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NSY PORTSMOUTH
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DEPARTMENT OF THE NAVY
PORTSMOUTH NAVAL SHIPYARD
PORTSMOUTH, N. H. 03804-5000

IN REPLY REFER TO:
4341c
Ser 105.5/230
23 Apr 1998

Meghan F. Cassidy
Remedial Project Manager
U.S. Environmental Protection Agency
Region I
JFK Federal Building
Boston, MA 02203-0001

Dear Ms. Cassidy:

Your letter dated November 14, 1997 provided joint EPA comments, from Region I and the National Air and Radiation Environmental Laboratory, on the Draft Historical Radiological Assessment (HRA), Volumes I and II, for Portsmouth Naval Shipyard.

Enclosure (1) contains the specific responses to your comments. Please let us know within 30 days whether you have additional questions, or that the HRA is acceptable to issue as final.

Should you have any questions regarding this response, please feel free to contact me at (207) 438-1283.

J. A. BRANN
Director, Radiation Health

Encl: 1. Navy Responses to Environmental Protection Agency (EPA) Comments/Questions on August 1997 Draft Historical Radiological Assessment for Portsmouth Naval Shipyard
2. Results of Soil Sampling for Radionuclides

Copy to:
NAVFACENGCOM (Code 1823/FE)
Maine Department of Environmental Protection
Restoration Advisory Board (RAB) Members

Navy Responses to Environmental Protection Agency (EPA)
Comments/Questions on
August 1997 Draft Historical Radiological Assessment for
Portsmouth Naval Shipyard

Ref: (a) Attachment I to November 14, 1997 EPA letter to Commander (Code 105.5), Portsmouth Naval Shipyard
(b) "Guidance for Performing Preliminary Assessments under CERCLA," EPA/540/G-91/013, September 1991

EPA Region I comments in reference (a) and corresponding Navy responses are listed below:

A. General Comment: EPA would like to see limited water, sediment, and biota samples collected in the two onsite ponds and analyzed for radionuclide content. EPA does not expect radionuclides would be identified at levels of concern but this appears to be an area where data is lacking.

Response: The Navy agrees there is no reason to expect surface water contamination, especially in the area of the ponds. However, as a matter of comity, the two onsite ponds will have limited water, sediment, and biota samples collected and analyzed for radionuclide content.

PNS notes that no radionuclides above background levels are expected in ground water, either, based on historical PNS information and the negative data obtained during sampling at other Naval Nuclear Propulsion (NNPP) facilities. Nevertheless, PNS previously agreed to conduct ground water monitoring, also as a matter of comity.

A Ground Water Monitoring Plan is currently being developed to analyze for radionuclides, and sampling protocol for the two onsite ponds will be included in this plan. The samples will be analyzed as described in Section 6 of the HRA. The analysis results will be provided to the EPA.

B. General Comment: The report presents ranges of measurements when multiple samples are analyzed, no standard deviations are provided. These standard deviations would provide a reviewer some insight into the accuracy and precision of the laboratory performing the measurements. In addition, no Minimum Detectable Activity (MDA) values were provided. MDAs can provide information regarding a laboratory's competence and performance. This information would be useful to the reader. However, since the Navy's data is comparable to that generated by the EPA NAREL during past radiological surveys, EPA is comfortable with the results as reported by the Navy.

Response: The HRA data tables are a compilation of available recorded data. The recorded data did not include standard deviations, and it would not be practical to recalculate the data to provide this parameter in the HRA. MDAs are provided in the data tables as much as practical (e.g., in footnotes to the data tables in Section 6).

Regarding data quality, Section 6 of the HRA discusses cross-checks by independent laboratories to verify sample analysis results. This program continues through the present, utilizing an independent Department of Energy (DOE) Laboratory. PNS results have been consistent with DOE laboratory results.

Since the EPA is comfortable with the results as reported by the Navy, PNS concludes no additional HRA changes are warranted.

C. Volume I

Comment 1: The information presented in the HRA, appears to support a conclusion that the operations associated with NNPP activities has had insignificant (in the report "no" is used) adverse impact on the human population of the region.

Response: Pages 1-2 and 9-1 will be revised to read "no significant adverse" vice "no adverse" impact. PNS notes that all available data indicate exposures to radioactivity from Shipyard operations are only a tiny fraction of (i.e., orders of magnitude less than) exposures from naturally occurring radioactivity, and in fact are far less than the variability in natural background radiation when moving from place to place.

Comment 2: Page 3-22, Ground Water Quality: No analysis of ground water samples for radioactivity was performed as part of the assessment. Is there any specific reason none were performed? It would seem appropriate that at least some screening analyses would have been conducted to document the fact that monitoring was unnecessary.

Response: PNS has historical records: (1) that radioactive waste from the NNPP was always disposed of at a licensed off-site disposal site; (2) that any inadvertent on-site releases were sampled and cleaned up at the time; and (3) that overall ground water flow for the site is toward the coastline where routine surface water and sediment environmental sampling occurs. Hence, there has been no identified need for ground water sampling. In accordance with the reference (b) guidance for performing a Preliminary Assessment under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), only existing data was presented. However, separate from the HRA and as a matter of comity, the Navy has previously agreed to perform

monitoring of ground water as noted in the response to General Comment A. The ground water plan is currently being developed. PNS notes that such monitoring has been performed at several other NNPP facilities, and no radionuclides above background levels have ever been detected.

Comment 3: Page 3-24, Surface Water Bodies Used for Public Water Supplies: Were these surface water bodies ever sampled and analyzed for radioactivity?

Response: Since ground water studies conducted under the CERCLA process have identified no pathways for migration of Shipyard ground water to surface water supplies, and since there have been no chemical/radioactivity releases that would affect such surface water bodies several miles away, no such surface water sampling has been done as part of any CERCLA project at PNS.

Comment 4: Page 5-6, Table 5-1: Why are tritium releases not reported?

Response: Tritium releases have not been reported for the reasons discussed in Sections 4.2.2 and 5.1.1.1 of the HRA. In particular, as noted on the top of page 5-4:

"The tritium (hydrogen-3) concentration in both reactor coolant and Controlled Pure Water is the same, at about $2x10^{-3}$ μCi/ml or less. This is below the 10 CFR 20 sanitary sewer release criteria for tritium which the Nuclear Regulatory Commission (NRC) uses for sites it regulates. Any such water which entered the river would be rapidly diluted and become indistinguishable from background tritium levels, as discussed in Section 4.2.2. If any small volume spilled on land and went undetected, it would be quickly washed into the river (e.g., by rainwater, or possibly by entering the shallow ground water system which discharges into the river as discussed in Section 3.3.3.3). No environmental mechanism to concentrate this radionuclide exists."

It should be noted that the EPA harbor surveys of Portsmouth Naval Shipyard did not detect elevated tritium concentrations, as reported in references 24 and 25 of the HRA.

Comment 5: Pages 5-10 and 5-11, first paragraphs and Table 5-3: It appears that the reduction in air activity is due to the removal of radon daughters and other particulates containing naturally occurring radioisotopes by the HEPA filters, thus reducing the total radioactivity being monitored. The discussion here and in subsequent sections (see comments on Section 8) seem to suggest that somehow this reduces the dose to some segment of the population. This is not the case. The removal of naturally

occurring particulates from the small amount of air, relative to the overall atmospheric volume, going through the HEPA system to no significant degree reduces the dose to any segment of the population. However, on the other hand, any radionuclides which were released by the facility and exiting the filter could conceivably produce some incremental dose to the affected population.

Response: The information provided on naturally occurring airborne radionuclides in Table 5-3 was to add perspective for a reader in the general public, to show the effectiveness of the HEPA filter system. While it is true that the HEPA filter system removes naturally occurring radioactivity, it also removes NNPP radioactivity. If the total radioactivity concentration exiting the filter is below the natural background level, then it results in a net reduction in the dose to that population exposed to the exhausted air from radiological facilities. Granted, this reduction is so minute as to be without significance, but it is a reduction nonetheless. It is correct that the impact of any releases of NNPP radioactivity require assessment (independent of any issues concerning natural background radionuclides); as noted on Page 5-11, this is performed per 40 CFR 61.

Comment 6: Page 5-11, last paragraph: I-129 is a radioiodine which does not have a short half life, although it is unlikely to have been released.

Response: It is true that iodine-129 has a long half life; however, its concentration in fission product gasses is insignificant compared to the more abundant short half life radioiodines. The third sentence will be revised to read: "....short half lives (or, in the case of iodine-129, its very low concentration)."

Comment 7: Page 6-2, Table 6-1: Units should be pCi/g-wet.

Response: A footnote will be added to page 6-2, Table 6-1 which will state, "A portion of the moist silt was dried for analysis. For all later sediment samples (1966 and on), samples were drained; since nearly all liquid is removed, the samples show the consistency of thick mud." The units in Table 6-1 (from 1966 and on) will have "wet" added.

Comment 8: Page 6-4, Table 6-1: Why are data missing from 1971 - 1977 (it is included in Vol. II)?

Response: The data are not missing. As noted on page 6-6 of the HRA, specific cobalt-60 data could not be determined until 1978. At this time the new 4096-channel analyzer and germanium high resolution spectroscopy system was put into service, which supported determination of actual cobalt-60 activities. Volume II does not include a column for specific cobalt-60, which may have led to the assumption that something was missing in Volume I.

Comment 9: Page 6-8, Table 6-2: Were the comparisons made on wet sediment? If so, the table should have units of pCi/g-wet.

Response: These are the same drained samples which were analyzed by Portsmouth Naval Shipyard. The units in the Table 6-2 title will have "wet" added.

Comment 10: Page 6-19: A figure showing the locations of perimeter monitoring stations would be helpful.

Response: Perimeter monitoring stations are shown on Figure 6.1 (referenced in paragraph three on page 6-19).

Comment 11: Page 6-24, Table 6-10: Some explanations should be offered for the higher shoreline gamma values in 1966. To simply say that no records are available to explain it, is inadequate.

Response: Since both the background and shoreline gamma levels are proportionately higher, the higher shoreline gamma levels in 1966 are attributed to the calibration/use of the detection instrument. Specifics are not available. The note to Table 6-10 will be revised to reflect this.

Comment 12: Page 6-25, last paragraph: Why was the gross gamma activity from the drain system near Building 233 excluded from the average quoted? It would be more appropriate to cite averages with and without this data included.

Response: The purpose of taking storm drain sediment samples is to provide information on the effectiveness of on-going controls for radiological work performed at Portsmouth Naval Shipyard. Since the storm drain system near Building 233 was already known to be contaminated, the building/area was not the site of any work, and the site was being separately controlled/evaluated, including this data would have inappropriately skewed the data and not provided the information needed to assess operations at the remainder of the Shipyard.

For information, the Building 233 storm drain data average for this time frame was 17.7 pCi/g gross gamma radioactivity.

Comment 13: Page 8-1, 8-3, Ground Water Pathway: A statement is made, "That no radioactivity to infiltrate the aquifer exists above background levels is established in evaluating the soil exposure pathway in Section 8.3." More discussion is needed on this assumption, plus the soil pathway evaluation is superficial (see later comment).

Response: No change is considered necessary. Please see the response to Comment 14.

Comment 14: Pages 8-7 and 8-8, Section 8.3 Soil Exposure Pathway: This discussion is rather superficial. Justification is needed to document that the sensitivity of the measurements cited are sufficient to reach a "no likelihood of exposure" finding. No data on soil sampling, including core samples, are given.

Response: This comment appears to be based on an assumption that Navy environmental sampling is not sensitive enough to determine a "no likelihood of exposure" finding. The basis for this assumption is unclear. The Portsmouth Naval Shipyard's environmental monitoring program was designed within the framework of the total NNPP radiological control system. The Navy has not historically conducted routine monitoring of release pathways for which no reasonable potential for release was thought to exist. For example, since the beginning of the NNPP Program, radiological controls have been in place at the work site to prevent releases to the air, soil, and ground water pathways. Effective oversight of radiological work, and documentation of deviations from control requirements (e.g., as shown in Table 5-4), provide a direct indication of the likelihood for such releases to have occurred. Portsmouth Naval Shipyard believes that the compilation of this type of information and the environmental monitoring results in the HRA indicate that these controls have been effective, and support the conclusion of "no reasonable likelihood of release" to the soil pathway. Additional data such as soil sampling, including core sampling, are not considered by the Navy to be necessary to support the HRA conclusion. These sections are also consistent with HRAs for numerous other Navy facilities which have already been finalized, with EPA agreement.

Comment 15: Pages 8-9, Section 8.4 Air Pathway: Justification is needed for the statement, "Since air leaving radiological facilities contains less than background concentrations, the likelihood of an airborne release is very low." What about

accidental releases and those outside the facilities where HEPA filters are employed, including decontamination activities?

Response: There have been no historical releases of airborne radioactivity above allowed limits or sufficient to contribute measurable exposure to any individual. This has been confirmed independently in recent years by the NESHAPS program COMPLY calculations. Controls over airborne radioactivity releases have not changed since the beginning of the Program. Improved monitoring methods have continued to confirm that no changes are needed. A historical record that radiological controls have been effective in preventing significant environmental releases provides a valid basis for concluding that continued application of such controls will result in a minimal likelihood for future such releases.

As noted in the HRA, "Other potential sources of airborne radioactivity, such as from contaminated soil or spills of contaminated liquids, have been discussed in other sections of this report. Based on the lack of detectable soil contamination, and the immediate containment and recovery actions taken for spills, PNS considers these potential sources of airborne radioactivity have been eliminated from consideration."

For clarification, routine decontamination activities are not performed outside controlled areas. They are conducted under controlled conditions (usually within radiological facilities) to preclude contamination of the environment.

To further document this issue, the following two new paragraphs will be added to page 8-12 of the HRA, after the existing second paragraph:

> "Since 1989, PNS has used the Environmental Protection Agency COMPLY computer program to provide a quantitative estimate of the radiation exposure to which any member of the general public might be exposed as a result of radioactivity in airborne effluents. This analysis is performed in accordance with EPA regulations in 40 CFR 61 Subpart I. Site-specific input parameters include radionuclide releases and distance to members of the public. Cobalt-60 values include actual measurements of cobalt-60 emissions from the exhaust of monitored ventilation in addition to very conservative estimates of other potential sources of cobalt-60. Values for other airborne radionuclides, including iodine-131, are conservative estimates based upon detailed study of land-based Naval nuclear propulsion prototype plants. Thus, the actual exposures to members of the public are expected to be lower than the results of this analysis.

Since the controls for airborne releases have remained the same over the years, the assessment for 1996 can be used for evaluation purposes. The result of the airborne effluent analysis in 1996 was 0.0037 millirem from particulate and gaseous radionuclides and 0.00000067 millirem from radioiodine releases. The estimated maximum radiation exposure to a member of the general public from releases of airborne radioactivity is much less than the standard of 10 millirem per year established by the Environmental Protection Agency in 40 CFR 61."

Additional PNS Changes: In addition to the HRA Volume I changes discussed above, Page 5-11 will be revised to reflect final agreement between the Navy and EPA concerning 40 CFR 61 compliance. Specifically, the last sentence of paragraph 2, and paragraphs 3 and 4, will be deleted.

It has recently come to our attention that small sections of Building 300 and Building 80 were used in the past to perform very limited radiological work. These buildings will be added to Table 5-6 in Section 5.4. The radiological use involved work on radioactive material within a controlled radiological containment tent, using the strict controls that have been in place since the beginning of the NNPP. This type of work occurred very infrequently, and only lasted 4-6 weeks in duration. The radiological work areas were surveyed and released in accordance with NNPP requirements. Records indicate no release of radioactive contamination ever occurred in Building 300 or Building 80 as a result of this work.

C. Volume II

Comment 16: Page 5-1, Section 5.1.1 Liquids: The statement, "Storage and use controls for these items prohibit(s) release to the environment", ignores the possibilities of accidents and human error.

Response: As the previous sentence already addresses that the sources are controlled in accordance with the applicable requirements, this sentence will be deleted. Inadvertent releases are addressed in Section 5.1.4.

Comment 17: Page 5-8, Section 5.2.2, Non-Regulated G-Ram: More information is warranted on the incineration of solids and the affect this may have had on contamination of the areas involved.

Response: Information on the incineration of solids during the early years is sparse. Fortunately, records were found that provide the following perspective:

(a) A 1949 historical record indicates that one person applied the radioactive luminous paint infrequently (approximately 20 grams of paint a year).

(b) As noted in the HRA, incineration of radium-226 contaminated consumables occurred at Henderson's Point and potentially in the Building 46 incinerator.

(c) A 1954 historical record indicates that the noncombustible residue from the open burning area at Henderson's Point, and the ashes from the incinerator at Building 46, were taken to the Jamaica Island Landfill.

There is no documentation that this practice was viewed as disposal of radioactive material; only small quantities of radium are expected to have been present. In the context of the time, when tens of millions of radium-dial clocks and watches were being sold in the civilian economy without adverse health effects being detectable, this practice appears understandable.

The information from paragraph (a) will be added to Section 4.4.3 and the information from paragraph (c) will be added to Section 5.2.2 of the HRA.

In Section 3 (page 3-20), the discussion on the DRMO Salvage Yard will be revised to address (for clarification) the open burning area during the late 1940's and early 1950's (i.e., ashes from the burning of radium-226 contaminated consumables). This will also address that the May 1991 radiological survey did not include the open burning area.

In Section 3 (page 3-21), the discussion of Jamaica Island Landfill will be revised to address the potential G-RAM disposal during the late 1940's and early 1950's (i.e., ashes from the burning of consumables from Henderson's Point and the Building 46 incinerator). This will also address that radiological monitoring of intrusive work in 1997 detected no radioactivity above background levels.

Finally, Section 5.4 will be revised to identify the past use of Henderson's Point and the Building 46 incinerator, and the subsequent fate of these facilities.

To further support the HRA conclusion that the incineration of small quantities of radium-226 contaminated consumables had no significant effect on the background levels of radium in the

soil, soil samples were collected from locations near and out to a maximum distance of approximately 1500 feet from the two sites of incineration. Samples included all likely areas of currently exposed soil. Background samples were also collected at locations away from the sites being sampled. The analysis results are shown in Enclosure (2) and will be added to Section 5.4 of the HRA. The results demonstrate that the radium-226 concentrations are within the normal background range for this area, and support the HRA conclusion that no further action appears necessary.

Comment 18: Page 6-12, Fifth Paragraph: It is not clear as to the meaning of, "...necessary to assure equilibrium between radium-226 or thorium-232 ...are not performed in the course of generating the Table 6-2 data." How does this affect the data?

Response: The purpose of this information was to illustrate that there were differences in the analysis methodology, so the sample results aren't directly comparable. However, other differences of more significance, such as the sample types and depths, were not similarly addressed. The paragraph will be revised to read: "...Reference 16 data. Significant differences in sampling and analysis techniques exist between the two data sets, but comparison of each data set with its respective background shows no increase relative to background radioactivity either over time or by location."

Comment 19: Page 7-1, Third Paragraph: The surveys quoted in this paragraph were not directed toward the identification of radium-226 sources. Therefore, they should not be quoted as excluding their existence.

Response: The surveys conducted by the Navy and EPA were capable of identifying naturally occurring radioactivity (and thus enhanced naturally occurring radioactivity). Although in most cases naturally occurring radioactivity that was observed in samples was not recorded by isotope, the fact remains that sampling and other surveys have shown no increase in levels of radiation or naturally occurring radioactivity, including radium-226. The latest EPA survey (1997) specifically compared radium-226 concentrations between on-site and off-site samples, and found no difference in concentrations. Hence, it appears to PNS that the wording in this section is appropriate.

Comment 20: Page 8-7, Section 8.3.1, Release Mechanisms Affecting Soil: In addition to the sources cited, others, including decontamination activities and non-regulated source burial, are possible.

Response: Decontamination activities are performed in controlled environments (e.g., Building 291 Radiological Control Facility) with specific engineering controls to prevent the spread of radioactive contamination. Decontamination activities are not considered by PNS to be a likely or reasonable release mechanism affecting the soil. With respect to unregulated G-RAM disposal, the following will be added at the end of the paragraph: "Although records do not indicate disposal of items containing radioactive material on-site (other than disposal of incinerator ash in the Jamaica Island Landfill, as discussed in Section 5), minor quantities of unregulated (e.g., Nuclear Regulatory Commission "exempt") radioactive material could have existed in solid consumer type items (e.g., electron tubes) which were improperly disposed of in the normal waste stream. The presence of such items is no more likely than in civilian areas throughout the country."

Comment 21: Page 8-9, Section 8.4.1: Release Mechanisms Affecting the Air: Decontamination activities should be included here. Without indications of the amount of material incinerated, how can one state, "This is not expected to have had a detectable effect on background levels of radium in soil?"

Response: Please see the response to Comment 17. In addition, the last sentence in Section 8.4.1 will be revised to read, "This did not have a detectable effect on background levels of radium in soil (see Section 5.4)."

Comment 22: Page 8-10, Section 8.4.3 Air Pathway Assessment: Again, the amount of airborne releases from incineration of solid material from the radium dial painting is an unknown.

Response: See response to Comment 17 above. With no current effect on the soil, and with any direct air releases during burning having ended about 40 years ago, no further issues regarding the need for present-day CERCLA remediation appear to exist.

Comment 23: Page 9-1, Second Paragraph: The basis for this conclusion is not clear, given the absence of survey data obtained specifically for that purpose. Further justification for the conclusion is needed.

Response: As noted in the response to Comment 19, surveys that have been conducted of the environment in and around Portsmouth Naval Shipyard were capable of detecting changes in the radiation levels from G-RAM as well as NNPP radioactivity. In the absence of any known unremediated spill sites, and in the absence of any data indicating a potential problem, no further action appears warranted within the context of CERCLA.

RESULTS OF SOIL SAMPLING FOR RADIONUCLIDES

Ref: (a) Draft Historical Radiological Assessment, Portsmouth Naval Shipyard, August 1997.
(b) Merril Eisenbud, Environmental Radioactivity from Natural, Industrial, and Military Sources, Third Edition, Academic Press, Inc., 1987.

Att: (1) Activity Levels in Soil Samples from Portsmouth Naval Shipyard
(2) Soil Sample Locations at Portsmouth Naval Shipyard
(3) KAPL Analysis Results of Soil Samples from Portsmouth Naval Shipyard

1. While compiling reference (a), Portsmouth Naval Shipyard (PNS) personnel became aware that during the late 1940's and the early 1950's radium-226 contaminated consumables (e.g., paper towels) may have been incinerated near where Building 310 is currently located (Henderson's Point), and possibly also in a former Building 46 incinerator. Because there was a potential for enhanced levels of radium-226 in these areas, soil samples were collected during February 1998 for isotopic analysis.

2. The soil samples were collected and analyzed in accordance with standard Shipyard procedures. Isotopic analyses results are presented in attachment (1). Sample locations are shown on attachment (2).

3. The results of the soil sampling indicate the following:

a. Radium-226 levels are not enhanced as indicated by:

(1) Comparison of activity levels in samples from the areas of interest to those in background samples taken away from the areas being evaluated. The average value of the soil sample activities is within 1.95σ (standard deviation) of the average value of the background activities for all isotopes considered.

(2) Radium-226 levels in both the potentially contaminated soil samples and the background soil samples are consistent with values given in reference (b) (on the order of 1 pCi/g, depending on the type of rock or soil formation).

(3) Radium-226 results listed in attachment (1) are corrected values due to interference from naturally-occurring uranium-235 (having a gamma-ray with nearly the same energy as that from radium-226).

b. The radon progeny lead-214 and bismuth-214 had activity levels consistent with their precursor (radium-226).

c. Four of the soil samples (sample numbers 1, 9, 16, and B6) were sent to a Department of Energy Laboratory (KAPL, as identified in the HRA) for independent analysis. (See attachment (3).) Results were consistent with those of PNS.

d. Cesium-137 was detected in all of the soil samples, consistent with levels expected due to past atmospheric nuclear weapons testing.

e. There was no detectable cobalt-60 activity in any soil samples.

4. Examination of the results of attachment (1) leads to the conclusion that radium-226 levels in soil taken from all areas near historical incineration sites are not elevated, relative to levels in background samples. All radium-226 levels appear to be consistent with those expected based on values cited in literature.

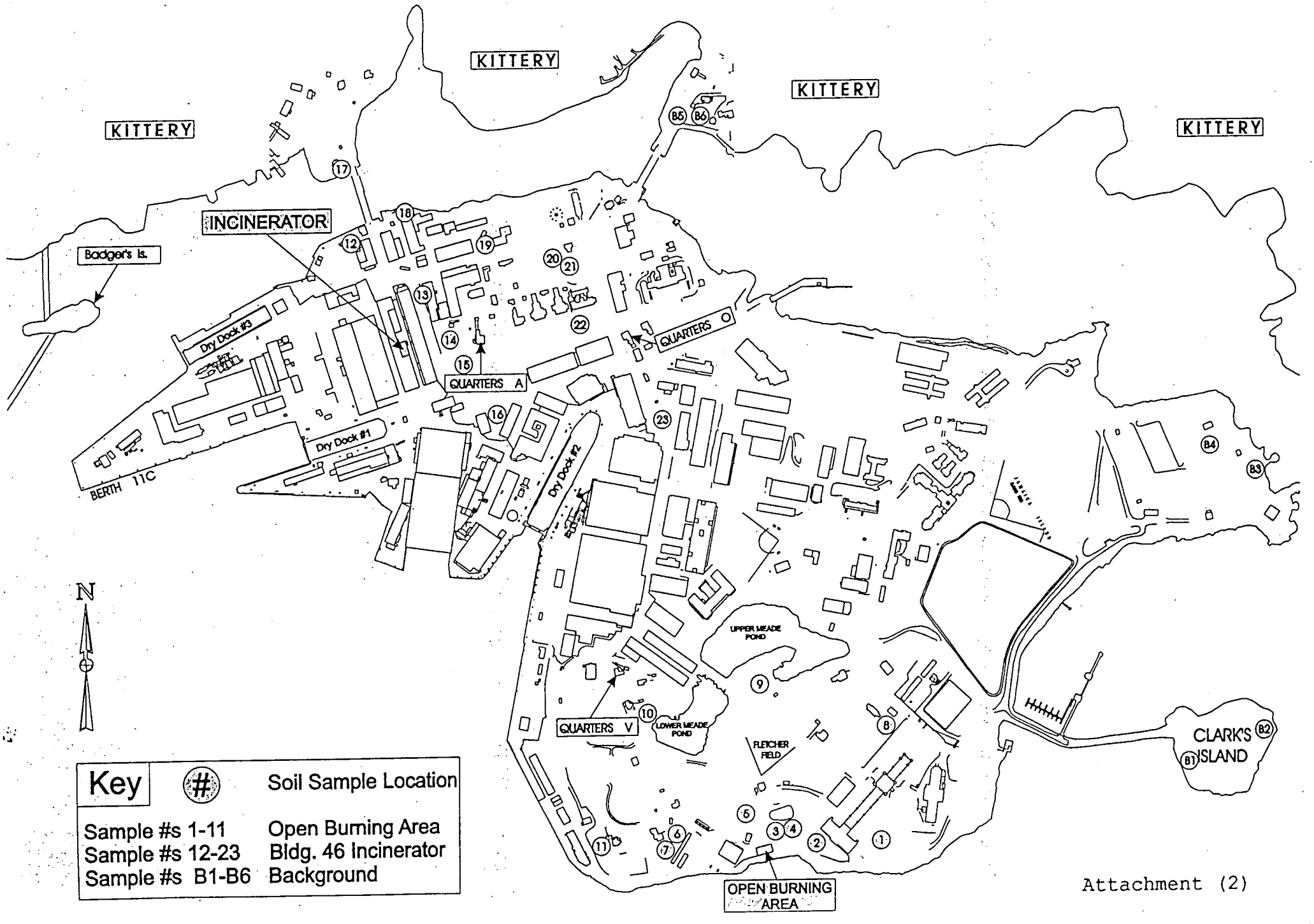
Activity Levels in Soil Samples from Portsmouth Naval Shipyard

Soil Sample I. D. (1)	Date of Analysis	Weight (grams)	Specific Cobalt-60 (pCi/g)	Naturally-Occurring Radionuclides & Cs-137									
				Ac-228 (pCi/g)	Bi-212 (pCi/g)	Bi-214 (pCi/g)	Cs-137 (pCi/g)	K-40 (pCi/g)	Pb-212 (pCi/g)	Pb-214 (pCi/g)	Ra-226 (pCi/g)	Ra-226 (3) (pCi/g)	Tl-208 (pCi/g)
1 (2)	02-Mar-98	668	< 0.03	0.80	0.46	0.62	0.36	11.9	0.70	0.62	1.35	0.78	0.25
2	02-Mar-98	576	< 0.04	0.85	< 0.23	0.48	0.50	8.8	0.65	0.51	1.41	0.82	0.22
3	03-Mar-98	593	< 0.04	0.98	< 0.24	0.59	0.41	11.3	0.75	0.63	1.37	0.79	0.27
4	03-Mar-98	563	< 0.04	0.88	< 0.23	0.50	0.54	10.0	0.68	0.57	1.27	0.74	0.24
5	04-Mar-98	626	< 0.04	0.98	0.66	0.60	0.43	14.0	0.77	0.63	0.96	0.56	0.27
6	04-Mar-98	331	< 0.06	0.68	< 0.32	0.47	0.87	9.1	0.59	0.56	1.53	0.89	0.25
7	04-Mar-98	478	< 0.04	0.93	< 0.28	0.62	0.25	12.0	0.73	0.78	2.10	1.22	0.28
8	04-Mar-98	509	< 0.04	0.69	< 0.25	0.41	0.43	7.4	0.58	0.45	1.30	0.75	0.22
9 (2)	05-Mar-98	636	< 0.05	1.56	0.85	0.88	0.10	18.3	1.19	0.94	2.23	1.29	0.45
10	05-Mar-98	451	< 0.05	0.72	< 0.26	0.48	0.80	6.4	0.56	0.57	1.17	0.68	0.20
11	05-Mar-98	474	< 0.04	0.72	< 0.27	0.44	0.37	9.3	0.63	0.52	1.17	0.68	0.24
12	05-Mar-98	674	< 0.04	0.89	< 0.22	0.61	0.29	12.1	0.74	0.64	1.50	0.87	0.26
13	05-Mar-98	523	< 0.04	0.86	< 0.26	0.58	0.18	9.5	0.66	0.58	1.05	0.61	0.26
14	10-Mar-98	542	< 0.04	0.74	< 0.25	0.49	0.30	9.2	0.61	0.60	1.52	0.88	0.21
15	06-Mar-98	462	< 0.04	0.65	< 0.22	0.43	0.57	9.1	0.54	0.53	1.23	0.71	0.21
16 (2)	06-Mar-98	435	< 0.05	0.71	< 0.26	0.58	0.10	8.2	0.59	0.73	1.34	0.78	0.22
17	06-Mar-98	614	< 0.04	0.91	< 0.24	0.47	1.91	11.2	0.62	0.49	1.17	0.68	0.25
18	06-Mar-98	633	< 0.04	0.92	< 0.22	0.56	0.13	12.5	0.78	0.64	1.11	0.64	0.27
19	07-Mar-98	616	< 0.04	0.80	< 0.25	0.55	0.13	13.2	0.68	0.61	1.26	0.73	0.25
20	07-Mar-98	671	< 0.04	0.54	< 0.20	0.51	0.31	6.6	0.46	0.51	0.90	0.52	0.16
21	07-Mar-98	652	< 0.03	0.55	< 0.21	0.49	0.29	6.5	0.49	0.50	1.04	0.60	0.18
22	07-Mar-98	690	< 0.03	0.61	< 0.18	0.39	0.65	8.6	0.41	0.47	1.20	0.70	0.16
23	08-Mar-98	528	< 0.04	0.85	< 0.26	0.50	0.25	10.3	0.70	0.61	1.19	0.69	0.26
B1	08-Mar-98	478	< 0.04	0.70	< 0.24	0.37	0.58	6.8	0.38	0.41	1.03	0.60	0.19
B2	08-Mar-98	442	< 0.04	0.68	< 0.25	0.39	0.44	8.1	0.56	0.43	0.90	0.52	0.18
B3	08-Mar-98	478	< 0.04	0.72	< 0.25	0.44	0.33	7.7	0.63	0.53	1.09	0.63	0.21
B4	09-Mar-98	410	< 0.04	0.69	< 0.27	0.45	0.49	5.7	0.53	0.48	0.99	0.57	0.21
B5	09-Mar-98	610	< 0.04	0.77	< 0.23	0.50	0.29	10.3	0.66	0.60	1.44	0.84	0.23
B6 (2)	26-Feb-98	548	< 0.04	0.84	< 0.24	0.58	0.27	X9.2	0.76	0.65	1.27	0.74	0.25
Ave. Smpl.	N/A	N/A	< 0.04	0.82	< 0.30	0.53	0.44	10.2	0.66	0.60	1.32	0.77	0.24
1.96σ Smpl.	N/A	N/A	< 0.01	0.41	< 0.16	0.10	0.75	5.4	0.15	0.11	0.62	0.18	0.06
Ave. Bkg.	N/A	N/A	< 0.04	0.73	< 0.25	0.46	0.40	8.0	0.59	0.52	1.12	0.65	0.21
1.96σ Bkg.	N/A	N/A	< 0.00	0.12	< 0.01	0.08	0.24	3.3	0.13	0.10	0.39	0.12	0.02
Uncertainties overlap between smpl. and bkg. ?			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: (1) All samples were counted for 10000 sec.
(2) Samples 1, 9, 16 and B6 were sent to a Department of Energy laboratory for independent analysis.
(3) Adjusted for interference from U-235 γ at 185.7 keV

Attachment (1)

SOIL SAMPLE LOCATIONS AT PORTSMOUTH NAVAL SHIPYARD



Attachment (2)

KAPL Analysis Results of Soil Samples from Portsmouth Naval Shipyard

Sample	Wt	Co-60	(pCi/g)	Ac-228	(pCi/g)	Bi-212	(pCi/g)	Bi-214	(pCi/g)	Cs-137	(pCi/g)	K-40	(pCi/g)
#	grams	PNS	KAPL	PNS	KAPL	PNS	KAPL	PNS	KAPL	PNS	KAPL	PNS	KAPL
1	668	< 0.03	< 0.02	0.80	0.85	0.46	1.01	0.62	0.78	0.36	0.43	11.90	14.87
B6	548	< 0.04	< 0.01	0.84	0.98	< 0.24	1.13	0.58	0.75	0.27	0.34	9.24	11.81
9	636	< 0.05	< 0.02	1.56	1.54	0.85	1.67	0.88	1.05	0.10	0.09	18.30	23.01
16	435	< 0.05	< 0.02	0.71	0.70	< 0.26	0.86	0.58	0.76	0.10	0.14	8.20	10.84

Sample	Wt	Pb-212	(pCi/g)	Pb-214	(pCi/g)	Ra-226	(pCi/g)		Tl-208	(pCi/g)	Th-234	(pCi/g)
#	grams	PNS	KAPL	PNS	KAPL	PNS (1)	PNS (2)	KAPL	PNS	KAPL	PNS	KAPL
1	668	0.70	0.98	0.62	0.89	1.35	0.78	1.13	0.25	0.28	N/A	1.14
B6	548	0.76	1.09	0.65	0.88	1.27	0.74	1.16	0.25	0.30	N/A	1.23
9	636	1.19	1.83	0.94	1.20	2.23	1.29	1.79	0.45	0.48	N/A	1.72
16	435	0.59	0.85	0.73	0.88	1.34	0.78	1.23	0.22	0.24	N/A	1.08

Notes: (1) PNS values uncorrected for interference from U-235 γ at 185.7 keV.
(2) PNS values corrected to represent Ra-226 contribution only.

Basis for U-235 interference correction:
The primary gamma peak for Ra-226 is 186.1 keV. There is interference to this peak from the 185.7 keV peak of U-235. It is therefore necessary to subtract the U-235 contribution of the peak to correctly quantify Ra-226.

Ra-226 was calculated based on the following assumptions:

1. The samples contain natural uranium and there has been no interference in the natural decay scheme.
2. The activity ratio of U-238/U-235 = ~22.5
3. Th-234 = U-238
4. U-238 = Ra-226
5. Gamma yields: Ra-226 (186.1 keV) = 3.5% & U-235 (185.7 keV) = 57.5%

(Substituting Ra-226 for U-238) The activity ratio of Ra-226/U-235 = ~22.5
(22.5) * (3.5%/57.5%) = ~1.37 (ratio of Ra-226 gammas at 186.1 keV to U-235 gammas at 185.7 keV)

Therefore, the ~186 keV gamma peak is made up of: U-235 = 1/(1+1.37) = ~42% with the remainder being the Ra-226 contribution = 100% - 42% (U-235 contribution) = ~58% or...58% of the ~186 keV peak is from Ra-226.