The Great Majority of Hunters Point Sites Were Never Sampled for Radioactive Contamination

And the Testing That Was Performed Was Deeply Flawed

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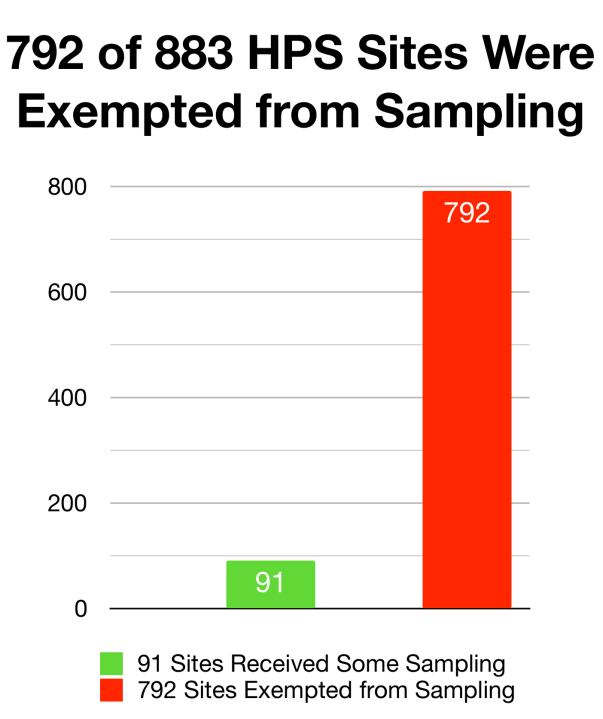
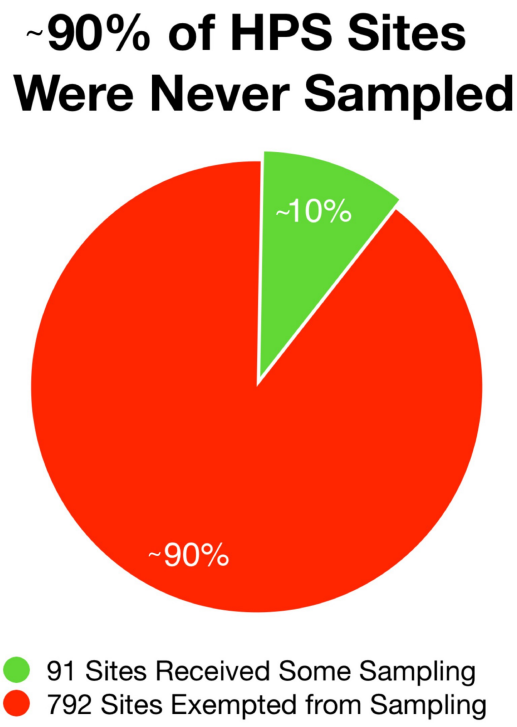
EXECUTIVE SUMMARY

The problems involving falsification of data by Navy contractor Tetra Tech at Hunters Point are but the tip of the iceberg.

1. The Navy Exempted the Great Majority of Hunters Point Sites from Sampling

The Navy identified 883 historic and current sites at Hunters Point Shipyard (HPS), but simply declared, based on review of spotty historical records, all but 91 of them to not possibly be impacted and thus not needing sampling. Since there were numerous mechanisms by which contamination could have spread throughout HPS, such as the open-air sandblasting and steam-cleaning of more than 80 radioactive ships from the Pacific nuclear tests, no part of HPS can be reasonably presumed to be non-impacted and all of HPS facility should have been sampled.





2. The Premise That Contamination Couldn't Exist in Most of HPS Has Been Disproven

The recent discovery of radioactivity in Parcel A, previously declared "non-impacted" and not needing testing, undermines Navy claims that only a few areas for which it has records of radioactivity use could be impacted or need to be tested. Similarly, in Parcel B, the Navy found "ubiquitous" contamination when it had expected it to be localized around known spill locations, and found radioactivity in places not expected. All of HPS should be considered potentially impacted and all should have thorough soil sampling.

3. No Sampling Was Conducted for ~90% of Radionuclides

The Navy identified 108 radionuclides used at HPS, of which it determined 33 to be "radionuclides of concern." Yet, for the small fraction of HPS that was sampled, the Navy frequently tested and set cleanup levels for as few as three or four of those radionuclides.

Large quantities of a wide array of radionuclides were present at HPS; it was inappropriate to decline to test and to require cleanup for ~90% of those radionuclides.

4. Background Measurements Were Inappropriately Taken from Potentially Contaminated Areas

The Navy inflated claimed levels of "background" radiation by taking measurements from potentially contaminated locations, and thus may have inappropriately declared as "clean" and not needing cleanup soil that should have been remediated. Background is the level of radionuclides that would have been at Hunters Point had HPS nuclear activity never occurred there. Taking samples in the midst of the contaminated Superfund site, and at times even in buildings that were admitted to be impacted, can artificially skew upward claimed background and thus inappropriately prevent contaminated soil from being cleaned up.

5. For Much of What Was Tested, Only A Few Measurements Were Taken, Too Few to Have Confidence of Finding the Contamination

Of the sites that were measured, the Navy inappropriately declared significant fractions to be "Class 2" or "Class 3" sites and thereby took only a few measurements in them. For example, for buildings that were declared significantly impacted, the Navy nonetheless automatically declared large portions of them to require only the minimal surveys of Class 2 or 3 sites. HPS is a Superfund site, by definition one of the most contaminated locations in the country, and all of the areas should be presumed to be potentially impacted and requiring full sampling.

6. The Radiation Testing Procedures Were Often Blind to Most Radionuclides

a. "Gamma Scanning" Can't Detect Alpha- or Beta-Emitting Radionuclides, Nor Even Most Gamma Radionuclides at the Levels Requiring Cleanup; It is Mainly for PR

The gamma scans performed were blind to alpha-emitting radionuclides such as plutonium-239 and to beta-emitting radionuclides such as strontium-90. For the two gamma radionuclides primarily declared by the Navy to be the ones of concern, the scans could only detect one of the two at the levels requiring cleanup. To a significant degree, the gamma scans were for PR purposes; they couldn't determine safety. Soil sampling is required for that determination.

b. When Soil Samples Were Taken, ~90% of Them Were Not Measured for Two of the Four Radionuclides Declared by the Navy to Be of Primary Concern, Strontium-90 and Plutonium-239

In addition to not measuring for ~90% of the radionuclides of concern, ~90% of the measurements that were made on soil samples didn't measure for two of the four radionuclides admitted by the Navy to be key at HPS: strontium-90 and plutonium-239. The soil samples were mainly measured for gamma-emitters, and strontium-90 and plutonium-239 are, as indicated above, beta- and alpha-emitters.

7. Even With All These Other Defects, the Navy's Contractor Tetra Tech Fabricated or Falsified Readings from 90-97% of the Survey Units that Were Measured

It is difficult to comprehend, but given all of the defects described above, of choosing to not sample from most areas at HPS, of not measuring for most radionuclides, of taking background measurements from areas potentially contaminated, etc., that Tetra Tech still ended up apparently falsifying data from almost all of the survey units it worked on. Samples that came back "hot" were thrown out and replaced with soil from areas deemed clean. Data strings for buildings were repeated over and over again—apparently, rather than taking actual measurements, measurements from elsewhere were just pasted into the reports. Over and over again, the limited sampling that was done was fabricated. EPA and state regulators estimate as few as 3% of the survey units were free of evidence of falsification.

Conclusion

There are essentially no data to support presumptions of safety at HPS. The great majority of the site was never tested for radioactivity, and what measurements were made ignored the great majority of radionuclides. What testing was done generally could not detect most of the radionuclides at the levels requiring cleanup. Furthermore, EPA and the other regulatory agencies have determined that 90-97% of the measurements by Tetra Tech are suspected to be falsified. The problems are thus not restricted to the existing Tetra Tech scandal. For example, the recent CDPH limited gamma scan of Parcel A-1 and the similarly deeply flawed Navy plan for retesting Parcel G, subject of detailed critiques in other of our reports, repeat and indeed expand rather than correct these fundamental defects. Absent a top-to-bottom reformation of the conduct by the Navy and its contractors and its regulators that allowed this dangerous situation to occur, public health and safety cannot be guaranteed.

For access to other reports on HPS in this series: http://www.committeetobridgethegap.org
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Introduction

Our previous report detailed the extraordinary breadth and magnitude of radiological activities and poor environmental controls which occurred at the Hunters Point Shipyard (HPS). As shown there, more than 80 ships heavily contaminated during nuclear weapons tests in the Pacific were brought to HPS where they were sandblasted in an effort to be remove the radioactivity. This, along with numerous other intensive activities involving radioactive materials, had the potential to spread the contamination throughout HPS. In addition, scores of radionuclides were used at the site, often in vast quantities. Yet, as shall be seen in this report, the Navy simply declared ~90% of Hunters Point sites to be "non-impacted" and not needing testing, and ~90% of radionuclides used at the site to be "not of concern" and also not sampled.

The Navy Exempted ~90% of Hunters Point Sites from Sampling

The public would reasonably think that sampling of soil and other materials for radioactive contamination had been performed across the whole Hunters Point Shipyard site, and with numbers of samples and techniques sufficient to have high confidence that contamination that might be present was not overlooked. **In fact, however, the Navy decided to exempt ~90% of the locations at Hunters Point from any soil sampling or building measurements.**

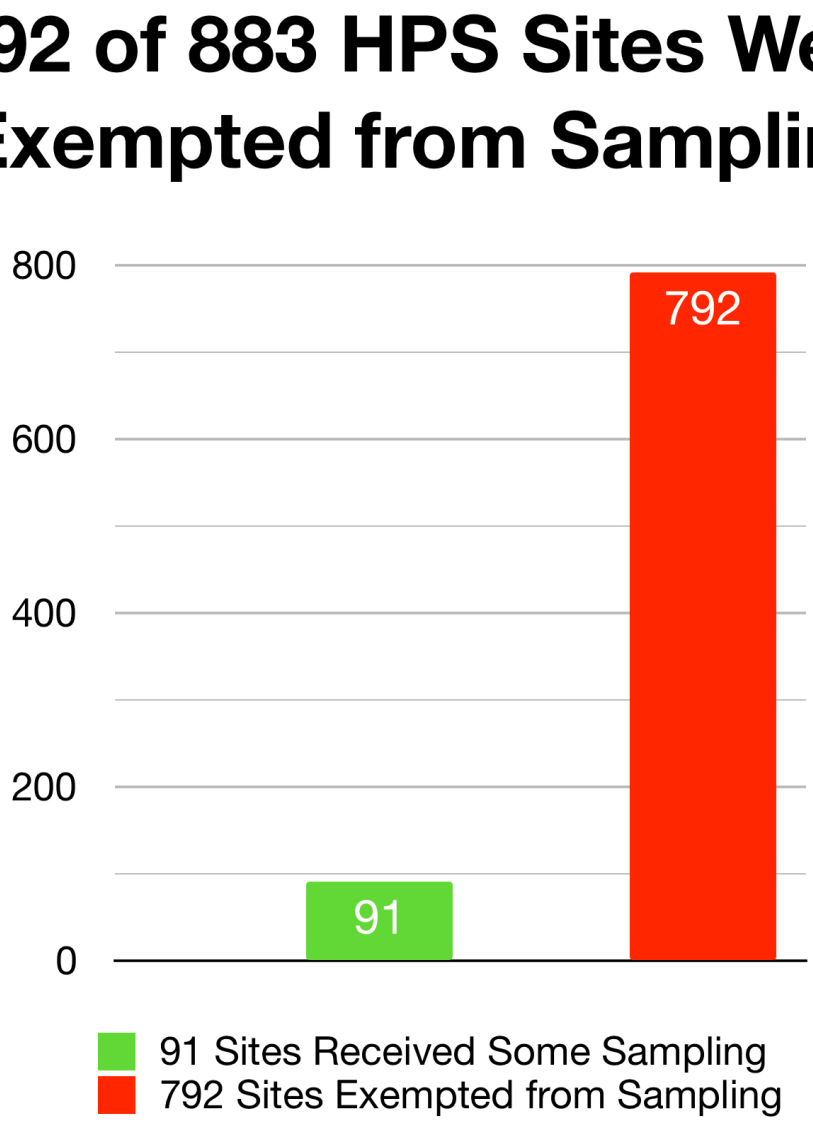
Instead of sampling across the site, which would provide a comprehensive determination of what contamination was present and where, the Navy reviewed some available records of what activities occurred in different buildings and other related sites and then artificially restricted the sampling to the small fraction of sites for which it had records indicating specific radiological work had been carried out there. **This completely ignored the potential for contamination to have migrated throughout Hunters Point (e.g., from the open-air sandblasting of contaminated ships)**.

The resulting Historic Radiological Assessment (HRA):

- Identified "**883 HPS historic and current sites**, including buildings, structures, defined open areas, drydocks, and ships' berths."[1]

- **Only 91 of these (~10%) were identified in the HRA as "impacted,"** defined as places where radiological operations occurred, including the use, handling, packaging, or disposal of radioactive materials."[2] Consideration of sampling was thus arbitrarily limited

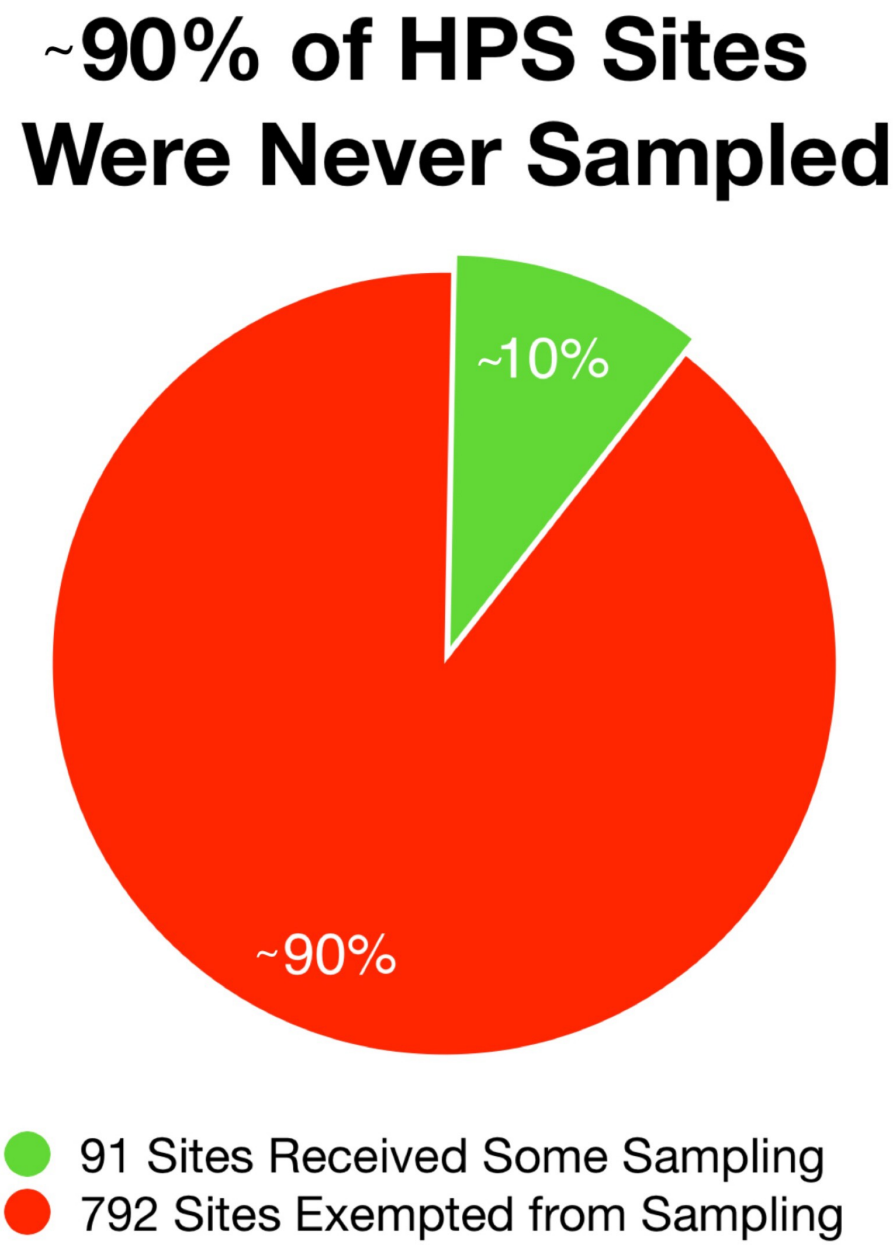
to these 91 sites, based on whether the Navy had records of specific radiological activity at them.[3]



The entire basis for the **Navy's decision to cut corners and exempt 90% or more of Hunters Point sites from sampling** was a paper exercise—reviewing old records and assuming that contamination could only exist where they had documents showing radioactive materials were stored or used in those particular locations. The logical flaws in such an approach are obvious.

First of all, the likelihood that the available records going back seven decades are complete or accurate is very small. On the one hand, it is implausible that every use of radioactive materials and every spill would be written up, particularly back in the forties, fifties, and sixties. On the other hand, it is inconceivable that even were there such comprehensive records, they would be fully retained for many decades; and further unrealistic that those who prepared the HRA would

have found and gone over all records that do still exist. The Navy even admits it themselves in the HRA that: **"Many documents had been destroyed because Federal and Navy record retention requirements allow record destruction after a designated amount of time."**[4]



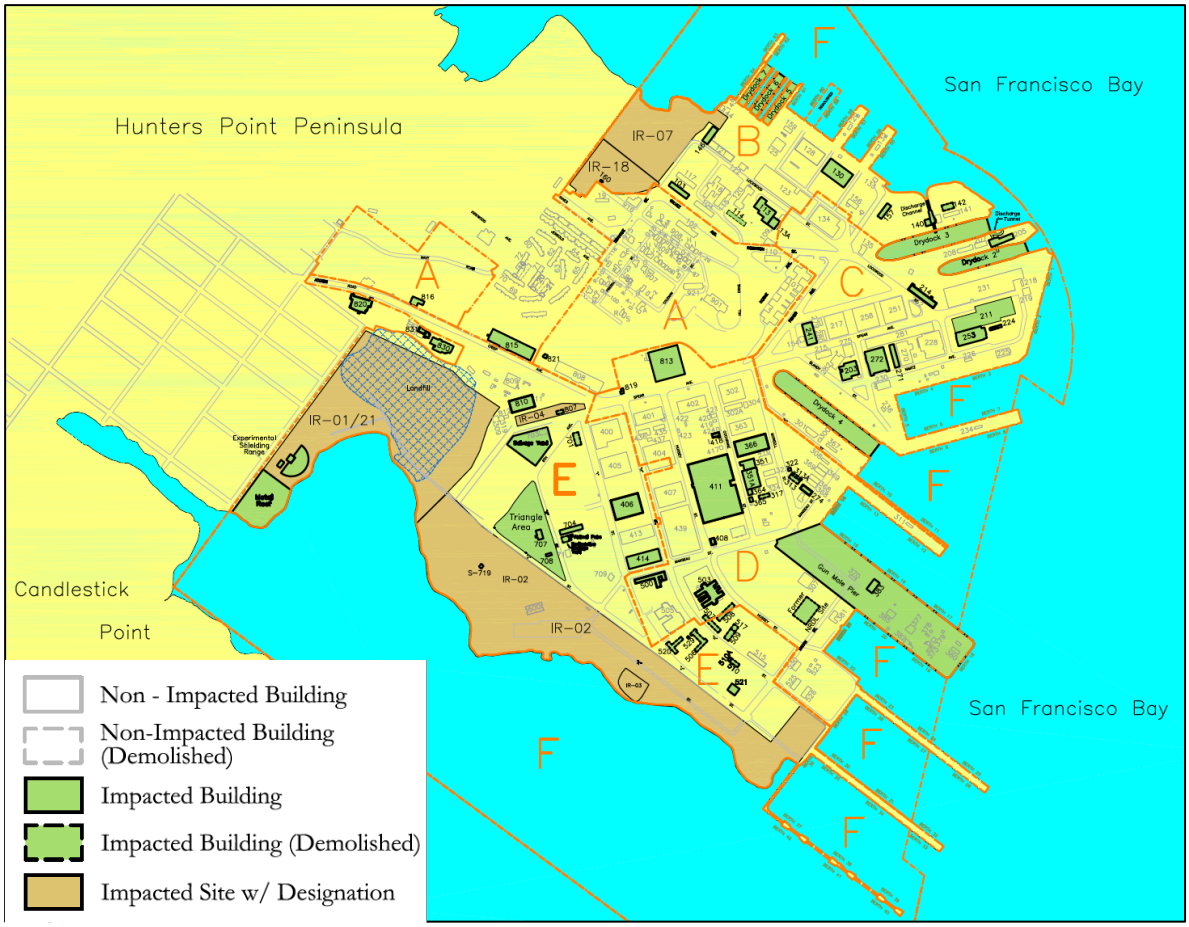
Secondly, the assumption that radioactive contamination is limited to buildings and other locations where there is a record of storage or use of radioactive materials is fundamentally flawed. One is concerned with *contamination migration;* by definition it doesn't stay put. When the wind blows, the rain falls and stormwater flows, when trucks drive over one contaminated area tracking the contamination into other areas, the pollution moves.

Furthermore, as shown in our report on the radioactive history of Hunters Point, much of the activity carried with it the potential for widespread distribution of radioactivity across the whole facility. More than 600,000 gallons of radioactively contaminated fuel oil from three badly impacted ships from the nuclear weapons tests in the Pacific were burned in boilers at Hunters Point; the radioactivity in the plume from that burning could thus have fallen out over much of the site. Onsite incinerators burned dead test animals and other materials that could have contained radioactivity, again potentially resulting in widespread dispersal of contamination. The sandblasting and high pressure steam cleaning of contaminated nuclear test ships is likely to have resulted in radioactivity being spread throughout the area. The fire in the landfill that contained radioactive wastes could have similarly resulted in fallout from the radioactive emissions at distance from the landfill. Helicopters landing at and taking off from the helicopter pad for the SF Police Department, near contaminated soil, could blow that contamination around widely. Decades of excavation of contaminated soil, spreading it across radiological screen yards for measurements, moving it again to fill trucks for offsite disposal or returned to trenches or use as fill—all of these intensive activities lofted significant amounts of contamination into the air and otherwise spread it widely. These are but a few examples of potential mechanisms for radioactivity in one place at HPS to be spread elsewhere.

At other Superfund sites, such as Hanford, Rocky Flats, and Santa Susana, radioactive contamination has been found in soil far from the buildings in which nuclear operations occurred. It is technically indefensible, therefore, to limit one's sampling to buildings and other sites where the available historical record indicates radioactive materials were stored or used. The whole point is that contamination from those materials can pollute wide areas.

In short, the foundation of the cleanup plan of HPS relies on an admittedly incomplete set of records, and assumes (rather than testing to see if true) that there can be no contamination except where records indicate specific radionuclides were used. This completely neglects extensive information about the radiological activities that created a high probability for contamination to have migrated throughout the site.

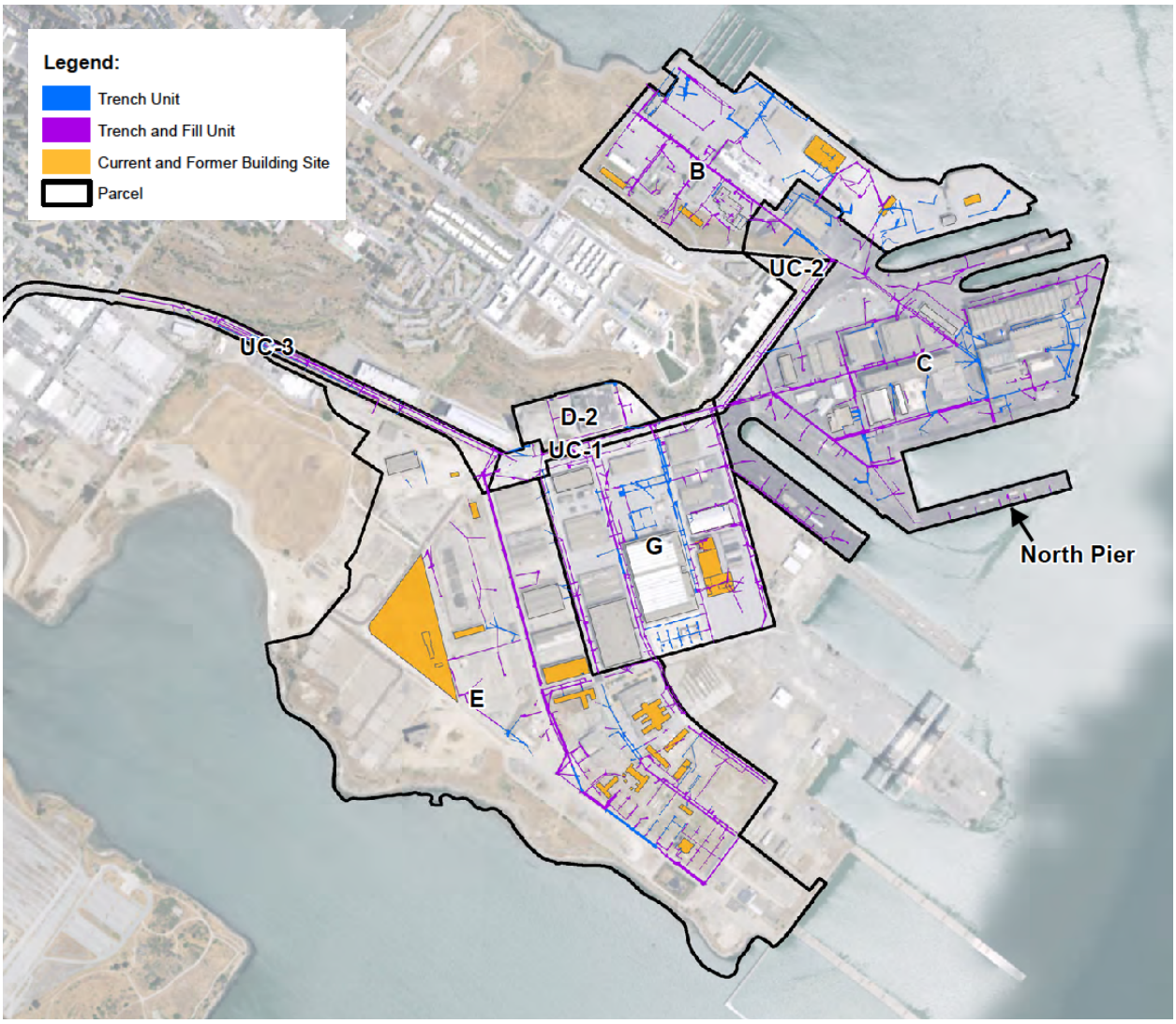
The following map from the HRA identifies the areas that were simply assumed to be not radiologically impacted (shown in yellow), based solely on a records search, and thus exempted from having any soil sampling or building measurements.[5] [Buildings the Navy assumed were not impacted are outlined in gray.]



from HRA Figure 4.1, "Overall Impacted Sites"

[The HRA was finalized in 2004, and therefore it is possible that in the time which has since elapsed some additional sites have been determined to be radiologically impacted and subsequently sampled or surveyed. One such example is Building 401, located in Parcel G. Building 401 was initially deemed non-impacted by the HRA, but that designation was later rescinded because items containing radium-226 were identified within it. In the Final Status Survey Report for Building 401, carried out by Navy contractor Tetra Tech, it is reported that "non-licensed radioactive materials, such as check sources, electron tubes, and other radioluminescent devices" as well as "several gauges and dials containing radium-226," were identified inside the building.]

The Navy has recently prepared a map showing the locations which received soil sampling by Tetra Tech. That map also graphically demonstrates that the great majority of soil at HPS was not tested, but rather sampling was limited to narrow trenches where drain lines had been and soil under and/or near a small fraction of the site's building. The map, reproduced below, does not include some areas, such as Parcel A, where essentially no soil sampling took place, and possibly some soil sampled by contractors other than Tetra Tech. But Tetra Tech did the primary work, and the Navy map is the best and most current representation of what was and what wasn't sampled. The great majority of the site appears not sampled for radioactivity.[6]



from US Navy, *Draft Radiological Data Evaluation Findings Report for Parcels B and G Soil* September 2017, Figure 1-2

The Premise That Contamination Couldn't Exist Elsewhere at HPS Has Been Disproven

As discussed above, the Navy simply *presumed* that the great majority of HPS was non-impacted, based on the claim that contamination would be limited to specific buildings and related sites for which it had records of specific radioactive use. The Navy employed what it called the "spill model" for this claim—the assumption that contamination could only exist in very small spots around spills, which in turn were restricted to structures or other small areas where the records indicated particular radionuclides were employed. These assumptions have since been disproven, as discussed in the following two sections.

A. The Recent Finding of Radioactivity in Parcel A, Previously Declared to be "Non-Impacted"

Parcel A was transferred to the City by the Navy in 2004. Based on the Navy's claim that essentially none of the Parcel was radiologically impacted, no soil sampling was conducted for radionuclides, with one minor exception.[7] The Parcel A Record of Decision (ROD) was for "no further action," asserting there was no possibility of radioactive contamination that would need cleanup. In part on that basis, the parcel was transferred, new housing built, and people allowed to live there today.

After the revelation of the Tetra Tech data falsification, the California Department of Public Health (CDPH) recently performed limited gamma scanning of some surface areas in Parcel A. The CDPH gamma scan work had very major limitations – no soil samples were taken to be sent to a lab for measurement, the gamma scan could not detect alpha- or beta-emitting radionuclides at all, and the scans excluded many parts of Parcel A. Additionally, the scanner apparently couldn't detect most gamma-emitters at the levels requiring cleanup, nor beneath about a foot below the surface.

Nonetheless, CDPH found a radium source (a radioluminescent deck marker) buried less than a foot below ground in Parcel A. The dose rate at the surface above the buried source was 0.09 millirem/hour, which equates to about 800 millirem per year, the equivalent of receiving about 400 chest X-rays annually, more exposure than getting a chest X-ray every day. This dose rate is more than 60 times what EPA has deemed automatically "non-protective" for Superfund sites and far above any permissible dose rate for the public. The contact dose rate when uncovered was 3.4 millirem/hour, or about 30,000 millirem/year; six times higher than even what a worker at a nuclear power plant or atomic weapons facility is allowed, and thousands to hundreds of thousands of times higher than what EPA aims for at Superfund sites.

Understand the significance of the finding: essentially all of Parcel A had been **declared** non-impacted, with no need for soil sampling. This was based merely on a records search, not measurements. The CDPH limited gamma survey didn't look in most places and couldn't detect most radionuclides at the levels requiring cleanup; nonetheless they stumbled upon a large radioactive source **where it had been declared there could be no radioactivity at all.**[8] It thus raises the question of what other radioactivity is in Parcel A and would be found if measurements were made in and around residences and in particular if soil measurements were made, capable of detecting alpha-, beta- and gamma-emitters at the levels requiring cleanup, not just cursory gamma scanning. **However, the finding of radioactivity in Parcel A, where it wasn't supposed to be possible to be there, demolishes the claims that by a records search one can declare the great majority of HPS to be non-impacted and not needing sampling.**

B. The Finding of "Ubiquitous" Contamination and Radioactivity in Parts of Parcel B Which Were Supposed to Be Non-Impacted

Unlike Parcel A, the Navy conceded there was contamination in Parcel B that needed to be cleaned up. The original 1997 ROD for Parcel B selected as its remedy the removal of the contaminated soil, based on what the Navy called the "spill model." In this model, contamination was presumed to be limited to where toxic materials had been used and would not extend further than the immediate area where they had been spilled, with concentrations decreasing quickly from the point of the spill.

However, the cleanup took several times as long and cost several times as much as anticipated.[9] This was due to the discovery that the spill model was wrong.[10] Unlike the assumption that contamination would be localized around spill areas where hazardous materials had been known to be used, the Navy found contamination to be far more widespread, indeed, what it called "ubiquitous."[11] Additionally, they found fill with large amounts of demolition debris: "The highly nonuniform distribution of chemicals within the debris fill also did not conform to the spill model and, consequently, excavations...often greatly exceeded the originally planned extent of the removals."[12]

Critically, the Navy acknowledged that part of the reason why so much more cleanup would be needed in Parcel B than they had anticipated was the following: "In addition, **radiological contamination has been identified at some locations of Parcel B that was not known when the original ROD was prepared.**"[13] By contrast, the original ROD had asserted that "No air or radiation concerns were identified on Parcel B."[14] Yet they later found that to be wrong, identifying radioactive contamination in parts of Parcel B where they had assumed it couldn't be.[15]

Because of the "ubiquitous" contamination found, disproving the "spill model," and the discovery of radioactive contamination where it was presumed there was none, the Navy made a dramatic shift that has had major significance to the remediation or non-remediation of HPS. Up until this point, the promise had been to clean up contamination that existed above health-based remediation goals. In the Parcel A case, they simply assumed there wasn't such contamination, that the site was basically non-impacted, and transferred the land without almost any soil samples for radioactivity and with "no further action" as the cleanup decision. In the Parcel B case, the initial ROD mandated removal of all contamination above cleanup limits. However, after it was discovered that there was much more contamination than the Navy had anticipated, and that its model, which assumed contamination limited to small areas of spills in places where hazardous materials had been recorded to have been used, was wrong, and that radioactive contamination, was found in places the Navy had presumed there to be none, the Navy reversed course on its cleanup commitments.

The longstanding promises to the public that the contamination would be cleaned up fully so that the site could be released for unrestricted, residential use were suddenly abandoned. **The Parcel B ROD was amended to no longer require removal of contamination and instead rely on covering up the contamination, with soil or asphalt, and imposing land use restrictions.**

Rather than cleaning up the contamination, the "remedies" shifted to covering it up. These adjustments set a precedent, and all subsequent RODs took the same new approach. The implications of this major shift from cleanup to cover up are discussed in detail in our separate report on that subject.

Both the Parcel A and Parcel B examples discussed above, in which radioactivity was discovered in places where it had previously been declared to not be possible to exist, demonstrate that the Navy's simple declaration that the great majority of HPS was "non-impacted" and didn't need sampling was fundamentally erroneous. The Navy continues to operate under the fiction that there is no potential for radiological contamination in most of HPS and therefore no need to sample the soil to find out if that is true. However, science works by acquiring data first and drawing conclusions thereafter from the data. Instead, the Navy declared a presumption and from that simply asserted no data needed to be acquired. It was a dangerously wrongheaded approach. And indeed, the HPS experience showed it to be foolhardy to assume contamination could only be in limited locations where sketchy records showed specific radioactive operations, and that the contamination would be restricted to small areas around spill locations. The Navy in fact discovered that this "spill model" was wrong, and contamination appears widespread. The full site needed to be sampled, as contamination could be found anywhere and could have readily migrated to all parts of HPS. Simply declaring the great majority of the site non-impacted, without soil samples, doesn't survive scrutiny.

No Sampling Conducted for the Great Majority of Radionuclides

In addition to not sampling the great majority of HPS at all, what sampling was done did not include measurements for the great majority of radionuclides of concern. No cleanup levels were established for them, thus allowing unlimited levels of contamination if present. Furthermore, most soil measurements did not even include the most critical radionuclides like strontium-90 and plutonium-239.

The USEPA has established Preliminary Remediation Goals (PRGs) for over 400 radionuclides for cleanup at Superfund Sites.[16] While not all radionuclides are likely to be present at every site, a large number must be presumed to be possible at a complex site such as Hunters Point. HPS was involved, for example, with the decontamination of more than eighty naval vessels that had been heavily contaminated in nuclear weapons tests in the Pacific. The radionuclides associated with those tests would thus be expected to include the full range of the longer-lived fission products (the radioactive fragments from splitting uranium and/or plutonium[17]), unfissioned plutonium and uranium, and a wide array of activation products (normal materials such as sand, corral, ship metals, etc. that become radioactive when irradiated with neutrons, as well as unique radionuclides, including "high-Z" materials produced by irradiating bomb materials at the extraordinary pressures reached in a hydrogen bomb).[18] Additionally, the Naval Radiological Defense Laboratory (NRDL) that was established at Hunters Point did extensive work with a very wide range of radionuclides, often in large quantities, as discussed in depth in our previous report on the HPS history of radioactivity use.

A few hundred miles south of Hunters Point, at the former reactor testing facility known now as the Santa Susana Field Laboratory (SSFL), USEPA conducted radiation sampling of soil. There it identified over ninety radionuclides of concern (ROCs), of half-lives sufficiently long to still be present, based on similar findings at the Hanford Nuclear Reservation; to focus resources, USEPA chose to measure at SSFL for more than sixty of those ROCs).[19] Hunters Point would be expected to have more radionuclides of concern than SSFL, in part because of the unique radionuclides produced by nuclear weapons tests and in part because of the extensive and unusual work done with radioactive materials by NRDL.

Indeed, the Navy in the 2004 HRA identified **108 radionuclides used at HPS:**

TABLE 4-2
RADIONUCLIDES USED AT HPS

Radionuclide	Half-Life	Radiation
I-125 (Iodine)	59.4 Days	Beta⁻ and gamma
I-129	1.57×10^7 Years	Beta⁻ and gamma
I-131	8 Days	Beta⁻ and gamma
In-115 (Indium)	4.4×10^{14} Years	Beta⁻
Ir-192* (Iridium)	73.8 Days	Beta⁻ and gamma
K-40 (Potassium)	1.27×10^9 Years	Beta⁻ and gamma
K-42	12.36 Hours	Beta⁻ and gamma
Kr-85 (Krypton)	10.76 Years	Beta⁻ and gamma
La-140 (Lanthanum)	1.68 Days	Beta⁻ and gamma
Lu-177 (Lutetium)	6.71 Days	Beta⁻ and gamma
Mn-54 (Manganese)	312.1 Days	Beta⁻ and gamma
Mo-99 (Molybdenum)	2.75 Days	Beta⁻ and gamma
Na-22 (Sodium)	2.6 Years	Beta⁺ and gamma
Na-24	14.95 Hours	Beta⁻ and gamma
Nb-94 (Niobium)	2×10^4 Years	Beta⁻ and gamma
Nd-147 (Neodymium)	10.98 Days	Beta⁻ and gamma
Ni-63 (Nickel)	100 Years	Beta⁻
Np-237 (Neptunium)	2.14×10^6 Years	Alpha and gamma
P-32 (Phosphorus)	14.28 Days	Beta⁻
Pa-234 (Protactinium)	6.7 Hours	Beta⁻ and gamma
Pb-210 (Lead)	22.6 Years	Beta⁻ and gamma
Pd-109 (Palladium)	13.5 Hour	Beta⁻ and gamma
Pm-147 (Promethium)	2.62 Years	Beta⁻ and gamma
Po-210 (Polonium)	138.4 Days	Alpha and gamma
Pr-143 (Praseodymium)	13.57 Days	Beta⁻ and gamma
Pr-144	17.28 Minutes	Beta⁻ and gamma
Pu-237 (Plutonium)	45.2 Days	Alpha and gamma
Pu-238	87.7 Years	Alpha and gamma
Pu-239*	2.41×10^4 Years	Alpha and gamma
Ra-226* (Radium)	1,599 Years	Alpha and gamma
Rn-222 (Radon)	3.82 Days	Alpha and gamma
Rb-86 (Rubidium)	18.65 Days	Beta⁻ and gamma
Ru-103 (Ruthenium)	39.27 Days	Beta⁻ and gamma
Ru-106	1.02 Years	Beta⁻
S-35 (Sulfur)	87.2 Days	Beta⁻
Sb-125 (Antimony)	2.76 Years	Beta⁻ and gamma
Sc-46 (Scandium)	83.8 Days	Beta⁻ and gamma
Se-75 (Selenium)	119.8 Days	Gamma
Sm-145 (Samarium)	340 Days	Gamma
Sm-153	1.93 Days	Beta⁻ and gamma

TABLE 4-2
RADIONUCLIDES USED AT HPS

Radionuclide	Half-Life	Radiation
Ac-227 (Actinium)	21.8 Years	Alpha, beta⁻, and gamma
Ag-110 (Silver)	24.6 Seconds	Beta⁻ and gamma
Am-241 (Americium)	432.7 Years	Alpha and gamma
Am-243	7,370 Years	Alpha gamma
As-73 (Arsenic)	80.3 Days	Beta⁻ and gamma
As-76	26.3 Hours	Beta⁻ and gamma
Au-195 (Gold)	186 Days	Gamma
Au-198	2.7 Days	Beta⁻ and gamma
Ba-133 (Barium)	10.5 Years	Beta⁻ and gamma
Ba-140	12.8 Days	Beta⁻ and gamma
Be-7 (Beryllium)	52.28 Days	Beta⁻ and gamma
Bi-207 (Bismuth)	32 Years	Beta⁻ and gamma
Bi-210	5.01 Days	Beta⁻ and gamma
Br-82 (Bromine)	1.47 Days	Beta⁻ and gamma
C-14 (Carbon)	5715 Years	Beta⁻
Ca-45 (Calcium)	162.7 Days	Beta⁻ and gamma
Cd-109 (Cadmium)	462 Days	Gamma
Cd-115	2.23 Days	Beta⁻ and gamma
Ce-141 (Cerium)	32.5 Days	Beta⁻ and gamma
Ce-144	284.6 Days	Beta⁻ and gamma
Cf-252 (Californium)	2.65 Years	Alpha, beta⁻, and gamma
Cl-36 (Chlorine)	3.01×10^5 Years	Beta⁻
Cm-242 (Curium)	162.8 Days	Alpha and gamma
Cm-244	18.1 Years	Alpha and gamma
Co-57 (Cobalt)	271 Days	Gamma
Co-58	70.9 Days	Beta⁻ and gamma
Co-60*	5.27 Years	Beta⁻ and gamma
Cr-51 (Chromium)	27.7 Days	Gamma
Cs-134 (Cesium)	2.07 Years	Beta⁻ and gamma
Cs-137*	30.1 Years	Beta⁻ and gamma
Eu-152 (Europium)	13.5 Years	Beta⁻ and gamma
Eu-154	8.6 Years	Beta⁻ and gamma
Eu-155	4.8 Years	Beta⁻ and gamma
Eu-156	15.2 Days	Beta⁻ and gamma
Fe-55 (Iron)	2.73 Years	Gamma
Fe-59	45.5 Days	Beta⁻ and gamma
Gd-152 (Gadolinium)	1.1×10^{14} Years	Alpha
Ge-68 (Germanium)	270.8 Days	Beta⁻ and gamma
H-3 (Tritium)	12.3 Years	Beta⁻
Hg-203 (Mercury)	46.6 Days	Beta⁻ and gamma

TABLE 4-2 RADIONUCLIDES USED AT HPS		
Radionuclide	**Half-Life**	**Radiation**
Sn-113 (Tin)	115.1 Days	Beta$^-$ and gamma
Sr-85 (Strontium)	64.84 Days	Gamma
Sr-89	50.52 Days	Beta$^-$ and gamma
Sr-90*	28.78 Years	Beta$^-$
Ta-182 (Tantalum)	114.4 Days	Beta$^-$ and gamma
Tb-161 (Terbium)	6.91 Days	Beta$^-$ and gamma
Tc-97 (Technetium)	2.6×10^6 Years	Beta$^-$ and gamma
Tc-99	2.1×10^5 Years	Beta$^-$ and gamma
Te-127 (Tellurium)	9.4 Hours	Beta$^-$ and gamma
Te-133	12.4 Minutes	Beta$^-$ and gamma
Te-133m	55.4 Minutes	Beta$^-$ and gamma
Th-228* (Thorium)	1.91 Years	Alpha and gamma
Th-232	1.4×10^{10} Years	Alpha
Ti-44 (Titanium)	67 Years	Gamma
Tl-204 (Thallium)	3.78 Years	Beta$^-$
Tm-170 (Thulium)	128.6 Days	Beta$^-$ and gamma
Tm-171	1.92 Years	Beta$^-$ and gamma
U-233 (Uranium)	1.59×10^5 Years	Alpha and gamma
U-235	7.04×10^8 Years	Alpha and gamma
U-236	2.34×10^7 Years	Alpha and gamma
U-238	4.478×10^9 Years	Alpha and gamma
W-185 (Tungsten)	74.8 Days	Beta$^-$ and gamma
Xe-133 (Xenon)	5.24 Days	Beta$^-$ and gamma
Y-88 (Yttrium)	106.7 Days	Beta$^+$ and gamma
Y-90	2.67 Days	Beta$^-$ and gamma
Y-91	58.5 Days	Beta$^-$ and gamma
Zn-65 (Zinc)	243.8 Days	Beta$^+$ and gamma
Zr-95 (Zirconium)	64 Days	Beta$^-$ and gamma

The HRA then reduced the list of 108 radionuclides used at HPS to 33 radionuclides of concern. [Part of the reduction was due to eliminating shorter-lived radionuclides (i.e., those for which ten half-lives was less than a few decades). However, some of these shorter-lived materials would still be present far beyond decades, because they are continually replenished by decay of longer-lived parent isotopes. It is not clear why others that were longer-lived, such as I-129, were removed.] The HRA Table 4-3 of the Hunters Point Radionuclides of Concern is included below.

TABLE 4-3 RADIONUCLIDES OF CONCERN AT HPS		
Radionuclide	**Half Life**	**Radiations**
Ac-227 (Actinium)	21.8 Years	Alpha, beta, and gamma
Am-241 (Americium)	432.7 Years	Alpha, beta, and gamma
Am-243	7,370 Years	Alpha and gamma
Ba-133 (Barium)	10.5 Years	Beta and gamma
Bi-207 (Bismuth)	32 Years	Beta and gamma
C-14 (Carbon)	5715 Years	Beta
Cl-36 (Chlorine)	3.01×10^5 Years	Beta
Cm-244 (Curium)	18.1 Years	Alpha and gamma
Co-60 (Cobalt)	5.27 Years	Beta and gamma
Cs-137 (Cesium)	30.1 Years	Beta and gamma
Eu-152 (Europium)	13.5 Years	Beta and gamma
Eu-154	8.6 Years	Beta and gamma
Gd-152 (Gadolinium)	1.1×10^{14} Years	Alpha
H-3 (Tritium)	12.3 Years	Beta
In-115 (Indium)	4.4×10^{14} Years	Beta
K-40 (Potassium)	1.27×10^9 Years	Beta and gamma
Nb-94 (Niobium)	2×10^4 Years	Beta and gamma
Ni-63 (Nickel)	100 Years	Beta
Np-237 (Neptunium)	2.14×10^6 Years	Alpha and gamma
Pb-210 (Lead)	22.6 Years	Beta and gamma
Pu-238 (Plutonium)	87.7 Years	Alpha and gamma
PU-239	2.41×10^4 Years	Alpha, beta, and gamma
Ra-226 (Radium)	1,599 Years	Alpha and gamma
Sr-90 (Strontium)	28.78 Years	Beta
Tc-97 (Technetium)	2.6×10^6 Years	Beta and gamma
Tc-99	2.1×10^5 Years	Beta and gamma
Th-232 (Thorium)	1.4×10^{10} Years	Alpha
Ti-44 (Titanium)	67 Years	Gamma
Tl-204 (Thallium)	3.78 Years	Beta
U-233 (Uranium)	1.59×10^5 Years	Alpha and gamma
U-235	7.04×10^8 Years	Alpha and gamma
U-236	2.34×10^7 Years	Alpha and gamma
U-238	4.478×10^9 Years	Alpha and gamma

Source:"Radionuclides of Concern at HPS," Table 4-3, Navy Historical Radiological Assessment, 2004

Despite over a hundred radionuclides identified as having been used at HPS and thirty-three deemed in the HRA to be "radionuclides of concern," **during actual sampling and cleanup, however, only a few radionuclides were considered**. For example, the Navy now claims that there are only three or four radionuclides of concern in Parcel G (see Table 3-4) and sets cleanup standards only for those:[20]

Table 3-4. Soil Radionuclides of Concern

Soil Area	Radionuclide of Concern
Former Sanitary Sewer and Storm Drain Lines and Building 351A Crawl Space	^{137}Cs, ^{226}Ra, ^{90}Sr
Former Buildings 317/364/365 Site	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu

Table 3-5. Soil Remediation Goals

Radionuclide	Residential Soil Remediation Goal[a] (pCi/g)
^{137}Cs	0.113
^{239}Pu	2.59
^{226}Ra	1.0
^{90}Sr	0.331

[a]All RGs will be applied as concentrations above background.

Source: Navy's Parcel G Draft Retesting Plan, Tables 3-4 and 3-5

It gets even worse. In practical effect, they generally primarily measured for radium-226, and perhaps cesium-137. Gamma scans could only detect radium-226 at the cleanup levels, not cesium-137, and couldn't see alpha- or beta-emitting radionuclides at all. Soil samples were generally only measured for gamma-emitters. Only 10% of soil samples were routinely measured for strontium-90, unless cesium-137 was detected above its remediation goal, and then strontium-90 would be checked in that sample. Only if cesium-137 was detected above the cleanup level would alpha spectroscopy be performed, primarily to look for plutonium and uranium.

This sampling approach is technically indefensible. Large amounts of separated strontium-90 were used at HPS, for radioluminescent devices, deck markers, and radioisotope thermal

generators (RTGs), so one could readily have storntium-90 where cesium-137 isn't found. Similarly, the NRDL radioactive materials licenses allowed large quantities of separated plutonium and uranium, so one could find contamination from them in places where cesium-137 wasn't present. Additionally, at OPERATIONS CROSSROADS, the efforts at decontamination-at-sea were abruptly halted when it was discovered that large amounts of plutonium were being found on ships in places where there weren't fission products and that the plutonium was highly resistant to decontamination. Moreover, even if originally spilled or deposited in the same location, radionuclides migrate at different rates (e.g., have different k_d soil partition coefficients), so one readily can have cesium, strontium, and plutonium in different locations even if originally at the same location. This was seen in the EPA's Santa Susana Field Laboratory radiation survey, which found strontium in some locations and cesium or plutonium in others. Finally, the cleanup levels for different radionuclides are different, so one could have cesium contamination that was below its cleanup level while the strontium contamination at the same location was above its remediation goal, but one would not know that because the Navy declined to measure for strontium-90 unless the cesium-137 exceeded its threshold for removal.

On the other hand, one could frequently also have cesium-137 present as part of the full mix of fission products, activation products, and unfissioned plutonium and uranium that would be found from nuclear weapons test contamination and debris. Thus there is no defensible rationale for not measuring and setting cleanup standards for the dozens of radionuclides identified in the HRA as radionuclides of concern. Declaring ~90% of HPS not impacted and not needing to besampled, and then failing to measure or set cleanup levels for ~90% of the HPS radionuclides of concern cannot be readily justified.[21]

Background Measurements Taken from Potentially Contaminated Areas

To know if measurements taken at Hunters Point represent contamination, it must first be known how much radioactivity there is in local "background"—the level of naturally occurring radionuclides and global fallout, i.e., how much radioactivity there would be if the Navy had never been there. The Multi-Agency Radiological Survey and Site Investigation Manual (MARSSIM), which contractors employed by the Navy are supposed to follow, defines a non-impacted area as "an area where there is no reasonable possibility (extremely low probability) of residual contamination." These areas determined to be non-impacted, if truly free from any contamination, can reasonably be used for background reference areas. What has been and continues to be done at HPS, however, is to use locations in the midst of the contaminated Superfund site for background, areas that have a significant likelihood of being radiologically contaminated themselves, but were inappropriately labeled as "non-impacted," as discussed above.

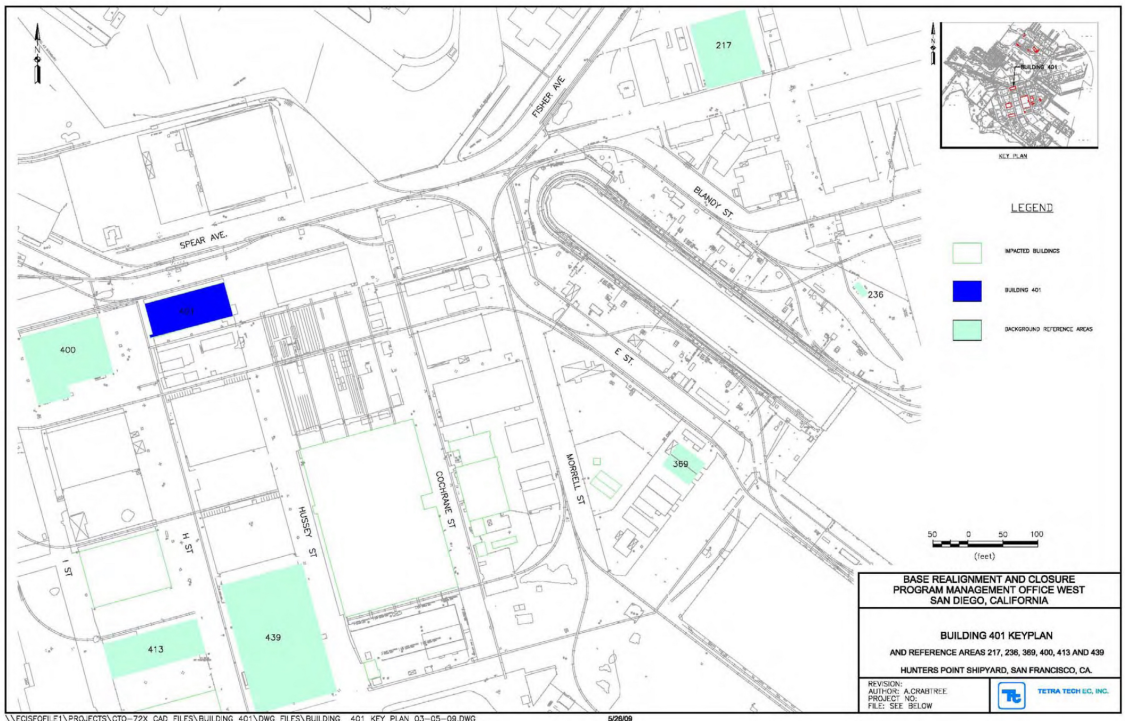
The use of background reference areas that have the potential to not be representative of true background but in actuality are contaminated creates the potential for background measurements which are significantly inflated. In doing so, soil samples would be falsely declared clean that are in fact contaminated and thus receive no remediation when they should. Soil and buildings that require cleanup would thus not get cleaned up, as a result of the manipulation of the value

claimed for background. It is thus disturbing that the Navy and Tetra Tech would take background measurements in the midst of the Superfund site, when doing so compromises the integrity of the entire cleanup.

An example is given below from a Tetra Tech report, where the impacted building location is indicated in dark blue and the background reference areas, each chosen nearby in the midst of the contaminated HPS, are identified in light green.

FIGURE 1-1

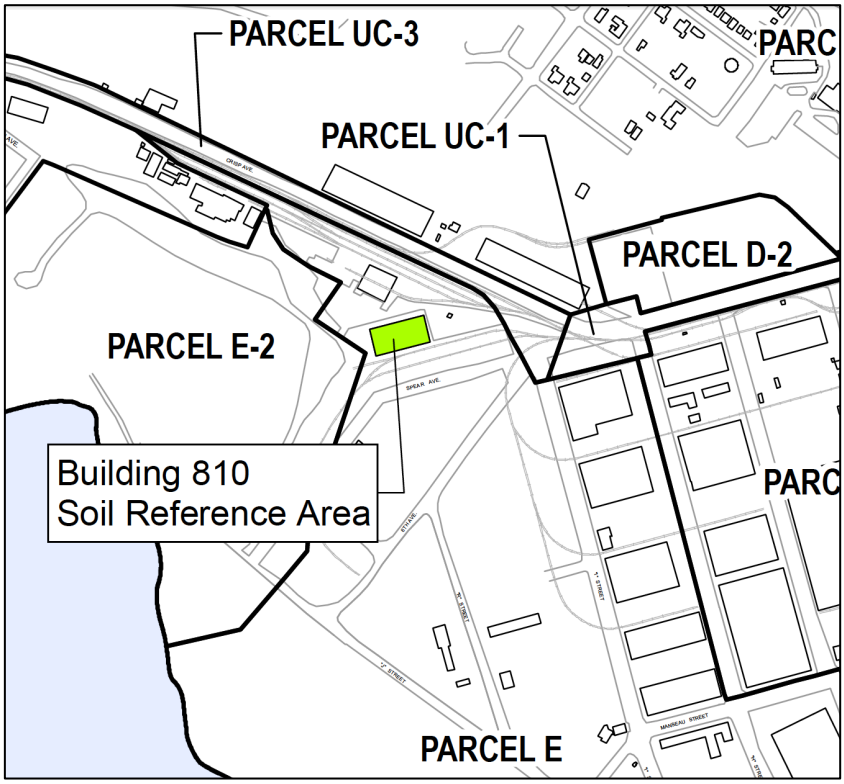
BUILDING 401 AND REFERENCE AREA LOCATIONS



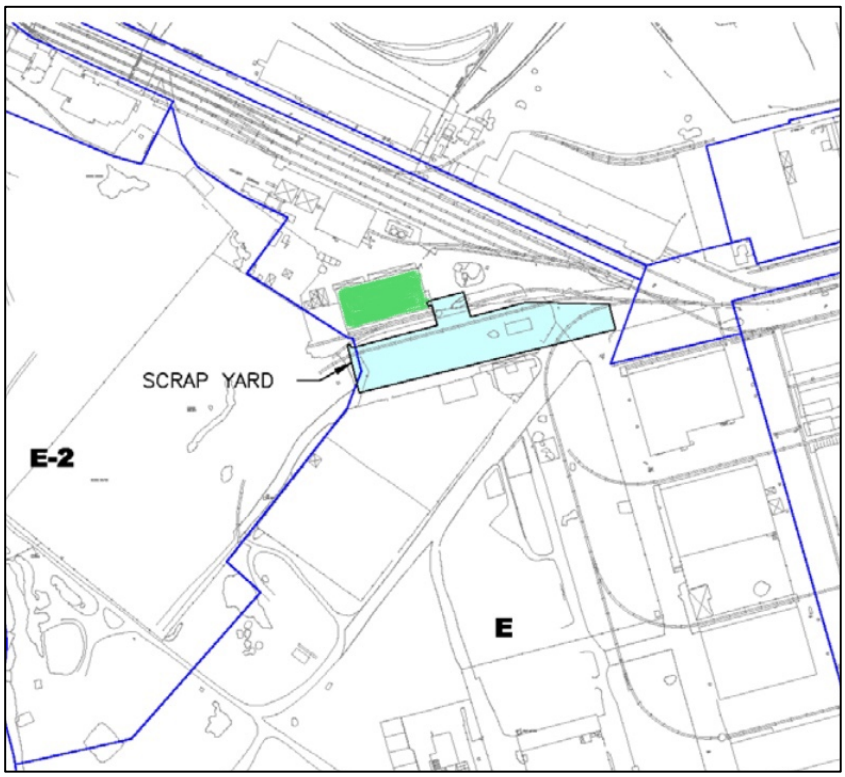
Source: Figure 1-1, Tetra Tech, *Final Status Survey Results, Bldg 401, Hunters Pt.*, Sept. 21, 2009

This manipulation strategy of taking "background" measurements in the midst of the contaminated shipyard is not merely one of past actions by Tetra Tech, but recurring to this day. Indeed, as we showed in our Critique of the Navy's Draft Parcel G Retesting Plan that was supposedly designed to eliminate the problems created by Tetra Tech, the same pattern continues. Background locations were chosen in the midst of the polluted HPS, and for buildings, within an impacted building itself.

Below is another example of how this manipulation of background continues up to the present: a figure from a July 2018 Navy report, showing once again the choice of the background soil reference area in the midst of the Superfund site. It is very close to the Parcel E-2 landfill and the IR-04 Former Scrap Yard, among other known contaminated areas. For example, according to the Final Status Survey Report for IR-04, "the HRA specifies that known areas with elevated levels of cesium-137 (^{137}Cs) and ^{226}Ra exist within the footprint of the IR-04 Former Scrap Yard Site." Yet the background location chosen, which will greatly determine what is and is not cleaned up, is in close proximity to the contaminated Former Scrap Yard site, as shown below.



Source: *FINAL REMEDIAL ACTION WORK PLAN ADDENDUM, Remedial Action in Parcel D-1, HUNTERS POINT NAVAL SHIPYARD,* prepared for the Navy by Aptim Federal Services, July 2018



Source: *FINAL STATUS SURVEY RESULTS,* IR-04 Former Scrap Yard Site and Former Building 807 Site, HUNTERS POINT NAVAL SHIPYARD, prepared for the Navy by Tetra Tech EC, INC.

An additional technique that has been employed at HPS to inflate background artificially, and thus avoid cleaning up contamination that should be removed, has been the practice of adding three standard deviations ("3 sigma") to the background value. We discussed the problems of doing this in our critique of the CDPH partial gamma scan of Parcel A and refer the reader to that discussion. In brief, this practice overstates the supposed background levels so as to make vanishingly small the chance one would clean up something that didn't actually need to be, while making a very high chance one would fail to clean up something that should have been. It is a technique to bias the measurements so as to err heavily on the side of reducing cleanup expenses as opposed to erring on the side of protecting public health.

The manipulation of background, by choosing potentially polluted areas to take the background measurements and by further inflating the value by adding three standard deviations to it, thus leads to significant potential for failing to clean up contamination that should be addressed. It is one more in a long series of problems that undermine the ability to provide assurance that the public is being protected.

For Much of What Was Tested, Only A Few Measurements Taken

After deciding to exempt from any testing the great majority of Hunters Point sites, the Navy then decided, for many of the sites remaining, to exempt much of each of them from testing. The Navy, as indicated above, declared 90% of the Hunters Points sites "non-impacted" and thus not needing any testing, when there is significant potential for them to have been impacted. Of the remaining 10%, they divided those into three classes: Class 1, 2, and 3. Class 1 sites were to have some form of testing over 100% of the site; Class 2 sites would have testing on as little as 10% of the site; and Class 3 could have even less. As of the time of the HRA, most of the impacted sites were designated merely for Class 3 minimal measurements. The Navy has estimated that at present, as much as nearly half of all sites were designated as Class 2 or 3,[22] meaning that many areas deemed necessary to receive testing were only partially tested, and in a very limited way, sometimes receiving at most a few samples in a survey unit. A large number of sites were categorized as Class 3, and received as few as four samples. The chances of finding all contamination with such few samples is exceedingly low.

For buildings, as seen Anthony Smith's declaration, and confirmed in Final Status Survey Reports for various buildings across the site, the upper halves of walls were automatically surveyed as Class 2 and the ceilings as Class 3, even when the entire building was suspected to have high potential for contamination.[23] It appears this minimal survey approach was done out of convenience rather than reason, and raises the concern whether many of the buildings which were designated as recommended for "free release" were adequately tested for contamination.

The Radiation Testing Procedures Were Often Blind to Most Radionuclides

The Basics of Measurement of Radioactive Contamination

A. Soil Sampling Versus "Scanning" – Soil Sampling is for Determining Safety, Scanning Alone is for PR

To determine the nature, location, and level of radioactive contamination at a site like Hunters Point requires the careful collection of a large number of samples of soil and other materials (e.g., asphalt, concrete) which are then sent to a qualified laboratory to identify the specific radionuclides and their concentration. These laboratory measurements often require hours per sample to obtain the required detection limit and accuracy, and for some radionuclides like strontium-90, require complex chemical separation.

Sampling generally requires two sets of samples selected in different ways. One set is randomly selected, because you doesn't know where the contamination is and are trying to find out by taking enough samples at random intervals so that there is a reasonable chance of finding the places where the radioactivity is. The second set is composed of "biased" samples, where you focus additional sampling on areas where you have special reason to believe there may be a higher chance of contamination than in other areas, e.g., because of historical information about past spills in those areas or because of hints from field instruments like metal detectors or Geiger counters.

Field survey instruments are generally insufficient on their own to locate contamination at the levels of concern but can help focus additional biased soil samples to send to a laboratory that can "see" radioactivity at the required cleanup levels. As we will discuss later, walking or driving over soil or asphalt with a field survey gamma radiation device can't detect some kinds of radioactivity at all (e.g., alpha emitters like plutonium-239 or beta-emitters like strontium-90), nor detect many gamma-emitters at the levels that would require cleanup. If used honestly, gamma scans merely help focus where one should take additional biased samples for laboratory measurement; **if used in a less than candid fashion, they are just for PR purposes, to claim one has "surveyed" the site and all is OK, when they couldn't possibly detect contamination at the levels of concern in the first place.**

B. Radiation Versus Radioactivity; Internal vs. External Emitters

As this is a key reason why there can be so little confidence in claims of safety at Hunters Point based on the current record, a bit of technical explanation is in order at the outset. The layperson tends to think of *radiation* rather than *radioactivity*. You go to a dentist or doctor and get an X-ray; the radiation source (the X-ray machine in that case) is at a distance from you and emits *radiation* that penetrates your body. In the comics, a lump of Kryptonite emits green rays that penetrate Superman's body and make him ill. The Kryptonite is radioactivity, the green rays are

radiation. Radioactive materials give off radiation. Radioactivity is the *stuff* that gives off radiation; radiation is the energy that radioactive materials give off and can impact your body.

The kind of radiation of concern at Hunters Point is *ionizing* radiation. That means that the energy when absorbed by the body can ionize atoms it hits, ripping off electrons from them, making the atoms unstable and ripping off electrons from atoms near them. They essentially damage molecules, as though hit by sub-microscopic bullets. If they damage molecules in the DNA in a cell, there might be no significant effect if that part of the DNA is unimportant; or if a critical part, the cell can die, which is no big deal because you have lots of cells. But if it hits a part of the DNA that controls cell reproduction, the cell can reproduce rapidly, which can result in a cancerous tumor. If the damage is to a reproductive cell, it can cause genetic defects in subsequent generations.

Radiation dose (how much radiation energy your body absorbs) can be reduced through three factors: time, distance, and shielding. If you are exposed for a short time, your risk is lower than being exposed at the same dose rate for a longer time. If you are further away from the radioactivity that is the radiation source, your dose is lower than if it is closer to you (for a point source, the dose goes down by the square of the distance). If you have a thick layer of, say, lead between you and the radioactive source, the dose receive is lower than if there is no shielding.

One can readily see that the risk is different from standing for a few minutes some feet away from a shielded radiation source, and getting some radioactivity into your body. In the latter case, there is no distance between the affected cells and the radiation source; there is no shielding between the radioactivity and your cells; and the radioactivity can remain inside you for decades, irradiating nearby tissues for long periods of time. Miniscule amounts of radioactivity, if ingested or inhaled, can thus cause significant risks.

Thus a primary risk at many contaminated sites is from the *inhalation or ingestion* of radioactive particles into your body. Tiny bits of radioactive material resuspended in the air can be breathed in; you can get similar particles into you by drinking contaminated water, getting a bit of radioactive dirt on your hands and then into your mouth, or by eating fruits or vegetables grown in radioactive soil. Depending on the radionuclide, the ingestion/inhalation pathways can be much larger contributors to risk than the external radiation from sources outside you.

C. Alpha, Beta, and Gamma Radiation

There are three main types of ionizing radiation emitted by radioactive materials: alpha particles, beta radiation, and gamma rays. Gamma rays are deeply penetrating; gamma-emitting materials do not need to be inside you to do harm. Beta radiation can penetrate only a short distance; if the source is outside you and close, the beta radiation can primarily affect skin and your eyes. However, if the beta-emitting materials gets inside your body, it can irradiate tissue for long periods of time. Finally, alpha particles are non-penetrating; they can't get through a piece of paper, so they are not harmful so long as they are outside you. But if you breathe any in, or drink liquids or eat food contaminated with alpha-emitting radioactive materials, they can irradiate a small amount of tissue with high energy for significant time.

This long explanation underscores why taking soil samples and sending them to a laboratory for measurement of the concentration of the particular radionuclides contained therein is the central feature of appropriate characterization of site contamination. Minuscule amounts of alpha- and beta-emitting materials, for example, can cause significant health risk if you get them inside your body, where they can irradiate nearby tissue for long periods of time with no shielding and no intervening distance to reduce the dose. **Hand-held or van-mounted gamma scanners simply can't reliably detect radioactivity at the levels of concern, the levels where cleanup may be required.** More detail about the problems with the gamma scans performed at Hunters Point can be found in the Appendix to this report.

Much of the Measurements That Were Taken at Hunters Point Couldn't Detect Radionuclides at the Cleanup Levels or Didn't Even Measure for Them At All

As we have seen above, the great majority of Hunters Point was never sampled for radioactivity; those portions that were did not receive sampling for the great majority of radionuclides of concern. However, the situation is even more troubling than that. The measurements that were done were heavily reliant on gamma scanning for radium-226, and either couldn't detect at the cleanup levels the other radionuclides the Navy admitted were of concern, or couldn't detect them at all (e.g., beta and alpha emitters like strontium-90 and plutonium-239).

The Navy and its contractor, Tetra Tech, were supposed to take soil samples and send them to laboratories to measure, but only ~10% of soil samples were measured for strontium-90. Additionally, they were to measure for strontium-90 and plutonium-239 *if* cesium-137 were over its cleanup level, but that assumes one couldn't have strontium-90 or plutonium without there also being significant concentrations of cesium-137 at the same location.[24] As we discussed in a prior report, however, Hunters Point was licensed to possess large quantities of separated strontium-90, i.e., pure strontium-90 or plutonium-239 alone, without cesium or anything else, so it makes little sense to decline to routinely measure for them and only do so if unless were elevated. Also, migration rates for different radionuclides differ as well, so even if originally mixed together, one could find them separately over time. For example, at the Santa Susana Field Laboratory, EPA frequently found strontium or plutonium in places where it didn't find cesium. Finally, during OPERATIONS CROSSROADS, very high plutonium levels were found on the contaminated ships, without other radioactive materials at those locations, and these ships were brought back to Hunters Point for decontamination, posing another mechanism for plutonium to be found in places where cesium wasn't elevated.

Despite Not Sampling the Great Majority of Hunters Point Sites and for the Great Majority of the Radionuclides of Concern, and Inflating Background Values, Tetra Tech Nonetheless Appears to Have Fabricated or Falsified Readings from 90-97% of the HPS Survey Units that Were Measured

It is difficult to comprehend, but given all of the defects described above, of choosing to not sample from most areas at HPS, of not measuring for most radionuclides, of taking background measurements from areas potentially contaminated, etc., that Tetra Tech still ended up falsifying data from almost all of the survey units it worked on. Samples that came back "hot" were thrown out and replaced with soil from areas that would be called clean. Data strings for buildings were repeated over and over again—apparently, rather than taking actual measurements, measurements from elsewhere were just pasted into the reports. Over and over again, the limited sampling that was done was fabricated. EPA and state regulators estimate as few as 3% of the survey units were free of evidence of falsification.

Conclusion

There are essentially no data to support presumptions of safety at HPS. The great majority of the site was never tested for radioactivity, and what measurements were made ignored the great majority of radionuclides. What testing was done generally could not detect most of the radionuclides at the levels requiring cleanup. Furthermore, EPA and the other regulatory agencies have determined that 90-97% of the measurements by Tetra Tech are suspected to be falsified. The problems are not restricted to Tetra Tech. The CDPH limited gamma scan of Parcel A-1 and the similarly deeply flawed Navy plan for retesting Parcel G, subject of detailed critiques in other of our reports, repeat and indeed expand rather than correct these fundamental defects. Absent a top-to-bottom reformation of the conduct by the Navy and its contractors and its federal and state regulators that allowed this dangerous situation to occur, public health and safety cannot be guaranteed.

The problems with the HPS cleanup go far beyond the scandalous fabrication of measurements by Tetra Tech. Equally troubling is the decision by the Navy to simply declare the great majority of HPS "non-impacted," based on very incomplete historical records and the clearly erroneous assumption that there could be no migration of contamination from one location to another. Our earlier report showed numerous mechanisms for such site-wide contamination, beginning with the sandblasting and steam-cleaning of more than 80 radioactively contaminated ships from the Pacific nuclear tests. There is no technical justification for simply *assuming*, as the Navy did, that about ~90% of HPS sites couldn't be impacted and did not need to have sampling conducted. Subsequent findings have demonstrated the fallacy of this presumptions.

Additionally, even when measurements were made, the Navy arbitrarily reduced the number of radionuclides of concern to just a few of the dozens its own historical radiological assessment had concluded were indeed of concern at HPS. Thus measurements—and cleanup levels—were inexplicably restricted to a mere handful, leaving the great majority of radionuclides neither measured nor subject to cleanup.

Furthermore, what measurements were made frequently couldn't detect most of those radionuclides at the levels set for cleanup. The reliance on gamma scans which cannot detect alpha- or beta-emitting radionuclides at all or most gamma radionuclides at cleanup levels becomes a kind of PR rather than scientific endeavor. Even when soil samples were taken, two of the four radionuclides focused on—plutonium-239 and strontium-90—were not measured in ~90% or more of the tests.

On top of all these problems, the great majority of what measurements were made appear fraudulent, according to the regulatory agencies themselves. Only a small fraction of measurements were deemed to be free of evidence of falsification.

In summary, the great majority of Hunters Point soil was never sampled and what samples were taken ignored the great majority of the radionuclides of concern, with unlimited contamination levels allowed without requiring cleanup. Only a tiny fraction of HPS and the radionuclides of concern were subject to sampling, and only a tiny fraction of those samples are free of evidence of fabrication. Essentially none of the entire HPS radiological cleanup endeavor to date can be relied upon to assure protection of the public.

[1] HRA2: 9-1 It is unclear whether other parts of Hunters Point Shipyard (e.g, roads, parking areas) are excluded from the 883. If so, the fraction exempted from sampling would be even larger.
[2] HRA2: 9-1, 8-1
[3] Of these 91 locations, the HRA asserted, "The potential for residual radioactive contamination exists and needs to be addressed at 60 of the impacted sites."[3] HRA2: 9-3, emphasis added
[4] HRA2: 4-7, emphasis added
[5] HRA2:4-14. A few additional sites were later designated as impacted.
[6] In 2004, EPA ran a gamma scan van over parts of HPS. The van was incapable of detecting alpha- or beta-emitting radionuclides at all. For gamma-emitters, the van was not able to detect most of those radionuclides at the levels requiring cleanup, nor anything deeper than a foot or so. It missed radioactivity that was subsequently found.
[7] Three buildings were identified where some radioactive operations may have occurred, but after declaring them non-impacted, no soil sampling was conducted, with one exception: there was some very limited soil sampling for tritium outside Building 816. Additionally, a gamma scanner van did drive over some roads in Parcel A and elsewhere, but the van could not detect alpha- or beta-emitting radionuclides and could not detect most if not all gamma-emitting radionuclides at the cleanup levels, nor any contamination below the surface.
[8] It is important to note that the EPA scanner van failed to detect the radioactivity now found in Parcel A, as well as other radioactivity in other parcels subsequently discovered.
[9] "The estimate in the original ROD for the remedial action included removal of 38,000 cubic yards of soil over a period of 3 to 6 months at a cost of $11.2 million. The remedial action at Parcel B removed more than 100,000 cubic yards of soil over a period of 31 months at a cost of more than $40 million." Amended ROD p. 1-5.
[10] See Amended Parcel B ROD, pp. 1-4 – 1-5.
[11] The Navy attempted to rely on a Tetra Tech study to assert that the "ubiquitous" toxic metal contamination was due to naturally occurring materials in the fill used to build up HPS. The regulatory agencies disagreed. As conceded in the 2009 amended ROD, "The Navy further acknowledges that the regulatory agencies do not agree with the Navy's position that ubiquitous metals are naturally occurring." The Navy also admitted, "The Navy acknowledges that industrial sources of metals exist at HPS and that there is a potential that some concentrations of metals could have sources other than naturally occurring materials." The issue of ubiquitous contamination versus the former spill model was focused on chemicals, but the same issue applies to radioactivity, in that radionuclide contamination was also found where they had not anticipated it.
[12] Amended Parcel B ROD, p. 1-5.
[13] *ibid.*, emphasis added
[14] p. 10
[15] The HRA occurred after the original Parcel B ROD but before the amended ROD.
[16] USEPA, *Preliminary Remediation Goals for Radionuclides, https://epa-prgs.ornl.gov/radionuclides/*
[17] The range of fission products could include not just the standard fission products from U-235 or Pu-239 fission. U-238, which is fissionable but not fissile, and used as a tamper/reflector in some A-bombs of the era and as a third stage in some thermonuclear weapons, would produce a range of other fission products, as well as other transuranics.
[18] See Daniel Hirsch and William Matthews, "The H-Bomb: Who Really Gave Away the Secret?", *The Bulletin of the Atomic Scientists,* Vol. 46, No. 1, January/February 1990
[19] *Final Field Sampling Plan for Soil Sampling, Area IV Radiological Study, Santa Susana Field Laboratory, Ventura County, California,* Prepared for US EPA by Hydrogeologic, Inc. (HGL), March 5, 2012, Tables 2.1, 2.2, and 2.3; https://www.dtsc-ssfl.com/files/lib_doe_area_iv/epaareaivsurvey/fnlfspplansoil030512/65849_1-Final_FSP_for_Soil_Sampling_030512.pdf last accessed August 23, 2018 EPA eliminated short-lived radinouclides (less than 1 year) from the list unless they were decay products of longer-lived radionuclides that were on the list.
[20] Table 3-4, Radionuclides of Concern, Draft Parcel G Removal Site Evaluation Work Plan, June 2018
[21] In the 2006 Basewide Radiological Removal Action Memorandum, the Navy put forward cleanup standards for eleven radionuclides, just a third of the Radionuclides of Concern identified in the HRA. However, in subsequent RODs, only a handful of these were actually measured for or held to cleanup standards.
[22] email communication with Danielle Janda, Environmental Engineer, Navy BRAC Hunters Pt., July 19, 2018, indicating that the majority of sites were classified Class 1, but she could not specify what percentages were Class 2 and 3.

[23] Anthony Smith Declaration in Support of Petition to Revoke the License of Tetra Tech EC, Inc., Before the U.S. Nuclear Regulatory Commission, June 3, 2017, ¶ 24-25

[24] See, e.g., Tetra Tech EC, Inc. 2010. "Final Project Work Plan (Revision 4) Base-wide Storm Drain and Sanitary Sewer Removal, Hunters Point Shipyard, San Francisco, California." July 30. https://www.envirostor.dtsc.ca.gov/public/final_documents2?global_id=38440002&doc_id=60259663

Appendix A

Scanner Vans & Other Scanning Devices Cannot Determine Safety of a Site

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Scanner vans and other scanning devices (e.g., hand-held detectors and towed arrays such as have been used by the California Department of Public Health in Parcel A) are supposed to be used only as a gross or screening tool for **helping focus subsequent soil sampling.** They are never a substitute for taking hundreds or thousands of soil samples in the field, some at random or systematic intervals, some additional ones targeted, and sending them to a laboratory where they can undergo very sensitive testing. At the laboratory one puts the soil sample in a special device such as a gamma or alpha spectroscopy machine, or for strontium-90, one chemically separates the strontium from the rest of the soil matrix and then measures for radio-strontium concentration. The sample remains in the device for hours as the emissions are counted; the longer the count time, the lower the detection limit. A scanner just drives over an area, passing over any particular soil in just seconds, and has very gross ability to detect some contamination and no ability to detect other types.

The scanner van is used to help you figure out where to take the soil samples beyond the random or systematic ones already chosen. **It is not supposed to be used to declare an area clean, without soil testing.** And, of course, and this is key, subsequent soil testing at Hunters Point found lots of contaminated soil that needed cleanup in the other parcels that the scanner van declared clean and not needing further radiological investigation. (Note that the scanner van was not just used in Parcel A, which the Navy is trying to say was clean, but in Parcels B, C, and parts of D & E, all of which are now known to have had contamination.) The 2002 quick-and-dirty run with the scanner van obviously can't detect contamination at the levels of concern, i.e., above cleanup limits. The same is true for other gamma scans.

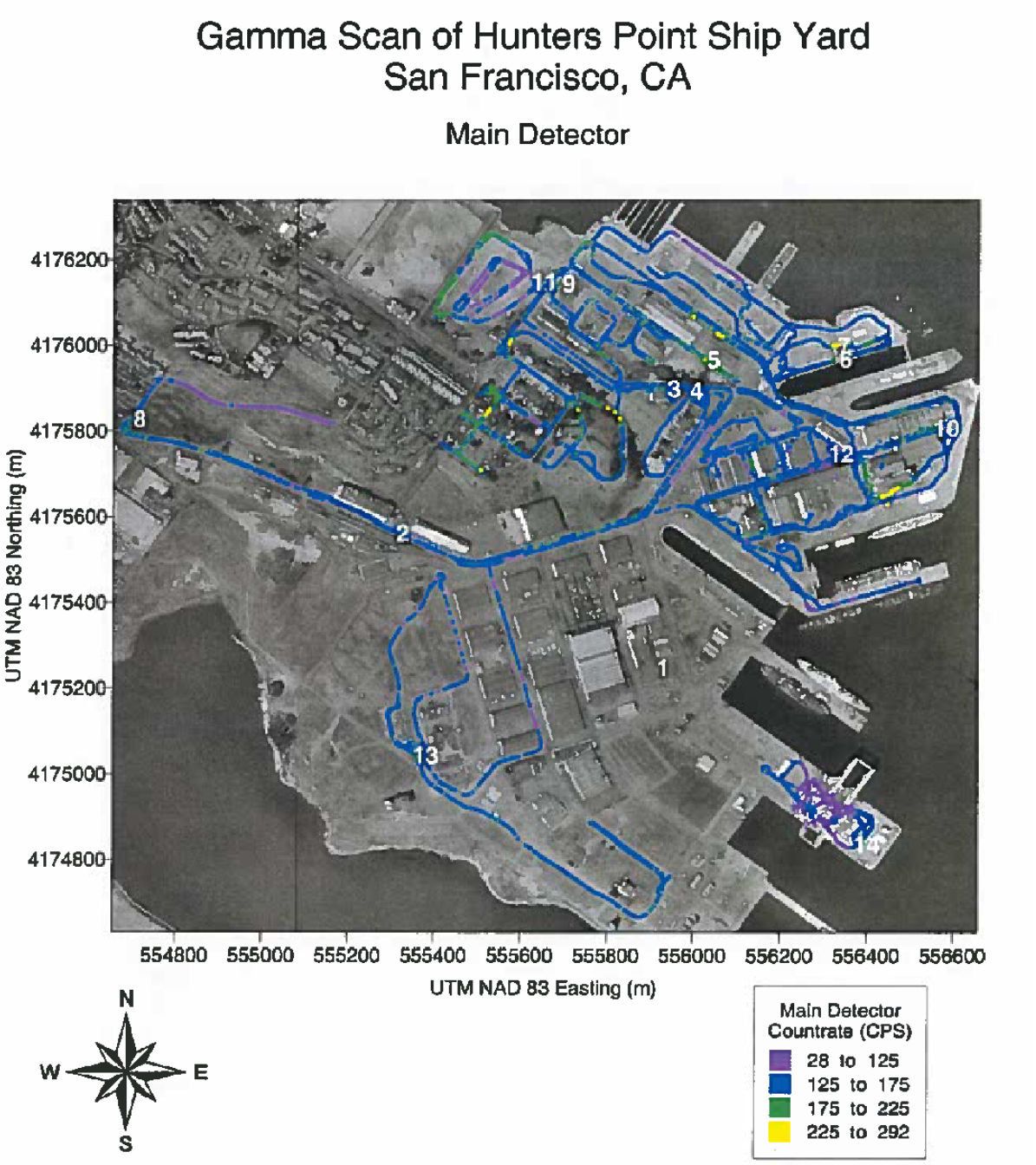
Here is the key passage of the 2002 scanner van report[i]:

> The scan covered all navigable *roads* on and immediately adjacent to Parcel A. In addition to Parcel A, *areas of Parcel B, Parcel C, and minor portions of Parcels D and E were scanned.* (A map of the scanned areas is included in the subject report.) The scan covered only minor portions of Parcels D and E due to the inaccessibility of navigable roads and ongoing radiation investigation and/or remediation. All of the anomalies detected during the scan were attributable to natural occurring sources at levels consistent with what would normally be found in the environment. *Based on the scan results, none of the areas which were scanned warrant further radiological investigation.*
>
> (emphasis added)

The scanner van is fairly large, like an ice cream truck (see photos below). So, the scanner van just scanned roads.

The scanned areas were quite narrow on those roads, as seen in the map below showing the roads scanned. (One notes that the gross gamma readings varied by a factor of ten, giving very little ability to discriminate potential problems.)

Scanner Van surveying the former residential areas in Parcel A



The van scanned not just Parcel A—which the agencies in recent months tried to claim was free of radiation based on this drive-by, even though essentially no soil samples were taken—but also Parcels B, C, and parts of D & E. For all, it was claimed that no anomalies not due to background radiation were detected and that "none of the areas…warrant further radiological investigation." Yet further radiological investigation took place in those other parcels in the years since 2002, and even with the Tetra Tech scandal, a good deal of contamination was found. So, if the scan "proved" Parcel A is OK, then all of Hunters Point was fine and no remediation was needed, but that turned out to be false. If there is much of Hunters Point that is acknowledged to be contaminated, then obviously the scanner van missed it, not just in Parcels B, C, D &E, but also in Parcel A.

Furthermore, the recent discovery of a radium deck marker, emitting quite elevated radiation levels, in Parcel A, sixteen years after the prior scanning declared the area clean, further demonstrates the unreliability of the scanner van.

Note that the 2002 scanner van report states:

> USEPA ensures that releases of radiological contamination to the environment at HPS are fully addressed under CERCLA and has requested that the Navy cleanup radiological contamination to a level *that meets our risk based preliminary remediation goals (PRGs) for radionuclides or to indistinguishable from background*. (emphasis added)

However, the scanner van generally can't "see" contamination at the PRG concentrations. It can only detect far higher radiation levels. And it can't detect at all many of the key radionuclides of concern at Hunters Point, for example, plutonium-239 and strontium-90. The van can only detect gamma, and only pretty strong gamma at that; it cannot detect alpha- or beta-emitting radionuclides. Plutonium-239 is primarily an alpha-emitter and strontium-90 a beta-emitter. And even the gamma radiation would be significantly attenuated through the asphalt and cement the truck was driving over; much of the contamination at Hunters Point is from buried pipes that carried radioactively polluted liquid and which leaked into the surrounding soil. Note further than the scanner van is 1980 vintage and was designed primarily for dealing with contamination at uranium mines.

So, here is how it should have been done: the way EPA surveyed the Santa Susana Field Laboratory a few years ago. [ii] (See their report, at http://www.dtsc-ssfl.com/files/lib_doe_area_iv/epaareaivsurvey/gammascanning/65818_2_Final_Gamma_Radiation_Scanning_Report_101712.pdf). They covered 100% of the nuclear area, not just driving over a few roads. (see p. 1-1) They used far more sensitive equipment, and not just a van, but multiple devices that allowed them to cover the whole area, slowly and carefully (see p. 3-1 and the pages following in the above-cited EPA report:

> Enhanced Radiation Ground Scanner II,
> Dual Detector Track Mounted Gamma Scanner
> Wheel Mounted Gamma Scanner
> Single Detector Track Mounted Gamma Scanner
> Mule-mounted Gamma Scanner
> Hand Held Gamma Scanner
> In Situ Gamma Spectrometer

Thus, in addition to a van, which could only work on roads, EPA used far more mobile and agile devices at SSFL — including, a mule-mounted device for tough to reach areas. For photos of the range of devices they used, see, e.g., Figures 3.1, 3.4, 3.5, 3.10, 3.15 in their report.

Yet even with this far more sophisticated equipment and ability to take it where a van on roads can't go, and spending months, not the four days spent at Hunters Point, EPA acknowledged that the **scan was only useful as the initial screening tool for helping determine where to take soil**

samples to send to labs for analysis, the real core of the survey. As they say, the results of the gamma survey "were used to targetsoil sample locations." p. 1-2

Note the limitations identified by EPA, even when using the most advanced devices available today (as opposed to the 1980 van used for the 2002 Hunters Point drive-over):

> Findings discussed in this report were derived from data collection efforts conducted with the *best commercially available detector*s, software, techniques, and procedures *available at the time the investigation* was conducted. However, the gamma detectors used during the investigation *were not capable of detecting radionuclides that emit only alpha or beta radiation*. In addition, f*ield-based detection systems are not as sensitive (meaning they have a higher detection limit) as laboratory based analytical methodologies. Consequently, less gamma emitting radionuclides were detectable than analytical laboratory based radiochemical methods.* Findings of the gamma radiation scanning, and other lines of evidence, as presented in the soil Field Sampling Plans *were used in identifying targeted soil sampling locations for collection and analyses.*
>
> p. 1-3 emphasis added

On p. 2-4 EPA indicates that even with the best techniques available a few years ago, many of the radionuclides of concern could not be seen at all with the gamma scan, as quoted below:

> The SSFL Radiological Background Study compiled a list of potential radionuclides of concern (HGL, 2009). Many of these do not emit gamma radiation that is detectable by real-time, field portable detection systems. Radionuclides undetectable with field gamma scanning detection systems generally fall into one or more of the following categories:
> • Radionuclides that emit alpha radiation only; for example polonium-210;
> • Radionuclides that emit beta radiation only; for example strontium-90;
> • Radionuclides that emit very low energy gamma radiation that are not readily detectable with field based instruments; for example iodine-129; and
> • Radionuclides that emit gamma radiation with low intensity (abundance); for example, plutonium (Pu)-239. Field based gamma radiation detection systems could possibly detect Pu-239 contamination if present in relatively large environmental concentrations.

One will note that strontium-90 and plutonium-239 are among the radionuclides of greatest concern at Hunters Point, and couldn't be detected even by the far better scanning equipment used by EPA most recently at SSFL; soil samples sent to a lab were necessary. For key Hunters Point parcels such as Parcel G, strontium-90 and plutonium-239 represented half of the radionuclides deemed of concern (a limitation which we have criticized elsewhere), leaving only radium-226 and cesium-137 as gamma-emitting radionuclides that might possibly be picked up in a scan. But the gamma scanning equipment is reported by the Navy in its Parcel G retesting plan as incapable of detecting cesium-137 at the levels established as requiring cleanup at HPS. So of all the radionuclides of interest, the gamma-scanner is aimed at only two and can only

detect one of those at the cleanup limits.

In short, the purpose of a gamma scan is to try to provide information useful for subsequent biased or targeted sampling of soil, in addition to the systematic soil sampling. The real measurements are made by taking soil and sending it to a lab that can use specialized equipment, with counting times of hours, not the few seconds a van passes over. The van just can't see many of the critical radionuclides at all, and only quite high levels of some of the gamma emitters, and even those would be potentially hidden beneath and diminished in signal by the road over which the van was driven. Gamma scanning generally can't "see" even gamma emitters that are deeper than half a foot or a foot.

The van isn't for the purpose of declaring a site clean; it is merely for helping figure out where to take additional soil samples. And that is the whole question about Parcel A — the Navy just declared in non-impacted, and essentially no soil samples were taken to find out if it indeed was.

In the SSFL case, after the gamma scan was done, generally finding very little that was detectable by the scans, with little clarity as to whether anomalies were due to background, EPA then took thousands of soil samples—and found large numbers of samples that were contaminated. If one had just stopped after the gamma scan, as was the case for Parcel A at Hunters Point, all that contamination would have gone undetected.

In summary, gamma scanning without detailed soil sampling is incapable of determining a site is safe. It is blind to most radionuclides at the levels requiring cleanup. At Hunters Point, gamma scans have been used more for PR purposes than for genuinely determining if contamination is present.

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[i] EPA, *Radiological Scanner Van Survey, Hunters Point Naval Shipyard, California, September 9-12, 2002*

[ii] HGL, FINAL GAMMA RADIATION SCANNING REPORT AREA IV RADIOLOGICAL STUDY SANTA SUSANA FIELD LABORATORY VENTURA COUNTY, CALIFORNIA, prepared for USEPA, 17 October 2012 http://www.dtsc-ssfl.com/files/lib_doe_area_iv/epaareaivsurvey/gammascanning/65818_2_Final_Gamma_Radiation_Scanning_Report_101712.pdf, last accessed 17 October 2018