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U.S. NAVY REPORT
OF ENVIRONMENTAL MONITORING IN
SASEBO, YOKOSUKA, AND NAKAGUSUKU WAN, JAPAN
FOR RADIOACTIVITY ASSOCIATED WITH
NAVAL NUCLEAR PROPULSION PLANTS
2005



NAVAL NUCLEAR PROPULSION PROGRAM
DEPARTMENT OF THE NAVY
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INTRODUCTION

The policy of the U.S. Navy is to reduce to the minimum practicable the amounts of radioactivity released from Naval nuclear-powered ships, particularly within twelve miles from shore, including into harbors. Consistent with that policy, the total amount of gamma radioactivity released within all U.S. and foreign harbors visited by nuclear-powered ships in the U.S. Navy was less than 0.002 curie¹ in 2005. This amount of radioactivity is too small to have had any discernable effect on the radioactivity of any harbor environment. However, to provide additional assurance that procedures used by the U.S. Navy to control radioactivity are adequate to protect the environment, the Navy conducts periodic radiological environmental monitoring surveys. This report summarizes the results of environmental monitoring in the harbors of Sasebo and Yokosuka, and in Nakagusuku Wan on Okinawa Island.

The Navy environmental monitoring program consists of analyzing samples of harbor water, sediment, and marine life. Sampling harbor water and sediment each quarter year is emphasized since these materials would be the most likely affected by releases of radioactivity. The environmental samples are analyzed by a laboratory of the U. S. Department of Energy for cobalt 60 and other gamma emitting radionuclides. These environmental media are analyzed since they are the ones that would most likely reveal any changes in radioactivity concentrations due to nuclear-powered ship operations. Cobalt 60 is specifically analyzed because it is a sensitive tracer used to follow environmental distribution of radioactivity and it is the predominant long-lived radionuclide associated with liquid effluents from U.S. Naval nuclear-powered ship operations. Results of this monitoring show that radioactivity in the harbor environment has not increased above natural background levels as a result of operations by U.S. Naval nuclear-powered ships. These results also confirm that procedures used by the Navy to control radioactivity are effective in protecting the environment and the health and safety of the general public.

¹ One curie equals 3.7×10^{10} Becquerels.

HARBOR WATER SAMPLES

Harbor water samples are taken once each quarter year in Sasebo, Yokosuka, and Nakagusuku Wan in areas where nuclear-powered ships berth and from upstream and downstream locations. These samples are analyzed for gamma radioactivity, including cobalt 60. A germanium detector with a multichannel analyzer is used to measure gamma radioactivity and to detect the presence of cobalt 60. Procedures for analysis are selected to detect cobalt 60 if its concentration exceeds 3.7 Becquerel per liter², which is at least thirty times lower than the applicable limits for water set by agencies such as the U.S. Nuclear Regulatory Commission and the International Commission on Radiological Protection. No cobalt 60 was detected in any of the quarterly water samples collected. The harbor water sample locations are shown in Figures 1, 2, and 3.

HARBOR SEDIMENT SAMPLES

Sediment samples are obtained once each quarter year in Sasebo, Yokosuka, and Nakagusuku Wan from preselected locations including U.S. nuclear-powered ship berthing locations and areas away from these berthing locations. This frequency is adequate to monitor nuclear-powered ship operations since the predominant associated radionuclide, cobalt 60, has a half-life slightly in excess of five years, and will not appreciably decay between surveys. The harbor sediment sample locations are shown in Figures 1, 2, and 3. The samples are collected with a six inch square Birge-Ekman dredge (grapple type sampler) modified to collect only the top one-half to one inch of sediment. This layer was selected because it should be more mobile and more accessible to marine life than deeper layers. The dredge samples are analyzed for gamma radioactivity, including cobalt 60 and other non-naturally occurring radionuclides using a germanium detector with a multichannel analyzer. The dredge samples are not dried prior to analysis, but are drained of excess water. Results from the dredge samples are summarized in Table 1. A range is shown since samples from different locations show some variation.

Results of these analyses show that the most predominant gamma emitting radionuclides are naturally occurring potassium 40 and daughters of uranium and thorium. Cesium 137 was detected in some sediment samples from Sasebo, Yokosuka, and Nakagusuku Wan. The cesium 137 detected is not related to U. S. Naval nuclear reactor operations because the high integrity Naval fuel retains all related fission products. The cesium 137 concentrations measured in the sediment are due to worldwide dispersion from weapons testing. All Sasebo, Yokosuka, and Nakagusuku Wan samples analyzed contained no detectable cobalt 60. Accordingly, the operation of U.S. Naval nuclear powered ships has had no significant effect on the natural background radioactivity levels in Sasebo, Yokosuka, and Nakagusuku Wan. Table 1 summarizes the results of these analyses.

² One Becquerel per liter equals 2.7×10^{-8} microcurie per milliliter.

TABLE 1
RESULTS OF HARBOR SEDIMENT SAMPLES

SASEBO HARBOR

Quarter	Number of Samples	Number of Samples with Detectable Co-60	Range of Co-60 Analytical Results (Bq/kg)	Range of Other Non-Naturally Occurring Radionuclides (Bq/kg)
1 st	17	0	<0.90 – <1.23	Cs-137: 0.62 – 1.63
2 nd	17	0	<0.89 – <1.22	Cs-137: 0.77 – 1.60
3 rd	17	0	<0.91 – <1.19	Cs-137: 0.67 – 1.33
4 th	17	0	<0.95 – <1.28	Cs-137: 1.21 – 2.33

NAKAGUSUKU WAN

Quarter	Number of Samples	Number of Samples with Detectable Co-60	Range of Co-60 Analytical Results (Bq/kg)	Range of Other Non-Naturally Occurring Radionuclides (Bq/kg)
1 st	12	0	<0.56 – <0.81	None
2 nd	12	0	<0.48 – <0.80	None
3 rd	12	0	<0.60 – <1.05	Cs-137: 0.52 – 0.61
4 th	12	0	<0.51 – <0.88	None

Notes:

- (1) Results with a "<" symbol contained less than the minimum detectable activity. The minimum detectable activity may differ from sample to sample or quarter to quarter due to differences in the amount of naturally occurring radioactivity in each sample, differences in detection equipment, statistical fluctuations and variations in sample size.
- (2) Values given as "<X - <Y" reflect the range of minimum detectable activities measured for individual samples.
- (3) One Becquerel per kilogram (Bq/kg) equals 0.027 picocurie per gram.

TABLE 1
RESULTS OF HARBOR SEDIMENT SAMPLES - CONTINUED

YOKOSUKA HARBOR

Quarter	Number of Samples	Number of Samples with Detectable Co-60	Range of Co-60 Analytical Results (Bq/kg)	Range of Other Non-Naturally Occurring Radionuclides (Bq/kg)
1 st	16	0	<0.88 – <1.12	Cs-137: 0.78
2 nd	16	0	<0.74 – <1.25	Cs-137: 0.67 – 1.33
3 rd	16	0	<0.81 – <1.19	Cs-137: 0.58 – 1.49
4 th	16	0	<0.81 – <1.23	Cs-137: 0.55 – 1.11

Notes:

- (1) Results with a "<" symbol contained less than the minimum detectable activity. The minimum detectable activity may differ from sample to sample or quarter to quarter due to differences in the amount of naturally occurring radioactivity in each sample, differences in detection equipment, statistical fluctuations and variations in sample size.
- (2) Values given as "<X - <Y" reflect the range of minimum detectable activities measured for individual samples.
- (3) One Becquerel per kilogram (Bq/kg) equals 0.027 picocurie per gram.

MARINE LIFE SAMPLES

An evaluation by the U. S. Environmental Protection Agency shows that the cobalt 60 from Naval nuclear propulsion plants is in the form of metallic corrosion product particles which do not appear to be concentrated in the food chain. However, samples of marine life such as mollusks, crustaceans, and marine plants were collected from the harbors in 2005. Marine life samples were also analyzed using a germanium detector with a multichannel analyzer. The results of these analyses are shown in Table 2. No cobalt 60 has been detected in these samples of marine life.

TABLE 2
RESULTS OF MARINE LIFE SAMPLES

SASEBO HARBOR

Sample Type	Co-60 Analytical Results (Bq/kg)	Other Non-Naturally Occurring Radionuclides (Bq/kg)
Mollusk	<0.56	None
Crustacean	<0.47	None
Plant	<0.47	None

NAKAGUSUKU WAN

Sample Type	Co-60 Analytical Results (Bq/kg)	Other Non-Naturally Occurring Radionuclides (Bq/kg)
Mollusk	<0.47	None
Crustacean	N/A	N/A
Plant	<0.49	None

YOKOSUKA HARBOR

Sample Type	Co-60 Analytical Results (Bq/kg)	Other Non-Naturally Occurring Radionuclides (Bq/kg)
Mollusk	<0.44	None
Crustacean	N/A	N/A
Plants	N/A	N/A

Notes:

- (1) Results with a "<" symbol contained less than the minimum detectable activity. The minimum detectable activity may differ from sample to sample or quarter to quarter due to differences in the amount of naturally occurring radioactivity in each sample, differences in detection equipment, statistical fluctuations and variations in sample size.
- (2) N/A = Not Available. Marine life samples of the specified type were not available for collection.
- (3) One Becquerel per kilogram (Bq/kg) equals 0.027 picocurie per gram.

CONCLUSION

The results of this environmental monitoring show that there has been no increase in radioactivity above natural background levels in the Sasebo, Yokosuka, and Nakagusuku Wan environment as a result of U.S. Navy nuclear-powered ship operations. These results confirm that procedures used by the U.S. Navy to control radioactivity are effective in protecting the environment and the health and safety of the general public.

Figure 1

Environmental Monitoring
Survey Chart

Sasebo Harbor, Japan

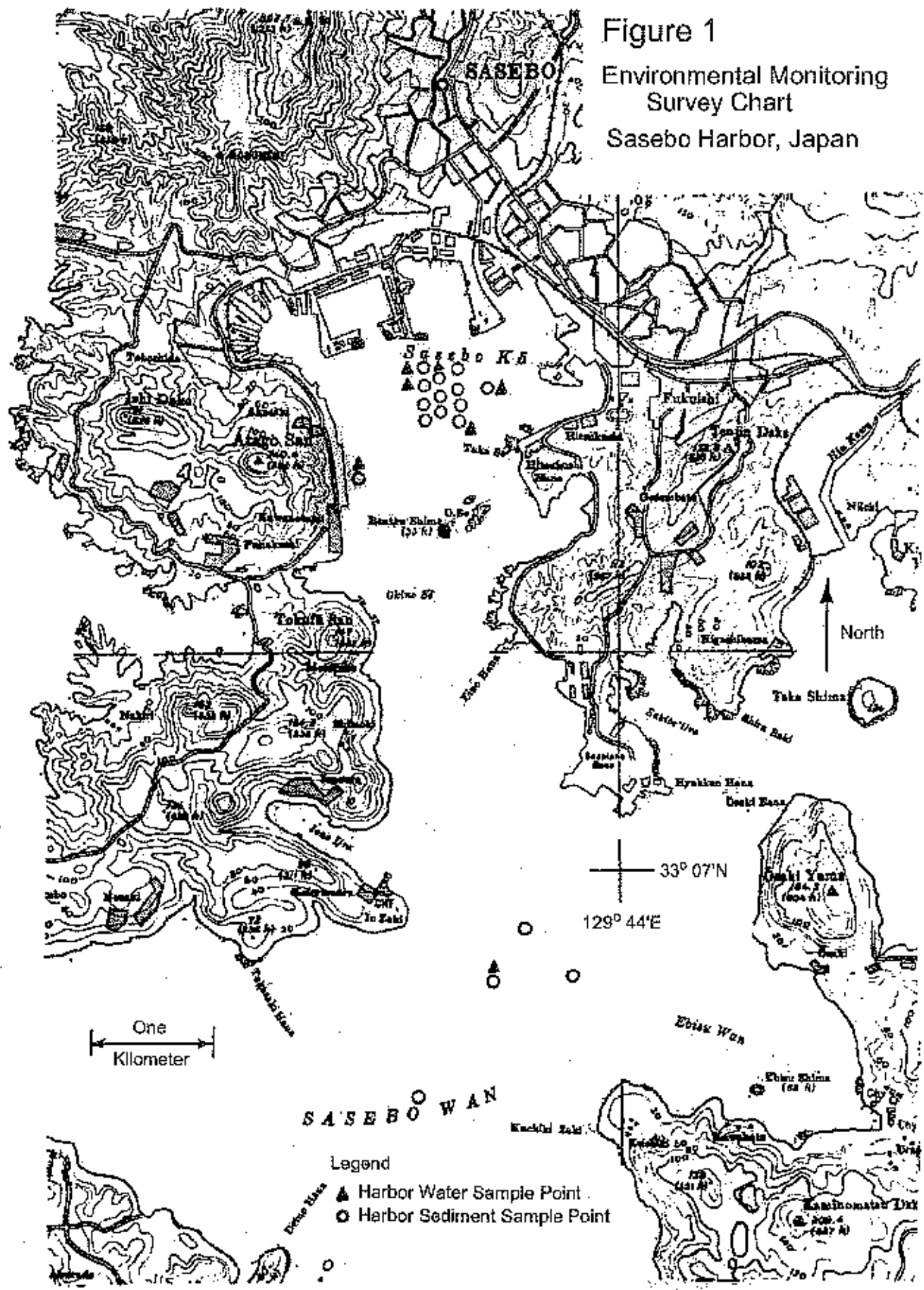
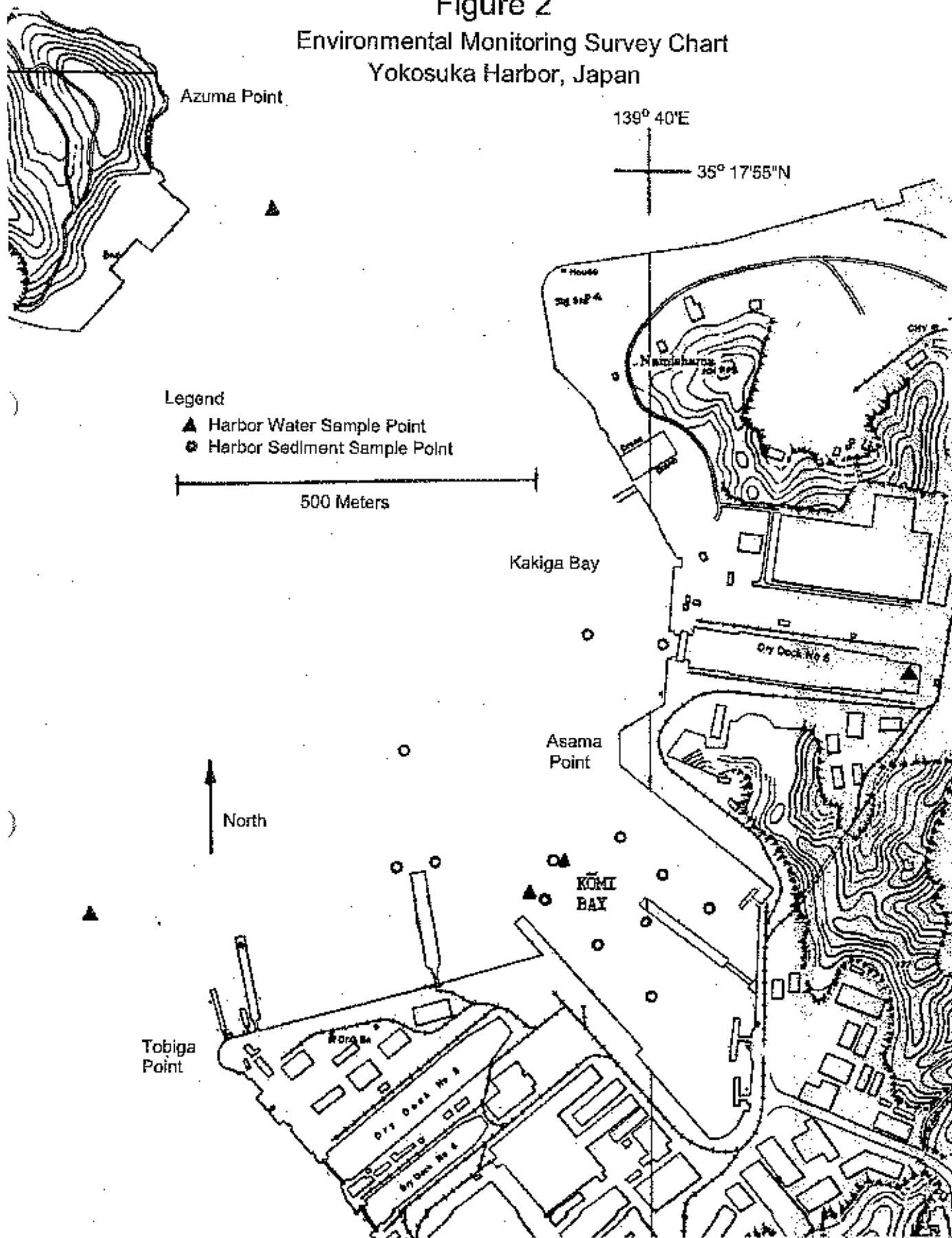


Figure 2
Environmental Monitoring Survey Chart
Yokosuka Harbor, Japan



Three additional sediment and one additional water sampling sites are not shown. These sites are located approximately two thousand yards northeast of the harbor where ships sometimes anchor off shore.

Figure 3

Environmental Monitoring Survey Chart
Nakagusuku Wan, Okinawa Island

