 Fluence Rate to Exposure Rate (FRER, no units)

The fluence rate to exposure rate (FRER) may be approximated by:

$$FRER \sim (1\ \mu R/hr)/(E_\gamma)(\mu_{en}/\rho)_{air}$$

Where,

E_γ = energy of the gamma photon of concern, kiloelectron volts (keV)

$(\mu_{en}/\rho)_{air}$ = the mass energy absorption coefficient for air, square centimeters per gram (cm^2/g)

The FRER is shown in tabular form in Table 2.

Table 2. Fluence Rate to Exposure Rate Conversion

$Energy_\gamma$, keV	$(\mu_{en}/\rho)_{air}$, cm^2/g	FRER
15	1.334	0.0500
20	0.5389	0.0928
30	0.1537	0.2169
40	0.06833	0.3659
50	0.04098	0.4880
60	0.03041	0.5481
80	0.02407	0.5193
100	0.02325	0.4301
150	0.02496	0.2671
200	0.02672	0.1871
300	0.02872	0.1161
400	0.02949	0.0848
500	0.02966	0.0674
600	0.02953	0.0564
662	0.0293	0.0516
800	0.02882	0.0434
1,000	0.02789	0.0359
1,500	0.02547	0.0262
2,000	0.02345	0.0213

2.4.2 Probability of Interaction (P) Through Detector End for a Given Energy

The probability, P, of a gamma ray interaction in the NaI scintillation crystal entering through the end of the crystal is given by:

$$\text{Probability (P)} = 1\text{-}e^{-(\mu/\rho)_{NaI}(X)(\rho_{NaI})}$$

Where

$(\mu/\rho)_{NaI}$ = the mass attenuation coefficient for NaI

X = the thickness through the bottom edge (end facing soil) of the RX-700 NaI crystal, 10.16 cm

ρ = the density of the NaI crystal, 3.67 g/cm^3

Values for P are listed in Table 3.

Table 3. Probability of Interaction

$Energy_\gamma$, keV	$(\mu/\rho)_{NaI}$, cm^2/g	P
15	47.4	1.00
20	22.3	1.00
30	7.45	1.00
40	19.3	1.00
50	10.7	1.00
60	6.62	1.00
80	3.12	1.00
100	1.72	1.00
150	0.625	1.00
200	0.334	1.00
300	0.167	1.00
400	0.117	0.99
500	0.0955	0.97
600	0.0826	0.95
662	0.078	0.95
800	0.0676	0.92
1,000	0.0586	0.89
1,500	0.0469	0.83
2,000	0.0413	0.79

2.4.3 Relative Detector Response

The Relative Detector Response (RDR) by energy is determined by multiplying the relative fluence rate to exposure rate (FRER) by the probability (P) of an interaction and is given by:

RDR = FRER (Table 2) x P (from Table 3)

Values for RDR are listed in Table 4.

Table 4. Relative Detector Response

$Energy_{\gamma}$, keV	FRER	P	RDR
15	0.0500	1.00	0.0500
20	0.0928	1.00	0.0928
30	0.2169	1.00	0.2169
40	0.3659	1.00	0.3659
50	0.4880	1.00	0.4880
60	0.5481	1.00	0.5481
80	0.5193	1.00	0.5193
100	0.4301	1.00	0.4301
150	0.2671	1.00	0.2671
200	0.1871	1.00	0.1871
300	0.1161	1.00	0.1158
400	0.0848	0.99	0.0837
500	0.0674	0.97	0.0655
600	0.0564	0.95	0.0538
662	0.0516	0.95	0.0487
800	0.0434	0.92	0.0399
1,000	0.0359	0.89	0.0318
1,500	0.0262	0.83	0.0216
2,000	0.0213	0.79	0.0168

2.4.4 Determination of cpm per μR/hr as a Function of Energy

The FRER, P, and RDR were calculated at the energies provided above for a NaI Scintillation detector. Calculation of these values specifically at the cesium-137 (^{137}Cs) energy of 662 keV has also been performed by the Microshield® software. This point allows one to determine the cpm per μR/hr and ultimately activity concentration and minimum detection sensitivity level in terms of pCi/g.

If:

- the fluence rate to exposure rate conversion is 0.0514, and
- the energy$_\gamma$ (based upon ^{137}Cs) is 662 keV, and
- the air density is 0.0294 cm^2/g, and
- the mass attenuation coefficient of the the RSI-700 NaI crystal is 0.078 cm^2/g, and
- the ^{137}Cs relative detector response is 0.0486

Then the detector response (cpm) to other energies (such as ^{226}Ra and daughters) was based upon the ratio of the RDR at energy (E_i) to the known ^{137}Cs energy RDR demonstrated as:

$$(cpm / \mu R / hr)_{E_i} = (cpm_{Cs-137}) * ((RDR_{Ei}) / (RDR_{Cs-137}))$$

Which equals 20,770 cpm * ((RDR_{Ei})/(RDR_{Cs-137})). This is shown in tabular form in Table 5.

Table 5. Detector Response

Energy$_\gamma$, keV	RDR$_{Ei}$	RSI-700 4-Liter NaI Detector, E_i, cpm per µR/hr
15	0.0500	21295
20	0.0928	39536
30	0.2169	92413
40	0.3659	155904
50	0.4880	207964
60	0.5481	233540
80	0.5193	221291
100	0.4301	183276
150	0.2671	113813
200	0.1871	79737
300	0.1158	49359
400	0.0837	35663
500	0.0655	27917
600	0.0538	22945
662	0.0487	20770
800	0.0399	16996
1,000	0.0318	13560
1,500	0.0216	9213
2,000	0.0168	7138

Finally, the count rate to exposure rate ratio for each of the ^{226}Ra and progeny gamma emissions and their contribution to the total exposure rate was computed using the output of the Microshield® runs and the count rate to exposure rate ratios from Table 5. Table 6 provides the counts from each of the calculated observations intervals. Figure 6 provides a copy of the Microshield® output for the RS-700.

Table 6. Detector Weighted Response

keV	MicroShield® Exposure Rate, µR/hr (with buildup)	cpm/µR/hr	cpm/µR/hr (weighted)	Percent of NaI detector response
15	1.441	21,295	3.07E+04	0.99%
20	0.0	39,536	0.00E+00	0.00%
30	0.0	92,413	0.00E+00	0.00%
40	0.0	155,904	0.00E+00	0.00%
50	0.557	207,964	1.16E+05	3.73%
60	0.0	233,540	0.00E+00	0.00%
80	2.586	221,291	5.72E+05	18.44%
100	0.01592	183,276	2.92E+03	0.01%
150	0.0	113,813	0.00E+00	0.00%
200	2.012	79,737	1.60E+05	5.17%
300	5.602	49,359	2.77E+05	8.91%
400	13.61	35,663	4.85E+05	15.64%
500	0.7828	27,917	2.19E+04	0.70%
600	24.920	22,945	5.72E+05	18.42%
800	6.119	16,996	1.04E+05	3.35%
1000	24.35	13,560	3.30E+05	10.64%
1500	20.2	9,213	1.86E+05	6.00%
2000	34.82	7,138	2.49E+05	8.01%
Total	137		3,106,487	100%

The minimum detectable count rate, MDCR, was calculated as:

$$MDCR = (d') \times (b_i)^{0.5} \times (60 \text{ sec}/1 \text{ min})$$

Where d' is equal to 1.38 from table 6.1 of NUREG-1507, and represents the rate of detections at a 95 percent true positive proportion with a false positive proportion of 60 percent. Table 7 lists potential values for b and the (1 min) denominator for the different scan speeds, and was based on

the estimated reference area background count rate of 2,527 cps. The MDCR values for different scan speeds are listed in Table 7.

MicroShield 10.00
Cabrera Services

Date	By	Checked

File Name	Run Date	Run Time	Duration
20171129_MSCASE_Ra226Marker_5uCi_Intact_CLASSwOffset.msd	November 29, 2017	17:16:59	00:00:00

Project Info	
Case Title	20171129_Case 1
Description	CLASS 5uCi Ra226 Intact Marker 10cm with 15cm offset
	3 - Disk

Source Dimensions	
Radius	2.22 cm (0.9 in)

Dose Points			
A	X	Y	Z
#1	10.0 cm (3.9 in)	0.0 cm (0 in)	15.0 cm (5.9 in)

Shield			
Shield N	Dimension	Material	Density
Shield 1	.953 cm	Methyl methacrylate	0.943
Shield 2	.5 cm	Carbon	2.25
Air Gap		Air	0.00122

Source Input: Grouping Method - Standard Indices
Number of Groups: 25
Lower Energy Cutoff: 0.015
Photons< 0.015: Included
Library: Grove

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Bi-210	3.8904e-006	1.4395e+005	2.5127e-001	9.2970e+003
Bi-214	4.8919e-006	1.8100e+005	3.1595e-001	1.1690e+004
Pb-210	3.8910e-006	1.4397e+005	2.5131e-001	9.2985e+003
Pb-214	4.8919e-006	1.8100e+005	3.1595e-001	1.1690e+004
Po-210	3.8731e-006	1.4330e+005	2.5015e-001	9.2556e+003
Po-214	4.8909e-006	1.8096e+005	3.1589e-001	1.1688e+004
Po-218	4.8929e-006	1.8104e+005	3.1602e-001	1.1693e+004
Ra-226	4.8929e-006	1.8104e+005	3.1601e-001	1.1693e+004
Rn-222	4.8929e-006	1.8104e+005	3.1602e-001	1.1693e+004

Buildup: The material reference is Shield 2
Integration Parameters

Radial	20
Circumferential	20

Results

Energy	Activity	Fluence Rate	Fluence Rate MeV/cm²/sec	Exposure Rate mR/hr	Exposure Rate mR/hr	Absorbed Dose Rate	Absorbed Dose Rate	Absorbed Dose Rate	Absorbed Dose Rate
(MeV)	(Photons/sec)	MeV/cm²/sec No Buildup	With Buildup	No Buildup	With Buildup	mrad/hr No Buildup	mrad/hr With Buildup	mGy/hr No Buildup	mGy/hr With Buildup
0.015	6.186e+04	9.346e-03	1.680e-02	8.016e-04	1.441e-03	6.998e-04	1.258e-03	6.998e-06	1.258e-05
0.05	7.832e+03	4.840e-02	2.091e-01	1.289e-04	5.570e-04	1.126e-04	4.863e-04	1.126e-06	4.863e-06
0.08	4.173e+04	4.506e-01	1.634e+00	7.130e-04	2.586e-03	6.225e-04	2.258e-03	6.225e-06	2.258e-05
0.1	2.457e+02	3.428e-03	1.040e-02	5.244e-06	1.592e-05	4.578e-06	1.390e-05	4.578e-08	1.390e-07
0.2	1.950e+04	6.028e-01	1.140e+00	1.064e-03	2.012e-03	9.288e-04	1.756e-03	9.288e-06	1.756e-05
0.3	3.735e+04	1.840e+00	2.953e+00	3.491e-03	5.602e-03	3.048e-03	4.890e-03	3.048e-05	4.890e-05
0.4	6.926e+04	4.744e+00	6.985e+00	9.244e-03	1.361e-02	8.070e-03	1.188e-02	8.070e-05	1.188e-04
0.5	3.233e+03	2.837e-01	3.988e-01	5.607e-04	7.828e-04	4.895e-04	6.834e-04	4.895e-06	6.834e-06
0.6	8.727e+04	9.483e+00	1.277e+01	1.851e-02	2.492e-02	1.616e-02	2.176e-02	1.616e-04	2.176e-04
0.8	1.711e+04	2.572e+00	3.217e+00	4.891e-03	6.119e-03	4.270e-03	5.342e-03	4.270e-05	5.342e-05
1.0	5.667e+04	1.094e+01	1.321e+01	2.017e-02	2.435e-02	1.761e-02	2.126e-02	1.761e-04	2.126e-04
1.5	3.446e+04	1.044e+01	1.201e+01	1.756e-02	2.020e-02	1.533e-02	1.763e-02	1.533e-04	1.763e-04
2.0	4.844e+04	2.011e+01	2.252e+01	3.110e-02	3.482e-02	2.715e-02	3.040e-02	2.715e-04	3.040e-04
Total	4.850e+05	6.154e+01	7.707e+01	1.082e-01	1.370e-01	9.450e-02	1.196e-01	9.450e-04	1.196e-03

Figure 6. Microshield® Output for 5 µCi ^{226}Ra Deck Marker Using RS-700

The Minimum Detectable Count Rate for the surveyor is calculated as:

$$MDCR_{surveyor} = MDCR/(p)^{0.5}$$

Where

p = Surveyor Efficiency, equal to 0.7 (NUREG-1507 suggests values between 0.5 and 0.75)

Table 7 provides the $MDCR_{surveyor}$ for different scan speeds.

The Minimum Detectable Exposure Rate for the surveyor was obtained from the $MDCR_{surveyor}$ divided by the weighted count rate to exposure rate value of 3,106,487 cpm/µR/hr for radium and its progeny. Table 7 provides the $MDER_{surveyor}$ for different scan speeds.

The scan MDC was equal to the ratio of the $MDER_{surveyor}$ to the total weighted MicroShield® Exposure Rate from Table 6 for a deck marker containing 5 µCi of ^{226}Ra. The MDC values for the different scan speeds are listed in Table 7.

Table 7. Minimum Detectable Concentration

Scan Speed (m/s)	Observation Interval (sec)	Counts (b_i)	MDCR (cpm)	$MDCR_{surveyor}$ (cpm)	$MDER_{surveyor}$ (µR/hr)	MDC (pCi)
0.5	1.0	2,527	4,162	4,975	1.60E-03	58
1.0	0.5	1,263	5,885	7,034	2.26E-03	83
2.0	0.25	632	8,326	9,952	3.20E-03	117
3.0	0.167	421	10,193	12,184	3.92E-03	143
4.0	0.125	316	11,775	14,074	4.53E-03	165

2.5 CONCLUSION

The RSI-700 NaI scintillation scan MDC for ^{226}Ra in secular equilibrium with progeny, for an intact point source, is estimated to be less than 200 pCi for scan speeds less than 4.0 m/s. The values computed are indicative of a sensitive instrument that agrees with scan MDC data presented in NUREG-1507 Section 6.8.2 and MARSSIM Table 6.7 for the contaminants of concern.

An intact deck marker containing 5 microcuries of ^{226}Ra can be detected by the RS-700 at any reasonable scan speed (see Table 7). Other point sources (e.g., broken or degraded deck markers) containing less than 200 pCi of ^{226}Ra (0.004% of an intact deck marker) can also be detected by the RS-700 at scan speeds ranging from 0.5 to 4.0 m/s (Table 7). For the purposes of this project, scan speeds for the RS-700 will be maintained at 1 m/s or less, providing a MDC of 83 pCi (0.00017% of an intact deck marker).

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3.0 3-INCH BY 3-INCH NAI ^{226}RA SCAN MINIMUM DETECTABLE ACTIVITY

Hand-held 3-inch by 3-inch NaI detectors were used to scan for elevated concentrations of ^{226}Ra. The assumptions, methodology, and calculation of the detector response for ^{226}Ra for the 3-inch by 3-inch NaI for anticipated conditions and situations are described in this section. For this calculation, the detector is assumed to be 15 cm (6 inches) above the center of the source. The source was assumed to be an intact deck marker containing 5 microcuries of ^{226}Ra. The active area of the deck marker was assumed to be a disk with a radius of 2.22 cm, covered with a 3/8-inch plastic cover. The calculations and methodologies used to determine the MDC follow the guidance contained in NUREG-1507, Section 6.8.2 (USNRC, 1997). This is the same methodology and same size area of elevated activity used to determine the scan MDA for the RS-700 in Section 2 of this appendix.

Table 8 lists the FRER.

Table 9 lists the probability of interaction with the detector.

Table 10 lists the relative detector response.

Table 11 lists the detector response to ^{226}Ra based on a response to ^{137}Cs of 2,700 cpm/μR/hr.

Table 12 lists the weighted detector response.

Table 8. FRER for 3x3 NaI(Tl)

$Energy_\gamma$, keV	$(\mu_{en}/\rho)_{air}$, cm^2/g	FRER
15	1.29	0.0517
20	0.516	0.0969
30	0.147	0.2268
40	0.064	0.3906
50	0.0384	0.5208
60	0.0292	0.5708
80	0.0236	0.5297
100	0.0231	0.4329
150	0.0251	0.2656
200	0.0268	0.1866
300	0.0288	0.1157
400	0.0296	0.0845
500	0.0297	0.0673
600	0.0296	0.0563
800	0.0289	0.0433
1,000	0.0280	0.0357
1,500	0.0255	0.0261
2,000	0.0234	0.0214

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Table 9. Probability of Interaction for the 3x3 NaI(Tl) Detector

$Energy_{\gamma}$, keV	$(\mu_{en}/\rho)_{NaI}$, cm^2/g	P
15	47.4	1.00
20	22.3	1.00
30	7.45	1.00
40	19.3	1.00
50	10.7	1.00
60	6.62	1.00
80	3.12	1.00
100	1.72	1.00
150	0.625	1.00
200	0.334	1.00
300	0.167	0.99
400	0.117	0.96
500	0.0955	0.93
600	0.0826	0.90
800	0.0676	0.85
1,000	0.0586	0.80
1,500	0.0469	0.73
2,000	0.0413	0.68

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Table 10. Relative Detector Response

$Energy_\gamma$, keV	FRER	P	RDR
15	0.0517	1.00	0.0517
20	0.0969	1.00	0.0969
30	0.2268	1.00	0.2268
40	0.3906	1.00	0.3906
50	0.5208	1.00	0.5208
60	0.5708	1.00	0.5708
80	0.5297	1.00	0.5297
100	0.4329	1.00	0.4329
150	0.2656	1.00	0.2656
200	0.1866	1.00	0.1866
300	0.1157	0.99	0.1146
400	0.0845	0.96	0.0812
500	0.0673	0.93	0.0626
600	0.0563	0.90	0.0507
800	0.0433	0.85	0.0367
1,000	0.0357	0.80	0.0287
1,500	0.0261	0.73	0.0191
2,000	0.0214	0.68	0.0146

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Table 11. 3x3 NaI(Tl) Detector Response

$Energy_{\gamma}$, keV	RDR_{Ei}	Ludlum 44-20 3x3 NaI Detector, E_i, cpm per μ/hr
15	0.0517	3064
20	0.0969	5745
30	0.2268	13445
40	0.3906	23161
50	0.5208	30881
60	0.5708	33842
80	0.5297	31404
100	0.4329	25667
150	0.2656	15748
200	0.1866	11061
300	0.1146	6797
400	0.0812	4816
500	0.0626	3714
600	0.0507	3005
662	0.0455	2700
800	0.0367	2175
1,000	0.0287	1704
1,500	0.0191	1131
2,000	0.0146	867

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Table 12. 3x3 NaI(Tl) Weighted Detector Response

keV	MicroShield® Exposure Rate, µR/hr (with buildup)	cpm/µR/hr	cpm/µR/hr (weighted)	Percent of NaI detector response
15	5.773	3,064	1.77E+04	3.24%
20	0.00E+00	5,745	0.00E+00	0.00%
30	0.00E+00	13,445	0.00E+00	0.00%
40	0.00E+00	23,161	0.00E+00	0.00%
50	0.4873	30,881	1.50E+04	2.75%
60	0.00E+00	33,842	0.00E+00	0.00%
80	2.291	31,404	7.19E+04	13.16%
100	0.01556	25,667	3.99E+02	0.07%
150	0.00E+00	15,748	0.00E+00	0.00%
200	2.525	11,061	2.79E+04	5.11%
300	7.585	6,797	5.16E+04	9.43%
400	19.01	4,816	9.16E+04	16.75%
500	1.110	3,714	4.12E+03	0.75%
600	35.63	3,005	1.07E+05	19.58%
800	8.987	2,175	1.95E+04	3.58%
1000	35.99	1,704	6.13E+04	11.22%
1500	29.92	1,131	3.38E+04	6.19%
2000	51.56	867	4.47E+04	8.18%
Total	201		546,726	100.00%

Figure 7 provides a copy of the Microshield® output for the 3-inch by 3-inch NaI(Tl) detector.

MicroShield 10.00
Cabrera Services

Date	By	Checked

File Name	Run Date	Run Time	Duration
20171129_MSCASE_Ra226Marker_5uCi_Intact_3x3.msd	November 29, 2017	17:50:45	00:00:00

Project Info

Case Title	20171129_Case 3
Description	3x3 NaI 5uCi Ra226 Intact Marker 15cm with 0cm offset
	3 - Disk

Source Dimensions

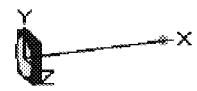
Radius	2.22 cm (0.9 in)

Dose Points

A	X	Y	Z
#1	15.0 cm (5.9 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shield

Shield N	Dimension	Material	Density
Shield 1	953 cm	Methyl methacrylate	0.943
Shield 2	05 cm	Aluminum	2.7
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices
Number of Groups: 25
Lower Energy Cutoff: 0.015
Photons< 0.015: Included
Library: Grove

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Bi-210	3.8904e-006	1.4395e+005	2.5127e-001	9.2970e+003
Bi-214	4.8919e-006	1.8100e+005	3.1595e-001	1.1690e+004
Pb-210	3.8910e-006	1.4397e+005	2.5131e-001	9.2985e+003
Pb-214	4.8919e-006	1.8100e+005	3.1595e-001	1.1690e+004
Po-210	3.8731e-006	1.4330e+005	2.5015e-001	9.2556e+003
Po-214	4.8909e-006	1.8096e+005	3.1589e-001	1.1688e+004
Po-218	4.8929e-006	1.8104e+005	3.1602e-001	1.1693e+004
Ra-226	4.8929e-006	1.8104e+005	3.1601e-001	1.1693e+004
Rn-222	4.8929e-006	1.8104e+005	3.1602e-001	1.1693e+004

Buildup: The material reference is Shield 1
Integration Parameters

Radial	20
Circumferential	20

Results

Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	6.186e+04	4.381e-02	6.731e-02	3.757e-03	5.773e-03	3.280e-03	5.040e-03	3.280e-05	5.040e-05
0.05	7.832e+03	1.091e-01	1.829e-01	2.905e-04	4.873e-04	2.536e-04	4.255e-04	2.536e-06	4.255e-06
0.08	4.173e+04	9.726e-01	1.448e+00	1.539e-03	2.291e-03	1.344e-03	2.000e-03	1.344e-05	2.000e-05
0.1	2.457e+02	7.249e-03	1.017e-02	1.109e-05	1.556e-05	9.681e-06	1.358e-05	9.681e-08	1.358e-07
0.2	1.950e+04	1.189e+00	1.430e+00	2.093e-03	2.525e-03	1.832e-03	2.204e-03	1.832e-05	2.204e-05
0.3	3.735e+04	3.479e+00	3.998e+00	6.599e-03	7.585e-03	5.761e-03	6.621e-03	5.761e-05	6.621e-05
0.4	6.926e+04	8.709e+00	9.757e+00	1.697e-02	1.901e-02	1.481e-02	1.660e-02	1.481e-04	1.660e-04
0.5	3.233e+03	5.129e-01	5.656e-01	1.007e-03	1.110e-03	8.790e-04	9.691e-04	8.790e-06	9.691e-06
0.6	8.727e+04	1.674e+01	1.825e+01	3.267e-02	3.563e-02	2.852e-02	3.110e-02	2.852e-04	3.110e-04
0.8	1.711e+04	4.422e+00	4.725e+00	8.411e-03	8.987e-03	7.343e-03	7.846e-03	7.343e-05	7.846e-05
1.0	5.667e+04	1.846e+01	1.952e+01	3.403e-02	3.599e-02	2.971e-02	3.142e-02	2.971e-04	3.142e-04
1.5	3.446e+04	1.706e+01	1.778e+01	2.871e-02	2.992e-02	2.506e-02	2.612e-02	2.506e-04	2.612e-04
2.0	4.844e+04	3.225e+01	3.334e+01	4.986e-02	5.156e-02	4.353e-02	4.501e-02	4.353e-04	4.501e-04
Total	4.850e+05	1.040e+02	1.111e+02	1.860e-01	2.009e-01	1.623e-01	1.754e-01	1.623e-03	1.754e-03

Figure 7. Microshield® Output for 5 µCi ^{226}Ra Deck Marker Using a 3-inch by 3-inch NaI(Tl) Detector

The minimum detectable count rate, MDCR, was calculated as:

$$MDCR = (d') \times (b_i)^{0.5} \times (60 \text{ sec}/1 \text{ min})$$

Where d' is equal to 1.38 from Table 6.1 of NUREG-1507, and represents the rate of detections at a 95 percent true positive proportion with a false positive proportion of 60 percent.

At a scan speed of 0.5 m/s with an observation interval of 1 second and an estimated reference area count rate of 15,000 cpm for the 3-inch by 3-inch NaI(Tl) detector, the MDCR is 1.309 cpm.

The Minimum Detectable Count Rate for the surveyor was calculated as:

$$MDCR_{surveyor} = MDCR/(p)^{0.5} = 1{,}565 \text{ cpm}$$

Where

p = Surveyor Efficiency, equal to 0.7 (NUREG-1507 suggests values between 0.5 and 0.75)

The $MDER_{surveyor}$ is obtained from the $MDCR_{surveyor}$ divided by the weighted count rate to exposure rate value of 546,726 cpm/μR/hr for radium and its progeny, and equals 2.86×10^{-3} μR/hr.

The scan MDA is equal to the ratio of the $MDER_{surveyor}$ to the total weighted MicroShield® Exposure Rate from Table 6 for a deck marker containing 5 μCi of ^{226}Ra. The ^{226}Ra point source scan MDA using a 3-inch by 3-inch NaI(Tl) detector is 71 pCi for the described project conditions and parameters. Similar to the RS-700, the calculation demonstrates an intact deck marker can be readily identified at the recommended scan speed of 0.5 m/s. Point sources containing as little as 71 pCi of ^{226}Ra activity (0.0014% of 5 μCi) would also be identified.

4.0 Deck Markers Containing ^{90}Sr

The scan MDA for deck markers containing ^{90}Sr cannot be calculated using the approach described in MARSSIM and NUREG-1507 for gamma-emitting radionuclides, because ^{90}Sr does not emit any photons to detect using the RS-700. In addition, the ^{90}Sr deck markers are typically covered with 3/8-inch plastic covers preventing the identification of ^{90}Sr based on beta emissions. However, beta particles emitted by ^{90}Sr interact with surrounding materials to release bremsstrahlung radiation. Based on photon spectra collected from recovered deck markers containing ^{90}Sr, the bremsstrahlung radiation has energies from 50 to 250 keV with a peak centered around 80 keV (Figure 8).

The 80 keV peak appears to be at least four times the background for photons with energies around 80 keV. The increased count rate from the ^{90}Sr bremsstrahlung radiation in a window centered around 80 keV would be detectable using the equations from MARSSIM Section 6.7.2.1. An average count of 4,400 counts per keV in 300 seconds was assumed for a ^{90}Sr deck marker from 65 keV to 95 keV, with an expected background of 1,000 counts per keV for the same energy range. This results in 2,640 cpm for the ^{90}Sr deck marker with a background of 500 cpm.

The minimum detectable count rate, MDCR, was calculated as:

$$MDCR = (d') \times (b_i)^{0.5} \times (60 \text{ sec}/1 \text{ min})$$

Where d' is equal to 1.38 from MARSSIM Table 6.5, and represents the rate of detections at a 95 percent true positive proportion with a false positive proportion of 60 percent. Table 13 lists potential values for b for different scan speeds with different observation intervals, and was based on the assumed background count rate of 500 cpm for energies between 65 and 95 keV. The MDCR values for different scan speeds are listed in Table 13. All of the MDCR values are less

than the count rate of 2,640 cpm estimated for ^{90}Sr bremsstrahlung radiation. At scan rates less than 2 m/s, the RS-700 will detect deck markers containing ^{90}Sr.

Table 13. Minimum Detectable Count Rate

Scan Speed (m/s)	Observation Interval (sec)	Counts (b_i)	MDCR (cpm)
0.5	1.0	8.33	239.02
1.0	0.5	4.17	338.03
2.0	0.25	2.08	478.05
3.0	0.167	1.39	585.48
4.0	0.125	1.04	676.06

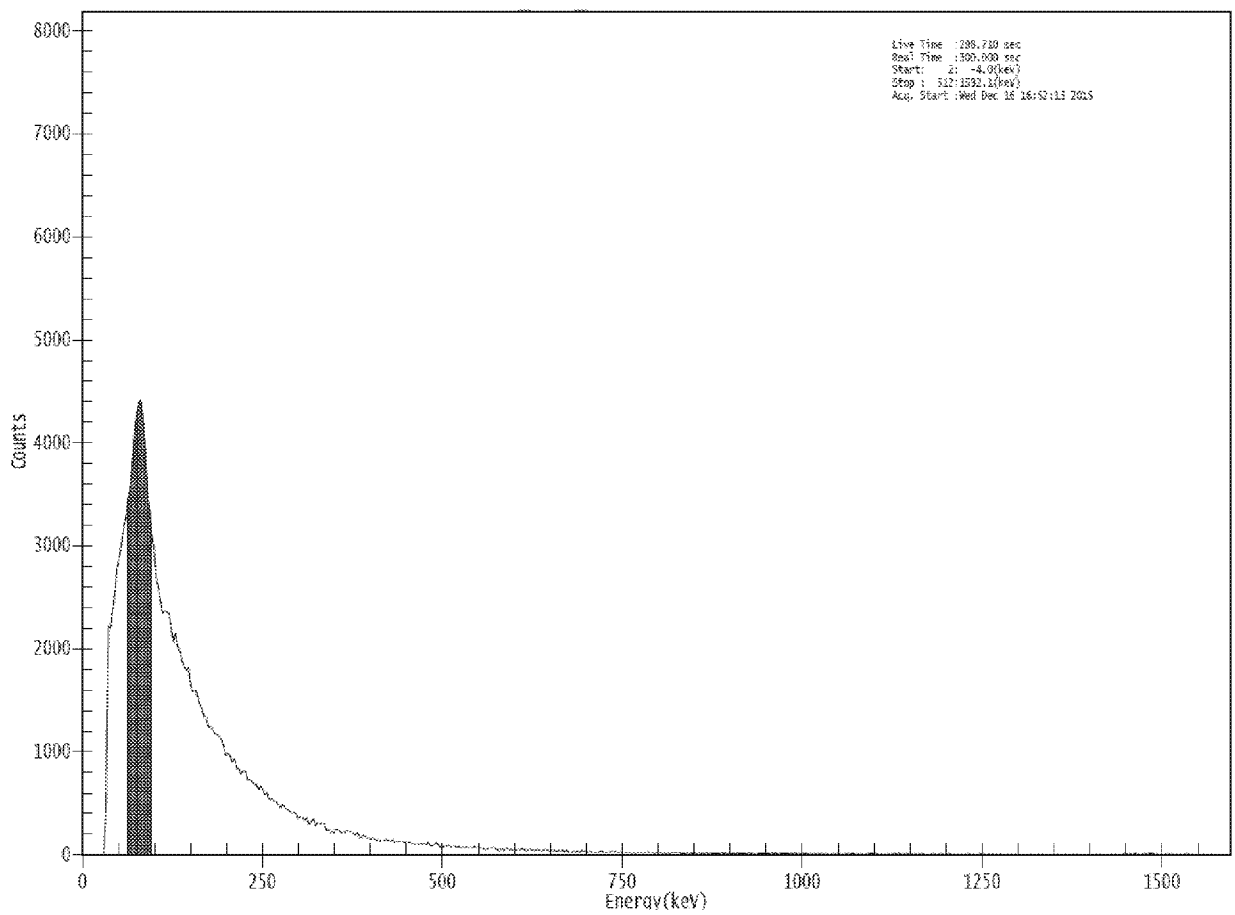


Figure 8. Example Photon Spectrum for Deck Marker Containing ^{90}Sr

Appendix E
Responses to Comments

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Response to Comments on the *Draft Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, February 2018, DCN: APTM-0006-4550-0014	
Comments by: Dr. Sheetal Singh, Senior Health Physicist, California Department of Public Health, Environmental Management Branch, comments dated May 15, 2018; comments received May 16, 2018	
General Comments	**Response**
1. The California Department of Public Health - Environmental Management Branch (CDPH-EMB) utilizes the California Code of Regulations (CCR), Title 17, Section 30256(k), which requires: a. Radioactive material be properly disposed; b. A reasonable effort has been made to eliminate residual radioactive contamination; c. A radiation survey has been performed which demonstrates that the premises are suitable for release for unrestricted use. In practice this means employing the process outlined in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, NRC et al, 1997), which includes establishing a reference background area for each of the materials to remain in situ. These reference background measurements are then compared to survey units (SUs).	**a.** Work Plan Section 4.6, Waste Management Plan, was revised as follows: "A WMP was prepared to allow for proper storage, characterization, and disposal of liquid and solid waste generated during the field activities. This plan addresses management, anticipated stockpiling, handling/transportation, and disposal of the non-radioactive waste streams derived during the fieldwork. The WMP is included as Appendix C. APTIM will not dispose of radioactive waste. Radioactive material, if any, that is identified during field activities will be collected, segregated, and stored in appropriate containers per the RPP (APTIM, 2017b) for subsequent packaging and disposal by a certified waste broker under the direction of the Navy LLRW Disposal Program." **b.** The survey areas have been classified as Class 3 area with little or no potential for residual radioactivity. Work Plan Section 7.5, Waste Management, states "Any investigation derived waste will be managed in accordance with the WMP (Appendix C)." **c.** Work Plan Section 9.0, Reporting Requirements, describes how the results of surveys implemented using this Work Plan will be documented. As stated in Work Plan Section 5.3.1 "The reference area behind Building 810 (Figure 1) will be used to establish gamma instrument-specific investigation levels (ILs). Reference data will be collected in similar matrix (i.e., concrete pad, wood, metals). If needed, additional reference areas may be established with the approval of the Navy."
2. Please perform the following statistical analyses on the data collected from the SUs with data collected from the background reference area: box plot, histogram, distribution analysis, normal probability plot, and comparison to background reference area.	No background data has been collected prior to the field work. The investigation level (IL) will be established based on the background data as described in Work Plan Section 5.3.1. The following bullet was added to Work Plan Section 9.0, Reporting Requirements: • "Data evaluation results including data conversion, summary statistics, graphical data review (e.g., histograms, normal

	probability plots), and comparison to background reference area data."
3. Please provide explanation why soil background measurements are being used for potential investigation levels (IL) rather than material representative of that being sampled (i.e. concrete, wood, etc.).	It is not anticipated that concrete samples will be collected during this work effort. Additional reference samples (i.e., concrete) will be established, if needed, with the approval of the Navy. Reference area data and investigation levels (ILs) will be provided to the radiological control technicians (RCTs) prior to the start of a survey for their use during data collection.
4. Gamma Walk-over survey/Drive-over survey (GWS/GDS) data should be cross- hatched to ensure that no GDS data gaps exist larger than the detector area and no GWS data gaps exist larger than 1 meter, without acceptable explanation (i.e. physical obstructions, water, etc.)	Survey coverage will be determined by the detector field of view and the path that the detector takes, based upon global positioning system (GPS). The survey coverage will be compared against the survey data quality objective (DQO) identified in the Work Plan. If insufficient survey data coverage exists, the field team will return to the area to collect additional data. Inaccessible areas (i.e. physical obstructions) will be noted in the field documentation. Cross-hatching gamma walkover survey (GWS) and gamma drive-over survey (GDS) data will not be necessary if the coverage obtained is greater than or equal to the survey coverage DQO.
Specific Comments	**Response**
5. Section 1.0 ("Introduction"). Page 1-2: a. "The Objective of this Work Plan is to describe radiological characterization surveys designed to provide results with sufficient quantity and quality to meet requirements for a final status survey and achieve unrestricted release for Parcel F structures". EMB noted the work plan is a characterization survey plan, in addition, will a Final Status Survey report be provided to review? **b.** Page 1-2, Section 1.0, Introduction, Please justify and describe how the characterization surveys are designed to provide results with sufficient quantity and quality to meet requirements for a final status survey?	a. As described in Work Plan Section 5.4, the data quality objectives lay out the details for the characterization surveys to support the final status survey (FSS). The objective of the radiological characterization surveys is to characterize and remove potential residual radioactivity of the Parcel F structures. The surveys are designed to support unrestricted release if no contamination is identified. As stated in Section 9.0, if no contamination is identified a FSS report will be prepared to document the results of the survey. b. For survey design purposes, the Parcel F structures are classified as Class 3 areas in a *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM; NRC et al., 2000) framework. Class 3 areas are unrestricted in size and meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity. This characterization survey has been designed such that if contamination is not found, the survey results can be

	presented as a FSS to achieve unrestricted release. In addition, if residual radioactivity is found during the radiological surveys at levels that would prevent unrestricted release of the site, then the Navy will be notified of the presence of residual radioactivity to determine the appropriate next steps for further investigation.
6. **Section 2.3 ("Nature and Extent of Contamination"), Page 2-3:** "Nature and Extent of Contamination", based on this section the HRA has identified that radiological operations were conducted on the dry docks/piers such as: traces of radioluminescent devices are present, decontamination using sandblast material and the storage of radiological waste supports a radiological impacted for Parcel F structures. Although the sections also state, "the probability of residual radioactivity from radioluminescent devices, contaminated ships and leaking waste packages is very low, the Parcel F structures are radiologically impacted. Include a section explaining why the Navy thinks there is a low potential for residual radioactivity?	The approach and rationale of the *Final Historical Radiological Assessment Volume II, History of the Use of General Radioactive Materials, 1939–2003, Hunters Point Shipyard, San Francisco, California* (HRA; Naval Sea Systems Command, 2004), document reviews, site designation, radionuclide identification, and evaluation of previous investigations conducted during the HRA concluded there is a low potential for residual radioactivity for Parcel F structures. Furthermore, Drydocks and ship berths were decontaminated and surveyed following maintenance and decontamination of radiologically impacted ships. Sandblast material was removed and disposed of as described in Section 6.4.1 of the HRA (Naval Sea Systems Command, 2004). After removal of the sand, the drydock floor was vigorously washed and the water pumped into the harbor. The drydocks were surveyed and met the criteria for release.
7. **Section 3.3 ("Anticipated Waste Streams"), Page 3-2. bullet 4:** This bullet discusses radiologically contaminated soil. Since the piers appear to be concrete and metal, please explain where the soil is expected to be found.	Contaminated soil is not expected to be found during the radiological surveys. However, Survey Unit 3 (Ship Berths 62 and 63) appears to have soil on the surface as shown on Photograph 1 of the Work Plan. There are also areas currently inaccessible that may contain soil or sediment requiring sampling and analysis.
8. **Section 5.1 ("Classification and Survey Units"), Page 5-1:** a. This section states Parcel F structures are classified as Class 3 areas. Please state why the Navy decided to classify the structures as class 3 since radiological operations were identified at this site according to the HRA and the Navy has classified previous ship berths and piers as Class 1? b. The section states objective of the radiological characterization surveys is to characterize potential residual radioactivity of the Parcel F structures. The surveys have been designed to support unrestricted release if no contamination is identified". CDPH has noted the surveys described in this work plan function as a characterization surveys to	a. The HRA states the contamination potential for Drydocks 5, 6, and 7 is unlikely, with contaminated media and potential migration pathways identified as "low" or "none" which is consistent with a Class 3 classification. HRA Section 8.3.7.2 states the potential for contamination of ship berths is likely, especially berths where Operation Crossroads decontamination occurred. Ship berths with the highest potential for residual radioactivity have been surveyed as Class 1 areas and little or no contamination was identified. The results of previous investigations in areas with the highest potential for

identify radiological impacted material and also support unrestricted release. Please state how the characterization surveys will support unrestricted release? **c.** Explain why the Navy did not select a pier or dry dock as reference area? Please also refer to comment #3.	residual radioactivity support classification of the remaining ship berths as Class 3. b. The surveys meet the requirements of a MARSSIM Class 3 final status survey as well as including additional characterization. Therefore, the results of the survey can support unrestricted release if no contamination is identified. c. No non-impacted piers or drydocks are available at HPNS to use as reference areas.
9. Section 5.3.1 ("Site wide Soil Background Area"), Page 5-1: Please explain why the Navy did not select a pier or dry dock as a reference area?	No non-impacted piers or drydocks are available at HPNS to use as reference areas.
10. Section 5.4.3 ("Step Three- Identify Inputs into the Decision"), Page 5-3. Bullets 1 and 2: Please add the word scanning to differentiate types of surveys. Example bullet one would begin by reading, "surface gamma scanning surveys... "	The text was revised as requested.
11. Section 5.4.5 ("Step Five- Develop a Decision Rule"), Page 5-3. Paragraph 2. Sentence 1: If elevated radioactivity is discovered above the IL, how will the Navy address it?	Work Plan Section 5.8 states "Any time a radioactive anomaly is confirmed during radiological surveys, the location will be marked or flagged and GPS/grid coordinates will be recorded." Investigations will be performed to confirm the elevated readings. Investigations will start with data review and proceed to additional measurements and possible sample collection and analysis if warranted to confirm the presence of residual radioactivity and characterize contamination.
12. Section 5.4.5 ("Step Five - Develop a Decision Rule"), Page 5-4, Bullet 1: "If a gamma scan survey result exceeds the IL, that location will be included in the surface area covered by the alpha/beta survey." Please specify which alpha/beta survey.	The text was revised as follows: • "The IL for gamma scan measurements is the average of gamma scan measurements for a similar material in an appropriate background area plus three standard deviations. If a gamma scan survey result exceeds the IL, that location will be included in the surface area covered by the alpha/beta <u>scanning</u> survey. The IL for gamma scan measurements will be determined separately for the RS-700 and gamma scintillator handheld radiation detection instruments."

Response to Comments on the *Draft Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, February 2018, DCN: APTM-0006-4550-0014	
Comments by: Dr. Sheetal Singh, Senior Health Physicist, California Department of Public Health, Environmental Management Branch, comments dated May 15, 2018; comments received May 16, 2018	
13. Section 5.5 ("Survey Instrumentation"), Page 5-4. Paragraph 1, Sentence 2: Instrumentation listed in Table 4 for Alpha/Beta surveys is a Ludlum Model 43-37 attached to a Ludlum Model 2221. Since this instrument cannot differentiate between alpha and beta in the field please explain how the instrument will be utilized.	Table 4 and the Work Plan text were revised throughout to state alpha and beta radiation will be measured using scans and static measurements using a Ludlum Model 43-37 connected a Ludlum Model 2360 (or equivalent).
14. Section 5.5.1 ("Instrument Setup and Quality Control"), Page 5-5. last sentence: "A Chi-square test will also be performed according to procedure to maintain QC compliance for Ludlum Model 2929/3030 (smear counter) and Ludlum Model 2360 ratemeter/scaler (direct measurement)." In Table 4 of this work plan there is no mention of a 2360 utilized for alpha/beta scans or statics, instead only Ludlum Model 2221 is listed. Please correct as needed.	Table 4 was revised to include the Ludlum Model 2360 for alpha/beta scan and static measurements.
15. Section 5.5.3 ("Gamma Surface Scan Minimum Detectable Concentration"), Page 5-7. First full paragraph on page, Last Sentence: The word "foil" is used instead of "soil". Please change to "soil".	The text was revised as requested.
16. Section 5.5.4 ("Alpha and Beta Instrumentation"), Page 5-7. Sentence 2: "Total alpha and beta radiation will be measured using scans and static measurements using a Ludlum 43-37 gas proportional detector connected to a Ludlum Model 2221 ratemeter/scaler, or equivalent." A Ludlum Model 2221 is a single channel analyzer incapable of distinguishing between both alpha and beta radiation in one static or scan and must be specifically calibrated for either alpha or beta radiation. How will the Ludlum 2221 or equivalent be utilized on-site to collect both alpha and beta results?	The text was revised as follows: "Total alpha and beta radiation will be measured using scans and static measurements using a Ludlum 43-37 gas proportional detector connected to a Ludlum Model <u>2360</u> ratemeter/scaler, or equivalent."
17. Section 5.6 ("Gamma Count Rate Surveys :), Page 5-9. Paragraph 2. Sentence 2: "Systematic gamma static measurements will be collected as part of the second stage of the survey." Please clarify whether biased statics measurements based on elevated location identification will be collected along with systematic gamma static measurements.	The text was revised to state: "<u>Biased</u> gamma static measurements will be collected as part of the second stage of the survey."
18. Section 5.6 ("Gamma Count Rate Surveys"), Page 5-9. Paragraph 2. Sentence 1: Please specify whether that reacquisition of elevated gamma scan locations will be performed using the same GPS unit or equivalent that originally captured the data.	The text was revised as follows: "Static measurements will consist of reacquiring the location of the elevated gamma count rate and conducting a 1-minute gamma static count using a Ludlum Model 44-20 3-inch by 3-inch NaI gamma scintillation detector coupled with a Ludlum Model 2221 ratemeter/scaler, or equivalent, handheld instrument. <u>A high resolution GPS receiver will record all gamma scan, static, and biased</u>

	locations. The RS-700 has an internal GPS system, which displays real time data collection. An additional GPS receiver will be used to verify locations of interest using handheld meter Model 2221 coupled with Model 44-20 NaI detector for the static and biased locations. The nearby area will be resurveyed to assess if the elevated gamma scan reading is due to a point source or distributed radioactive material. If the gamma static (1 minute) count is less than the instrument specific static IL and there is no evidence of a point source, further survey investigation is not required."
19. Section 5.7.2 ("Systematic Alpha and Beta Static Measurements"), Page 5-10: Please explain why this section discusses random measurement locations and not systematic static measurements as stated in the section title.	The text was revised to remove the word "Systematic" from the section heading.
20. Section 5.8 ("Remediation Approach and Radiological object Management"), Page 5-12. Paragraph 1. Sentence 2: **a.** "If the material is soil..." Please see comment# 7 **b.** Sentence 4: Remove the word "by" to make sentence read, "Under RCT oversight, the location with an elevated radiation level will be removed using whatever means necessary." **c.** The term "removed" is used instead of "remediated" please explain the choice of terminology.	a. Please see the response to CDPH Comment Number 7. b. The text was revised as requested. c. The text was revised to state "remediated" instead of "removed."
21. Section 6.5 ("Mobilization"), Paragraph 1. Sentence 3: "... will be notified regarding the planned schedule for mobilization and site remediation activities." Why are the activities referred to as remediation activities in this characterization work plan?	The text was revised to state "characterization" instead of "remediation."
22. Section 6.5 ("Mobilization"), Page 6-2. Paragraph 2. Sentence 2: Please specify whether the short and long-term storage of materials will solely be for non-radiological materials.	Short and long-term storage of materials will include non-radiological and radiological materials. Site activities will consist of radiological surveys and will require sources of radioactivity to calibrate and monitor the performance of radiation detection instrumentation. Radiological materials will be stored in posted, controlled, secured areas.
23. Section 6.6.1 ("Temporary Construction Facilities"), Page 6-2, Paragraph 1. Sentence 2: Same request as comment #22.	Please see the response to CDPH Comment Number 22.
24. Section 6.6.2 ("Field Observations and Photographic Documentation"). Page 6-3. Paragraph 1, Sentence 2: Please specify whether expected	The text was revised as follows:

weight loads include the vehicle (ATV or otherwise) that will be towing the RS-700.	"The expected loads include personnel and radiological equipment, including the RS-700 system attached to an all-terrain vehicle for the drive over gamma scanning."
25. Sections 7.1.1 ("Gamma Scan Surveys") and 7.1.2 ("Alpha and Beta Surveys"): Please provide explanation as to why manholes, grates, and components of the suction and discharge system are not to be surveyed for radiological contamination.	The first sentence of the second paragraph in Work Plan Section 7.1.2 states: "Manholes, grates, and components of the suction and discharge system will be investigated during the characterization survey of Drydocks 5, 6, and 7." No changes were made to the text.
26. Section 7.1.2 ("Alpha and Beta Surveys"), Page 7-3: Is the Navy planning to clean surfaces of debris as it may interfere with surveys?	Surface scans of MARSSIM Class 3 survey units are selected on a judgmental basis. Thus, it is not necessary to clear all the surface area of debris. If the location selected for scanning is covered by debris, it will be relocated as necessary to achieve a suitable surface scan. Work Plan Section 7.1.2, Alpha and Beta Surveys, was revised to state the following: "Debris will be relocated as necessary to complete these scans."
27. Section 7.1.2 ("Alpha and Beta Surveys"), Page 7-3, Paragraph 1. Sentence 1: This sentence implies that 25% of the accessible surfaces will be covered by a combination of alpha/beta scans, statics, and smears. This is in contradiction to a previous statement on page 5-10, first full paragraph, sentence 1, which states, "Alpha and beta static scans will be performed over 25 percent of the area of each SU." Please explain the change in area coverage methods.	The text was revised as follows for consistency: "Alpha and beta surveys will include scans, static measurements, and smear measurements for Class 3 areas consistent with MARSSIM guidance (NRC, et.al, 2000) for Class 3 surveys. Alpha and beta static scans will be performed over 25 percent of the area of each SU."
28. Section 7.1.2 ("Alpha and Beta Surveys"), Page 7-3. Paragraph 2. Sentence 6: The only Alpha/Beta scanning instrument mentioned in table 1 of the work plan is a Ludlum Model 43-37, please specify how the radiological control technician (RCT) performing the survey plans to access manholes, grates, and components of the suction and discharge system and maintain the same scanning procedure mentioned in Section 5.7.1.	Surfaces inaccessible with the Ludlum Model 43-37 (e.g., smaller than the detector, access smaller than the detector) or incompatible with the Ludlum Model 43-37 (e.g., curved surface) will not be included as part of the 25% of surfaces covered by alpha/beta static scan measurements.
29. Section 7.1.2 ("Alpha and Beta Surveys"), Page 7-4, First Full Paragraph, Sentence 1 and 2: These sentences imply that alpha/beta static surveys will consist of 6 second count times, while the following paragraph states that two minute count times will be collected; please explain	The text was revised as follows to clarify count times for alpha/beta static scans (i.e., "stamping") at 6-seconds each and alpha/beta static measurements at 2-minutes each: "The alpha/beta static measurements will be performed using portable contamination survey instruments specifically, the Ludlum Model 43-37 gas flow proportional "floor monitor" detector (or equivalent) coupled with a Ludlum Model 2360 scaler/ratemeter (or equivalent) (Table 4). The scaler/ratemeter will be set to a 2-minute

	count time. At the start of each measurement, the RCT will position the detector, and begin the 2-minute count. At the completion of each 2-minute count, the alpha and beta result will be recorded. The IL for the alpha and beta static measurements will be developed and used as described in the decision rules in Section 5.4 of this Work Plan. The release criteria were established from the AM (Navy, 2006) and are presented in Table 1."
30. Appendix A Sampling and Analysis Plan. ("SAP worksheet #17: Sampling Design and Rationale"), Page 45. Paragraph 2. Sentence 1: "A scoping survey that is also consistent with MARSSIM guidance (NRC et al., 2000) for Class 3 final status survey will be performed." Why is this survey referred to as a scoping survey in this section?	The text was revised to remove reference to "scoping surveys." The text was revised as follows: "Surveys consistent with MARSSIM guidance (NRC et al., 2000) for a Class 3 final status survey will be performed."
31. Appendix A Sampling and Analysis Plan. Section 17.1 ("Biased Radiological Characterization Sampling"), Page 45. Paragraph 2. Sentence 4: "If the results following the full ingrowth are consistent with background and gamma count rate scanning and static measurements are below instrument specific lLs, the radiological survey will be considered complete." Why are the alpha and beta results not considered?	This sentence refers to the review of laboratory gamma spectroscopy analysis and field data; it is not related to alpha and beta data collection or evaluation.
32. Appendix A Sampling and Analysis Plan. Worksheet #22 (" Field Equipment Calibration. Maintenance. Testing, and Inspection Table"), Page 50: Please furnish a copy of standard operating procedure (SOP) referenced under heading "SOP Reference", "Operation and use of portable instruments at HPNS (RPP[APTIM,2017a])").	The APTIM Radiation Detection Instrumentation Work Instruction (AMS-710-07-WI-04014) was added to Attachment 2.
33. Appendix A Sampling and Analysis Plan. Worksheet #34-36 ("Data Verification and validation (Steps I and lla/llb) Process Table"), Page 74: Please clarify verbiage. Illustrate that prior to sample shipment to off-site laboratory, sample release survey has been reviewed, accepted, and attached to the cooler by appropriate staff.	Text describing the sample release survey data documentation and review was added to WS#34-36.
34. Appendix B Contractor Quality Control Plan. Section 8.1 ("Definable Feature of Work 1: Radiological Surveys of Parcel F Structures"), Page 8-1: Change references from "Cabrera Large Area Scanning System" to RS-700 To remain consistent with the rest of the document.	Contractor Quality Control Plan, Section 8.1 was revised as requested.
35. Appendix C Waste Management Plan. Section 3.1 ("Waste Classification"), Page 2, Paragraph 1: Table 2 discusses methods of waste	Table 2 was revised to include analytical methods for total strontium/strontium-90 and plutonium-239.

characterization by gamma spectroscopy for identification of Ra-226 and Cs-137. Please explain why Pu-239 was excluded from the waste characterization process.	

Response to Comments on the *Draft Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, February 2018, DCN: APTM-0006-4550-0014	
Comments by: Environmental Protection Agency, comments dated May 22, 2018; comments received May 22, 2018	
General Comments	**Response**
1. Section 2.3 (Nature and Extent) of the Draft Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California (Work Plan) states that surveys of the drydocks following decontamination operations did not identify areas of elevated radioactivity, indicating a low probability of finding residual radioactivity from contaminated ships. The text does not explain, however, what types of surveys were performed (gamma and/or alpha/beta) or what percentage of the drydocks were actually scanned. In order to demonstrate that the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* classification of these Ship Berth areas is appropriate and to support the sufficiency of the proposed characterization plan, the Work Plan should include this information. For example, Section 5.1 (Classification and Survey Units) states that the Parcel F structures were classified as Class 3 areas. MARSSIM guidance states that Class 3 areas are impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the Derived Concentration Guideline Level for the wide area ($DCGL_W$), based on site operating history and previous radiation surveys. Historical information is especially important for the alpha/beta emitting radionuclides of concern (ROCs), Plutonium-239 (Pu-239), which is an alpha emitter, and Strontium-90 (Sr-90), which is a beta emitter, because the current Work Plan proposes to only survey 25% of the Parcel F structures for gross alpha/beta and includes survey units for the finger piers that are very large, around 7,000 – 8,000 square meters (m^2). Please revise the Work Plan to include information about the types and locations of previous radiological surveys of the Parcel F structures.	Previous radiological surveys in Parcel F are discussed in the *Final Historical Radiological Assessment Volume II, History of the Use of General Radioactive Materials, 1939–2003, Hunters Point Shipyard, San Francisco, California* (HRA; Naval Sea Systems Command, 2004). While the historical survey information is not sufficient to support a decision to release these areas from radiological controls, all historical survey data support a conclusion there is little or no residual radioactivity associated with these areas and they are consistent with classification as *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) Class 3 areas. There is no historical information indicating levels of residual radioactivity exceeding the current remediation goals. Activities historically performed in Parcel F involved radioactive materials; therefore, these areas are considered radiologically impacted. However, radiological activities were primarily completed approximately 60 years ago. Time and weathering of surfaces would be expected to reduce levels of potential surface residual radioactivity over this time. Starting with a low potential for residual radioactivity that has been reduced over time also supports classification as MARSSIM Class 3 areas. There is no historical information indicating plutonium-239 (^{239}Pu) was used for any purposes in Parcel F. Instead, ^{239}Pu was one of multiple radionuclides associated with nuclear weapons tests and fallout that could still be present at HPNS. This survey is designed to look for a mix of radionuclides emitting alpha, beta, and gamma radiation that could indicate residual radioactivity associated with nuclear weapons testing and fallout. Radium-226 (^{226}Ra) and strontium-90 (^{90}Sr) were used in radioluminescent devices. Residual radioactivity from these sources would result in photons being released (gamma and x-rays from ^{226}Ra decay, and bremsstrahlung from ^{90}Sr decay) that will be detected by the gamma scanning surveys. The gamma scanning survey is designed to identify discrete sources of photon emissions (^{226}Ra and ^{90}Sr radioluminescent devices) as well as delineate areas with elevated gamma radiation relative to surrounding areas (cesium-137 and fallout radiation). Alpha/beta scans are performed over 25 percent of surfaces to identify areas of elevated activity potentially

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Comments by: Environmental Protection Agency, comments dated May 22, 2018; comments received May 22, 2018	
	associated with nuclear weapons testing or fallout, or traces of damaged radioluminescent devices. The 25 percent coverage is consistent with MARSSIM guidance for Class 3 final status surveys and should be adequate to characterize these areas in Parcel F. The alpha/beta random static measurements provide an estimate of the average levels of residual surface radioactivity for comparison with remediation goals to support decisions on releasing these areas in Parcel F from radiological controls.
1. Section 1.0 (Introduction) states that the Table 1 release limits/cleanup goals for localized radioactive contamination are based on the U.S. Nuclear Regulatory Commission (NRC) dose limit of 25 millirems per year. However, in order to demonstrate compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP), a risk assessment will need to be completed to demonstrate that future potential receptors will not be exposed to residual contamination that results in an Excess Lifetime Cancer Risk of greater than 10E-04 to 10E-06. U.S. EPA's "Radiation Risk Assessment at CERCLA Sites: Q & A" states "The PRG calculators (U.S. EPA 2002a, 2007, 2009a), which are used to develop risk-based PRGs for radionuclides, are recommended by EPA for Superfund remedial radiation risk assessments." (Source: https://epa-prgs.ornl.gov/radionuclides/RadRiskQAwithtransmitmemo_June_13_2014.pdf) As one of multiple lines of evidence, please revise the Work Plan include showing results from the EPA PRG Calculators for Parcel F. This addition would help demonstrate consistency with U.S. EPA's CERCLA approaches. The software is public and free. The human health PRG calculator is at https://epa-prgs.ornl.gov/radionuclides/ and the ecological risk version is at https://epa-eco.ornl.gov/radionuclides/. Please revise the Work Plan to discuss how it will be ensured that the final actions/end state of Parcel F structures will be evaluated to ensure risk to any potential receptor falls within the CERCLA acceptable risk range of 10E-06 to 10E-04.	The Table 1 release limits and remediation goals were established in the *Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, California* (Department of the Navy, 2006). The reference to the U.S. Nuclear Regulatory Commission dose limit of 25 millirems per year was removed.
2. It is unclear if the instrument efficiencies used to calculate the gamma spectrometry and alpha/beta survey surveys and static measurements Minimum Detectable Concentrations (MDCs) referenced in Section 5.5 (Survey Instrumentation), Table 5 of the Work Plan, and Worksheet #15 of the Appendix B Sampling and Analysis Plan, were adjusted to account for the various materials that will be surveyed, such as metal, wood, concrete, or	Instrument efficiencies, as defined in ISO-7503, are specific to an instrument and are independent of the source of radiation. Surface efficiencies may be developed for specific materials, but since the process requires a significant effort in terms of time and materials and adequate material-specific calibration sources are difficult or impossible to obtain, default values generally applicable to most situations were developed and

others. The instrument and matrix efficiencies have a significant impact on the achievable MDCs, therefore this information is critical for determining if the calculated MDCs can be met during the actual surveys. Please revise the Work Plan to discuss whether instrument efficiencies were adjusted for different materials (e.g., wood, metal, concrete, etc.) that will be surveyed at the ship berths areas.	included in ISO-7503. For this project, the default values from ISO-7503 will be used in place of developing material-specific surface efficiencies.
3. Table 3 lists the environmental background measurements collected from soil samples at the Hunter's Point Naval Shipyard; however, background measurements for other materials that will be surveyed for Parcel F structures are not included. Please ensure background measurements are collected from representative materials in order to support the MDCs, scan speeds, and static measurement times listed in the Work Plan.	Work Plan Section 5.3.2 states "Alpha/beta material-specific backgrounds will be established for each instrument based on measurements performed in the reference area."
Specific Comments	**Response**
1. Section 5.4.4, Step Four – Define the Study Boundaries, Page 5-3 and Appendix A, Sampling and Analysis Plan (SAP) Worksheet #11, Project Quality Objectives/Systematic Planning Process Statements, Page 30: The spatial boundaries are provided in the Step 4 discussion. Please also provide the temporal boundaries for this study.	There are no temporal boundaries associated with this project.
2. Section 7.1.2, Alpha and Beta Surveys, Page 7-4 and Section 7.3, Site Restoration, Page 7-5: The text in Section 7.1.2 states that cutting or sawing may be required to access manhole covers that are locked or welded in place or other plates or covers that limit access, but it is unclear how these areas will be secured to limit access after the surveys are completed. Section 7.3 states, Restoration of Parcel F structures is not expected or required," but subsurface structures should be left in an inaccessible condition. Please revise the Work Plan to discuss how areas where cutting or sawing is required to access manholes and other covered areas will be secured when the surveys are completed.	Prior to mobilization there is limited information available on what areas require access and what will be required to provide the required access. Similarly, there is limited information available on what will be required to limit access to these areas after the surveys are complete. Details on how access to areas was limited after completing the survey will be included in the final report.
3. Appendix A, SAP Worksheet #28.3, Laboratory Quality Control Samples -Alpha Spectroscopy, Pages 67 and 68: This worksheet does not include sample tracers as one of the quality control checks. Please revise the SAP to include the recovery of tracers to be included in this worksheet.	Tracer recovery was added to Worksheet #28.3.
4. Appendix A, SAP Worksheets #34-36, Data Verification and Validation (Steps I and IIa/IIb) Process Table, Page 76: The text states that validation (i.e., Stage 3) will be performed on 10 percent (%) of the samples, and 90 % will receive Stage 2 verification. It is requested that in addition to	As stated in Sampling and Analysis Plan Worksheets #34-#36, Page 79, Validation of Laboratory Data, a third-party data validation company will validate definitive-level project laboratory data for radiological confirmation samples, if collected, at 90 percent Stage 2B and 10 percent

these requirements, data validation be performed on one or more of the initial data packages from the laboratory at the beginning of the project to ensure the quality of the data is sufficient and is meeting the data quality objectives (DQOs) for the project. Please revise Worksheets #34-36 to require data validation of at least one of the initial data packages from the laboratory to ensure the DQOs are being met.	Stage 3. If samples are collected and sent to the off-site laboratory for analysis, the data will be validated. All data packages will be validated.
4. Appendix A, SAP Worksheet #37, Usability Assessment, Pages 78-81: This worksheet describes the process that will be followed to perform a data usability assessment but does not specify the frequency of such reviews. Additionally, neither SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIa/IIb) Process, nor Worksheet #37 states how the results of such an assessment will be documented and reviewed or what process will be followed if the data usability assessment (DQA) indicates the data are not usable. Please revise Worksheet #37 to include the percentage/frequency of data packages that will be subject to a data usability assessment, how these reviews will be documented and reviewed, and what process will be followed if anomalies are noted in the DQA and/or data are deemed not usable for decision making.	The following sentence was added to Section 37.1, Data Quality Assessment Report, second paragraph: "A data usability assessment based on data quality indicators will be performed for every data set subjected to Class 3 validation (SAP Worksheet #34-36)." Data usability for project decisions is continually assessed throughout the project with the Project Radiological Safety Officer and the Navy, including the Radiological Affairs Support Office. If data are determined unusable for project decisions, re-sampling is conducted.

Response to Comments on the *Final Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, July 2018, DCN: APTM-0006-4550-0025	
Comments by: Sheetal Singh, Senior Health Physicist, CDPH, comments dated August 15, 2018	
Specific Comment	**Response**
1. CDPH-EMB's Specific Comment 8(a) addresses concern with classification of Parcel F structures as MARSSIM Class 3 survey units (SUs). Historically the Navy has classified these structures as MARSSIM Class 1 SUs. This classification of MARSSIM Class 1 SUs is justified by the fact that radiological activities listed below have taken place on the Parcel F structures: a) Berthing and decontamination of Operation Crossroads vessels, b) Naval Nuclear Propulsion Program Operations, c) Berthing of YGN-73 radioactive waste disposal barge, d) Berthing of Naval Radiological Defense Laboratory (NRDL) experimental barges and YAG-39 and YAG-40, e) And radioactive waste staging on the piers prior to loading onto YGN-73. Due to various radiological activities listed above and the historical classification of similar structures, the response provided is inadequate to justify down-classification of these structures to MARSSIM Class 3 SUs.	The impacted categorization of the Parcel F structures is consistent with the list of Navy activities provided in the California Department of Public Health's (CDPH's) comment, and the discussions provided in the *Final Historical Radiological Assessment Volume II, History of the Use of General Radioactive Materials, 1939–2003, Hunters Point Shipyard, San Francisco, California* (HRA; Naval Sea Systems Command, 2004). The classification of the submarine pens and piers at Hunters Point Naval Shipyard (HPNS) as Class 3 areas is consistent with the historical use of these areas and what is known about these sites. The HRA (Naval Sea Systems Command, 2004) describes the potential for contamination of Parcel F ships' berths as likely, meaning the sites were impacted by past historical radiological activities performed by the Navy (i.e. items a-e listed in CDPH's comment 1). Further the HRA states the Navy's recommended actions include Scoping Surveys be completed for the ship berths. Although the potential for contamination is conservatively classified as "likely" (due to historical activities), HRA Section 8.3.7.2 states the current potential for contaminated media including soil, groundwater, structures, drainage systems and surrounding air as low or none. As defined in the HRA, a low potential categorization for media contamination indicates that the contamination potential is remote. While it was possible for submarine pens and piers to have come into contact with radioactive material in the past, the potential for any residual radioactivity to be present today is little to none. This is consistent with a *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) classification for Class 3 areas where there is little to no potential for a dose above the release criterion, or in this case, little to no potential for radionuclide concentrations exceeding the release criteria listed in Table 1 of the Work Plan. While classification of structures or areas with similar historical use of radioactive materials may be considered, the historical use of radioactive materials at each site should be the primary consideration when assigning survey class classifications. In this case, there are no other submarine pens and piers at Hunters Point Naval Shipyard (HPNS) with similar history for

	use of radioactive materials. Other areas at HPNS, such as the Gun Mole Pier, have a significantly different historical use and should not be compared directly with other sites and areas at HPNS. If radiological contamination is discovered during the survey, the Parcel F submarine pens and/or finger piers exceeding the release criteria listed in Table 1 of the Work Plan, will be re-surveyed as Class 1 areas. If no radiological contamination is discovered, the Parcel F structures will be recommended for unrestricted radiological release. Work Plan Section 5.1, Classification and Survey Units, was revised to include this text.
2. CDPH-EMB's Specific Comment 28 addresses its concerns pertaining to large area detector access to smaller components and entryways (i.e. manholes, grates, and associated structure components) while maintaining proper scanning procedures. Components and entryways maintain the same potential for radiological contamination as the rest of the structure. Therefore, the response that these components and entryways "will not be included as part of the 25% of surfaces covered by alpha/beta static scan measurements" is unacceptable. Disqualifying scan surfaces simply based on accessibility of large area detectors is unacceptable. Smaller area detectors should be utilized to scan areas inaccessible to large area detectors.	Small area detectors do not meet the survey data objectives for scanning because the scan detection limits for the small area detectors are higher than allowed. Detectors that meet the survey data objectives do not fit inside small penetrations inside the submarine pens. The potential for residual radioactivity at smaller components and entryways is considered low. These components would have been impacted by the flow of contaminated water through the system and not by direct contact of contaminated items. Ships were at sea for days or weeks prior to entering the submarine pens, so readily removable contamination would have been removed prior to entering the submarine pen. The time to secure and drain the submarine pen was several hours, so the potential for transferring additional contamination to the water following several days in the water is extremely small. The potential for contamination in the water being pumped out of the submarine pens is also small. The potential for contamination is higher on the walls of the submarine pens; therefore, the walls of the submarine pens will be surveyed preferentially. To ensure no areas are disqualified from the survey due to accessibility or large area detectors, static measurements with smaller detectors will be performed in selected locations. The Work Plan Sections 5.5.6, 7.1.2, and Tables 4 and 5 were revised to include small area detectors for collection of alpha/beta static measurements. Work Plan Section 5.5.6, Alpha Beta Static Minimum Detectable Concentration, was revised as follows: "Integrated static alpha and beta activity measurements will be performed using a Ludlum Model 43 37 gas proportional detector

	during scans. A Ludlum Model 43-68 gas proportional detector may be used in areas inaccessible to the large area detector." "Two-minute static measurements will be performed when using the Ludlum Model 43-37. Based on the backgrounds and efficiencies experienced using the Ludlum Model 43 37, the *a priori* MDC for alpha is 21.5 dpm/100cm^2 and for beta is 184 dpm/100cm^2. Five-minute static measurements will be performed when using the Ludlum Model 43-68. Based on the backgrounds and efficiencies experienced using the Ludlum Model 43-68, the *a priori* MDC for alpha is 32 dpm/100cm^2 and for beta is 202 dpm/100cm^2." Work Plan Section 7.1.2, Alpha and Beta Surveys, was revised as follows: "The alpha/beta static measurements will be performed using portable contamination survey instruments specifically, the Ludlum Model 43 37 gas flow proportional "floor monitor" detector (or equivalent) coupled with a Ludlum Model 2360 scaler/ratemeter (or equivalent) (Table 4). If required, a Ludlum Model 43-68 gas flow proportional detector (or equivalent) small area detector may be used to perform static measurements in areas not accessible to the Ludlum Model 43-37 large area detector (Table 4)." Tables 4 and 5 were revised to include the Ludlum Model 43-68 detector for alpha/beta static measurements.

Response to Comments on the *Final Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, July 2018, DCN: APTM-0006-4550-0025	
Comments by: Lily Lee, Cleanup Project Manager, EPA, comments dated August 23, 2018	
Specific Comment	**Response**
1. Evaluation of the Response to General Comment 1: Currently, the Work Plan classifies Parcel F structures as Class 3 survey units and has proposed conducting radiological surveys of 25 percent (%) of these structures. The RTCs have not sufficiently justified a Class 3 designation. EPA agrees with the California Department of Public Health Specific Comment #1 on the RTCs, which lists relevant historical radiological activities and which recommends a Class 1 designation. Also, no records have established where ships from Operation Crossroads were berthed. Dry Docks 2-7 and the Gun Mole Pier are all considered radiological impacted. When the Navy surveyed onshore drydock areas adjacent to the piers and sub pens, radiological devices were found. The piers removed from Parcel B were removed as potentially radiologically impacted. In addition, the response is incomplete because it does not address the potential for the presence of elevated alpha activity on outdoor metal surfaces in Parcel F due to the sequestering of Polonium 210 (Po-210) from the decay of Radium-226 (Ra-226), which has been identified on metal structures at other areas of the Hunter's Point Naval Shipyard. The response states that the time and weathering of surfaces on Parcel F would be expected to reduce levels of potential surface residual radioactivity over time; however, Po-210 may increase the alpha radioactivity on surfaces over time. However, given the identification of elevated alpha activity above the release criteria on other surfaces throughout the Hunter's Point site due to the concentration of Po-210 from the presence of Ra-226, metal structures in Parcel F should be considered potentially impacted above the remedial goal (RG) and therefore should be classified as Class 1 survey units and receive more thorough evaluation to determine if the release criteria for these surfaces has been met. Please revise the Work Plan to reclassify these survey units to Class 1 and specify that 100% gross alpha/beta surveys and smear sampling for gross alpha of metal surfaces of structures located in areas of Parcel F that may be released for public access will be conducted to ensure the RGs have been met and to identify whether any of those surfaces have elevated levels of Po-210 that may pose a safety risk to potential future receptors.	The Work Plan classifies the Parcel F submarine pens and piers as Class 3 areas based on the historical use and what is known about these sites. Please refer to California Department of Public Health (CDPH) Comment 1, dated August 15, 2018, CDPH Comment 8a, dated May 15, 2018, and *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) guidance for additional discussions concerning classification of these areas. As stated in the response to CDPH's Comment 1, dated August 15, 2008, if radiological contamination is discovered above the release criteria (listed in Table 1 of the Work Plan) during the survey, then said Parcel F submarine pens and/or finger piers will be re-surveyed as Class 1 areas. If no radiological contamination is discovered, the Parcel F structures will be recommended for unrestricted radiological release. The Work Plan proposes 100 percent (%) survey for photons and 25% surveys for alpha and beta surface activity, which is consistent with MARSSIM guidance for Class 3 final status surveys. Work Plan Section 7.1.2, Alpha and Beta Surveys, states a minimum of one alpha/beta static measurement and one smear measurement will be collected from each accessible manhole and outlet impeller (or similar equipment) if safely accessible. Other components of the discharge system (i.e., metal plates and piping) will be visually inspected in the field and surveyed as practicable; scan, static measurements, and smear measurements will be collected from accessible surfaces as practicable. The samples may be biased to visible staining based on the direction and professional judgement of the Project Radiological Safety Officer. As determined in the *Final Historical Radiological Assessment Volume II, History of the Use of General Radioactive Materials, 1939–2003, Hunters Point Shipyard, San Francisco, California* (HRA; Naval Sea Systems Command, 2004), the radionuclides of concern (ROCs) for the Parcel F structures are cesium-137, plutonium-239, radium-226, and strontium-90. Polonium 210 (Po-210) is not identified as a ROC in the HRA for the Parcel F submarine pens and piers. The Navy concurs that Po-210 has been detected on outdoor metal structures at other areas of HPNS. However, the Navy has determined that

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Comments by: Lily Lee, Cleanup Project Manager, EPA, comments dated August 23, 2018	
	sequestering of Po-210 on metal structures is attributable to naturally occurring plating of radon and not related to historical Navy activities.
2. Evaluation of the Response to General Comment 1, Section 1.0 (Introduction): The response does not address EPA's comment that as part of the fourth Five-Year Review occurring in parallel this year, the Navy should perform updated risk evaluations of existing RGs using the current versions of the EPA's radiological risk models. These include the Preliminary Remediation Goals (PRG) Calculator for soil, the Building PRG Calculator for buildings and the Surface PRG Calculator for surfaces. The new work performed under this Work Plan should use cleanup criteria that reflect findings of the updated risk evaluations to ensure the protectiveness of the cleanup. Please revise the Work Plan include the results of the risk evaluation of current RGs and to include risk analysis (or refer to such analysis in the Five Year Review or other document) using the current version of the relevant PRG Calculator(s) for the structures to demonstrate that planned cleanup will protect any potential receptor to the CERCLA acceptable Excess Lifetime Cancer risk range of 10E-06 to 10E-04 using exposure pathways and scenarios specific to each structure.	The Parcel F Work Plan uses the current remedial goals (RGs) as established in the *Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, California* (Department of the Navy, 2006). The Navy conducted preliminary calculations of the risk using the U.S. Environmental Protection Agency's Preliminary Remediation Goal Calculator and found that the current RGs are within the risk management range of 10^{-4} to 10^{-6}. RGs are not proposed to be changed as part of this work plan. Future protectiveness will be evaluated in the Five Year Review.

Response to Comments on the *Final Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, July 2018, DCN: APTM-0006-4550-0025	
Comments by: Lily Lee, Cleanup Project Manager, EPA, comments dated November 15, 2018	
Specific Comment	**Response**
1. Evaluation of the Response to Specific Comment 1: The response states that if radiological contamination is discovered above the release criteria (listed in Table 1 of the Final Radiological Characterization Surveys Work Plan, Parcel F Structures [Work Plan]) during the survey, then the survey unit (e.g., Parcel F submarine pens and/or finger piers) will be re-surveyed as Class 1 areas; however, this commitment is not documented in the Final Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California, July 2018 (WP). Therefore, the decision rules, Sections 5.6 and 5.7 of the Work Plan, and Worksheets #11, 14, and 17 of the Appendix A Sampling and Analysis Plan and other sections as appropriate should be updated to require a Class 1 survey if radiological contamination is found. Please submit change pages that document the commitment to surveying all of the Parcel F structures as MARSSIM Class 1 survey units if contamination is identified during any of the characterization surveys.	Work Plan Section 5.4.2, Step Two-Identify the Decision, second bullet, and Sampling and Analysis (SAP) Worksheet (WS) #11, Step 2, second bullet were revised as follows: • "If residual radioactivity is found during the radiological surveys at levels that would prevent unrestricted release of the site, then the Navy will be notified of the presence of residual radioactivity to determine the appropriate next steps for further investigation <u>and the areas will be re-surveyed as Class 1 areas.</u>" SAP WS#14 summarizes the project tasks for the current work and WS#17 describes the sampling design and rationale. These worksheets are based on performing a Class 3 survey. If contamination is found, the areas will be re-surveyed as Class 1 areas. The Work Plan and SAP will be revised if Class 1 surveys are required. Work Plan Sections 5.6 and 5.7 and SAP WSs #14 and ##17 are correct as written and no changes were made.

Response to Comments on the *Final Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, July 2018, DCN: APTM-0006-4550-0025	
Comments by: Sheetal Singh, Senior Health Physicist, CDPH, comments dated October 25, 2018	
Specific Comment	**Response**
1. CDPH-EMB's Specific Comment 1 dated August 15, 2018 initially addressed our concern with classification of Parcel F structures as MARSSIM Class 3 survey units (SUs). Due to various radiological activities listed in this report, the Historical Radiological Assessment, 2004, EMB's previous comment, the historical classification of similar structures and recent radiological discoveries at Hunters Point Naval Shipyard in locations previously classified as having "low" or "none" contamination potential; the response provided is inadequate to justify down-classification of these structures to MARSSIM Class 3 SUs. Please adjust the SU MARSSIM classification for Parcel F structures to MARSSIM Class 1.	The Department of the Navy (Navy) is performing a Class 3 survey based on the findings and recommendations included in the *Final Historical Radiological Assessment Volume II, History of the Use of General Radioactive Materials, 1939–2003, Hunters Point Shipyard, San Francisco, California* (HRA; Naval Sea Systems Command, 2004). The HRA recommended scoping surveys of Drydocks 5, 7, and ship berths (Parcel F finger piers), and review of the final status survey report for Drydock 6. The Navy is not requesting a recommendation for unrestricted radiological release (RURR) at this time. Therefore, a Class 1 survey is not warranted. The Class 3 survey will include 100 percent gamma scans and 25 percent alpha/beta scans of accessible surfaces, and static measurements at random locations per survey unit. The surface scan coverage specified in the Work Plan is beyond the Class 3 survey recommended survey coverage outlined in *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, which has no minimum requirement for surface scan coverage for Class 3 surveys. Furthermore, as stated in the Work Plan, if radiological contamination is discovered during this Class 3 survey, the Navy will resurvey the Parcel F structures as a Class 1 survey.

Response to Comments on the *Final Revision 1 Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, November 2018, DCN: APTM-0006-4550-0025.R1/F	
Comments by: Sheetal Singh, Senior Health Physicist, CDPH, comments dated January 24, 2019	
General Comment	**Response**
1. The California Department of Public Health - Environmental Management Branch (CDPH-EMB) utilizes the California Code of Regulations (CCR), Title 17, Section 30256(k), which requires: a) Radioactive material be properly disposed; b) A reasonable effort has been made to eliminate residual radioactive contamination; c) A radiation survey has been performed which demonstrates that the premises are suitable for release for unrestricted use. In practice this means employing the decision making process outlined in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, NRG et al, 1997), which includes establishing a reference background area for each of the materials to remain in situ. These reference background measurements are then compared to survey units (SUs).	a. Work Plan Section 4.6, Waste Management Plan, states the following: "A WMP was prepared to allow for proper storage, characterization, and disposal of liquid and solid waste generated during the field activities. This plan addresses management, anticipated stockpiling, handling/transportation, and disposal of the non-radioactive waste streams derived during the fieldwork. The WMP is included as Appendix C. APTIM will not dispose of radioactive waste. Radioactive material, if any, that is identified during field activities will be collected, segregated, and stored in appropriate containers per the RPP (APTIM, 2017b) for subsequent packaging and disposal by a certified waste broker under the direction of the Navy LLRW Disposal Program." b. The survey areas have been classified as Class 3 area with little or no potential for residual radioactivity. Work Plan Section 7.5, Waste Management, states "Any investigation derived waste will be managed in accordance with the WMP (Appendix C)." c. Work Plan Section 9.0, Reporting Requirements, describes how the results of surveys implemented using this Work Plan will be documented. As stated in Work Plan Section 5.3.1 "The reference area behind Building 810 (Figure 1) will be used to establish gamma instrument-specific investigation levels (ILs). Reference data will be collected in similar matrix (i.e., concrete pad, wood, metals). If needed, additional reference areas may be established with the approval of the Navy." Please also see the response to California Department of Public Health (CDPH) General Comment 1, dated May 16, 2018.
2. CDPH-EMB requests an elevated classification of the Survey Units (SUs) based on the Historical Radiological Assessment (HRA, 2004) identified activities, and recent developments at locations on Hunters Point Naval Shipyard previously identified as "unlikely" or "non-impacted". Raising the classification will adjust SU size and switch sampling efforts from random	The Department of the Navy (Navy) is performing a Class 3 survey based on the findings and recommendations included in the *Final Historical Radiological Assessment Volume II, History of the Use of General Radioactive Materials, 1939–2003, Hunters Point Shipyard, San Francisco, California* (HRA; Naval Sea Systems Command, 2004). The HRA recommended scoping surveys of Drydocks 5, 7, and ship berths

Response to Comments on the *Final Revision 1 Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, November 2018, DCN: APTM-0006-4550-0025.R1/F	
Comments by: Sheetal Singh, Senior Health Physicist, CDPH, comments dated January 24, 2019	
locations to a systematic grid. This will promote confidence in the scoping effort through greater statistical assurance.	(Parcel F finger piers), and review of the final status survey report for Drydock 6. The Navy is not requesting a recommendation for unrestricted radiological release (RURR) at this time. Therefore, a Class 1 survey is not warranted. The Class 3 survey will include 100 percent gamma scans and 25 percent alpha/beta scans of accessible surfaces, and static measurements at random locations per survey unit. The surface scan coverage specified in the Work Plan is beyond the Class 3 survey recommended survey coverage outlined in *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* which has no minimum requirement for surface scan coverage for Class 3 surveys. Furthermore, as stated in the Work Plan, if radiological contamination is discovered during this Class 3 survey, the Navy will resurvey the Parcel F structures as a Class 1 survey.
3. It is the understanding of CDPH-EMB that the intent of this project is to perform a MARSSIM style scoping survey. If CDPH-EMB is correct in its understanding, please adjust the title and content of this document to reflect a scoping survey rather than a characterization survey.	The work plan title and content were revised to reflect a scoping survey rather than a characterization survey.

Response to Comments on the *Final Revision 1 Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, November 2018, DCN: APTM-0006-4550-0025.R1/F	
Comments by: Sheetal Singh, Senior Health Physicist, CDPH, comments dated January 24, 2019	
Specific Comment	**Response**
4. Section 1.0 ("Introduction"), Page 1-1, Paragraph 5, Last full sentence on page: "The objective of this Work Plan is to describe radiological characterization surveys designed to provide results with sufficient quantity and quality to meet the requirements of a final status survey and achieve unrestricted release for Parcel F structures." It is the understanding of CDPH-EMB that unrestricted release is no longer sought. Please clarify the goal of this project. Also, please refer to comment #3.	The paragraph was revised as follows: "The objective of this Work Plan is to describe radiological scoping surveys designed to provide results with sufficient quantity and quality to meet the requirements of a final status survey. The data will be presented in reports and used to support future site decisions for Parcel F structures. The Parcel F structures include the submarine pens (Drydocks 5, 6, and 7 and associated Ship Berths 61, 62, 63, and 64; Figure 2) and the finger piers (Finger Piers 1, 2, and 3 and associated Ship Berths 23 through 28, 30 through 35, and 37 through 42; Figure 3). The Navy is not requesting a recommendation for unrestricted radiological release of the Parcel F structures at this time."
5. Section 5.4.5 ("Step Five - Develop a Decision Rule"), Page 5-4, First sentence: "If the mean results of the survey are consistent with the release criteria (Table 1), the data will be used to support free release of the structures." Please refer to General Comment # 1.	The sentence was revised as follows: "If the results of the survey are consistent with the release criteria (Table 1), the data will be presented in reports and used to support future decisions for the Parcel F structures." The SAP text was also revised to be consistent.
6. Section 5.5.2 ("Gamma Surface Scan Minimum Detectable Concentration"), Pages 5-6 and 5-7, First sentence: a. "The gamma surface scan MDC was determined for identifying intact deck markers containing ^{226}Ra or ^{90}Sr attached to the surface being investigated (Appendix D)." The HRA does not list deck markers as a contaminant of concern for the structures. Furthermore, the last sentence of the first paragraph of Section 2.3 states, "However, it is more likely traces of radioactivity from damaged, discarded, or lost devices could be present on surfaces associated with the Parcel F structures, although the probability of residual radioactivity from radioluminescent devices is still low." Additionally, Section 2.3 ("Nature and Extent of Contamination"), Page 2-3, Sentences 5-7 states, "Radioactive wastes were typically sealed in drums or other packages for transport, and may have been staged on piers or alongside ship berths prior to loading the waste onto barges. The potential for residual radioactivity at the submarine pens and piers from leaking waste packages is low." Both of	a. These gamma scan surveys are performed to demonstrate there are no sources of gamma radiation exceeding background that could impact the radiological health and safety of the public and the environment. The only discrete sources of gamma radiation found at HPNS to date have been ^{226}Ra deck markers; therefore, these discrete sources form the basis of this survey. The minimum detectable count rate (MDCR) was calculated using the same basis the California Department of Public Health (CDPH) used in the recent Parcel A scan, which was also performed to demonstrate there were no sources of gamma radiation exceeding background that could impact the radiological health and safety of the public and the environment (*Hunters Point Shipyard Parcel A-1 Health and Safety Survey Work Plan*, CDPH Radiologic Health Branch, dated July 3, 2018). The MDCR was used to calculate the selected maximum scan speed of one meter per second (m/s), which is the same scan speed used by CDPH to survey Parcel A, based on the *Technical Basis Document, CA Radiologic Health Branch, RS-701*

these origins of contamination tend to yield activities lower than 5 micro-curies. Using the current iteration of the report (i.e:, the SUs classified, as MARSSIM class 3), the MDCR values presented in Appendix D are not understood. Please explain the choice of intact deck markers as the sole input to the MDCR calculations. b. Please clarify how the 5 micro-Curie (µCi) activity was determined to be appropriate for use in MDCR calculations. c. Please explain how the discussed MDCRs are capable of detecting the Derived Concentration Guideline level (DCGL).	*Radiation Mapping System* (CDPH, 2010). The Parcel F Class 3 survey includes both a 25 percent alpha/beta survey and a 100 percent gamma survey. b. The 5 microcurie activity is equivalent to an intact deck marker. See response to a. above for the justification for use of deck marker to calculate the MDCR. c. The alpha and beta scans performed as part of the MARSSIM survey are capable of detecting the radionuclides of concern at the project at concentrations below the release criteria listed in Table 1 as presented in Work Plan Section 5.5.5 for scans and Section 5.5.6 for static measurements.
7. Section 5.5.6 ("Alpha Beta Static Minimum Detectable Concentration"), Page 5-8. Paragraph 3, Sentence 1: "Two-minute static measurements will be performed when using the Ludlum Model 43-3." Please correct the Ludlum Model type to "43-37."	The typo was corrected.
8. Section 5.6 ("Gamma Count Rate Surveys"), Page 5-9, Paragraph 1. Last sentence: a. "The data collected during the gamma scan are evaluated and if all readings are below the instrument specific gamma scan IL, or otherwise do not indicate the presence of an anomaly (e.g., via Z-score analysis, spatial plots, or other statistical analysis), the second stage is not required." Please clarify how it is acceptable that scan results exhibiting measurements above the IL, but acceptable "via either Z-score analysis, spatial plots, or other statistical analysis" will not be investigated further? b. Paragraph 2: Please clarify when an anomalous scan result will trigger characterization of the anomaly (including isotopic identification).	a. Agree with comment. All locations exceeding the investigation level will be investigated. Section 5.6 was revised to delete the following text: "~~…or otherwise do not indicate the presence of an anomaly (e.g., via Z-score analysis, spatial plots, or other statistical analysis)…~~" Section 5.3.2 was also revised in response to this comment. The section title was retitled "Concrete Background Area" and revised so that reference area background data for each gamma instrument will still be collected from behind Building 810, but not to establish investigation levels. This data will be collected for comparison purposes as needed. New Section 5.3.3, "Survey Investigation Levels," was added to state the investigation levels for each instrument will be established as the mean of the survey data plus 3 standard deviations. b. Agree with comment. Section 5.6 was revised to delete the following text: "~~…or indicates that further investigation is warranted…~~"
9. Section 5.7.2: ("Alpha and Beta Static Measurements"), Page 5-10, Paragraph 5, Sentence 2:	Section 5.7.2 was revised as follows:

"Fifty-four two-minute static measurements will be collected .at random locations within each SU." According to Section 5.5.6 ("Alpha Beta Static Minimum Detectable Concentration"), Paragraph 3, Sentence 2: "Five-minute static measurements will be performed when using the Ludlum Model 43-68." Please clarify this in Section 5.7.2.	"The survey design requires the performance and evaluation of data from static measurements performed at random locations across each SU. Fifty-four static measurements will be collected at random locations within each SU. The static measurements will be two minutes when using the Ludlum Model 43-37 and five minutes when using the Ludlum Model 43-68, as discussed in Section 5.5.6. The random locations will be selected through the use of a map and random number generator. Any location that exceeds the IL will be marked with paint and further investigated."
10. Section 7.1.1 ("Gamma Scan Surveys"), Page 7-1, Paragraph 5, Sentence 2: "The Finger Pier subsurface areas are not considered impacted based on the site history (see sections 2.2 and 2.3 of this Work Plan)." These sections do not discuss manholes, grates, or subsurface areas. Please provide the basis of the assumption that these subsurface areas do not require investigation or characterization prior to potential unrestricted release and public access.	Agree with comment. The source of residual radioactivity on the Finger Piers is staging of radioactive waste on the piers prior to disposal. Therefore, the horizontal surfaces where radioactive waste may have been be staged are impacted. Similarly, ships with radioactive deck markers could have brushed against the pier leaving trace amounts of radioactivity. Therefore, the exterior edges of the finger piers are considered impacted. The accessible edges of all penetrations through the Finger Piers (including manholes, grates, access ports, etc.) will be included as part of the 25% of the surfaces that are scanned for alpha/beta activity to check for contamination migrating from the impacted areas to the non-impacted areas. Section 2.3, last paragraph, was revised to include the following sentence: "Residual radioactivity also could have migrated from horizontal surfaces of the submarine pens and finger piers to subsurface areas such as manholes, grates, and access ports." Section 7.1.1, Paragraph 5, was revised as follows: "The accessible edges of the Finger Pier manholes and metal grate areas will be accessed during the gamma scan surveys (see Photo 2)." Section 7.1.2, Paragraph 2, 1st sentence, was be revised as follows: "Manholes, grates, and components of the suction and discharge system will be investigated during the survey of Drydocks 5, 6, and 7 and Finger Piers 1, 2, and 3." Section 5.7.1 was also revised to include the accessible edges of all penetrations through the finger piers (including manholes, grates, access

	ports, etc.) as part of the 25% of the surfaces being scanned for alpha/beta activity. Further, the Work Plan was revised to state the Navy is not requesting a recommendation for unrestricted radiological release of the Parcel F structures at this time.
11. Section 7.1.2 ("Alpha and Beta Surveys"), Page 7-4. First Full Paragraph. Sentence 3 to the end of the paragraph: These sentences continuously state that two-minute static measurements will be collected. However, as addressed in Specific Comment # 9, statics collected using the Ludlum 43-68 should be five minute integrated counts.	Section 7.1.2 was revised as follows: "The alpha/beta static measurements will be performed using portable contamination survey instruments specifically, the Ludlum Model 43-37 gas flow proportional "floor monitor" detector (or equivalent) coupled with a Ludlum Model 2360 scaler/ratemeter (or equivalent) (Table 4). If required, a Ludlum Model 43-68 gas flow proportional detector (or equivalent) small area detector may be used to perform static measurements in areas not accessible to the Ludlum Model 43-37 large area detector (Table 4). The scaler/ratemeter will be set to a two-minute count time when using the Ludlum Model 43-37 or a five-minute count time when using a Ludlum Model 43-68. At the start of each measurement, the RCT will position the detector, and begin the two-minute or five-minute count. At the completion of each two-minute or five-minute count (depending on the instrument used), the alpha and beta result will be recorded. The IL for the alpha and beta static measurements will be developed and used as described in the decision rules in Section 5.4 of this Work Plan. The release criteria were established from the AM (Navy, 2006) and are presented in Table 1. Two minute or five-minute (depending on the instrument used) static measurements will be collected at 54 random locations per SU as discussed in Section 5.7 of this Work Plan, and as part of investigations of scanning results exceeding the IL, as needed. Smears will be collected at each location where a total alpha and total beta static reading is taken. Smears may be qualitatively field checked to identify gross contamination with the Ludlum Model 2360 with a Ludlum Model 43 68 (or equivalent) detector. This will assist in identifying the extent of removable contamination. Smears will be quantitatively counted with a Ludlum Model 2929 or Ludlum Model 3030 sample counter located at the APTIM project office."

Response to Comments on the *Final Revision 1 Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, November 2018, DCN: APTM-0006-4550-0025.R1/F	
Comments by: Sheetal Singh, Senior Health Physicist, CDPH, comments dated January 24, 2019	
12. Appendix A - Sampling and Analysis Plan, Section 17.1 ("Biased Radiological Characterization Sampling"), Page 44. Last Paragraph, Sentence 4 : "If ^{90}Sr is detected above release criteria, then additional analysis for ^{239}Pu or other alpha emitters may be performed to confirm contamination." Please explain the use of ^{90}Sr as a trigger for ^{239}Pu analysis.	If strontium-90 (^{90}Sr) is detected above the release criterion, the additional plutonium and other alpha emitter analysis is performed to verify is the detected ^{90}Sr is related to OPERATION CROSSROADS. This additional analysis supports complete characterization of beta activity detected above the release criteria.

Response to Comments on the *Final Revision 1 Radiological Characterization Surveys Work Plan, Parcel F Structures, Hunters Point Naval Shipyard, San Francisco, California*, November 2018, DCN: APTM-0006-4550-0025.R1/F	
Comments by: Sheetal Singh, Senior Health Physicist, CDPH, comments dated March 11, 2019; comments received March 25, 2019	
Specific Comment	**Response**
1. Response to CDPH-EMB's General Comment 2: CDPH-EMB's General Comment 2 dated January 24, 2019 requested the reclassification of survey units (SUs) investigated during this effort based on the Historical Radiological Assessment (HRA, 2004) and recent developments at the shipyard (i.e., Parcel A-1 Health and Safety surveys performed by CDPH-Radiologic Health Branch (RHB)). Historical activities identify the storage of radioactive waste at these locations. Stored radioactive waste is/was subject to leaks and spills. Leaks and spills originating from waste have the potential to exist with radiological activities above reference area I background levels. However, these activities may be well below 5 micro-Curies (µCi) (i.e., please see Specific Comment 3). Furthermore, these leaks/spills can cause "small areas of elevated activity," like those stated to be unlikely in Section 5.1 of the current iteration of this report. Without detailed information diagramming storage locations of waste, OPERATION CROSSROADS activities, and other forms of identified potential sources of radioactive contamination a SU styled after a MARSSIM class 2 (or higher) provides greater confidence that all areas have been investigated thoroughly. The classification of SUs as MARSSIM class 3 does not provide the level of confidence, in the sampling effort, demanded by a site where residual radioactivity is repeatedly described as, "trace amounts." CDPH- EMB continues to request the reclassification of all SUs. Adjustment to a MARSSIM class 1 or 2 SU will allow for systematic sampling. Systematic sampling affords a greater confidence in identification of smaller areas of elevated activity. Please refer to figure D.7 in Appendix D" The Planning Phase of the Data Life Cycle" of the MARSSIM manual. CDPH-EMB has requested this reclassification beginning with the first round of comments on the DRAFT report issued February 27, 2018. CDPH-EMB has yet to receive an adequate response to this request.	The surveys will be revised to Class 2 survey units. The survey units will retain the same size and will continue to include 100 percent surface gamma scans, 25 percent alpha/beta surveys, and 54 alpha/beta static measurements per survey unit at each Survey Unit. The static measurements will be collected systematically.
2. Response to CDPH-EMB's Specific Comment 4: CDPH-EMB recognizes that, "the Navy is not requesting a recommendation for unrestricted radiological release [RURR] of Parcel F Structures at this time." However, the survey protocols, as currently detailed in FINAL Rev 1	The Navy will implement a systematic static sampling approach, consistent with Response 1 to be sufficient for the scoping survey data quality objectives.

Radiological Characterization Surveys Work Plan, Parcel F Structures is inadequate to meet the requirements of a scoping survey.	
3. Response to CDPH-EMB's Specific Comment 6: CDPH-EMB's Specific Comment 6 requested clarification on minimum detectable count rate (MDCR) calculations. The response specified that the MDCR calculations rely on an input of five (5) micro-curies (μCi), representing an intact deck marker. This approach is inadequate as the focus of the current work plan is to find any radiological contamination even trace amounts and not just intact deck markers. Please note that the CDPH-RHB's health and safety survey effort was designed to identify immediate hazards to human health. The parameters used by RHB to develop their work plan are not applicable to the current work plan based on historical information of the Parcel F structures. Please see comment #1.	Appendix D was reviewed and revised to clarify the minimum detectable activity (MDA). The calculated MDA is well below 5 microcuries. Appendix D Section 2.5, Conclusions was revised to state: "The RSI-700 NaI scintillation scan MDC for ^{226}Ra in secular equilibrium with progeny, for an intact point source, is estimated to be less than 200 pCi for scan speeds less than 4.0 m/s. The values computed are indicative of a sensitive instrument that agrees with scan MDC data presented in NUREG-1507 Section 6.8.2 and MARSSIM Table 6.7 for the contaminants of concern. An intact deck marker containing 5 microcuries of ^{226}Ra can be detected by the RS-700 at any reasonable scan speed (see Table 7). Other point sources (e.g., broken or degraded deck markers) containing less than 200 pCi of ^{226}Ra (0.004% of an intact deck marker) can also be detected by the RS-700 at scan speeds ranging from 0.5 to 4.0 m/s (Table 7). For the purposes of this project, scan speeds for the RS-700 will be maintained at 1 m/s or less, providing a MDC of 83 pCi (0.00017% of an intact deck marker)." There are no records indicating that radioactive wastes were stored at the submarine pens or finger piers. Work Plan Section 2.2, Site Description and History, was revised as follows: "Radiological operations generally performed at HPNS that could impact the submarine pens and finger piers included the use of generally licensed radioactive material, including handling and refurbishment of radioluminescent devices. Other activities involving radioactive material included gamma radiography, and calibration of radiation detection instruments. There are no records indicating that wastes, including radioactive wastes, were stored at either the submarine pens or the finger piers."
4. Response to CDPH-EMB's Specific Comment 12: CDPH-EMB requested clarification of strontium-90 (^{90}Sr) and plutonium-239 (^{239}Pu) testing relationship (i.e., the reliance of ^{239}Pu testing on a positive ^{90}Sr result). The response is inadequate since it does not provide evidence that the two isotopes coexist in potential contamination. Since ^{239}Pu is a	Strontium-90 (^{90}Sr) and plutonium-239 (^{239}Pu) may coexist in potential contamination related to historical OPERATION CROSSROADS activities. The scoping survey has been revised to a Class 2 survey with systematic samples.

radionuclide of concern (ROC), sampling efforts must be able to identify any elevated location. Sporadic alpha static measurements coupled with a 25% alpha scanning effort does not supply confidence that elevated ^{239}Pu locations will be identified.	