UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA

March 26, 2018

George ("Pat") Brooks
U.S. Department of the Navy
33000 Nixie Way, Bldg 50
San Diego, CA 92147

Dear Mr. Brooks:

Thank you for providing for review the *Draft Work Plan, Radiological Survey and Sampling,* Former Hunters Point Naval Shipyard, San Francisco, California ("Work Plan"), February 2018. The U.S. Environmental Protection Agency (EPA) reviewed this report in detail with a technical team including national experts in health physics, geology, and statistics.

The site has a history of radiological activity, and the radiological data evaluation process in 2017- 2018 found widespread signs of potential falsification and data quality concerns in all parcels where Tetra Tech EC Inc. conducted radiological work. Given these conditions, the actions proposed in the draft Work Plan would not be sufficient to demonstrate protection of human health and the environment to an extent that would allow for EPA approval of property transfer of affected parcels. More extensive sampling and analysis needs to be done to address potential exposure to workers and future residents due to the uncertainty regarding the potential extent of contamination. Attached are EPA comments that address the deficiencies in the draft Work Plan and propose additional measures to be taken to address data falsification and data quality concerns.

EPA understands that the Navy is also drafting Task Specific Plans for its work on specific parcels, and that the Navy will send the plan for Parcel G for review soon. In anticipation of this forthcoming draft, EPA is also submitting the attached recommendations in advance to inform the development of this draft. The previous data collected by Tetra Tech EC Inc. has significant uncertainty. Full excavation and scanning targeted at the survey units associated with the greatest potential for contamination will be crucial to address this uncertainty and demonstrate that the clean-up standards set in each Record of Decision have been met. As we wrote in December 2016, "EPA recommends using a health-risk based approach to prioritize areas of concern based on factors that should include, but not be limited to, historical records of activities, current or future exposure based on land uses, sampling results already collected, and combination of highest risk radionuclides."

Attached please find the following:

Attachment 1 – EPA Review of the Draft Work Plan
- 1.1 General and Specific Comments
- 1.2 Statistician's Memo dated March 15, 2018

Attachment 2 – EPA Recommendations for Task Specific Plan for Parcel G
- 2.1 Main Text
- 2.2 Statistician Evaluation of Parcel G Resampling and Confidence, with attached Memo dated February 22, 2018

We look forward to working with the Navy to revise the draft Work Plan, to develop Task Specific Plans for individual parcels, and to begin the sampling component of the radiological assessment effort as soon as possible. If you would like to discuss any of these comments, please contact me at 415-972-3005 or chesnutt.john@epa.gov. You may also contact Lily Lee, Remedial Project Manager, on my staff at 415-947-4187 or lee.lily@epa.gov.

Sincerely,

John Chesnutt
Manager, Pacific Islands and Federal Facilities Section
Superfund Division

Attachments

cc: Janet Naito, DTSC
Sheetal Singh, CDPH
Alec Naugle, California Regional Water Quality Control Board
Amy Brownell, San Francisco Department of Public Health

Attachment 1.1

EPA Review of the Draft Work Plan Radiological Survey and Sampling
Former Hunters Point Naval Shipyard,
San Francisco, California, February 2018

GENERAL COMMENTS

1. The approach proposed in the Work Plan Radiological Survey and Sampling, Former Hunters Point Naval Shipyard dated February 2018 (Work Plan) is not sufficient to allow EPA to make decisions about the protectiveness of the site and therefore the suitability of the property for transfer. The site has a history of radiological activity, and the radiological data evaluation has found widespread signs of falsification and data quality concerns in all parcels evaluated. Far more extensive sampling and analysis needs to be done to address potential exposure to workers and future residents due to the uncertainty regarding the potential extent of contamination.

The Work Plan provides the outline of an investigation of the former Hunters Point Naval Shipyard (HPNS) that considers the Historical Radiological Assessment (HRA) as the primary basis for development of the sampling strategy and relies on assumptions that data obtained from the sampling of trench unit surface soils can be used to represent subsurface conditions. However, neither of these sources of information can be relied on solely for defining the parameters of the investigation because additional information about the site history and previous investigations have become known since the HRA was published. For example, data obtained from the sampling of trench unit soils is unreliable due to allegations, and in some cases proof, of sample collection fraud, improper sample and document custody/controls, and data manipulation. In addition to these confounding factors, a general failure to follow Work Plans by the previous contractor, as well as poor data quality associated with the previous investigation at the site, suggests that the previous data is unusable. Further, information that demonstrates the presence of radioactive objects, such as deck markers, has been identified at various locations at the site which were not accounted for in the previous site conceptual model.

As such, the Work Plan should be revised to provide a sampling strategy that considers the additional site history information, allegations of fraud, lack of work control, insufficient data quality, and new information about site conditions that differs from what was documented in the original investigation. The Regulatory Agencies have offered a suggested path forward on the investigation as Attachment 2, which should be considered in the revision of the Work Plan.

2. This Work Plan addresses previous work done by Tetra Tech EC Inc. in trench units, fill units, and building site soil survey units. In a separate workplan, the Navy will also address its work on buildings. Tetra Tech EC Inc. also conducted radiological cleanup work in ship

berths. The Navy should also address potential contamination in this and any other category of past radiological work by Tetra Tech EC Inc. at the HPNS.

3. This Report will likely attract interest from a broad audience that will include laypeople. Please create an Executive Summary that summarizes the entire document in terms understandable to this broad audience. It should begin with more context, including a broad overview of next steps. It should be written in "plain language". It would be helpful if it were written as if it could function as a standalone document, with references added to direct a reader to relevant, more detailed information within the body of the Work Plan. Please especially explain the differences among the Work Plan, the Task Specific Plan, and the Sampling and Analysis Plan. This language can be used as the basis for the Navy's fact sheet on the same subject. In addition, please add language to the end of the Executive Summary that answers the following questions: 1) What happens next with each parcel? 2) How does the public get involved? 3) What actions need to take place for each of these parcels? and 4) What needs to happen to initiate the restart of the transfer process for each of these parcels?

4. The Conceptual Site Model (CSM) presented in the text and Table 2-1 of the Work Plan does not provide a sufficient identification of the following sources of contamination and/or site conditions as follows:

a. The table in Potential Historical Sources of Radiological Contamination section should include radium paint as a potential source.

b. The third bullet point under the Site Operations and History section should include specific details regarding the manufacture and use of radiography and calibration sources.

c. The Radionuclides of Concern discussion on page 2-6 identifies Plutonium-239 as only associated with the Navy Radiological Defense Laboratory (NRDL) Building 529, and the HRA Table 5-1 indicates Pu-239 was only present in solid sources. However, according to the Atomic Energy Commission (AEC)-issued Special Nuclear Material (SNM) License-35 for the HPNS, the Navy also possessed up to two-thousand (2000) grams of Pu-239 and fifty-five (55) grams of Plutonium-238 (Pu-238). The Navy has indicated in previous responses to comments that this material was used in Building 815. In addition, the HRA lists Pu-239 as a radionuclide of concern (ROC) in numerous other buildings and areas (e.g., Buildings 103, 113, 140, 142, Dry Docks 5, 6, and 7, etc.) Therefore, the analysis of Pu-239 should not be limited to the former Building 529 Storage Vault or to locations where Sr-90 was detected since both Pu-239 and Pu-238 are a concern at multiple locations. The Work Plan should be revised to include a requirement to analyze for Pu-239 and Pu-238 in all areas that may have been impacted by activities in or near Building 529, Building 815, areas where the HRA indicates Pu-239 is a concern, or any other areas where Pu-239 and Pu-238 may have been used.

d. The table in Radionuclides of Concern section should include a list of all radionuclides used for making contaminated source materials and all other potential radionuclides that

may be encountered above background concentrations.

e. Under the first bullet point and fourth dash of the Uncertainties section, the phrase "and radionuclide decay" indicates the decay will alter concentrations of radionuclides at the site, adding to the uncertainty regarding the levels of such contamination at the site. However, the main ROC at the site is Ra-226, which has a half-life of 1600 years and as such will not have decreased significantly due to decay since site operations began. The table should be revised to remove the phrase "and radionuclide decay." Alternatively, the text could specify that radioactive decay will impact the concentrations of shorter-lived radionuclides, such as Sr-90 and Cs-137, but it will not significantly affect the longer-lived radionuclides, such as Ra-226, or uranium and plutonium isotopes.

f. The Uncertainty discussion claims that all known sources of contamination were removed; however, there are allegations that "hot" samples were returned to trenches and evidence that some areas have buried radiological devices, such as areas associated with use of dredge materials as fill to construct land in Parcel D-1. In addition, previous investigations have identified the presence of radiological devices with significant radioactive material at the site. One such example includes the device detected outside a drain line near Building 205. The CSM statement that all known sources of contamination at the site have been removed does not accurately reflect site conditions. Please modify this statement to represent site conditions more accurately with respect to the listed uncertainties in the CSM.

g. The Uncertainties discussion states that sediment data from inside pipes is not indicative of a large quantity disposal or contamination (e.g., with a maximum Ra-226 concentration of about 4 pCi/g and a maximum Cs-137 concentration of about 3 pCi/g for these radionuclides), with the exception of Cs-137 associated with Building 529 in Parcel E. However, the periodic removal of sediment from storm drains significantly reduced the amount of sediment present in the drain lines, so no conclusions should be drawn from the concentrations of Cs-137 and Ra-226 detected in sediment in pipes during the removal actions. Also, Cs-137 was found throughout Parcel G and is known to have been used by the Navy Radiological Defense Laboratory (NRDL) for numerous purposes and was found at elevated levels in Buildings 313, 313A, 351A, 364, and 366, in associated piping, and in manholes according to the HRA. Furthermore, both the Gun Mole Pier and the "peanut spill" were remediated due to elevated Cs-137. Likewise, Ra-226 was detected and remediated throughout the site and was used not only in the laboratories, but also in other ways, such as in radioluminescent paint, deck markers, and radiological buttons. Please revise the uncertainty discussion to remove the statement that data from inside pipes is not indicative of a large quantity disposal but was previously found at various locations throughout the site. Please also add that if radiological objects such as deck, bridge, or ship markers are found at the site, they will be expected to be highly radioactive.

h. The Uncertainties discussion states that low-level radiological waste (LLRW) bins were tested by the Navy's independent waste broker at an offsite laboratory using 5-point composites, and only 3 out of 1,411 bins had results with Ra-226 above the release

criteria. The Uncertainties section includes this condition as a fact supporting a hypothesis that there is a lower potential for radiological contamination to exist at the site than what is reported in the HRA. However, collection of random samples from large bins of waste soil would likely have missed most of the radiological contamination, which would have been present in small pockets in LLRW bins due to the practice of excavating one foot of soil surrounding any hot spot or radiological device and disposing of that soil as LLRW. The Work Plan CSM should be revised to modify the conclusion.

i. The fourth bullet point in the Uncertainties discussion should be reworded to state that Cs-137 and Sr-90 are present at HPNS because of Navy operations, not just as global fallout from nuclear testing or accidents. In addition, because of backfill activities, the presence of Cs-137 and Sr-90 from fallout and Navy activities are not necessarily found only on the surface. The table should indicate that Cs-137 and Sr-90 could be distributed throughout the surface and subsurface soil at HPNS.

j. The section on potential risk to human receptors does not include an evaluation of the cancer risk to potential receptors. The text in this section of the table only includes exposure pathways, but it contains no evaluation of risk or discussion of the inputs needed to determine the risk from a reasonable maximum exposure (RME) to an individual for any exposure scenario (resident or otherwise).

Please revise the Work Plan to address these issues.

5. Section 1.1 (Radiological Data Evaluation Findings) states on page 1-2 that based solely on a review of data previously collected by Tetratech EC Inc. (TtEC), survey units will be divided into three main groups which include no action, re-analysis of archived samples, and confirmation sampling. However, these options appear to be based on assumptions that are not supported by the current Conceptual Site Model (CSM) uncertainties, which include various and extensive methods of data collection and reporting fraud committed by the previous site contractor TtEC, lack of work control, and large-scale data quality problems. Given these factors, none of the previously collected samples or data reported by the Navy's former contractor TtEC should be considered usable for decision making at the site and this data should not be used as such. Therefore, all suspect areas will need to have newly generated supportable data for assessing compliance with the Record of Decision (ROD) release criteria.

6. Previous EPA comments on radiological data evaluation findings reports for Parcels B and G have stated that the re-analysis of archived samples cannot be relied on to produce defensible data and such data will not be accepted by EPA as valid for supporting decision making at the HPNS. Please revise the Report to remove all references to re-analysis of archived samples as a means to verify compliance with release criteria in accordance with the HPNS RODs.

7. Section 3.2 (Subcontractors) lists two laboratories, the Aleut Laboratory and the General Engineering Laboratory (GEL), will be used for this project; however, the text does not state which laboratory will perform each of the proposed analyses or how the laboratories were

determined to be qualified for such work. In addition, in accordance with EPA Quality System guidance provided in EPA QA/G-7, Guidance on Technical Audits and Related Assessments for Environmental Data Operations (EPA/600/R-99/080), technical audits and assessments of all activities related to data collection should be implemented to ensure that data collection is conducted as planned and data of the type and quality specified in project planning documents (i.e., Sampling and Analysis Plan, Quality Assurance Project Plan and associated Work Plans) is produced. As such, the laboratories performing analyses as part of the HPNS investigation should be audited prior to the start of the project. Please revise the Work Plan to clarify the responsibilities of each listed contract laboratory and to include a requirement that the laboratories will be audited by the Navy prior to the start of sample collection. In addition, the Work Plan should note that the regulatory agencies may also conduct their own independent audits/assessments of laboratory operations.

8. Section 4 (Survey Design) states that soils areas will be surveyed in accordance with their potential to be radiologically impacted, which include sites with known historical contamination, impacted sites with lower contamination potential, and background areas. These three main groupings of soil areas do not acknowledge that there are soil areas for which falsification of sample results have allegedly occurred. The Work Plan should acknowledge the data falsification allegations since, this condition defines the need to re-sample and should inform the development of the task specific plans (TSPs). Please revise Section 4 to incorporate information about the allegations so that the survey design fully reflects the range of site conditions in order to ensure the sampling plan/TSPs meet all of the data needs for the project.

9. Section 4.4 (Building Survey Areas) discusses the identification of survey locations within buildings, but it does not address the specifics of classification of survey units. In accordance with guidance provided in the Multi-Agency Radiation and Site Survey Investigation Manual (MARSSIM) classification definitions, all survey units where remediation was previously completed and any areas where known or suspected data falsification occurred should be classified as a Class I survey unit. Please make this change.

10. Section 4.1, Table 4-1 (Radionuclides of Concern) indicates that Potassim-40, Thallium-208, Bismuth-212, Lead-212, Bismuth-214, Lead-214, Radium-223, Radium-224, Thorium-227, Actinium-228, Protactinium-231, Protactinium-234, and Protactinium-234 metastable will be reported in the gamma spectroscopy analysis. Given the history of NRDL activities, which includes the possession of up to two thousand grams of Pu-239 and 55 grams of Pu-238, the gamma spectroscopy (gamma spec) analysis also should include the reporting of Americium-241 (Am-241) in order to provide a screening for special nuclear material radionuclides, such as plutonium. Further, all gamma-emitting radionuclides detected should be reported, and the raw laboratory data should be provided that includes any unquantified gamma photopeak energies. All soil gamma spectroscopy analysis should be performed on an N-Type high purity germanium detector in order to quantify the lower energy radionuclides that have gamma photopeaks below 100 kiloelectron volts (keV) (i.e., such as Americium-241). In summary, the Work Plan should be revised to include the reporting of all potential radionuclides by gamma spectroscopy, and it should also provide the sample specific Minimum Detectable Concentration (MDCs) per nuclide, as follows:

- Gamma Nuclides requiring Sample Specific MDCs:
  - Am-241, Cs-137, Co-60, Eu-152, Eu-154, K-40

- Uranium (U-238) Series Nuclides by Gamma Spec
  - Pa-234m, Ra-226, Pb-214, Bi-214, Pb-210

- Thorium (Th-232) Series
  - Ra-228/Ac-228, Ra-224, Pb-212, Bi-212, Tl-208

- Actinium (U-235) Series
  - Pa-231, Th-231, Th-227, Ra-223, Pb-211

- Since Am-241 is a contaminant of Pu-239, if Americium-241 is detected in any of the samples, the sample should be then also be analyzed for plutonium isotopes by alpha spectroscopy.

Please revise the Work Plan to include the gamma spectroscopy analysis of the bulleted list of radionuclides and to provide the associated MDCs for each radionuclide. Please also report any peaks, which the gamma spectroscopy radionuclide library identifies as a specific radionuclide.

11. Section 4.1.1 (Release Criteria) As part of the fourth Five-Year Review occurring in parallel this year, the Navy is performing updated risk evaluations of these existing Remedial Goals (RG's). EPA has previously recommended that this evaluation should use the current versions of the USEPA's Preliminary Remediation Goals (PRG) Calculator for soil and the Building PRG Calculator for buildings (BPRG). 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.

12. Section 4.2 (Reference Backgrounds) and Section 6.6 (Background Evaluation) One of two approaches should be taken to evaluate whether detected radionuclides are naturally occurring. Background reference areas may be identified for collection of new background samples. Alternatively, instead of developing new background numbers, existing background values could be used for comparison to site investigation samples. Once the background values have been identified and agreed to by the Navy and regulators for all samples that exceed the existing background plus the remedial goals (RGs) in the ROD, e.g., in the case of Ra-226, sample results that exceed 1 PCi/g over background, the soil containing the elevated radioactivity should be excavated and removed. Alternatively, a NORM evaluation may be conducted for the purpose of not requiring excavation by performing the gamma and alpha spectroscopy analyses for the full list of isotopes listed in the previous comments in order to evaluate whether all of the detected primordial parent and progeny radionuclides are in secular equilibrium. For Cs-137, the background number developed on Parcel E-2 could be used (0.049 pCi/g). Please revise the Work Plan to incorporate one of these two approaches. (Note: The Parcel C ROD states that the RG's are inclusive of background, so this Parcel would need to be discussed separately.)

13. Section 4.2.1 (Soil Reference Areas) indicates that new background samples will be collected at the same locations previously used for collection of background samples and will include sampling surface and subsurface soil at various depths. However, several issues should be incorporated into the plans:

a. The Work Plan and/or forthcoming TSPs should specify whether the areas selected for background measurement collection were built from imported soils originating from different locations and if the selected background areas remained undisturbed by site operations.

b. The text states background samples will be collected at various depths and that surface and subsurface background samples will be collected, but it does not state if depth-specific background values will be obtained and evaluated.

c. Background samples should not be collected from locations where import fill was placed. This includes locations of former trenches/excavations, for any remedial or removal action, and areas where import fill was placed as surcharge, e.g., to improve drainage as part of installation of the durable cover.

d. Section 4.2.1 indicates that all Ra-226 values for all depths and locations will be averaged together to obtain one value as the background concentration; however, Section 6.6 (Background Evaluation) states there is not a single, consistent radiological background at HPNS that can be used for evaluating all survey results because much of the land mass was obtained by using various soil types from different sources/locations. Section 6.6.3 (Regional and Local Background Evaluation) states "[W]hen the existing background reference area data set is not considered representative of background, it may be possible to identify a new background reference area to provide a local background that supports evaluation of local data. It may also be possible to identify a regional background based on scientific research at nearby sites, or radiological studies performed at neighboring sites." The text in Sections 4.2.1, 6.6, and 6.6.3 should be reconciled and revised to provide consistent information. Section 4.2.1 states that a minimum of 150 soil samples will be collected from at least five locations to represent background based on MARSSIM and NRC criteria. However, since the HPNS site was built using soils from different locations with different compositions, it is unclear how providing one general background number for each radionuclide to represent background across the entire HPNS site is defensible. Alternatively, the Navy should analyze background samples, as well as any site samples with remedial goal exceedances, for the full list of uranium, and thorium parent/daughter isotopes by alpha spectroscopy, as well as the full list of gamma spectroscopy radionuclides listed in this set of comments. The results of such analyses can be used to identify whether primordial radionuclides are in secular equilibrium for determining whether soil samples with concentrations exceeding release criteria represent background concentrations or if elevated concentrations are due to site contamination.

e. The location for Parcel C background sampling should not be near the former location of the on-site rad lab (Figure 4-1 proposes the sampling location in this area).

f. It is unclear if the Parcel B location is unimpacted or if import fill has been placed in this area. More information about this location should be provided.

g. Parcel D-1 location is near an area where numerous radiological devices were found on the surface; therefore, it is unclear if this location is unimpacted.

h. The Work Plan does not explain how multiple fill types will be handled in the assessment of identifying the appropriate locations to sample for background.

i. Both the surface prior to sampling and cores/samples should be scanned to ensure that background samples do not included any "hot spots" or soil adjacent to buried rad devices.

j. If Black Beauty sand blast grit is encountered at a background sample location, it should not be sampled. Black Beauty sand should be excavated for off-site disposal, consistent with past practice at HPNS.

k. Sand from Site 518 should be sampled to determine if it is in secular equilibrium. If it is in secular equilibrium, enough samples should be collected to constitute a separate data set for comparison to other fill sand. However, if other fill sand has different radiological characteristics, it may not be appropriate to use Site 518 sand data for comparison.

l. Similarly, background could be biased high if samples are collected from granite. There is evidence that crushed granite from the Sierras was used as backfill in some areas of the site. Crushed granite was identified definitively at IR 07/18 and may have been used in other areas. If crushed granite is found, background samples should be segregated for consideration for unique background numbers that would only be used in areas where granite is identified. Note that granite is not a rock type in the Bayview/Hunters Point Area, so samples of granite should be excluded from site-wide background.

m. If acceptable background areas are identified, the reference area should be scanned to ensure that there are no "hot spots" before any samples are collected. Samples should also be scanned before they are submitted for analysis. Scanning should be performed for both gamma and beta emitters to identify any locations that may have been contaminated by site operations. Beta scanning should be included to screen for areas where elevated beta may indicate Strontium-90 is present. If elevated beta radiation is detected, the sample should not be included in the background data set.

n. For each reference area sample, both gamma spectroscopy and alpha spectroscopy should be run for the full list of radionuclides listed in the previous comments to evaluate whether the primordial radionuclides in these samples (i.e., Th-232, U-238, and U-235) are in secular equilibrium with the daughter products. In addition, if Am-241 is detected in the gamma analysis, the sample should not be included in the background data set.

o. Any background evaluation for Cs-137 fallout should not include locations where surfaces could have been disturbed, or locations at the bottom of slopes where runoff could have deposited sediment and led to accumulation of Cs-137.

Please revise the Work Plan and/or forthcoming TSPs to address these questions and concerns.

14. Section 4.3.1 (Soil Area Groups) proposes to group all survey units not selected as Group 2a, into a broad Group 2b category, which will be investigated as MARSSIM Class 3 survey units and will receive random and biased soil sampling only. However, a defensible basis for the selection of such Group 2b areas is not provided in the Work Plan and does not appear to consider that previously collected data at these areas are not reliable for supporting any assumptions or decisions at the HPNS. Please revise the Work Plan to provide a more area-specific strategy that considers all historical, environmental/location specific factors, as well as recent revelations regarding the lack of integrity in previous data collection and that incorporates the regulatory agencies suggested path forward for identifying the sampling strategy.

15. Section 4.3.1, Soil Area Groups, states on page 4-17 that surface soils from trench units with one hundred percent native back fill, defined as Group 2a soils, is representative of Group 2b soils. However, the assumption that trench unit surface soils are representative of subsurface conditions/soils is not defensible based on the numerous allegations of worker fraud and data manipulation that occurred during site investigation and remediation activities between 2006 and 2015, and other factors as follows:

a. Numerous and extensive allegations of worker fraud with respect to sample substitution, falsification of sample custody records, data reporting manipulation, and others indicate that previous data regarding site conditions is not reliable or usable for decision making. For instance, these allegations include sample substitution, failure to investigate anomalous elevated gamma scan readings for both surfaces and excavated soil scanned at the radiological screening yards and placed back in trenches, and data manipulation. Therefore, the surface soils of trench units cannot be assumed to be representative of subsurface trench unit soil.

b. Group 2b soils include soils not removed during previous excavations. Analysis of trench unit surface soils that have been removed, mixed with one or more other trench unit fill materials and replaced in trenches cannot be considered representative of soil that was not previously removed.

c. Group 2b soils include those soils obtained from former building sites or surface soils from beneath building crawlspaces. Neither of these Group 2b soils are represented by other Group 2a data, and therefore, both will require investigation based on an independent assessment of the sampling needed to be representative of site conditions.

Please revise the Work Plan to remove references to the assumption that Group 2a soils are representative of those soils defined as Group 2b, including subsurface trench unit soils and former building sites or crawlspace soils from beneath current buildings.

16. Section 4.3.1 (Soil Area Groups) indicates Group 2a soil includes the collection of surface soils, which are considered mixed and homogenous. However, in many areas at the HPNS, the surface was graded for drainage and additional import fill was brought in to fill low spots (i.e., the surface has been changed). The Work Plan does not state how import soil used to fill low spots prior to placement of the durable cover will be identified. As such, former trench locations will need to be identified and inspected visually so that any import fill can be removed in order to ensure surface gamma scans are representative of the original soil surface of the trench unit to the greatest extent possible. Please revise the Work Plan to include this information and address this concern.

17. Section 4.3.1 (Soil Area Groups), Section 5.2.2.4 (Group 2b Fill Unit Surveys). Even if sufficient reliable data is gathered in the future to justify treating some survey units as Class 2 or Class 3, potential exposure to future residents would be highest from the surface. Gamma scans of the surface are needed to ensure hot spots on the surface, or gamma radiation due to highly radioactive objects in the subsurface are not present in areas which did not receive a full re-excavation and Class 1 Final Status Survey (FSS). Therefore, surface scans underneath asphalt, gravel, fill for low spots, etc., would still be crucial to evaluate risk from this exposure pathway. Please revise the Group 2b approach to include 100% surface scans. Followup to scans should be similar to procedures described in earlier Workplans,[1] which were not always followed. For example, where exceedances of the investigation levels, biased samples should be collected. Please see the attachment describing the Regulators' proposal for more details.

18. Section 4.3.2 (Size of Survey Units):

Originally, all soil survey units were considered MARSSIM Class 1 areas. Given the uncertainty from the conceptual site model, allegations of fraud, signs of falsification, and data quality problems, new characterization results that are reliable would be necessary before any substantial increase in survey unit, or change in classification size from those used during the original remediation can be justified.

The Ra-226 concentrations in some samples sent to the off-site laboratory exceeded the cleanup criterion of 1 pCi/g over background even when the on-site lab results showed no exceedance. Since contamination is suspected in many survey units (SU) due to the types of alleged falsification, there are no survey units that can be considered Class 3 survey units without collection of new reliable data.

Also, due to quality assurance problems in the on-site laboratory, most Cs-137 results were at or below zero, indicating that previous Cs-137 results were highly unreliable. The HRA

[1] See for example, U.S. Department of the Navy, *Final Workplan, Basewide Radiological Support*, Hunters Point Naval Shipyard, San Francisco, California, August 2015.

states that Cs-137 was found in Parcel G and was known to have been used by the Navy Radiological Defense Laboratory (NRDL) for numerous purposes. The HRA also states that Cs-137 was found at elevated levels in Buildings 313, 313A, 351A, 364, and 366, and in associated piping, and manholes. Additionally, both the Gun Mole Pier and the "peanut spill" were remediated due to elevated Cs-137. For these reasons, if contamination was found in piping or in any samples, it should be considered real and the associated trench units or building sites, as well as downstream trench units should be considered Class I survey units. In these cases, the size of these survey units should not be increased. Further, survey unit classification should be assigned according to the MARSSIM guidance definitions, as follows:

a. MARSSIM Class 1 areas include locations that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history), or known contamination (based on previous radiation surveys) above the $DCGL_W$.

b. MARSSIM Class 2 areas are locations that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGLw. To justify changing the classification from Class 1 to Class 2, there should be measurement data that provides a high degree of confidence that no individual measurement would exceed the $DCGL_W$. Other justifications for reclassifying an area as Class 2 may be appropriate based on site-specific considerations.

c. MARSSIM Class 3 areas include any 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 $DCGL_W$, based on site operating history and previous radiation surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification.

Without new reliable data to justify a change in classification, EPA will require full excavation and full scanning and sampling of trench walls and fill, consistent with a MARSSIM Class 1 approach, in 100% of soil survey units. Please see the attachment describing the Regulators' proposal for more details. Please revise the Work Plan to state that the original survey unit sizes will not increase substantially without new reliable data to justify such a change, and to state that survey unit classification will follow MARSSIM classification guidelines.

19. Section 4.3.3 (Number of Samples in Survey Unit) and Table 4-3 (Number of Samples in a Survey Unit) include the parameters used to calculate the required number of samples needed for Class 1 Survey Units. However, neither the table nor text in Section 4.3.3 state how the uncertainties associated with the release limits listed in Table 4-3 were determined. Please explain how the uncertainty values associated with background reference areas compare to the variance associated with measurements in the contaminated areas and provide a justification for which variance was selected (i.e., variance from reference areas versus contaminated areas) for use in the MARSSIM calculations.

20. Section 4.3.3 (Number of Samples in Survey Unit) does not provide sufficient justification to support a conclusion that collection of eighteen samples in the reference area and survey units is adequate to support a 99% statistical confidence in the outcome of the hypothesis testing used in the Wilcoxon Rank Sum (WRS) test. The number of samples needed depends in part on the variability of the data set. EPA analyzed the data provided by the Navy used in the past for determining reference background values. The maximum variability found in that data set would be associated with a requirement for more than eighteen samples per survey unit. However, if these data were collected by Tetra Tech EC Inc., they would be questionable. One option could be to collect new, reliable data to calculate the required number of samples, which may be higher or lower than eighteen, depending on the variability measured. Until reliable new results are collected, EPA recommends collecting 25 samples per survey unit based on the analysis detailed below:

The Work Plan uses MARSSIM equation 5-1 for determining the number of samples required for the WRS test. A value for variance (σ) of 0.28 for Ra-226 and of 0.033 for Cs-137 was selected in the Work Plan based on some portion of the total number of background data points. However, according to MARSSIM guidance, when the standard deviation of sample results in the reference area and the survey unit are different, the larger of these two values should be used to calculate the relative shift so the number of samples is sufficient to meet the assumptions of the statistical test. In this case, since site investigation sample data is not available, it seems appropriate to select a larger variance since it would be likely that site sample results will have a higher variability than background data. From review of the background reference area data sets provided by the Navy for Parcels A, B, C, D-1, and D-2, the largest variance (σ) for Cs-137 was identified as 0.0498 picoCuries per gram (pCi/g) from the off-site laboratory measurements from Parcel B. The largest variance reported for Ra-226 was identified as 0.479 pCi/g from the off-site laboratory data, also in Parcel B.

Using the remaining parameters selected in the Work Plan, which include confidence levels of 99% (i.e., alpha (α) and beta (β) error of 0.01), and a delta (Δ) of 1 for Ra-226 and 0.113 for Cs-137, the calculated number of samples (N/2) required to be collected considering the 20% increase in number of samples recommended by MARSSIM is 25 per on-site SU and per background reference area for Ra-226, and 21 per on-site SU and per background area for Cs-137:

See the example below for calculating N for Ra-226 using variance of 0.479:

From MARSSIM Table 5.1 Values of Pr for Given Values of the Relative Shift, Δ/σ, when the Contaminant is Present in Background

Δ/σ	Pr	Δ/σ	Pr
0.1	0.528182	1.4	0.838864
0.2	0.556223	1.5	0.855541
0.3	0.583985	1.6	0.871014
0.4	0.611335	1.7	0.885299
0.5	0.638143	1.8	0.898420
0.6	0.664290	1.9	0.910413
0.7	0.689665	2.0	0.921319
0.8	0.714167	2.3	0.944167
0.9	0.737710	2.5	0.961428
1.0	0.760217	2.8	0.974067
1.1	0.781627	3.0	0.983039
1.2	0.801892	3.5	0.993329
1.3	0.820987	4.0	0.997658

If Δ/σ > 4.0, use Pr = 1.00

$\frac{\Delta}{\sigma} = \frac{1}{0.479} = 2.0877 \approx 2.0$

therefore Pr = 0.921319

FROM MARSSIM Table 5.2 Percentiles Represented by Selected Values of α and ß

α (or ß)	$Z_{1-\alpha}$ (or $Z_{1-ß}$)	α (or ß)	$Z_{1-\alpha}$ (or $Z_{1-ß}$)
0.005	2.576	0.1	1.282
0.01	2.326	0.15	1.036
0.015	2.241	0.20	0.842
0.025	1.960	0.25	0.674
0.05	1.645	0.30	0.524

$$N = \frac{(Z_{1-\alpha} + Z_{1-\alpha})^2}{3\,(Pr - 0.5)^2}$$

$$N = \frac{(2.326 + 2.326)^2}{3(0.921319 - 0.5)^2} * 1.2 = 48.766 \approx 50 = N$$

Therefore $\frac{N}{2} = 25$

In addition, the following two considerations should be kept in mind during the site investigation process:

a. It is possible that the variance for site investigative samples is higher than currently reported for background samples. For example, twenty Final Status Survey (FSS) systematic samples collected in Parcel G, Trench Unit 70 on December 3, 2007, indicate the highest variance associated with the Ra-226 results is 0.72 pCi/g. Using equations from Chapter 5 of MARSSIM and calculating the number of samples required to be collected using a variance of 0.72 at the 99% confidence level gives a value for 'N', (total number of samples) of 62.8. A 20% increase in samples (13 samples in this case) to account for lost samples, rejected data, etc., results in a total of 76. Dividing the 'N' value in half and rounding up to a whole number results in a value of 38, indicating 38 samples would be required to be collected in the reference area and 38 samples in each SU. As such, a re-calculation of the required number of samples needed to demonstrate the statistical confidence in the WRS test has been met will be required to be performed if site investigation sample data result in a variance greater than the 0.479 for Ra-226 or 0.0498 for Cs-137.

b. The past practice at HPNS sitewide has been to excavate any material found that exceeds the cleanup goals, which are usually the reference background plus the Remedial Goal in the Records of Decision (RODs) for a given radionuclide, i.e., the "not to exceed" (NTE) approach. This approach is common practice at cleanup sites nationwide. In addition, EPA's national guidance[2] states the following: "EPA's Superfund remedial program general practice has been to use the NTE approach for soil where residential land use is assumed." Therefore, the final data set and reports generated by the Navy will need to demonstrate that all sample results are below the release criteria. If any of the data are above the release criteria, then either (1) sufficient data should be provided to determine that the elevated levels are due to Naturally Occurring Radioactive Material (NORM) or (2) exceedances must be remediated/removed.

Please revise Section 4.3.3 to address these concerns and to include a requirement to select 25 as the required sample size for the initial investigations of survey units and background

[2] EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-40, EPA 540-R-012-13, May 2014, Q3, p. 8.

reference areas. If new data generated[3] indicate a reduced variance, sample size calculations may be performed to update the required number of samples for all future data collection within in an area that has similar conditions (e.g. parcel-wide).

21. Section 4.4 (Building Survey Areas): EPA received the draft Buildings data evaluation report March 20, 2018, and has not yet had time to review that thoroughly. EPA may provide additional comments about the Workplan related to buildings after reviewing that report.

22. Section 4.5 (Data Quality Objectives) does not address all of the identified data needs for demonstrating the site meets the release criteria as specified in the HPNS RODs. These additional objectives include investigating areas at the site where the allegations were made about data falsification and manipulation are alleged or have been proven to have occurred, to address areas where there was a lack of adherence to Work Plan instructions, and to include consideration of the presence of radiological objects remaining at the site, as well as all of the uncertainties for the CSM. Please revise the Work Plan to include more comprehensive Data Quality Objectives to be utilized to define the nature and extent of any contamination to address the additional uncertainties with respect to site conditions.

23. Section 4.7 (Radiological Laboratory Analysis) states that site investigation soil samples will be analyzed for Cs-137 and Ra-226 by gamma spectroscopy analysis. In addition, this section states ten percent of the soil samples will also be analyzed for Sr-90 or total strontium by a gas flow proportional counter in accordance with the Master SAP. It also states that if other ROCs are identified in the TSP, analyses will be performed for the additional ROCs. Some additional clarifications about these requirements are requested and include the following:

a. The Work Plan proposes analyzing site investigative samples for Ra-226 by gamma spectroscopy initially, as opposed to using radon emanation, as is proposed for analysis of background reference area samples. The Work Plan should require a demonstration that the two analysis methods (gamma spectroscopy and radon emanation) are comparable prior to implementing this practice at this site and to ensure that the MDC for Ra-226 falls below the release limit for both radioanalytical methods.

b. The required laboratory analyses do not indicate how the gamma spectroscopy data will be reviewed to determine if additional analyses should be conducted. For instance, if Am-241 is identified in the gamma analysis, the sample should then also be analyzed by alpha spectroscopy for plutonium isotopes because Am-241 is a contaminant of plutonium. The Work Plan and forthcoming TSPs should include data decision rules for detection of all potential ROCs, refined by area-specific history/knowledge.

c. Samples should be screened in the field for radioactivity for both gamma and beta emitters. The Work Plan should include this requirement.

[3] New data would be generated under the HPNS Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Radiological Data Evaluation and Confirmation Survey issued June 2017 ("Master SAP") and future approved TSPs.

Please revise the Work Plan to address these bulleted items.

24. Section 5.2.2.3 (Group 2b Trench Unit Surveys) states that for group 2b survey units, core samples will be collected and scanned for gamma-emitting radionuclides. While gamma scanning can identify elevated radiation levels from ROCs that are gamma emitters, some of the ROCs are not identifiable by gamma scanning, including those that are primarily alpha or beta emitters. For instance, site history included the use of Strontium-90, which is a pure beta emitter; so gamma scanning would not detect the presence of this radionuclide. Therefore, the Work Plan should be revised to also require scanning of core samples for beta radiation. Furthermore, for any core samples sent for laboratory analysis, the gamma spectroscopy analysis is expected to include the quantification of Am-241, if present. A positive result for Am-241 would indicate other alpha-emitting radionuclides are most likely present. As such, the Work Plan should then require that alpha spectroscopy analysis be completed to quantify any plutonium and thorium isotopes that may be present. Please revise the Work Plan to include a requirement to scan core samples for the presence of elevated gross gamma and beta radiation and to ensure laboratory analyses of core samples include the identification of Am-241 if present, as an indication that other alpha-emitting radionuclides may be present.

25. The fifth bulleted item in Section 6 (Data Evaluation) and Figures 6-2 (Group 1 Soil Data Evaluation Process) and 6-3 (Group 2 Soil Data Evaluation Process) indicate that the Derived Concentration Guideline Level for the wide area (DCGLw) test will be used to evaluate sample results for compliance with release criteria. However, it is unclear why the Work Plan refers to the DCGLw test instead of the Wilcoxon Rank Sum (WRS) test. For clarity in the Work Plan, all references to the DCGLw test should be replaced with the MARSSIM terminology, 'WRS test.' Please revise the Work Plan to replace all references to the 'DCGL test' with 'WRS test,' where appropriate.

Furthermore, the MARSSIM WRS test is a non-parametric statistical test designed to compare population estimators (median) of the survey unit data to the median of the background data to determine if the two data sets have the same distributions. Including the WRS in documentation is valuable to demonstrate compliance with MARSSIM requirements, so please include that in future reports. However, it is not designed to demonstrate that individual results meet a 'not to exceed' remedial goal limit. As such, the results of the WRS test cannot be used directly to demonstrate that further excavation should not be conducted. A point-by-point comparison of the data to the ROD-specified release limits will need to be completed in addition to demonstrate that results are below these release limits. Please ensure that the Work Plan and future TSPs require a point-by-point comparison of the data to the ROD-specified release limits.

26. Section 6.5 (Remediation of Group 1 Survey Units): All import backfill should be sampled for chemical and radiological constituents prior to transporting it to the site. If any concentrations exceed background or cleanup goals, the soil should be rejected for use as backfill. Please revise the Work Plan to require sampling and analysis of import backfill to determine if it is suitable for use at HPNS.

27. Section 6.5 (Remediation of Group 1 Survey Units): The extent of actual contamination is known, so please revise this section to refer not only to Group 1 but instead to all Survey Units.

28. Section 6.6.1 (NORM Evaluation) proposes analyzing Uranium-238 (U-238), Uranium-235 (U-235) and Thorium-232 (Th-232) by alpha spectroscopy and Ra-226 by radon emanation in order to perform a Naturally Occurring Radioactive Material (NORM) evaluation for radionuclides with concentrations above the release criteria. Figure 6-4 (NORM Evaluation Process) on page 6-8 includes a formula for use in evaluating whether elevated concentrations of certain radionuclides are considered part of NORM or represent site contamination. However, a reference for use of this equation as scientifically supported has not been provided in the Work Plan. Also, the Work Plan does not propose an evaluation of whether the individual radionuclides in the U-238 or Th-232 decay series are in equilibrium. Additionally, the value obtained using the equation may be subject to interpretation given that the results for U-238, U-235, Th-232, and Ra-226 at such low concentrations will have an uncertainty associated with those results that cannot be accounted for in the formula and that may alter the outcome of the test. It is unclear why this approach is proposed in the Work Plan versus the approach proposed by EPA in previous comments on the SAP and the Radiological Data Evaluation Reports, which is to analyze Uranium isotopes U-234, U-235, and U-238 and Thorium isotopes Th-234, Th-230, Th-232, and Th-228 by alpha spectrometry in addition to the gamma spectroscopy analysis in order to identify whether parent and progeny radionuclides are in secular equilibrium for purposes of differentiating background versus site-related contamination in soils. In addition, providing the analysis of parent and progeny radionuclides from the Uranium-238 decay chain will help substantiate the results obtained for Ra-226 by radon emanation analysis If after a certain number of samples have been analyzed, it is determined that providing only the results for U-238 by alpha spectroscopy and Ra-226 by radon emanation is sufficient for identifying whether levels of primordial radionuclides in samples are present in secular equilibrium or are present at elevated levels that indicate site contamination, consideration may be given to reducing the analytical requirements. Please revise the Work Plan to require that all reference area samples and site investigation samples requiring a NORM evaluation, be analyzed by alpha spectroscopy, including uranium isotopes U-232, U-234, U-235/236, U-238, and for thorium isotopes Th-234, Th-230, Th-232, Th-228, and Th-227, and to include the reporting of the additional isotopes by gamma spectroscopy.

29. It is imperative that the TSPs include all of the site-specific quality assurance requirements not specified in the Master SAP. TSPs should be provided in the Uniform Federal Policy Act Quality Assurance Project Plan (UFP-QAPP) format to ensure all implementing technical and quality requirements for sample collection, analysis, reporting, validation and quality assessment are documented for each site being investigated. Please provide TSPs in the UFP-QAPP format to ensure that all necessary site-specific quality assurance requirements are included.

30. Section 6.6.3 (Regional and Local Background Evaluation). Similar to the above comment on Section 4.2.1 (Soil Reference Areas), any local or regional background evaluation for Cs-

137 fallout should exclude locations where surfaces could have been disturbed or locations at the bottom of slopes where runoff could have deposited sediment that led to accumulation of Cs-137.

31. Please find and update all references to the Nuclear Regulatory Commission's (NRC) Regulatory Guide 1.86, which has been withdrawn. Some of the release criteria in the RODs were originally based on Regulatory Guide 1.86 limits. Please see above comment on Section 4.1.1 (Release Criteria) regarding review of the protectiveness of these criteria using the current versions of EPA's risk models, the PRG and BPRG Calculators.

32. The listing of soil volumes throughout the Work Plan should be provided in metric units in order to provide consistency with the MARSSIM guidance references so that compliance with MARSSIM guidance is more clearly demonstrated. Please revise the Work Plan to address this change.

33. Database "fields definitions" should be included in the Work Plan, including instrument and analytical specific fields identified (i.e., Date/Time, Count time, sample volume, MDC, result, uncertainty, etc.), which are included on paper forms and electronic data deliverables.

34. The Work Plan does not reference the Master Sampling and Analysis Plan (SAP) or discuss the role of Regulatory Agency involvement/oversight for the site investigation at HPNS. EPA will continue to partner with the Navy and the State of California in the site investigation process. For example, the EPA will be involved in the following actions: independent oversight of field activities; conducting laboratory and/or field audits, requesting split samples for independent analysis, and independent data review/validation of some portion of the data generated during the forthcoming investigation. Therefore, please revise the Work Plan to require ten percent (10%) split sampling for every survey unit sampled for analyses by another laboratory for quality control purposes.

35. The Work Plan and Master SAP provide the outline for the forthcoming TSPs which should include more specific detailed plans. For consistency with EPA quality assurance guidance and quality program policy, please ensure the following requirements for the project are met:

a. An agreed upon, the final QAPP/Master SAP and TSPs will be needed to be provided to the regulators prior to the review of the Contractor Supplied SOPs to ensure compliance.

b. Field audits and contractor lab audits should be performed by the Navy to ensure compliance with the QAPP, SAP, SOPs. The regulators will also perform their own independent audits and assessments.

c. The Work Plan states that laboratories that will be used for sample analyses have been certified and are compliant with the Department of Defense/Department of Energy (DoD/DOE) Quality Systems Manual for Laboratories version 5.0/5.1 of the DOD/DOE QSM. Please ensure this requirement is also included in the Master SAP.

d. A discussion concerning potential laboratories will be needed after the QAPP/SAP and TSPs are finalized to optimize sample size collection, counting geometry used by the laboratory, and counting times needed to ensure MDCs are met.

e. Soil gamma scan data will need to be collected with sub meter global positioning system (GPS) coordinates, and soil sample collections will need to include sub-meter GPS coordinates and hand measured sample collection depths.

f. The Regulatory Agencies will likely collect/analyze split samples.

g. On-going communication between the Navy and regulators should continue frequently to discuss the nature and extent of contamination found while the survey unit investigation is ongoing.

h. The sample specific required MDC for lab analyses shall be stated in the QAPP and are required to be less than or equal to 10% of the release criteria for all ROCs.

i. Per previous HPNS Work Plans, 10% of all samples collected per survey unit will need to have Sr-90 specific analyses completed, and 100% of areas that require Cs-137 remediation shall also be analyzed for Sr-90.

j. Currently, the Work Plan only includes calculations of the required Gamma Scan Speed based on the Ra-226 micro-shield exposure rate, which includes all of the gamma emitting progeny nuclides; therefore, Cs-137 would be the more limiting radionuclide for determining the scan speed. Scan speed determinations should be included individually for each ROC.

Please ensure the HPNS QAPP/Master SAP and TSPs include all of these requirements.

36. Please include the Regulators' comments and the Navy's responses to them in the next version of the draft Work Plan and in the draft Parcel G Task Specific Plan.

37. EPA is making every effort to include in our formal comments everything that we have already conveyed via email and all the comments that our reviewers have on this report to-date. If significant new information comes to light or significant new insights result from further evaluation, EPA may supplement these comments at a later date.

SPECIFIC COMMENTS

1. **Section 4.1.1, Release Criteria, Page 4-12 and Table 4-2, Project Release Criteria, Page 4-12:** Section 4.1.1 and Table 4-2 should include loose surface contamination release criteria in addition to residential soil, building surfaces, and equipment or waste surfaces. Also, Table 4-2 should be revised to include radionuclide progeny with half-lives greater than 5 to 7 years and Pb-210, with detection limits defined in the quality assurance project plan (QAPP)/Master SAP. Please revise Section 4.1.1 and Table 4-2 to include these additional

details.

2. **Section 4.1.2.1, Soil Investigation Levels, Page 4-12 and Section 6.3, Evaluation of Scan Data, Page 6-5:** The second paragraph of Section 4.1.2.1 states the investigation level for gamma scan results will be established at three standard deviations above the mean for the gamma scan data set being evaluated. However, the ability to identify contamination is reduced if the investigation level is based on three standard deviations of the mean of the survey unit being investigated. Therefore, the Work Plan should be revised to state that for gamma scanning data, the investigation level will be established at three standard deviations above the mean for the gamma scan reference data set in lieu of "the gamma scan data set being evaluated." Also, the appropriateness of identifying the investigation level as three standard deviations above the mean should be discussed in the Work Plan. Please revise Section 4.1.2.1 to state that gamma scan results will be established based on the gamma scan reference background data set. In addition, please revise the Work Plan to justify using a three standard deviation of the mean concentration as the investigation level. This comment applies to the investigation level in the context of scanning sidewalls and bottoms of trenches, scanning excavated soil on Radiation Screening Yards, scanning surfaces of backfill in trenches after removing asphalt, scanning the entire lengths of core samples, and any other relevant scanning.

3. **Section 4.1.1.2, Building Investigation Levels, Page 4-13:** Please revise Section 4.2 to indicate that Alpha and beta static and scan measurement investigation levels will be based on scans of reference background areas.

4. **Section 4.2.1, Soil Reference Areas, Page 4-13 through 4-16:** Please revise Section 4.2.1 to specify the minimum sample size that will be collected.

5. **Section 4.2.1, Soil Reference Areas, Page 4-16:** Please revise the Work Plan to specify that the samples should be well homogenized before they are split or to specify that the full sample volume will be sent to each laboratory for analysis.

6. **Section 4.2.2, Building Reference Areas, Page 4-16:** Please replace the phrase "static measures" in the third paragraph of Section 4.2.2 with "static measurements."

7. **Section 4.3.1, Soil Area Groups, Page 4-17:** The same Survey Unit Numbering that was previously used should be carried over in this Work Plan. Additionally, a table should be provided to clarify the Soil Areas within a Survey Group, scan measurements, surface soil sampling, and core sampling numbers. Please revise Section 4.3.1 to clarify and discuss soil area groups and/or to ensure this information is included in the TSPs for each survey unit and parcel.

8. **Table 4-3, Number of Samples in a Survey Unit, Page 4-19:** Please revise Table 4-3 to include units (e.g., pCi/g) for Ra-226 and Cs-137.

9. **Section 4.6.1, Soil Survey Instruments, Page 4-22:** Please revise Section 4.6.1 to state that background will not be subtracted from gamma scanning instrument measurements during

characterization.

10. **Table 4-5, Instruments and Investigation Limits for Static Measurements, Page 4-22:** Please revise Table 4-5 to specify the nuclide that was used to determine efficiency.

11. **Section 4.6.6.3, Instrument Beta Scan Measurement Rates and Alpha Detection Probabilities, Page 4-29:** Additional details should be provided regarding alpha/beta scanning instrumentation. Based on example calculations used for alpha/beta scanning instruments, it is unclear which instrument will be selected for alpha/beta scanning to meet data quality objectives (DQOs) and what scan speed will be selected. Please revise Section 4.6.6.3 and forthcoming TSPs to discuss additional details regarding instrumentation and scan speeds for alpha/beta scanning.

12. **Section 4.7, Radiological Laboratory Analysis, Page 4-33:** Please revise Section 4.7 to also discuss additional analyses required, which may include uranium/thorium and plutonium/americium analyses by alpha spectroscopy.

13. **Section 5.1.2.1, Group 1 Trench Unit Surveys, Pages 5-2, 5-3, and 5-4:** The Work Plan does not account for the presence of gravel (asphalt base course) beneath asphalt or for the fact that in many areas, import soil was used to build up the surface to improve drainage prior to paving each parcel. After the asphalt has been removed, all asphalt base course, gravel beneath concrete, and import fill soil should be removed from the surface prior to gamma scanning and sampling to ensure surveys are representative of site conditions. Please revise the Work Plan to state that asphalt, asphalt base course, concrete, gravel, and import fill soil will be removed from the surface prior to gamma scanning and sampling.

14. **Section 5.1.2.1, Site Preparation, Page 5-2:** Please revise the text to add a statement indicating that all activities will be included in the TSPs.

15. **Section 5.2, Surface and Subsurface Soil Investigations, Page 5-2:** For clarity, please revise Section 5.2 to include a table with investigation details including Group Areas, survey unit sizes, scanning requirements, surface sampling requirements, and core sampling requirements.

16. **Section 5.2.1.2, Group 1 Trench Unit Surveys, Page 5-4:** This section does not discuss whether gravel (asphalt base course or gravel beneath concrete surfaces) will receive a gamma scan. Similarly, there may be import fill beneath the asphalt base, which is not representative of the trench unit contents. Please revise this section to discuss the presence of the gravel and possibility of the presence of fill beneath the asphalt base so that information in the Work Plan is sufficient for developing a sound sampling strategy for collecting representative data from the trench units.

17. **Section 5.2.2.2, Group 2b Surface Soil Surveys, Page 5-5:** This section states that surface soil at former building sites and in crawl spaces underlying existing buildings in Group 2b areas will be surveyed as Class 3 survey units. The durable cover generally consists of two or more inches of asphalt, and four inches of gravel (asphalt base course). However, there

may also be an unknown thickness of import fill beneath the gravel (placed for grading to control drainage). All of durable cover and import fill beneath the gravel should be removed before surface scanning is conducted in order to ensure the gamma surface scans can achieve the calculated MDC for the target soils in accordance with the sampling plan. Please revise the Work Plan to specify that the durable cover and all import fill be removed prior to performing surface gamma scans.

18. **Section 5.2.2.3, Group 2b Trench Unit Surveys, Page 5-5 and Figure 6-2, Decision Matrix for Soil Sampling, Page 6-4:** These sections of the Work Plan do not discuss how the location of a trench unit will be confirmed given that trench units will have a durable cover and possibly import fill material covering the units. The locations of the trench units were not surveyed, so it may not be possible to locate the trench units or determine whether import fill covers the trench units without removing the durable cover. Please revise the Work Plan to include information about how the trench units will be located and also ensure that the durable cover and any fill material located under the durable cover be removed prior to performing any gamma scans.

19. **Section 5.4.1, Building Surface Investigations, Page 5-6:** Please revise Section 5.4.1 to discuss building survey unit measurements data logging requirements for, such as date/time stamp requirements and how alpha, beta, and gamma measurements will be recorded.

20. **Section 5.5.4, Exposure Rate Surveys (Dose Rates), Page 5-8:** Please delete the phrase "subtracting an equivalent measurement" from the first bullet point of Section 5.5.4.

21. **Section 6.4, Evaluation of Sample Data and Static Measurements, Page 6-6:** Please revise the text to indicate that the mean, median, standard deviation, range, and the 95% upper confidence limit (UCL) statistics should be included for the sample analytical data for each survey unit without subtracting background. Background reference areas selected may not be appropriate for comparison, so background subtraction should not be done first.

22. **Section 6.4.1, Sample Analytical Data, Page 6-6:** A background evaluation should only be performed for naturally occurring radionuclides (e.g., Ra-226). When a background evaluation is performed, all natural decay series should be evaluated for secular equilibrium and expected ratios. Please revise the text to include these details.

23. **Section 6.6, Background Evaluation, Page 6-7:** In the first paragraph, please delete "and ubiquitous fallout." Since the surface soil materials have been mixed and dispersed with subsurface soil materials, no non-natural radionuclide concentrations will have a "background" concentration for comparison.

24. **Section 6.6.1.1, Sample-specific Background Determination, Page 6-9:** Please modify the last sentence of Section 6.6.1.1 to read as follows: "The sample specific analytical result will be compared to the other nuclides in the decay series to determine if the sample specific result exceeds the expected result with the natural decay series in secular equilibrium."

25. **Section 6.6.1.2, NORM Evaluations, Page 6-9:** The text states that a NORM evaluation will be required when a gamma spectroscopy result for a specific laboratory sample analyzed for Ra-226, U-235, or Th-232 exceeds the mean for the background reference area data set by more than the release criteria. It is unclear why U-235 is listed as being identified using gamma spectroscopy only, since the detection efficiency of U-235 is low using this method of analysis. Please revise the Work Plan to require samples being investigated for the presence of U-235 to be analyzed by alpha spectroscopy.

26. **Table 6-1, Laboratory Alpha Spectroscopy and Emanation, Page 6-9:** The table indicates that if U-235 exceeds the mean for the background reference area by more than the release criterion, alpha spectroscopy analysis will be performed for U-235 and U-238. It is assumed that the concentrations of these two isotopes will be evaluated to determine if they are present in an approximate 1:1 ratio; however, the Work Plan does not include this information. Please revise Section 6.6.1.2 (NORM Evaluations) to include additional detail about how the U-235 and U-238 data will be evaluated to identify whether the results indicate the soil is representative of background or of site contamination. In addition, as previously requested by EPA, please revise the Work Plan to require the reporting of all Uranium isotopes, U-234, U-235, and U-238 as well as thorium isotopes Th-228, Th-230, Th-232, Th-234, and Po-210 for the purposes of NORM evaluations.

27. **Table 6-1, Laboratory Alpha Spectroscopy and Emanation, Page 6-9:** Table 6-1 indicates that an evaluation of whether elevated levels of Th-232 are due to background or site contamination will include alpha spectroscopy analysis of Th-232 and U-238. It is assumed that the concentrations of these two isotopes will be evaluated to determine if they are present in an approximate 1:1 ratio; however, the text does not explicitly state this. Please revise Section 6.6.1.2 (NORM Evaluations) to provide additional detailed information about how this evaluation will be made. In addition, also revise the Work Plan to include the reporting of all uranium and thorium isotopes reportable by alpha spectroscopy to assist in identifying whether the concentration of radionuclides represents background levels or site contamination.

28. **Section 6.6.4, Dose and Risk Analysis, Page 6-10:** Please revise Section 6.6.4 to specify that risk analyses will use the EPA Preliminary Remediation Goal (PRG) calculator for natural decay chain radionuclides and any non-natural radionuclides determined to be present with the required cover in place, inclusive of background.

29. **Section 8.2, Waste Management for Hazardous/Non-Hazardous Sites, Page 8-2:** This section discusses the identification and management of hazardous and/or radioactive wastes but does not discuss requirements that must be met prior to off-site disposal. Please revise the Work Plan to state that the EPA Region 9 off-site rule coordinator will be consulted before disposal of hazardous and/or Low-Level Radioactive Waste (LLRW) soil to ensure that the landfill used for disposal is acceptable.

Attachment 1.2

STATISTICAL REVIEW OF UNITED STATES NAVY PROPOSED WORK PLAN FOR RADIOLOGICAL SURVEY AND SAMPLING, HUNTERS POINT NAVAL SHIPYARD SITE (HPNS)

Memorandum dated March 15, 2018

Note about data labels: Comment 4 on Section 4.2.1 Soil Reference Areas and associated Figure 1 show analysis of data collected from locations with various Parcel labels. Please note that background reference areas are intended to be locations that are not impacted by contamination. Parcel A data is therefore included, even though it is not currently the subject of the Tetra Tech EC Inc. evaluation. In addition, at the time of data collection Parcel boundaries may have been different from current boundaries. For example, current day Parcels G, UC-1, and UC-2 used to be part of Parcel D-1. Historically, Parcels D-1 and G used the same reference background values for Ra-226. Finally, in the Tables, columns labelled "SITEDSC" showing building numbers means "Site Description" and indicates that the sample was collected near the building named.

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DATE: March 15, 2018

TO: Felicia Barnett, Director SCMTSC, EPA WAM

FROM: Donna J. Getty, SERAS Statistician

THROUGH: Richard Leuser, SERAS Deputy Program Manager, Task Leader

SUBJECT: FINAL -- STATISTICAL REVIEW OF UNITED STATES NAVY PROPOSED WORK PLAN FOR RADIOLOGICAL SURVEY AND SAMPLING, HUNTERS POINT NAVAL SHIPYARD SITE (HPNS), SERAS-106, WORK ORDER #83

INTRODUCTION

United States (US) Environmental Protection Agency (EPA) Region 9 personnel requested a statistical review of the sampling strategies outlined in the US Navy's proposed *Work Plan, Radiological Survey and Sampling, Former Hunters Point Naval Shipyard, San Francisco, California* (February 2018) (Work Plan). The Work Plan presents an overview of proposed methodologies and protocols for the investigation of radiological contamination in Parcels B, C, D-2, E, G, UC-1, UC-2, and UC-3 on the Hunters Point Naval Shipyard (HPNS) (Site), located in San Francisco, California. Allegations of Navy subcontractor data falsification in reference to historical remedial work conducted at the Site has resulted in the need for an assessment of potential residual radiological contamination potentially left on-site. The Navy has proposed to perform characterization surveys and final status surveys (FSS), and then remediate as needed. The US EPA's objective is to assess the full extent of radiological contamination which remains at these Parcels on HPNS for the identified radionuclides of concern (ROCs), those present in background and those not present in background, in: surface soils (land areas), within previously defined trench units (the backfill, walls, bottom and immediate peripheral soil), and buildings.

This Technical Memorandum (TM) formalizes comments which were made verbally and via emails to the EPA Region 9 Remedial Project Manager (RPM) and the HPNS team of Regulators. Specifically, comments on Sections:

4.1.2.1 Soil Investigation Levels
4.2 Reference Backgrounds
4.3 Soil Survey Areas
4.4 Building Survey areas
4.5 Data Quality Objectives
5.2 Surface and Subsurface Soil Investigations
5.3 Former Building and Pavement Investigations
5.4 Building Investigations
6 Data Evaluation

Regulator concerns include proposed sample sizes for background and site areas, statistical testing, confidence levels, interpretation of final results, and application of *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM, 2002) and *Multi-Agency Radiation Survey and Assessment of Materials and Equipment* (MARSAME, 2009) strategies.

GENERAL COMMENTS

Comment 1: Application of MARSSIM. In reviewing the Work Plan, proposed strategies/methodologies were compared with recommended strategies from MARSSIM (2002) which is frequently referenced in the Work Plan. However, it is important to recognize that MARSSIM does not provide guidance on sampling strategies for subsurface soil contamination. It specifically addresses surface contamination in land areas and buildings. As stated on page 5-51 of MARSSIM:

"In addition to the building and land surface areas described above, there are numerous other locations where measurements and/or sampling may be necessary. Examples include items of equipment and furnishings, building fixtures, drains, ducts, and piping. Many of these items or locations have both internal and external surfaces with potential residual radioactivity. Subsurface measurements and/or sampling may also be necessary. Guidance on conducting or evaluating these types of surveys is outside the scope of MARSSIM."

All subsurface sampling strategies presented in the HPNS Work Plan are outside of the scope of MARSSIM. However, many of the statistical methodologies presented in MARSSIM can be adapted to subsurface soils if appropriate sampling protocols and relevant statistical methodologies are applied. All proposed methodologies for subsurface soil evaluation were reviewed for statistical validity and to determine the adequacy of the proposed sample sizes.

Comment 2: Application of MARSAME. The MARSAME manual supplements MARSSIM and provides technical information on survey approaches to determine proper disposition of materials and equipment (M&E). Guidance within this manual was also reviewed to assess its application to the HPNS Site. Similar to MARSSIM, MARSAME does not specifically address subsurface soils:

"The scope of MARSAME is M&E potentially affected by radioactivity, including metals, concrete, tools, equipment, piping, conduit, furniture and dispersible bulk materials such as trash, rubble, roofing materials, and sludge." (MARSAME, pg. RM-1)

"Examples of M&E include metals, concrete, tools, equipment, piping, conduit, furniture, and dispersible bulk materials such as trash, rubble, roofing materials, and sludge. Liquids, gases, and solids stored in containers (e.g., drums of liquid, pressurized gas cylinders, containerized soil) are also included in the scope of this document." (MARSAME, pg. 1-1)

Like MARSSIM, statistical analyses presented within MARSAME can be adapted for evaluation of subsurface soils if assumptions associated with the statistical analyses are met and adequate sample sizes are computed.

SPECIFIC COMMENTS

Comment 3: Section 4.1.2.1 Soil Investigation Levels – Second Paragraph, page 4-12

"*The investigation level for gamma scan results will be established at three standard deviations above the mean for the gamma scan data set being evaluated."*

Reviewer Comments: As read, this implies that the Navy will determine an investigation level (IL), for each survey scan they conduct, based on the mean of the data they collect during that scan. As proposed in the Work Plan, survey scans will be conducted per defined sample unit (SU). If the Navy uses the mean per scan survey, it can lead to higher ILs and less recognized contamination.

Gamma scan data is measured as count data not continuous data. It is well established that count data typically follow what is called a Poisson distribution as opposed to a normal distribution (Gaussian curve). The variance of a Poisson distribution is equal to the mean. This implies that as the mean of the survey scan data increases, the standard deviation (square root of the variance) increases, hence the IL increases (3 standard deviations above the mean). When large numbers of count data are collected the distribution approximates a Gaussian curve, but still retains the property that the mean is approximately equal to the variance.

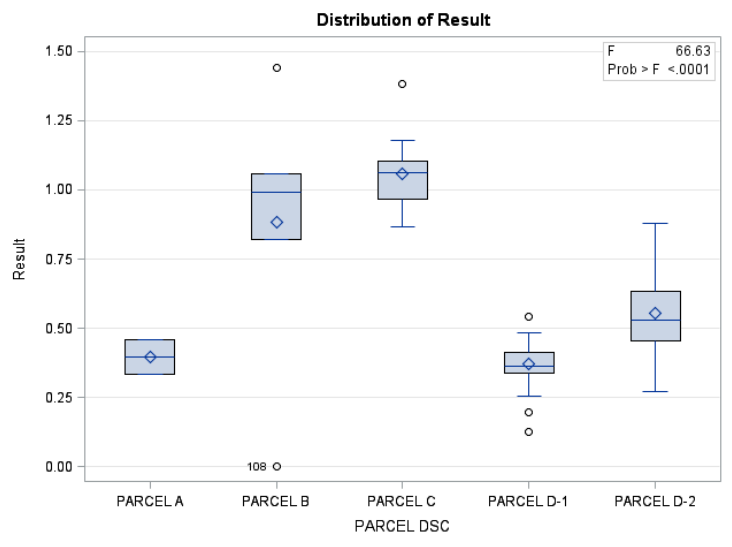
It is recommended that the IL for ROCs found in background should be based on background reference area measurements with similar soil type to the SU being evaluated, to ensure identification of residual contamination.

Comment 4: Section 4.2.1 Soil Reference Areas – page 4-14

Navy proposes five surface and 25 subsurface samples collected at a minimum of five background reference areas to establish concentrations of Ra-226 and Cs-137 in soils, cites MARSSIM guidance as requiring a minimum of 18 measurements per SU and each background area and the Nuclear Regulatory Commission (NRC) as requiring at least 100 samples from at least 5 distinct locations. The Navy has proposed increasing the minimum requirement of 18 measurements to 25 to ensure sufficient background data would be available.

Reviewer Comments: In order to meet MARSSIM and NRC criteria, sample sizes for background reference areas should be computed per independent interval, surface soils and subsurface soils, not across both. Additionally, it is clear from historical data provided by the Navy and collected at the background reference areas in Parcels A, B, C, D-1, and D-2, that variability is not consistent across the five areas for off-site laboratory Ra-226 measurements (Figure 1).

Figure 1. Distribution of Ra-226 Off-Site Laboratory Measurements in picocuries per gram (pCi/g) in Background Reference Areas



Recommendations: Given the differences in variability and mean/median concentrations for Ra-226 as demonstrated in Figure 1, it is recommended that background reference area sample data should not be combined across the five areas, but rather background reference areas should be established per Parcel with sample sizes computed based on the variability within each background reference area per independent interval (surface soils and subsurface soils).

Sample sizes should be justified with detailed statistical analyses and explanations of how inputs to the computations were derived, including specifics of how estimates of variability were obtained (e.g., what data was included in the calculation, how and where the data was collected, what assumptions were made). If measurements from multiple background reference areas will be combined, the results of a comparative analysis such as an Analysis of Variance (ANOVA) or non-parametric equivalent (Kruskal-Wallis Test) must be documented to support combining the areas. These comparative tests will establish if there is a statistically significant difference between Ra-226 and Cs-137 in the background reference areas at a specified confidence-level.

Comment 5: Section 4.3.3 Number of Samples in a Survey Unit – page 4-19

Table 4-3 provides the inputs the Navy used to compute the number of samples which will be collected from each SU based on Section 5.5.2.1 of MARSSIM. Inputs include the $DCGL_w$, Δ ($DCGL_w$ – Background), σ (standard deviation),

α (probability of rejecting the null hypothesis when it is true), and β (probability of accepting the null hypothesis [H_0] when it is false).

Reviewer Comments: Proposed sample sizes only apply to ROCs which have been identified in background, Ra-226 and Cs-137, and are representative of the number of samples which need to be collected from each SU and background reference area to achieve the chosen confidence levels (α=0.01 and β=0.01) when running a Wilcoxon Rank-Sum (WRS) test, if the proposed estimates of σ are valid.

The reviewer agrees with the chosen confidence level for α and β of 0.01 as it is the most conservative and protective of human health.

The Work Plan uses σ =0.28 for Ra-226 and σ=0.113 as inputs to the sample size calculations. To evaluate the validity of these proposed estimates of σ, basic descriptive statistics including standard deviation were computed for historical background reference measurements for Ra-226 and Cs-137 (Tables 1 and 2). Table 1 provides the descriptive statistics for the historical off-site laboratory measurements and Table 2 for the historical on-site laboratory measurements. The statistics are computed per nuclide and parcel. For off-site laboratory measurements, Cs-137 σ ranges from 0 in Parcel A to 0.0498 in Parcel B and Ra-226 σ ranges from 0.0788 in Parcel D-1 to 0.479 in Parcel B. For on-site laboratory measurements, Cs-137 σ ranges from 0.0310 in Parcel D-1 to 0.0456 in Parcel B and Ra-226 σ ranges from 0.274 in Parcel D-2 to 0.471 in Parcel B.

Note that variability is greatest for both Cs-137 and Ra-226 in Parcel B for on-site and off-site laboratory measurements. This supports the recommendation that background reference areas should be established per Parcel with sample sizes computed per background reference area. If consistency is preferred, then sample sizes across Parcels for on-site SUs and background reference areas should be based on the reference background area with the greatest variability.

Table 1. Original Background Data/FRED - Sigma (σ) for Cs-137 and Ra-226
By Parcel/Site for Off-Site Laboratory Results

Nuclide=Cs-137

Analysis Variable : Result						
PARCEL	**SITEDSC**	**N Obs**	**N**	**Mean**	**Median**	**Std Dev (σ)**
PARCEL A	**Building 901**	**2**	2	0	0	0
PARCEL B	**Building 116**	**6**	6	0.0150000	-0.0015000	0.0497835
PARCEL C	**TURAC**	**18**	18	-0.0019527	-0.0027005	0.0103421
PARCEL D-1	**Building 526 Berth 29**	**40**	40	0.0022800	0	0.0125294
PARCEL D-2	**Building 813 Lot**	**36**	36	0.000254861	0.000055500	0.0107954

Nuclide=Ra-226

Analysis Variable : Result						
PARCEL	**SITEDSC**	**N Obs**	**N**	**Mean**	**Median**	**Std Dev (σ)**
PARCEL A	**Building 901**	**2**	2	0.3965000	0.3965000	0.0883883
PARCEL B	**Building 116**	**6**	6	0.8836667	0.9900000	0.4793085
PARCEL C	**TURAC**	**18**	18	1.0572611	1.0610000	0.1176851
PARCEL D-1	**Building 526 Berth 29**	**40**	40	0.3703000	0.3635000	0.0787987
PARCEL D-2	**Building 813 Lot**	**36**	36	0.5562500	0.5280000	0.1443607

Table 2. Original Background Data/FRED - Sigma (σ) for Cs-137 and Ra-226
By Parcel/Site for On-Site Laboratory Results

Nuclide=Cs-137

Analysis Variable : Result						
PARCEL	**SITEDSC**	**N Obs**	**N**	**Mean**	**Median**	**Std Dev (σ)**
PARCEL A	**Building 901**	**18**	18	0.0337060	0.0266382	0.0359294
PARCEL B	**Building 116**	**37**	37	0.0240768	0.0247570	0.0455666
PARCEL D-1	**Building 526 Berth 29**	**20**	20	0.0368457	0.0293925	0.0310762
PARCEL D-2	**Building 813 Lot**	**18**	18	-0.0218994	-0.0215520	0.0380905

Nuclide=Ra-226

Analysis Variable : Result						
PARCEL	**SITEDSC**	**N Obs**	**N**	**Mean**	**Median**	**Std Dev (σ)**
PARCEL A	**Building 901**	**18**	18	0.3626028	0.1038700	0.4403894
PARCEL B	**Building 116**	**37**	37	0.4477704	0.3972000	0.4713866
PARCEL D-1	**Building 526 Berth 29**	**20**	20	0.6331562	0.6552700	0.3061107
PARCEL D-2	**Building 813 Lot**	**18**	18	0.4845711	0.4617150	0.2740493

Sample sizes were computed using MARSSIM methodology for the maximum computed σ's for Ra-226 and Cs-137 in Tables 1 and 2, with α=0.01, β=0.01, and Δ=1 (Ra-226) and Δ=0.113 (Cs-137). These are presented in Table 3.

Table 3. Sample Size based on Maximum Sigma (σ) Computed from Historic Background Reference Area Data
Based on MARSSIM Table 5.3

		Off-site Lab Measurements		**On-site Lab Measurements**	
PARCEL	**SITEDSC**	**Cs-137**	**Ra-226**	**Cs-137**	**Ra-226**
PARCEL B	**Building 116**	21	25	15	21

Recommendations: Following MARSSIM guidance, an equal number of samples should be collected from the designated background area and the on-site SU. Sample sizes should be conservative and protective to human health and therefore be based on the greatest expected levels of variability. Sample size computations based on historical background reference area support the Navy's recommendation made on page 4-14 in Section 4.2.1 *Soil Background Reference Areas*, which is to collect a minimum of 25 samples per SU and background reference area. However as stated earlier, 25 samples should be collected per background reference area at surface and another 25 at depth, not across the five reference areas. This will result in 125 background reference area surface soil samples and 125 background reference area cores to be sampled at designated intervals.

Comment 6: Wilcoxon-Rank Sum Test (WRS)

It is unclear as to whether WRS tests will be performed to support remedial efforts. MARSSIM guidance clearly states that the WRS is to be used when ROCs are present in background surface soils. Historical sampling at the HPNS site confirms that RA-226 and Cs-137 can be found in background reference areas. However Section 6.6.2 of the Work Plan, Statistical Evaluation, states:

"*The statistical test presented in this Work Plan compares each analytical result for each ROC to the release criterion added to the mean for the background reference data set.*"

This is a point-to-action level (AL) comparison not a population distribution comparison. Figure 6-2, Group 1 Soil Data Evaluation Process, indicates that the first step in data evaluation is to "Perform the $DCGL_w$ test". Again, as defined within the Work Plan this is a point-to-AL comparison. MARSSIM guidance and NRC guidance clearly indicate that comparisons of individual measurements to actionable levels is insufficient in determining whether or not a site meets the release criterion. Nuclear Regulatory Commission Publication NUREG-1505 refers to elevated measurement comparisons (EMC) which is similar to the methodology proposed by the Navy. NUREG-1505 states:

"*The EMC is intended to flag potential failures in the remediation process, and cannot be used to determine whether or not a site meets the release criterion until further investigation is done.*"

There is statistical justification for requiring the WRS test or another test which accounts for variability and distributional characteristics of the sample data. Statistical tests such as the WRS test are hypothesis tests which are based on statistical inference. Statistical inference permits one to generate a conclusion about population characteristics based on information provided by a sample collected from that population. It provides a means for comparing the characteristics of one population sample to another population sample. In other words, the conclusions drawn from these tests can be applied to all of the un-sampled components of the population. There are also specified statistical levels of confidence associated with these tests. The proposed $DCGL_w$ test is only applicable to the single sample measurement that is being compared. The conclusion cannot be extrapolated to the remaining population (e.g., surface soil within an SU), and therefore cannot be used to determine if the release criterion has been met for an SU.

The hypotheses associated with the WRS test are:

> Null hypothesis (H_0): The median concentration in the SU exceeds that in the background reference area by more than the DCGL
> Alternate hypothesis (H_A): The median concentration in the SU exceeds that in the background reference area by less than the DCGL

It is possible for samples collected within an SU to exceed the release criterion, even if the final conclusion based on the WRS test is that the SU meets the release criterion. Because of the possibility of the presence of a few elevated concentrations, MARSSIM does recognize the need to support release/remedial efforts by comparing elevated measurements to the release criterion. However this is done in addition to the WRS test not instead of the WRS test. As stated earlier, results of those comparisons cannot be extrapolated to soils beyond where the discrete samples were collected with any statistical confidence.

It is incorrect to compare an individual sample measurement to a population parameter such as the mean in place of the WRS test. A possible alternative to computing the WRS test per SU, is to compute upper tolerance limits (UTLS) or upper prediction limits (UPLS) based on background reference data to which the individual sample measurements collected within an SU are compared. The UTL or UPL would become a background threshold value (BTV). This would provide a level of confidence associated with the comparisons. However, sample size calculations need to be based on the computation of these limits, not on the WRS test, and this method is not recommended when greater than six measurements will be compared (U.S. EPA, 2016).

Alternately, a UTL can be computed per SU and compared to a specified AL, such as a release criterion. Using a previously computed release criterion for Ra-226 at the HPNS site, 2.4 pCi/g, exploratory computations were performed to determine the sample size required for the computation of a non-parametric UTL using Visual Sample Plan (VSP) software. For at least 95% confidence that 95% of the population of surface soil within an SU has Ra-226 measurements below the AL, 59 samples would need to be collected. The non-parametric UTL was chosen to parallel the non-parametric choice of the WRS test by MARSSIM.

Recommendations: A minimum of 25 samples should be collected from appropriate background reference areas at appropriate depths and from each SU. It is recommended that the WRS test be used to support release of the individual

SUs, followed by comparison of the individual SU measurements to the appropriate release criterion to identify localized areas of high-level Ra-226 or Cs-137 contamination for possible remediation.

DISCUSSION

At the time of this review, the Work Plan presented by the Navy for assessment of the HPNS site is inconsistent in the discussed protocols for evaluating and interpreting the data that will be collected. This reviewer is in concurrence with the findings of the Navy's third party reviewer, that the procedures outlined in the current version of the Work Plan will provide insufficient data to support release of the HPNS Parcels. Although the Work Plan cites MARSSIM as guidance for the sample size determinations and the handling of background reference areas, the information provided in these Sections of the Work Plan do not always follow MARSSIM recommendations.

Additionally, comparisons of ROC measurements between on-site SUs and background reference areas are only addressed for Ra-226 and Cs-137. These ROCs are expected to be found in background. Other ROCs include, plutonium-239, strontium-90, thorium-232, and uranium-235. It is unclear from the Work Plan why these additional ROCs will not be compared to the project release criteria identified in Table 4-2 on page 4-12. MARSSIM provides guidance on applying the one-sample Sign Test for ROCs not found in background. Clarification regarding the evaluation of these ROCs is required before a review can be conducted.

Because of the allegations of fraud associated with historical data, the reliability of historical data is unknown at this time. Sample size calculations are driven by estimated variability and if the variability within the on-site SUs prove to be much greater than the variability of the historical data for the background reference areas, then appropriate statistical confidence and power will not be achieved in the WRS testing. A dynamic approach to designing survey/sampling activities would be the most defensible approach for the HPNS, with sampling activities broken down into phases. At the conclusion of each phase assumptions regarding the statistical distributions of the ROCs would be verified, and sample sizes adjusted, if needed.

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cc: Central File - WA # SERAS-106 (w/attachment)
Electronic File - I:/Archive/SERAS/106/D/TM/031418
Kevin Taylor, SERAS Program Manager (cover page only)

Attachment 2.1

EPA Recommendations for Task Specific Plan for Parcel G

1. Introduction

The previous soil data collected by Tetra Tech EC Inc. since 2006 at the Hunters Point Naval Shipyard should be viewed with significant uncertainty due to widespread signs of potential falsification, data quality concerns, and extensive allegations from former workers of fraudulent practices. EPA's comments on the Navy's draft *Work Plan Radiological Survey and Sampling*, Former Hunters Point Naval Shipyard, San Francisco, California, February 2018, demonstrate that far more extensive sampling and analysis needs to be done to address potential exposure to future workers and residents due to the uncertainty regarding the potential extent of contamination. The Navy is drafting Task Specific Plans (TSPs) for its work on specific parcels, and EPA expects to receive the draft TSP for Parcel G for review soon. In anticipation of this forthcoming draft, EPA is submitting recommendations in advance to inform the development of this draft.

The EPA, the State of California Department of Toxic Substances Control (DTSC), and the State of California Department of Public Health (CDPH) ("Regulators") require an approach that will protect public health and the environment. As we wrote in December 2016, "EPA recommends using a health-risk based approach to prioritize areas of concern based on factors that should include, but not be limited to, historical records of activities, current or future exposure based on land uses, sampling results already collected, and combination of highest risk radionuclides." Additional areas that should be prioritized include those with specific allegations from former workers and data evaluation findings of signs of falsification and/or data quality concerns.

Full excavation, sampling, and scans targeted at the survey units associated with the greatest potential for contamination will be a crucial first step to address uncertainty and demonstrate that the clean-up standards set in the Record of Decisions (RODs) have been met. The results will provide evidence and better understanding about the potential scope of contamination parcel-wide to inform plans for resampling and rescanning the remaining survey units in Parcel G.

Please note that these recommendations apply only to Parcel G, which we understand is the next parcel proposed for transfer to the City. Other parcels will be treated on a case-by-case basis. These recommendations only apply to soil survey units, which include trench units, fill units, and building site soil survey units. They do not apply to buildings, which will be discussed separately. These recommendations give a broad framework for an approach, and details will be refined after receiving the Navy's draft Task Specific Plan for Parcel G and as new reliable data is collected to inform future decisions.

2. Summary of Regulators' Proposed Approach

To achieve a high level of confidence that site conditions meet the remedial goals set forth in the Parcel G ROD, the Regulators propose a two-step process. For Step 1, full excavation, sampling, and scanning in survey units of highest concern should be done to best protect public health and the environment. For trench soil survey units ("trench units"), if resampling of these targeted trench units (starting with 21 out of 63 (33%) of the total units), and the fill soil survey units ("fill units") within them, demonstrates that contamination was left behind, the Navy must then fully excavate, sample, and scan 100% of trench units and associated fill units in Parcel G. If the initial 21 targeted trench and associated fill units meet standards, Step 2 focusing on the remaining trench units would require scanning of 100% of the surface of all fill in trenches as well as core samples at depth to increase confidence for the remaining Parcel G trenches.

Similarly, for building site soil survey units, if any of the targeted units (initially 16 out of total 32, or 50%) show contamination during Step 1 (full excavation, scanning, and sampling), then 100% of these units must be fully excavated, scanned and sampled. Even if all targeted units meet the remedial goals set forth in the Parcel G ROD, the Regulators would still require scanning of 100% of the surfaces as Step 2 for the remaining Parcel G Building Site Soil survey units. These survey units are not deep, so no core subsurface samples would be required.

Given that all survey units will receive some level of assessment of the presence of radionuclides of concern, this approach would achieve a 95-100% level of confidence that ROD remedial goals have been met for soil survey units. This is consistent with the level of confidence achieved nationally for Superfund sites slated for mixed use, including residential. In all the above activities, the regulatory agencies will send inspectors to monitor field work closely and take independent samples and scans.

3. Selection of priority survey units

Survey units for priority sampling will be selected based on criteria including the following:

a. Historical documentation of specific potential upstream sources (e.g. buildings where radiological work was performed), spills, or other indicators of potential contamination

b. Signs of potential falsification found in data evaluation, for example:
    i. Gamma scan exceedance not investigated, as required, through collection of biased samples
    ii. Gamma static samples have low variability, e.g. less than 1500 counts per minute (cpm) and/or are not consistent with the gamma scan data, which could indicate the scans were not completed according to requirements
    iii. Onsite and off-site lab samples have different weights, which could indicate soil samples had been switched
    iv. Some samples were analyzed on different dates
    v. Gamma scan results low enough to indicate potential degraded detectors or failure to operate detectors according to requirements

c. Signs of data quality problems found in data evaluation, for example:
    i. Missing gamma scan data
    ii. Numerous results that are zero or negative, especially for Cs-137

d. Allegations from former workers, for example:
    i. More than 3 rounds of excavation, which allegedly motivated falsification
    ii. Specific locations where workers reported wrongdoing

e. Independent field testing, e.g. EPA scans of cleanup sites.

Other criteria may also be used as appropriate.

4. Step 1 – Full excavation, sampling, and scanning of priority survey units

Full excavation, sampling, and scanning must be conducted as the first step in priority survey units for trenches and building site survey units using the broad approaches required in previous Basewide Radiological Support Workplans,[1] with updates that improve reliability of results, as noted in EPA's comments on the Navy's draft new Draft *Work Plan Radiological Survey and Sampling*, Former Hunter's Point Naval Shipyard, San Francisco, California, February 2018 ("Work Plan"). The actions include full excavation of trench units, sampling and scanning of the side walls and bottom of the trenches, scanning of the excavated soil, and excavation of any contamination found.

Sampling results for each Radionuclide of Concern must be compared to the respective cleanup goal, i.e., Reference Background plus the Remedial Goal, as set in the Records of Decision, updated if needed as part of the Five-Year Review. If an exceedance of the cleanup goal is found, and evaluation of equilibrium does not demonstrate that the value represents Naturally Occurring Radioactive Material (NORM), then that finding represents evidence of contamination. This failure to meet the cleanup goal would trigger the requirement to perform full excavation, sampling, and scanning of 100% of trench units and associated fill units in Parcel G. A similar approach would apply to building site soil survey units.

5. Step 2 – 100% surface scans and core samples

Step 2 entails completing 100% surface scans and core samples. Step 2 can only be considered if Step 1 found no contamination exceeding the ROD clean-up goals in trench units or building site survey units. Otherwise, excavation of 100% of trench units or building site survey units would be required. For trench units, if in Step 1, the 33% of targeted trench units showed no contamination, then the remaining 67% (43) of trench units must receive 100% surface scans and core sampling. Similarly, for building site survey units, if in Step 1, the 50% of targeted building site soil survey units showed no contamination, then the remaining 50% (16)

[1] See for example, U.S. Department of the Navy, *Final Workplan, Basewide Radiological Support*, Hunters Point Naval Shipyard, San Francisco, California, August 2015.

of units must receive 100% surface scans. If contamination is found, then that survey unit must be fully excavated and treated in a manner similar to Step 1. If multiple Step 2 survey units have contamination, then additional survey units may need 100% full excavation and treatment in a manner similar to Step 1.

a. 100% Surface scans – To address the potential exposure to future residents, 100% surface scans would be required. The Navy must first remove any asphalt cover and any imported fill that may have been used to achieve the desired grade, i.e. not part of backfill that potentially came from an area excavated by Tetra Tech EC Inc. Any locations where scan results exceed the investigation level would require collection of biased samples.

b. Core samples – Only if no contamination is found in surface scans, then core samples would be an option to address potential exposure to future trench workers from contamination at depth. Each core will be scanned and will have a sample collected from the bottom, surface, and at any point exceeding the investigation level or, if no points exceed that level, then at the point of the highest gamma reading.

    i. *Inside the trench walls* - The number of core samples required within the trench walls will be determined based in new reliable data and statistical analysis.

    ii. *Outside the trench walls* – Additional core samples will be collected within a foot outside the trench wall, laterally along each side of the trench.

6. Conclusion

In a situation of considerable uncertainty, the Regulators have proposed a robust plan that addresses multiple possible scenarios using information from history, data review, and known allegations. Even if new allegations arise in the future, the thorough approach outlined above will protect public health and the environment through decisions based on evidence from new reliable data and sound statistical analysis.

Attachment 2.2

Statistician Evaluation of Parcel G Resampling and Confidence

To ensure that Parcel G trench and building site survey units meet ROD radiological cleanup levels with a high probability, EPA used the Visual Sample Plan (VSP) software tool based on several key assumptions. VSP was developed with support from the Department of Energy (DOE), EPA, the Department of Defense (DoD), the Department of Homeland Security (DHS), the Centers for Disease Control (CDC), and the United Kingdom. Applied properly, VSP is a tool that supports the development of a technically credible sampling plan based on statistical sampling theory and the statistical analysis of sample results. (See https://vsp.pnnl.gov/description.stm).

Historically it has been well established that statistical analyses of environmental data should be as conservative, powerful and as robust as possible (Green, 1979). To be conservative in the final assessment requires a high confidence level (represented by α) in the statistics that are applied, and power is reflected by the levels set for β. Within the environmental community, high confidence implies 95% ($\alpha<0.05$) or 99% ($\alpha<0.01$) confidence. The greater the risk (health and cost) which will be incurred by making an incorrect assessment, the greater the confidence that is required. The greater the confidence required, the more samples/resources needed. EPA believes the proposed methodology provides the necessary statistical confidence and power to address clean up concerns for Parcel G.

At this site, EPA recommends achieving a high level of confidence. A 95% confidence level has been chosen for the determination of the initial effort, with the knowledge that the final confidence will actually be greater than 95%, given that all survey units will receive some level of assessment of the presence of radionuclides of concern. Nationwide, this level of confidence is common for ensuring compliance with cleanup standards at sites slated for commercial, industrial, and/or recreational use. For sites slated for residential use, a confidence level above 95% is common.

As a first step, EPA recommends prioritizing full excavation of trenches that have the highest concerns (targeted vs. random). Analysis using VSP concluded that for Parcel G, if 21 targeted trench units (33% of 63 total) do not show exceedances of cleanup standards (using MARSSIM Class 1 evaluation), then Step 1 would show with 95% confidence that 95% of the total trench units would also not exceed standards. However, if even one trench unit shows exceedances, then we will no longer be able to achieve the desired confidence, and 100% excavation and 100% rescanning would be required for all trench units. EPA followed a similar process to calculate the percent sampling required for building site survey units.

If Step 1 shows no exceedances, then Step 2 would involve conducting further work (using a modified MARSSIM Class 2 or Class 3 evaluation) on the remaining trench units (67%) to increase the confidence level above 95%. This further work, using a modified MARSSIM Class 2 or Class 3 evaluation, would be needed on the remaining survey units not excavated due to the following factors:

- The statistical test used to derive the required number of survey units to be fully excavated and investigated as MARSSIM Class 1 SUs relies on the assumption that the 33% of the SUs selected sufficiently represent 95% of the remainder of SUs. Given the extent and variations in the ways which fraud occurred at the site, in many cases, it cannot be determined which SUs have falsified results and which do not. Therefore, the assumption of representativeness requires some level of verification sampling for the remainder of the SUs.

- In addition to the fraud that is alleged to have occurred, recent review of the previous investigation conducted by TetraTech EC Inc. revealed pervasive data quality issues for both the on-site and off-site lab, as well as a lack of compliance with the Work Plan for site investigative activities. It cannot be determined exactly which SUs had results that were not representative due to data quality issues or nonconformance with the Work Plans. These factors add to the uncertainty of using excavation and sampling data from the 33% of the SUs to represent the remaining 67%.

- The statistical test provides a 95% confidence level that results from the 33% of SUs selected for sampling are representative of 95% of the remainder of SUs data; however, verification sampling of the remaining SUs that did not get full excavation and MARSSIM Class 1 surveys would provide an additional level of confidence in the results.

- Given that historical investigations have identified the presence of radiological objects with significant levels of radioactivity, such as deck markers painted with radioluminescent Ra-226 or containing Sr-90, the remaining 67% of the SUs will require gamma/beta scanning and verification sampling to check for the potential presence of radiological objects containing high levels of radioactivity.

- Hot spots of contamination may be present at any given location within the HPNS due to the nature of the site history, which indicates radiological contamination was discarded down sanitary and sewer drains and may have been present due to air deposition from nuclear tests on ships in the ocean, and others. Therefore, verification sampling for the presence of hot spots due to residual contamination must be conducted to meet the ROD requirements for the site.

Additionally, if one trench unit shows exceedances, then the inference drawn from the statistical test is that other SUs will contain exceedances and 100% excavation and 100% rescanning would be required for all trench units.

The attached memo dated February 22, 2018 provides details to support the Regulators' proposed approach for resampling of Parcel G trench and building site survey units.

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DATE: February 22, 2018

TO: Felicia Barnett, Director SCMTSC, EPA WAM

FROM: Donna Getty, SERAS Statistician

THROUGH: Richard Leuser, SERAS Deputy Program Manager/Task Leader

SUBJECT: EXPLORATION OF A POTENTIAL METHOD FOR ESTABLISHING A LEVEL OF CONFIDENCE ACROSS A PARCEL THAT RADIOACTIVITY LEVELS ARE BELOW ACTIONABLE LEVELS, HUNTERS POINT NAVAL SITE, SERAS-106, WORK ORDER #84

INTRODUCTION

United States (US) Environmental Protection Agency (EPA) Region 9 personnel requested the exploration of a potential method to establish statistical confidence that remediation goals were achieved for designated areas (Parcels) at the Hunters Point Naval Superfund Site (Site). The US Navy's current proposal determines achievement of remediation goals on a Survey Unit by Survey Unit basis, while the EPA would like to establish statistical confidence for all Survey Units of a specific category (building sites, trench units) for each Parcel. The Record of Decision (ROD) called for the excavation and assessment of all trench units and building sites. The Navy and EPA are currently in discussions regarding whether 100 percent (%) of the Survey Units need to be re-evaluated per the specifications in the ROD or if a smaller effort could establish the presence/absence of residual contamination given the extensive work that has previously been conducted on the Site.

Presence/absence sampling, also known as item sampling, was originally presented as an option to EPA Region 9 in the form of an email, to establish statistical confidence for the achievement of remediation goals. Visual Sample Plan (VSP) software was used to perform the scenario-specific calculations. Uncertainties associated with applying this methodology are also presented following the discussion of how the method could potentially be applied.

PRESENCE/ABSENCE SAMPLING

Presence/absence sampling can be used as a method for evaluating appropriate thresholds for clearance of a site for future reuse. In the case of Hunters Point Naval Shipyard, VSP software was used to compute some possible scenarios as a demonstration of how item sampling works. The population of Trench Units (TUs) (N=63) located on Parcel G is used as an example. In this design, each TU is considered to be an item. Sampling results are categorized as binary as per VSP:

"…this design requires that each sample result be categorized as a binary outcome, such as 1) the presence or absence of a particular quality, 2) a sample result being acceptable or unacceptable as defined by an action level threshold, 3) contamination being detected or not detected, etc. "

Additionally,

"The objective of this design is to demonstrate, with high probability, that a high percentage of the decision area (or population) is acceptable, where none of the observed samples may be unacceptable."

For Parcel G, which has 63 TUs:

1) The 2 levels of confidence are set. For example, "I want to be 95% confident that 95% of the 63 TUs are acceptable."
2) A decision is made whether to include targeted TUs in addition to randomly selected TUs. This also requires, an input, how much more likely the targeted TUs are to be unacceptable as compared to the remaining TUs. For example: "I believe that a target TU is 2 times more likely to be unacceptable"
3) Based on the above two inputs, the number of targeted and the number of random TUs to be evaluated is computed using VSP.
4) Each of the TUs selected for evaluation (a subset of the 63 TUs) undergo a MARSSIM Class 1- based scan/sampling process.
5) If at the end of the Class 1 process for the subset of TUs, if any of the evaluated TUs is determined to be unacceptable, then the preset confidence levels will no longer hold, and it requires all TUs undergo a MARSSIM Class 1 process.

Some example calculations are presented below.

For a sampling design where all TUs for evaluation are targeted:

- If I believe that a targeted TU is 2 times more likely to be unacceptable, and I sample 21 (33% of 63 total) targeted TUs then I can be at least 95% confident that 95% of the TUs meet criteria. If I sample 16 (25% of 63 total) targeted TUs, then I can be at least 90% confident that 95% of the TUs meet criteria.
- In addition, Parcel G has 32 total Building Site Survey Units (SUs). If I believe that a targeted SU is 2 times more likely to be unacceptable, and I sample 16 (50% of 32 total) targeted SUs, then I can be at least 95% confident that 95% of the SUs meet criteria. If I sample 15 (47% of 32 total) targeted SUs, then I can be at least 90% confident that 95% of the SUs meet criteria.

For a sampling design where all TUs for evaluation are selected randomly:

- If one wants to be 95% confident that 95% of the 63 TUs are acceptable then 39 TUs selected randomly must meet criteria.

- If one wants to be 61% confident that 95% of the TUs are acceptable then 16 (25% of 63) TUs selected randomly must meet criteria.

For a sampling design with targeted and randomly selected TUs:

- If I believe that a targeted TU is 2 times more likely to be unacceptable and I want to sample 16 targeted TUs then I need to sample an additional 7 random TUs. If all of the combined (random and targeted) TUs meet criteria then I can be at least 95% confident that 95% of the TUs meet criteria.

UNCERTAINTIES

Item sampling is not included in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and is not typically used in this manner. It applies to grid cells across a region (a wall, a floor, etc), a group of drums, etc. where a single sample (wipe sample) dictates the presence/absence of the contamination. For Hunters Point, the Class 1 MARSSIM approach requires scanning 100% of the region followed by multiple sample collection and statistical analysis. The final binary answer, acceptable or unacceptable, is based on multiple lines of evidence not a single sample. The variability associated with a decision based on multiple lines of evidence is not captured.

cc: Central File - WA # SERAS-106 (w/attachment)
Electronic File - I:/Archive/SERAS/106/D/TM/022118
Kevin Taylor, SERAS Program Manager (cover page only)