17 December 2008

Parcel B

NAVY MEMORANDUM FOR THE RECORD

Subj: CONCEPTUAL SITE MODEL FOR THE REMOVAL OF THE SANITARY AND STORM SEWERS AT HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Encl: (1) Ra-226 and U-238 Sample Results
(2) Stubborn Trench Maps

1. Objective. The objective of this memorandum is to clarify and provide supporting information for the Navy's conceptual site model (CSM) for the removal of radiologically sanitary and storm sewer drains throughout Hunters Point Shipyard. In particular, this memorandum provides additional information on why the Navy's site-wide CSM is still valid for four specific Parcel B trenches currently undergoing remediation activities. Furthermore, the CSM information provided below continues to support the Parcel B radiological remedy approach presented in the Amended Parcel B ROD.

2. Background. Due to a complex radiological history at Hunters Point Shipyard (HPS), the sanitary and storm sewers were designated "radiologically impacted" in the Final HPS Historical Radiological Assessment (HRA) that was issued in August 2004. The HRA described the sewers as follows:

"The present day configuration of the sanitary and storm water sewer system is the result of an evolutionary process. This system was originally designed and built in the 1940s as a combined system, using the same conveyance piping and 40 separate discharge outfalls into the Bay."

"This combined system grew in sections from the 1940s to its maximum size in 1958, when it underwent the first in a series of separation projects. The Building 819 pump station was constructed for conveyance of much of the sanitary sewage from HPS to the City of San Francisco treatment works, and separation of the systems took place in the industrial areas and the southwest area of HPS. Separation of the systems involved installation of dedicated sanitary sewer collection piping or diversion structures within the combined system piping that normally directed all combined flows through the Building 819 pump station. However, during storm events, storm water flows would overwhelm Building 819, and much of the sewage and storm water was diverted to various existing outfalls into the Bay. Twenty-eight Bay outfalls were converted to exclusive use for storm water outlets, while 12 continued to serve as combined sanitary and storm water sewer outlets. A second segregation project, undertaken in 1973 provided some additional separation of the combined systems. The last of the separation projects performed in 1976 involved the installation of additional dedicated sanitary sewer piping. Complete separation of the combined systems was never achieved. Due to the evolutionary nature of the separation process, radiological contamination from the same source could have impacted the piping and other components of both systems."

The HRA lists the radionuclides of concern for the sanitary and storm sewers as Cs-137, Ra-226, and Sr-90. This is based on the fact that these were the three most commonly used, and subsequently discovered, radionuclides at HPS. Contamination from these radionuclides could have come from rework and repair of radioluminescent devices (Ra-226 and Sr-90), NRDL experimentation and development of radiation survey instrumentation (Ra-226, Cs-137, and Sr-90), or decontamination of ships that participated in atomic weapons testing

(fission products Cs-137 and Sr-90). However, it should be noted that the radiological operations at HPS started in 1941 and concluded in 1974 with the closure of the shipyard. During this time, controls of radioactive materials, particularly involving radioluminescent devices, were much more relaxed than today's standards and any radiological operation could have potentially impacted the sewer system.

The sanitary and storm sewer system runs throughout the shipyard and was installed and expanded as the shipyard grew. As documented by historical photos and maps in the HRA, the shipyard was expanded significantly when the Navy took over in 1941. Most of this expansion took place in the 1940s and early 1950s. This expansion included the Navy taking over additional acreage and using materials from the hillside to expand the shoreline. Waste materials were not used during the expansion as there were specific locations established for waste disposal. Many of the sewers currently being removed were originally installed during this expansion as evidenced by the conditions and locations of the piping and manholes as they would not meet today's standards.

Areas considered to be radiologically-impacted as a result of contamination being introduced into the sewer system would include the piping, manholes, outfalls, and soils and sediment surrounding these components. Piping was made of concrete, terra cotta, cast iron, steel, perforated metal and PVC. Manholes were constructed of concrete or brick. As the sewers had been modified and repaired numerous times, there is no one particular material predominantly used in construction of the sewer system. Slip fittings were used at pipe joints of the sewer system, therefore the lines were not sealed and some leakage from the pipe was expected when the system was built. Additionally, excavated manholes have been found to be porous. The potential for materials to migrate from piping and manholes into the surrounding soils is significant.

3. Conceptual Site Model

a. The conceptual site model (CSM) for the sewer removal project is based on the potential that sanitary or storm sewer systems were radiologically contaminated when radioactive materials were discharged into the systems from numerous locations throughout the shipyard, and may have potentially been released into surrounding soils during operations and repairs.

b. Historically, the systems were cleaned, repaired, and replaced as necessary. In addition to potential normal seepage, all three of these operations could have released contaminations into soils surrounding the systems. In fact, cleaning was often accomplished by power washing that could have forced the contamination from the systems and in some cases leave the piping free of contamination but the surrounding soils contaminated. The last power washing of the systems was conducted by the Navy in 1999. Power washing of old sewer systems easily cracks the pipes and allows for releases of pipe sediment into surrounding soils. Depending upon how the contamination was released from the systems, and then how it subsequently migrated through the surrounding soils, will greatly affect the extent and pattern of the soil contamination.

c. To date, the removal action has demonstrated the accuracy of the conceptual site model. Sewer removals have been conducted throughout Parcels B, D-2 and G. It should be noted that the Parcel D-2 sewer removals were

done as part of the Parcel B removal action and the Parcel G sewer removals were originally identified in documentation as Parcel D.

d. Similar types of fill materials have been found in all excavations and no types of debris or waste materials have been discovered. Terra cotta or clay piping is rarely able to be removed intact, breaks apart, and is being removed with the soil. The below figures represent removal information available as of 9 December 2008:

(1) Parcel B (including Parcel D-2):

Total Trench Excavated:	22,923 linear feet
Total Excavated Soil:	59,476 cubic yards
Total Contaminated Soil:	4,076 cubic yards
Total Contaminated Intact Piping:	504 linear feet
Percentage of Contaminated Soil:	6.9%
Number of Survey Units:	65
Number of Survey Units Cleared:	61
Number of Survey Units Pending:	4
Additional Trench to be Excavated:	76 linear feet (in D-2)

(2) Parcel G

Total Trench Excavated:	20,977 linear feet
Total Excavated Soil:	47,761 cubic yards
Total Contaminated Soil:	5,839 cubic yards
Total Contaminated Intact Piping:	425 linear feet
Percentage of Contaminated Soil:	12.2%
Number of Survey Units:	53
Number of Survey Units Cleared:	31
Number of Survey Units Pending:	22
Additional Trench to be Excavated:	Approximately 200 linear feet

Ra-226 and Cs-137 contamination has been identified in Parcels B and G. The above figures demonstrate a consistency in the types and locations of contamination that were originally anticipated prior to the initiation of excavation. Additionally, this information reinforces the CSM, in that the contamination was primarily located within the excavated soil and there is no widespread contamination throughout the site that would have come from a spill or waste disposal action.

e. All possible sources of contamination have been investigated in relation to the CSM.

(1) Spills or Accidental Releases. The sewer excavation work plan requires the removals to stop 10 feet before a radiologically-impacted site. This allows for the sewers closest to a radiologically-impacted site (i.e.; a radiologically impacted building) to be investigated as part of the radiologically impacted site investigation. Additionally, historical research has been conducted to try to identify any locations of recorded spills or accidents and it has been determined that all known areas have been

included in radiologically-impacted sites designated in the HRA. The sewers within 10 feet of a radiologically impacted site are the pipes considered to have the highest potential for contamination. Addressing the sewers with the radiologically impacted sites allows the potential impact of spills or accidental releases of radioactive materials to be investigated where they most likely would have occurred.

(2) Naturally Occurring Radioactive Materials

(a) There is always the possibility of naturally occurring radioactive material (NORM), however the types of contamination found in the sewer excavations do not fit the profile of NORM. This has been carefully monitored by the Navy to ensure there is no need to change the CSM. One method in use is comparison of the Ra-226 activity with the U-238 activity. This is based on the assumption that when Ra-226 is naturally occurring it exists in equilibrium with U-238. Theoretically, if two isotopes are in secular equilibrium the activities should be the same and thus the ratio of the activities should be 1 to 1. If Ra-226 was introduced into an environment by a man-made device or a contamination event then the ratio of Ra-226 relative to U-238 should be biased high by the amount of Ra-226 deposited.

(b) In order to account for the possibility that fission products from the ship decontamination efforts and NRDL experimentation may be present, the sewer removal work plan requires samples to be analyzed by alpha spectroscopy for uranium and plutonium when Cs-137 is identified above the release limit. Since this scenario is rare, there are not many samples available for comparison. However, whenever possible, the Navy compares Ra-226 and U-238 results to determine the correlation of the two isotopes. For Parcel B, the only samples with elevated levels of both Cs-137 and Ra-226 were pipe sediment samples. In these samples the U-238 activity was consistently lower than the Ra-226 activity by a significant margin. The U-238 activity ranged from 10 to 60 percent of the Ra-226 results. For further comparison, we looked at two samples from the Parcel G sewer removal that had elevated levels of Cs-137 and Ra-226. The U-238 sample results for these samples were 30 and 50% of the Ra-226 results. These results would indicate that although there is some small amount of Ra-226 and U-238 naturally occurring in the HPS soil the bulk of the Ra-226 activity was introduced by man-made sources. Based on the U-238 to Ra-226 ratios at Parcels B and G, the current CSM for HPS is correct and the majority of radioactive materials at the base is from man-made sources, and is not NORM. Sample results are provided in enclosure (1).

4. Ongoing Removal Operations

a. The removal of sanitary/storm sewers at Hunters Point began in May 2006 in Parcel B. The removal action was initiated to "eliminate the potential threat posed by future migration or release of radioactive material present in the systems into the surrounding environment." By removal of the sewers, the Navy intends to achieve unrestricted radiological release of the trenches and excavated materials. Following the guidance of the Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM), the Navy conducts Class 1 final status surveys of the excavated materials and resulting trenches. Survey and sample results are compared with release limits that were established by the Navy in consonance with the US Environmental Protection Agency, Region IX and detailed in the "Final Base-wide Radiological Removal Action, Action Memorandum-Revision 2006" for HPS. Once excavated materials or trenches are determined to meet release limits, the

final status survey results are documented in Survey Unit Project Reports (SUPRs) which detail the history of the subject trench and the excavated material or import fill used for backfilling, and the residual radiological dose and risk associated with the trench and backfill materials. As documented above, 93.8 percent of the sewer survey units in Parcel B have been successfully surveyed, remediated, if necessary, sampled and backfilled which demonstrates the validity of the CSM. Most contamination has been found in the soils surrounding the pipes, primarily below five feet. This is consistent with the pipe locations and the fact that repairs to the system or power washing would have resulted in the spread of contamination well beneath and beyond the piping system.

b. The 6.2 percent of Parcel B sewer surveys units still in question currently consists of four trenches that have not yet been radiologically cleared. These "stubborn trenches" were the result of removal of storm sewers. In the "stubborn" trenches two of the removals found Cs-137 contamination in the pipe sediment and all four trenches have found Ra-226 contamination in the surrounding materials, 95% of which has been below 5 feet below ground surface (bgs) which appears to be consistent with pipe depths. Enclosure (2) provides maps of these trenches.

c. These sewers were remediated based on the original work plan which segregated the peripheral material (material from one foot around the piping) from the other excavated material. All initial excavations included pipe and the soil one foot around and below the pipe. Materials excavated from the trenches have been spread out in a six-inch lift on a 1,000 square meter pad, surveyed, and sampled to determine if there was any contamination. All removed materials from the four trenches have been similar in nature and no debris or waste materials have been found. All sewer excavations around these trenches have been radiologically cleared. Excavation to remove residual contamination in the stubborn trenches is currently ongoing. Additionally, all sample results are being reviewed to ensure compliance with the CSM. However, it should be noted that no samples with elevated levels of both Cs-137 and Ra-226 were identified, therefore no comparison of the Ra-226 and U-238 levels have been made.

d. Building 157

(1) Two of the trenches (50 and 50A) are adjacent to and under the footprint of the former Building 157 which is a radiologically impacted site. The building was formerly used by the shipyard as an industrial laboratory, metal shop, sound laboratory and metals testing center. Additionally, non-destructive testing and gamma radiography were conducted in the building. Initially the building was quite small and at some point the building tripled in size which appears to account for the fact the some of the sewer and a manhole were located under the building. Radionuclides of concern for the building were Co-60, Cs-137 and Ra-226.

(2) Radiological surveys of the building were conducted in 2007 and the building was radiological cleared and demolished. Prior to the removal of the trenches a MARSSIM final status survey was conducted on the building footprint (Class 1) and the surrounding area (Class 2). No contamination was found in the footprint, however Cs-137 contamination was found in the top one foot of soil in Class 2 area. These areas of contamination appear to be directly related to a piping system that drained run off from the building roof into the storm sewers. Additional information on the trenches associated with Building 157 is provided below.

e. Building 146

(1) One of the trenches (51A) is located in the northwest corner of the shipyard just south of the dry docks. This trench is also located near Building 146 which is a radiologically impacted site. The building was formerly used by the shipyard as an industrial and photo laboratory, radioactive waste storage area, and radioluminescent device turn-in building. Radiological surveys of the building are currently ongoing. It is unclear at this time whether the radiological operations in this building are directly related to the contamination found in Trench 51A but it is a possibility. Additional information on this trench is provided below.

f. Specific information for each of the four "stubborn trenches" is provided below:

(1) Trench Unit 50 - Ra-226 in peripheral material.

(a) Trench. The trench is 243 linear feet in length. Pipe elevations ranged from 2 ft bgs to 6 ft bgs. There were two manholes in the trench unit, the bottoms of which were 7 ft bgs. Approximately one-third of the piping and one manhole were located under the footprint of Building 157. The piping depth was 6 to 7 ft bgs and the bottom of the manhole was located 7 ft bgs. The remaining trenches exit the building footprint and partially cover where Cs-137 contamination was found in an area around the building footprint in the top one foot of soil during a MARSSIM Class 2 final status survey. The depth of pipe in the area where the Cs-137 contamination was found outside of the building footprint was 2 to 2.5 ft bgs. Original remediation depth was 6 to 8 ft bgs depending on locations. Current post remediation depth is 8 to 10 ft bgs.

(b) Excavated Material. The materials removed in April 2007 were all disposed of as LLRW due to the consistent presence of Ra-226 contamination ranging from 1.57 to 2.7 pCi/g. Additional materials removed in May 2007 were radiologically cleared and are being held pending use as backfill. Additional analysis of elevated radium-226 samples is being conducted to review the ratio of Ra-226 and U-238.

(2) Trench Unit 50A - Ra-226 in peripheral material.

(a) Trench. The trench is 267 linear feet in length. In one section the pipe elevation ranged from 0.5 ft bgs to 1.0 ft bgs. This pipe was located just outside the footprint of the former Building 157. The roof drainage system for Building 157 was connected to the shallow pipe immediately adjacent to the building that connected to the storm drains. This appears to have been common practice throughout the shipyard. The remainder of the pipe in the trench unit was located 3.5 ft bgs to 7.5 ft bgs. The section of piping that was 7.5 ft bgs was located under Building 157. The final status survey of the Building 157 footprint found Cs-137 contamination in the top foot of soil during a MARSSIM Class 2 survey of an area around the footprint of the building. Some of the areas where this contamination was found are located in this trench unit where the shallow pipes were located. Original remediation depth was up to 8.5 ft bgs. Current post remediation depth is a maximum of 14.5 ft bgs.

(b) Excavated Material. Excavations from this trench were conducted in April 2007. Approximately 60 cubic yards of material was

disposed of as LLRW. Remaining materials were radiologically cleared and are being held pending use as backfill. Additional analysis of elevated radium-226 samples is being conducted to review the ratio of Ra-226 and U-238.

(3) Trench Unit 51A - Cs-137 in pipe and Ra-226 in peripheral material.

(a) Trench. The trench is 124 linear feet in length. Pipe elevations ranged from 4 ft bgs to 6 ft bgs. There was one manhole in the trench, the bottom of which was 6.5 ft bgs. Original remediation depth was 6 to 7 ft bgs. Current post remediation depth is 12 to 16 ft bgs.

(b) Excavated Material. Material was excavated from this trench in February and March 2007. Although some material was segregated as LLRW, most of the material was radiologically cleared and is being held pending use as backfill. Additional analysis of elevated radium-226 samples is being conducted to review the ratio of Ra-226 and U-238.

(4) Trench Unit 55 - Cs-137 in pipe and Ra-226 in peripheral material.

(a) Trench. The trench is 183 linear feet in length. Pipe elevations ranged from 3 ft bgs to 6.5 ft bgs. There was one manhole in this trench unit, the bottom of which was 5 ft bgs. Original remediation depth was 10 feet. Current post remediation depth is 15 to 16 ft bgs.

(b) Excavated Material. Material was excavated from this trench in June 2006, July 2006, April 2007 and September 2007. Some of the excavated material has been cleared and used for backfill in Trench Units 5, 10 and 56. Although some material was segregated as LLRW, the majority of the remaining material was radiologically cleared and is being held pending use as backfill. Additional analysis of elevated radium-226 samples is being conducted to review the ratio of Ra-226 and U-238.

g. Parcel G. The work in Parcel G is still ongoing at this time and 58.5% of the excavated trenches have been radiologically cleared and backfilled. The remaining trenches are pending data review for radiological clearance or are still under investigation. Additional data is still being compiled on the trenches under investigation and is not available for this document. However, it should be noted that there are trenches where multiple remediations have been conducted. These are not considered "stubborn trenches" as contamination can be detected by a survey meter and a final status survey (scans and sampling) has not been initiated at these trenches.

5. Summary

a. The Navy believes that the current CSM for sanitary and storm sewer removal remains valid and the Parcel B "stubborn trenches" fall within the CSM based on the following:

(1) The results of the HRA do not indicate existence of any kind of disposal or spill in the area of the trenches;

(2) The age and obvious degradation of the sewer system noted during the removal action would have significantly increased the possibility of contamination spreading from the pipes or manholes into adjacent soils;

(3) The type of materials excavated from the trenches has been consistent throughout the removal action and no debris or waste materials have been found in the excavations;

(4) The analysis of the Ra-226 and U-238 ratios for in Parcel B pipe sediment indicate the presence of radium contamination not the possibility of higher levels of naturally occurring radioactive material; and

b. The Navy also believes that the remedy presented in the Amended Parcel B ROD is valid. The purpose of the ROD is to document the selected remedy for Parcel B and the timing of the remedial action is secondary. The Navy is currently pursuing remediation the "stubborn trenches" as well as investigation of the radiologically-impacted buildings and sites in Parcel B in consonance with the ROD.

c. Further, the Navy believes that because the CSM is valid, that further remediation of the "stubborn trenches" as part of the ongoing radiological storm drain and sewer TCRA will be successful.

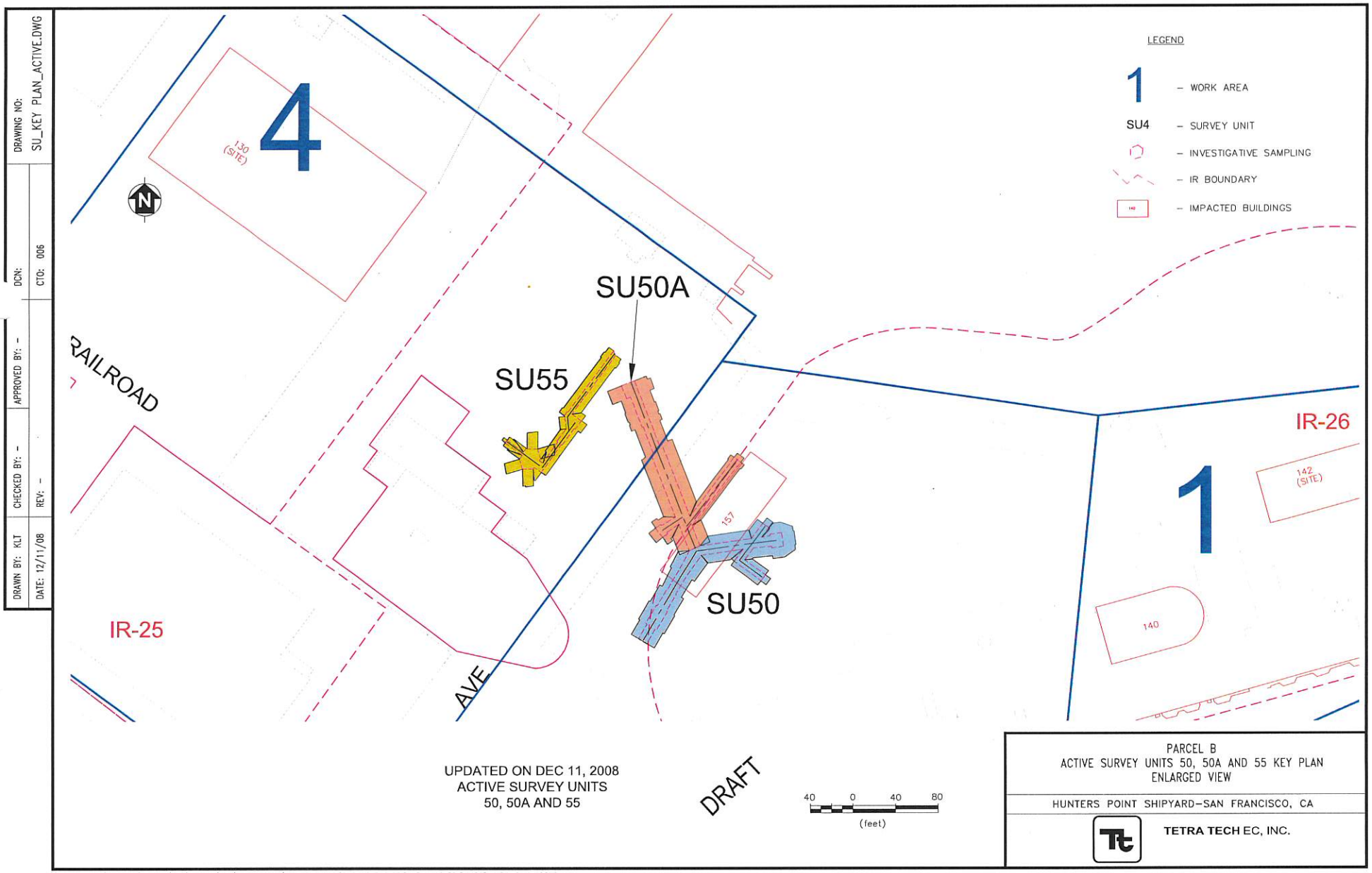
Spectrum No.	Sample ID	Parcel	Mass	Sample Date	Sample Time	Acquisition Date	Acquisition Time
2N000004.An1	70-PD-C0069-17	G	349g	12/21/2007	11:16	1/3/2008	12:49
4N000466.An1	6PBPI102D-003-184-01	B	348g	3/16/2007	10:00	3/27/2007	6:33
4N000751.An1	6PBPI52C-008-238-01	B	361g	5/16/2007	13:30	5/17/2007	22:19
1N000969.An1	6PBPI53A-003-255-01	B	364g	5/23/2007	15:40	5/24/2007	13:06
2N000942.An1	70-PDT-075-19	G	362g	11/29/2007	10:50	11/29/2007	21:32
5N000997.An1	6PBPI52A-011-259-01	B	349g	5/25/2007	14:00	5/29/2007	12:57
4N000734.An1	6PBPI52C-004-233-02	B	383g	5/15/2007	14:10	5/16/2007	15:08
7N000625.An1	6PBPI52B-008-222-01	B	365g	5/4/2007	10:00	5/7/2007	23:50
7N000848.An1	6PBPI52A-011-259-02	B	355g	5/25/2007	14:10	5/29/2007	12:58
6N000852.An1	6PBPI53A-003-255-02	B	341g	5/23/2007	15:50	5/24/2007	13:10
7N000795.An1	6PBPI52B-016-250-01	B	347g	5/21/2007	12:30	5/22/2007	14:02
1N001301.An1	6PBOPA04-017-239-15	B	316g	6/28/2007	7:49	6/29/2007	10:28
6N000675.An1	6PBPI52B-007-218-01	B	319g	5/3/2007	14:30	5/7/2007	15:10
4N000771.An1	6PBPI52C-016-248-01	B	379g	5/17/2007	14:20	5/21/2007	13:55

Live Time	Real Time	Cesium-137 Code	Cesium-137 Activity	Cesium-137 Counting Uncertainty	Cesium-137 2 Sigma Total Uncertainty	Cesium-137 MDA	Radium-226 Code
2700	2702		0.1342	0.0484	0.0487	0.0193	
2700	2704		0.1242	0.0783	0.0784	0.0581	
5400	5407		0.2829	0.0630	0.0639	0.0403	
2700	2705		0.2523	0.0884	0.0889	0.0560	
2700	2704		0.2068	0.0806	0.0810	0.0562	
2700	2704		0.1801	0.0767	0.0770	0.0518	
2700	2703	#	0.2065	0.0896	0.0899	0.0428	
2700	2706		0.2703	0.0888	0.0894	0.0613	
2700	2706		0.1976	0.0869	0.0872	0.0597	
2700	2706		0.1948	0.0786	0.0789	0.0560	
5400	5412		0.1851	0.0560	0.0565	0.0406	
5400	5414	F	0.0436	0.0465	0.0465	0.0362	B
2700	2702		0.3207	0.0892	0.0900	0.0569	
4000	4005		0.2117	0.0691	0.0696	0.0474	

				Alpha Spectro		
Radium-226 Activity	Radium-226 Counting Uncertainty	Radium-226 2 Sigma Total Uncertainty	Radium-226 MDA	Uranium-238 Activity	Uranium-238 2 sigma TPU	Uranium-238 MDA
2.3291	1.2214	1.2245	0.9390	0.981	0.078	0.002
2.1440	1.5800	1.5820	1.2800	0.245	0.030	0.002
1.4984	1.1979	1.1992	1.0000	0.730	0.064	0.004
2.6720	1.6039	1.6070	1.3000	1.152	0.090	0.002
3.6907	1.3636	1.3705	1.0300	1.275	0.096	0.004
1.5382	1.4437	1.4448	1.2100	0.601	0.055	0.002
2.0455	1.4870	1.4889	1.2200	0.392	0.040	0.002
1.8929	1.3582	1.3601	1.1200	1.112	0.084	0.005
2.0099	1.4491	1.4510	1.1800	0.785	0.066	0.002
1.8231	1.3891	1.3907	1.1700	0.462	0.045	0.002
2.0774	1.0996	1.1023	0.9040	0.987	0.079	0.006
0.5932	0.9544	0.9547	0.8130	0.391	0.040	0.005
1.6170	1.4851	1.4863	1.2300	0.935	0.076	0.002
1.7029	1.4165	1.4179	1.1900	0.548	0.050	0.002

scopy Results

Uranium-234 Activity	Uranium-234 2 sigma TPU	Uranium-234 MDA
0.961	0.077	0.002
0.227	0.028	0.002
0.677	0.061	0.004
1.144	0.090	0.006
1.131	0.087	0.002
0.621	0.061	0.003
0.441	0.044	0.004
1.078	0.085	0.005
0.719	0.067	0.003
0.258	0.035	0.006
1.048	0.083	0.005
0.435	0.044	0.006
0.917	0.075	0.004
0.609	0.054	0.002



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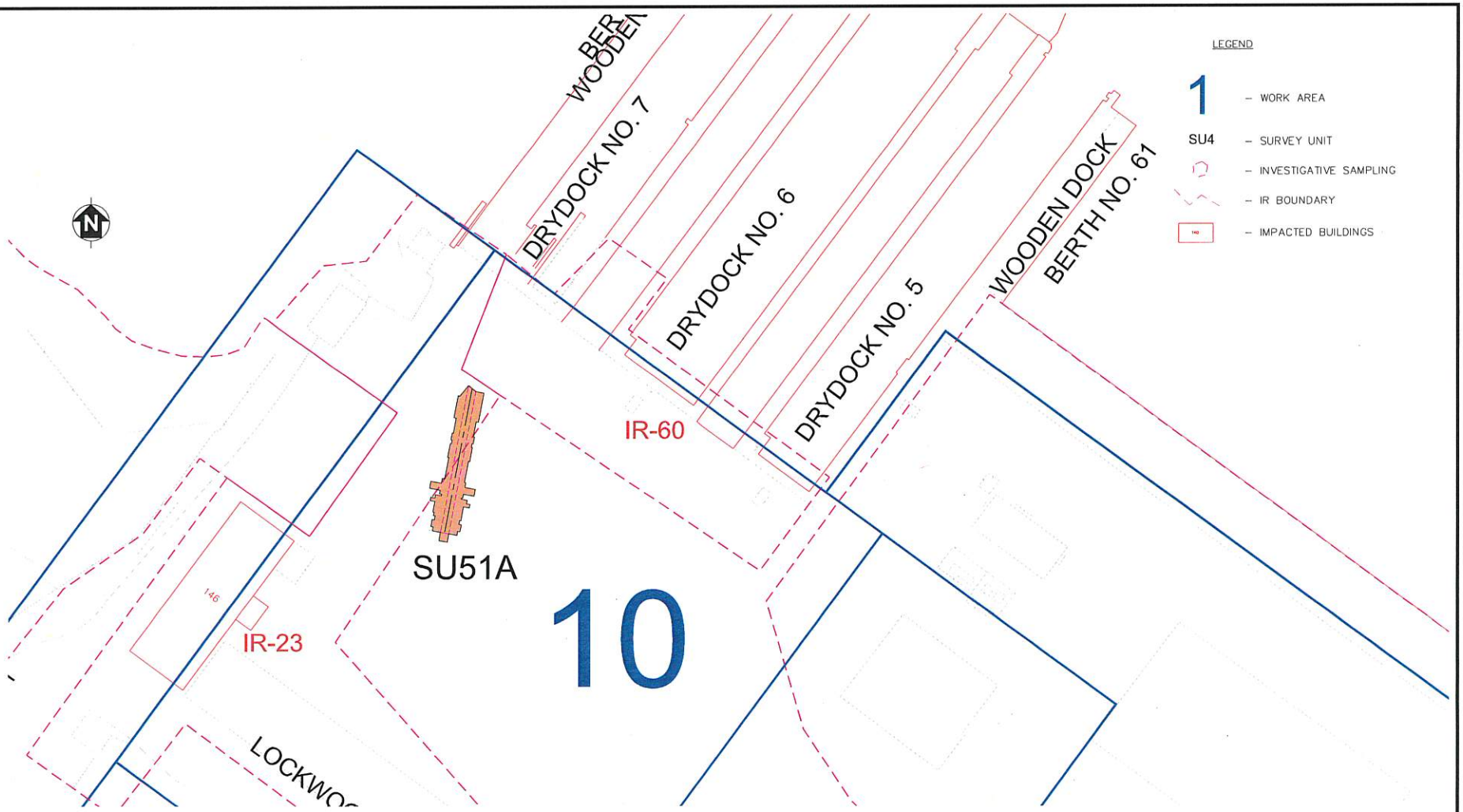

UPDATED ON DEC 11, 2008
ACTIVE SURVEY UNIT
51A

DRAFT

PARCEL B
ACTIVE SURVEY UNIT 51A KEY PLAN
ENLARGED VIEW

HUNTERS POINT SHIPYARD–SAN FRANCISCO, CA

TETRA TECH EC, INC.

DRAWN BY: KLT | CHECKED BY: – | APPROVED BY: – | DCN: | DRAWING NO: SU_KEY PLAN_ACTIVE.DWG
DATE: 12/11/08 | REV: – | CTO: 006

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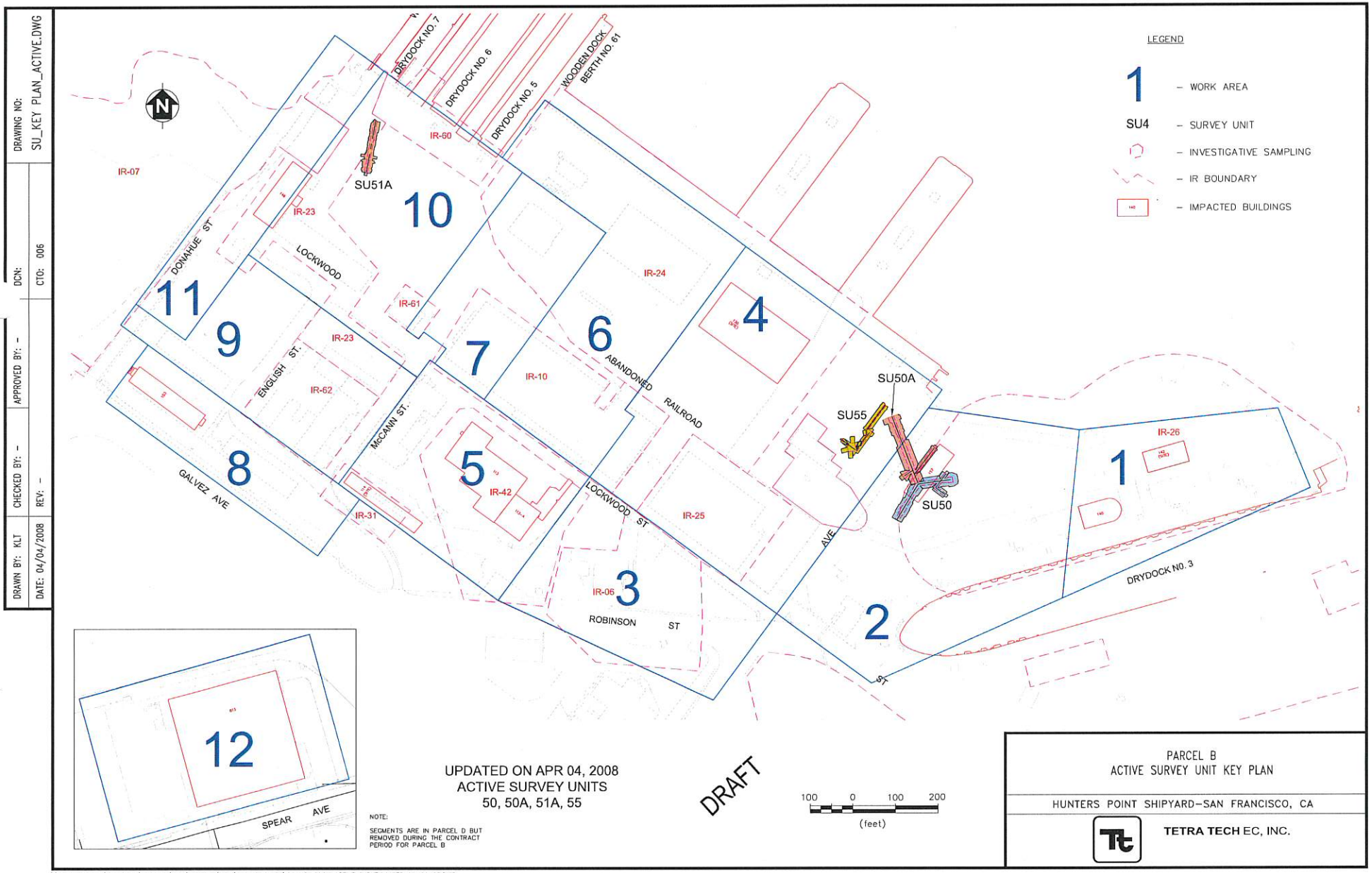

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