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Phase I Final Rule and Technical Development Document of Uniform National Discharge Standards (UNDS)

Appendix A

Deck Runoff: Nature of Discharge

April 1999

NATURE OF DISCHARGE REPORT

Deck Runoff

1.0 INTRODUCTION

The National Defense Authorization Act of 1996 amended Section 312 of the Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)) to require that the Secretary of Defense and the Administrator of the Environmental Protection Agency (EPA) develop uniform national discharge standards (UNDS) for vessels of the Armed Forces for "...discharges, other than sewage, incidental to normal operation of a vessel of the Armed Forces, ..." [Section 312(n)(1)]. UNDS is being developed in three phases. The first phase (which this report supports), will determine which discharges will be required to be controlled by marine pollution control devices (MPCDs)—either equipment or management practices. The second phase will develop MPCD performance standards. The final phase will determine the design, construction, installation, and use of MPCDs.

A nature of discharge (NOD) report has been prepared for each of the discharges that has been identified as a candidate for regulation under UNDS. The NOD reports were developed based on information obtained from the technical community within the Navy and other branches of the Armed Forces with vessels potentially subject to UNDS, from information available in existing technical reports and documentation, and, when required, from data obtained from discharge samples that were collected under the UNDS program.

The purpose of the NOD report is to describe the discharge in detail, including the system that produces the discharge, the equipment involved, the constituents released to the environment, and the current practice, if any, to prevent or minimize environmental effects. Where existing process information is insufficient to characterize the discharge, the NOD report provides the results of additional sampling or other data gathered on the discharge. Based on the above information, the NOD report describes how the estimated constituent concentrations and mass loading to the environment were determined. Finally, the NOD report assesses the potential for environmental effect. The NOD report contains sections on: Discharge Description, Discharge Characteristics, Nature of Discharge Analysis, Conclusions, and Data Sources and References.

2.0 DISCHARGE DESCRIPTION

This section describes the deck runoff discharge and includes information on: the equipment that is used and its operation (Section 2.1), general description of the constituents of the discharge (Section 2.2), and the vessels that produce this discharge (Section 2.3).

Decks are addressed in this NOD report under three categories: weather decks, aircraft flight decks, and oiler weather decks. The runoff from each deck type reflects the materials and treatment to which it is exposed during normal operations. All decks are exposed to a similar and harsh environment; however, there is a core group of activities, weapons, and machinery common to all ships. These common elements are addressed under the general category of weather deck runoff. Runoff from flight decks from which aircraft are launched and recovered and from oiler weather decks are addressed separately since the unique nature of the operations conducted on these decks distinguishes them from other weather deck surfaces.

2.1 Equipment Description and Operation

2.1.1 Weather Deck Runoff

Weather deck runoff consists of rain and other precipitation, seawater which washes over the decks (green water), and freshwater washdowns. Precipitation is usually the primary source within 12 nautical miles (n.m.) of shore. Except for small craft, green water or salt spray over the deck occurs primarily at sea and does not contribute to deck runoff while a ship is in port or in protected coastal waters. Freshwater washdowns also occur, but contribute less to weather deck runoff than precipitation.

The following paragraphs summarize each source that can contribute components to weather deck runoff.[1]

Deck Machinery - Ships have many pieces of deck machinery, such as windlasses, mooring winches, boat winches, underway replenishment gear, cranes, towing winches, and stern gates. This equipment is maintained with a variety of materials, including lubricating oils and greases that may be present in the deck runoff.

Topside Debris - Debris is trash (e.g., cigarette butts, dirt, paper) that can be washed overboard. The amount of debris is almost entirely a function of housekeeping practices, and crew discipline determines how much is collected for disposal instead of being washed overboard.

Wire Rope - Wire rope is used extensively in topside rigging, deck machinery, replenishment gear, and other equipment. It must be lubricated to prevent premature failure caused by friction between strands as the rope is worked. The lubricating oil or grease must be thin enough to flow or be worked between individual strands, but sufficiently wash-resistant to withstand rain and washdowns.

Fueling Operations - Fueling operations, either at sea or in port, may contaminate the deck with petroleum hydrocarbons (e.g., diesel, JP-5, fuel oil).

Weapons Systems - Gun mounts, missile launchers, weapons directors, and other weapons-related equipment can contribute constituents similar to those of deck machinery; however, they are less likely to contribute to deck runoff because most are contained in a turret or other water-tight or water-resistant enclosure.

Ship's Boats - Surface ships have small boats (e.g., punts, landing craft, rigid inflatable boats [RIBs]) that are stored topside. They have bilge plugs that are removed while stored, to drain rainwater, washdown water, or green water through their bilge and onto the deck if the boats are not properly covered. Constituents in the bilge (primarily diesel fuel) are discharged with the water.

Soot Particles - Burned fuels can leave fine soot particles on the deck. Except for MSC ships that are powered in equal numbers by steam and diesel propulsion equipment, the majority of the Armed Forces' surface ships and craft have diesel or gas turbine propulsion and use clean-burning distillates to minimize soot. However, significant amounts of soot can be produced during boiler light-off or after prolonged shutdowns of turbines and diesels.

Firefighting Agents - Aqueous Film Forming Foam (AFFF) firefighting systems are tested periodically in accordance with the planned maintenance system (PMS). These tests are conducted beyond 12 n.m. or while making 12 knots or more when transiting between 3 and 12 n.m.. The AFFF must be collected if the exercise occurs within 3 n.m. As discussed in the AFFF NOD report, AFFF is not discharged overboard within 3 n.m. of shore except in the rare instance of an actual shipboard fire.

Cleaning Solvents and Detergents - Miscellaneous solvents are used to clean and maintain topside equipment. These solvents may contain chlorinated compounds. However, they are also volatile and evaporate quickly. As such, their presence in deck runoff is expected to be minimal to nonexistent. During freshwater washdowns, crew members may use detergents that become part of the runoff.

Some or all of the above-listed sources that contribute to the contamination in deck runoff are common to all vessels.

Various Navy ports treat weather deck runoff differently. To date, no port is known to require the containment of rainwater runoff; however, a containment requirement may exist for some freshwater washdowns in certain Navy ports. For instance, at the Naval Submarine Base, Bangor, WA, freshwater washdowns containing cleaning agents, detergents, or other additives are considered to be industrial discharges; and, as such are not permitted to be discharged into the Hood Canal, rated a class AA "extraordinary" water body.[2] On the other hand, low-pressure freshwater washdowns completely free of cleaning agents or other chemicals need not be contained, and may be discharged into the Hood Canal.[2]

The U.S. Coast Guard (USCG) performs washdowns of its ships after returning to port and weekly while in port.[3] Initially, the decks are cleared of debris by hand and/or vacuum and then scrubbed with fresh water and detergent using brushes and screening pads. Fresh water is used to rinse the washdown overboard.[3]

Deck runoff occurs on boats and craft although some, such as RIBs, are stored on land. Because these vessels are small, green water becomes a significant contributor to deck runoff, and freshwater washdowns occur more frequently to remove the effects of green water on these vessels compared to larger ships. Craft, such as mechanized landing craft (LCMs), and smaller boats, such as RIBs and river patrol boats (PBRs), are washed down frequently to remove saltwater spray and residues left by heavy equipment and troops. However, many of these craft have large wells and very little deck area, which reduces the amount of deck runoff. Instead, precipitation, washwater, and green water collect in the bilge, rather than contributing to deck runoff. The USCG washes down its smaller vessels (i.e., those less than 65 feet long) nearly every day.[3]

2.1.2 Flight Deck Runoff

The same three sources of water contribute to this discharge as to that of weather deck runoff: precipitation, greenwater over the deck from heavy seas, and deck washdowns, in this case flight deck washdowns. As with weather deck runoff, flight deck runoff can be contaminated with a variety of chemicals.

Aircraft carrier launch and recovery equipment, e.g., catapult troughs and jet blast deflectors, are unique to aircraft carriers and are a major contributor of contaminants to flight deck runoff. Lubricating oil is applied to the catapult before each launch, and a fraction of this oil, along with the fuel mist emitted from aircraft during launch and hydraulic fluid and grease from the catapult, are deposited in the four catapult troughs of each carrier. [4-6] Most of these deposits drain overboard during flight operations, i.e., beyond 12 n.m., but a considerable amount of residual deposits can remain where precipitation can wash it overboard, either during transit or in port.[4-6] Oil sheens have been observed in port around aircraft carriers. This usually occurs following rainstorms due to runoff from the catapult troughs. In addition, the jet blast deflectors accumulate soot from jet exhaust, and have hydraulic system leakage that could contribute to flight deck runoff.

Most commissioned Navy vessels have flight decks for helicopter landing and takeoff. Many of these ships also have hangar facilities for helicopter storage and maintenance. The LHA, LHD, and LPH Classes of amphibious assault vessels have between 30 and 36 helicopters embarked, and some have about a dozen Vertical/Short Take-Off and Landing (VSTOL) aircraft as well. Flight exercises are conducted routinely with these aircraft.

Several other classes of vessels also have helicopter landing areas and hangars which accommodate one to three helicopters. These ships carry helicopters as part of their normal complement, but conduct flight operations less frequently than carriers or amphibious assault

ships. Exceptions are the large service force ships, such as fast support ships (AOEs), ammunition ships (T-AEs), and combat stores ships (T-AFSs), which carry two or three UH-46 Sea Knight helicopters for underway replenishment (UNREP). These ships use the helicopters to transfer large volumes of provisions and ammunition rapidly during UNREP operations.

Vessels with ancillary helicopter flight decks and do not have their own helicopters, are not included in this analysis because they contribute very little helicopter-specific flight deck runoff compared to an amphibious assault vessel, which can carry up to 36 helicopters.

Flight deck washdowns to eliminate fire and slip hazards and to wash salt spray off flight decks are performed while ships are underway.[7,8] Both Commander Naval Air Force, U.S. Atlantic Fleet (COMNAVAIRLANT) and Commander Naval Air Force, U.S. Pacific Fleet (COMNAVAIRPAC) have promulgated policies that carrier flight decks are not to be washed down within 12 n.m. of shore except in cases of emergency.[7,8] Further, both Commander Naval Surface Force, U.S. Atlantic Fleet (COMNAVSURFLANT) and Commander Naval Surface Force, U.S. Pacific Fleet (COMNAVSURFPAC) have policies in force that state that decks shall not be washed within 12 n.m. of shore.[9,10]

Aircraft and helicopter freshwater washdowns are performed to remove dirt, hydrocarbons, salt deposits, and other materials resulting from flight operations or from salt spray. Unless the ship's engineering officer is short of fresh water, the aircraft are washed before they disembark upon the ship's return to port. Since current policies require that flight deck washing be completed prior to the ship arriving within 12 n.m. of shore, and since aircraft are disembarked prior to washing the flight deck, aircraft are not usually aboard either aircraft carriers or amphibious assault ships within 12 n.m. of shore. Therefore, aircraft freshwater washdowns do not contribute to deck runoff with 12 n.m. of shore.[11]

MSC has not promulgated protocols for the washing of helicopter flight decks on its vessels. The cleaning agent/solvent used and the washdown frequency are at the discretion of the officer in charge of the deck. Except in unusual circumstances, flight decks are not washed in port.[12]

2.1.3 Oiler Weather Deck Runoff

Oilers carry various petroleum products as cargo. This report examines the discharge from Navy and MSC oilers and UNREP ships which perform fueling-at-sea (FAS) operations. It also examines the discharge from the fuel barge service craft, which are used to fuel and defuel surface vessels while in port.

During the receiving and off-loading of bulk fuel, oilers have the potential to discharge oil. To prevent this, the weather deck is sealed by plugging or blocking the weather deck openings as required by Federal Regulations.[13] If the liquid contains oil from inadvertent spills or releases, the liquid is processed through the ship's oily waste treatment system. These ships are also provided with oil spill containment and cleanup kits.

The newer oilers, such as the T-AO 187 Class, incorporate engineering design features and follow fueling practices that minimize oil releases. Excess oil and other uncontained liquids drain to a sludge collection tank, which is routed to an oily waste collection system. Any other liquid that collects in these sumps, such as rainwater or seawater, is also routed through the oily waste collection system.[14] The 7-inch fueling hoses contain check valves to prevent spills when disconnected. Additional protection against spills is provided by "blowing down" the hose with compressed air and/or taking a "back suction" with the cargo or stripping pumps and pumping the contents of the hose back to the oiler's cargo reclamation system before disconnecting the hose. FAS stations are also provided with spill response equipment to contain one to six barrels of oil (42 to 252 gallons), and with sorbents to contain any drips or small spills.

The newer designs also include the required catchment basin around fuel tank vent stations to contain oil and other liquids released because of overfilling during fueling operations.[13] If the liquids contain oily residues, these basins are pumped to the oily waste collection system. If the catchment basin contains only rainwater, the rainwater is discharged overboard. The catchments are routinely cleaned to remove oily residue. The disposition of these wash waters is to the oily waste collection system.[14] The treatment and disposition of oily waste is covered in the Surface Vessel Bilgewater/OWS Discharge NOD report.

All fuel barges have fire and flooding alarms, and are equipped with high tank level alarms. Ship alterations have been prepared to install oil retaining coamings and plugs for all fuel barges. Most barges currently in use were built or retrofitted with the coamings.[15] Fuel oil barges refuel ships within 12 n.m. of shore, whereas the oilers/UNREP vessels refuel ships beyond 12 n.m.

2.2 Releases to the Environment

Deck runoff is produced when water falls on or is applied to the exposed surfaces, such as weather and flight decks, superstructure, bulkheads, and the hull above the waterline, of a ship. Frequently runoff is contaminated by residues from the activities described in Section 2.1. The probable contaminants include: oil and grease; petroleum hydrocarbons; surfactants; cleaners; glycols; solvents; and particulates, such as soot, dirt, or metallic particles.

2.3 Vessels Producing the Discharge

Deck runoff is produced on all ships, submarines, boats, and craft of the Armed Forces (Table 1). Table 1 lists ship class, number of ships homeported in the U.S., dimensions (length and beam), flight deck dimensions (where applicable), and the number of days annually that each class of ship averages within 12 n.m.[16-25] The several thousand small boats and craft of the Armed Forces are not individually categorized.

Water, other than green water, that falls on the decks of submarines while they are in port or transiting inside of 12 n.m. is deck runoff. For submarines, green water is not considered deck runoff because of their design. All operating equipment on a submarine, with some minor exceptions, is contained within the double hull of the ship. Some outboard equipment, such as

the hydroplanes, rudder, shaft seals, periscope, and antennae, are greased on a submarine; however, discharges from these sources are described in a separate NOD report. When operating, submarines spend virtually all of their time submerged beyond 12 n.m., and no activities are performed topside on a routine basis that could contribute to the contamination of deck runoff. Similarly, while submarines are in port, the majority of work occurs on the inside of the ship, not topside. Based on this information, the deck runoff from submarines is not a significant discharge.

3.0 DISCHARGE CHARACTERISTICS

This section contains qualitative and quantitative information that characterizes the discharge. Section 3.1 describes where the discharge occurs with respect to harbors and near-shore areas, Section 3.2 describes the rate of the discharge, Section 3.3 lists the constituents in the discharge, and Section 3.4 gives the concentrations of the constituents in the discharge.

3.1 Locality

This discharge consists of runoff from rainfall and other precipitation, from freshwater washdowns, and from green water; therefore, it can occur while in port or at sea. Table 1 contains a tabulation of the number of days the various vessel types spend within 12 n.m. of shore.[16]

3.2 Rate

The gallons of precipitation runoff per year estimated for each home port of a ship class is the product of the deck area of a ship in the class, the number of ships in the class in a given homeport, the average fraction of the year spent within 12 n.m. of shore, the average annual rainfall in the homeport, and the appropriate conversion factors. The total gallons of runoff from a ship class is the sum of the estimates thus developed for all the homeports of the class.

3.2.1 Weather Deck Runoff

Precipitation is expected to be the largest contributor to deck runoff in all types of vessels. Annual average precipitation data were obtained for the largest ports used by the Armed Forces as homeports: Norfolk and Little Creek, VA; San Diego, CA; Pearl Harbor, HI; Groton, CT; Mayport, FL; Ingleside, TX; and Bremerton, WA.[26] The average number of transits and days in port were developed for the years 1991 through 1995 for Navy and USCG ships.[16]

The various deck areas were estimated by multiplying the product of a vessel's length and beam by a factor intended to account for the departure of the deck's shape from a rectangle. In Table 1, those ship classes which are asterisked have a helicopter platform, but do not have a helicopter routinely embarked. The deck areas listed for these vessel classes include the area of the flight deck. For vessel classes whose helicopter platform dimensions are without an asterisk, such as the Spruance Class destroyers (DD 963), the deck area listed in Table 1 does not include

the area of the helicopter platform.

The gallons per year precipitation runoff values listed in Tables 2 through 7 and in Tables 9a and 9b were all estimated using the same formula:

$$(N)\ (D/365)(A)(P)(PF)(FG) = \text{Annual Runoff (gallons per year)}$$

where N = the number of ships with the same deck area contributing to the annual runoff
D = the number of days per year each ship is within 12 n.m. of shore
A = the area in square feet of the deck or flight deck under consideration
P = the annual rainfall in inches
PF = 1/12, the conversion factor - one foot per 12 inches
FG = 7.48 gallons per cubic foot

Based upon this information and average deck area, an estimate of weather deck runoff from precipitation was developed for Navy ships by home port, and is presented in Table 2. Approximately 37.6 million gallons of weather deck runoff occurs annually from Navy surface ships in U.S. homeports due to rainfall.

To derive estimates of the precipitation-induced weather deck runoff from MSC, USCG, and Army vessels, a 40-inches-per-year rainfall was assumed, the annual average for the Navy homeports. The estimates are provided in Table 3. Approximately 54.6 million gallons of weather deck runoff occur annually within 12 n.m. of the U.S. coast from MSC, USCG, and Army vessels due to precipitation.

The Armed Forces operate literally thousands of boats and craft of a multitude of sizes throughout the offshore waters, harbors, and rivers of the U.S. Because neither the precise location of all of the boats and craft nor the mode of operation and storage at each location has been determined, it is impractical to estimate rates for these vessels.

3.2.2 Flight Deck Runoff

An estimate for aircraft carrier flight deck precipitation runoff is based upon reported average annual precipitation, the number of ships in each homeport, the flight deck area, and the number of days in port. Approximately 23.3 million gallons of weather deck runoff from aircraft carrier flight decks occur annually within 12 n.m. of the U.S. coast due to precipitation.

These results show that the quantity of aircraft carrier flight deck runoff varies significantly with geographical location. San Diego, CA, has the lowest average annual rainfall resulting in the least runoff. Although Norfolk, VA does not have the highest precipitation rate, it produces the highest amount of flight deck runoff because it is homeport to the most carriers. The data and results are presented in Table 4. Because it is not unusual for three carriers to be in Norfolk at the same time, and for summer storms to produce an inch of rain in a few hours, the

three carriers, with a combined flight deck area of 690,000 ft^2, will generate approximately 430,000 gallons of flight deck runoff for each inch of rain.

Of the 11 amphibious assault vessels in service, 10 are stationed in U.S. ports, and are homeported either in Norfolk, VA, or San Diego, CA. The ships, by class, are divided evenly between these two ports. The mine countermeasures support ship USS Inchon (MCS 12) is a converted Iwo Jima Class LPH, and is homeported in Ingleside, TX. The estimated total annual helicopter flight deck runoff for these vessels due to precipitation is approximately 8.3 million gallons. Table 5 is a compilation of the data used to estimate the average annual deck runoff from these ships due to precipitation.

Table 6 lists flight deck runoff from Navy surface vessels, other than aircraft carriers and amphibious assault vessels, by U.S. homeport, number and location of vessels by class, and the average annual rainfall for each port. Based on this information, these ships generate an annual deck runoff of approximately 2.6 million gallons due to precipitation.

The estimate for precipitation runoff from helicopter flight decks of MSC and USCG surface ships is presented in Table 7. The estimate was derived from the areas of the flight decks, the average annual rainfall, and the number of days in port for each ship class. Based on this information, MSC and USCG surface ships generate an estimated annual deck runoff of 860 thousand gallons due to precipitation.

A volume of helicopter flight deck wash water generated by USCG vessels is estimated in Table 8. The volume used to wash and rinse a given flight deck area is considered to be the same as would be used on a Navy ship, that is, 30-gallons of a cleaning solution mix of MIL-C-85570, type II detergent, sodium metasilicate (anhydrous or pentahydrate), and freshwater will treat approximately 3,000 ft^2 of deck. The amount of water used to rinse the cleaning solution off of the deck is on the order of three to five times the volume of the cleaning solution used. Further, because the USCG washes weekly, the number of washes annually is estimated by dividing the number of days a vessel is within 12 n.m. of shore by seven.[3] Based upon these assumptions, USCG surface ships generate approximately 70 thousand gallons of helicopter flight deck wash water as compiled in Table 8.

3.2.3 Oiler Weather Deck Runoff

Estimates have been prepared, using the same methodology, for the deck runoff from Navy and MSC oilers due to precipitation. They are presented in Table 9a. Similar estimates were prepared for the various service craft, such as fuel barges, and are presented in Table 9b. As indicated in the tables, the estimated annual runoff from the oilers is approximately 8 million gallons, and from the various service craft approximately 8.9 million gallons.

3.2.4 Runoff Summary

Table 10 is a compilation of the runoff volumes associated with the various runoff sources and vessel types. As indicated in the table, the estimated annual runoff from vessels of

the Armed Forces due to precipitation and the limited number of in-port washdowns is approximately 143.9 million gallons.

3.3 Constituents

The runoff from flight and other weather decks can contain a number of different constituents, including: JP-5, found in the runoff from aircraft carrier flight decks, helicopter flight decks, and the weather decks of support ships carrying JP-5 as cargo; diesel fuel marine, distillate fuel, or gasoline, from vessel fueling and refueling operations; various solids, such as soot, paint chips, dirt, and trash; glycol from the windshield washing system; hydraulic fluid leakage; metals from scrapes, gouges and corrosion; rubber from aircraft tires; and the residue from cleaners and solvents, particularly sodium metasilicate.

These materials contain short- and medium-length aliphatics, light and heavy aromatics, paraffins, olefins, surfactants, glycols, and metals. Some cleaning solvents can contain chlorinated compounds, such as tetrachloroethylene. These solvents quickly evaporate.

Analytical data are available for one element of aircraft carrier flight deck runoff: the runoff that flows through a catapult trough and is discharged overboard. This runoff was sampled in a study on the feasibility of using an oil/water separator to treat trough runoff.[27] The resulting data are not representative of the runoff from the entire flight deck of a carrier, only of runoff that is discharged from one of the catapult troughs. The aqueous phase of the catapult trough runoff was analyzed for:

- oil and grease,
- phenols, and
- metals (silver, cadmium, chromium, copper, nickel, and lead).

The four catapult troughs are located in close proximity to the aircraft fueling spots, and collect spilled JP-5. Lubricating oil is applied to a catapult before each shot. A fraction of this oil, along with fuel mist emitted from aircraft during launch, and hydraulic fluid and grease from the catapult is deposited in each of the four catapult troughs.[4-6] The concentrations originating in the catapult troughs can, therefore, be expected to exceed those for the flight deck runoff in general.

None of the constituents analyzed for are bioaccumulators, and no bioaccumulators are anticipated in this discharge. The materials used on the decks of vessels do not contain the pesticides, herbicides, PCBs, or other chlorinated aromatic compounds that constitute bioaccumulators.

Of the constituents listed above, silver, cadmium, chromium, copper, nickel, lead, and phenols are priority pollutants.

3.4 Concentrations

The laboratory data from an aircraft carrier catapult trough drain system are presented in Table 11. The data are the concentrations before processing the runoff through an oil/water separator, and are not representative of the runoff from the entire flight deck of an aircraft carrier.[27]

Constituent concentrations resulting from precipitation are expected to vary significantly with a number of factors. These include: time since the last rain or deck washing; the intensity and duration of the last rainfall; the season (which will effect glycol loading from deicing fluids); the ship's adherence to good housekeeping practices; and the type, intensity, and duration of weather (high sea state and green water) and ship's operations. For example, higher seas which result in more frequent green water runoffs and more frequent freshwater washdowns, both of which generally occur outside 12 n.m., will minimize the concentrations of accumulated residues that contribute to runoff contamination in port. Further, it should be noted that deck runoff from precipitation may mimic the constituent concentration patterns observed in storm water runoff from highways and parking lots: contaminant concentrations will be higher in first portions of the runoff, and then will taper off to low or nondetectable levels as the precipitation continues.

4.0 NATURE OF DISCHARGE ANALYSIS

Based on the discharge characteristics presented in Section 3.0, the nature of the discharge and its potential impact on the environment can be evaluated. A discussion of mass loadings is presented in Section 4.1. In Section 4.2, the concentrations of discharge constituents are compared with the water quality standards. In Section 4.3, the potential for transfer of non-indigenous species is discussed.

4.1 Mass Loadings

Currently, no basis exists for estimating the mass loadings of deck runoff accurately. The factors discussed in Section 3.4, that combine to produce the great variance in deck runoff, prohibit the development of engineering assumptions from which to estimate deck contaminant concentrations. The use of the data from any analysis of the untreated runoff that had flowed through an aircraft carrier catapult trough could result in mass loadings that are overestimated by orders of magnitude.

4.2 Environmental Concentrations

As with mass loadings, because the constituent concentrations vary with a number of factors, most of which vary over time since the last rainfall or washdown; the environmental concentrations will vary accordingly. For any given set of factors discussed in Section 3.4, the discharge concentrations for the catapult trough portion of deck runoff can be used as a worst case for a specific contributor.

The catapult trough discharges as a component of the flight deck runoff are diluted as they enter the receiving waters, but to what extent is unknown. Therefore, the raw concentration

values are used for comparison to the Federal and most stringent state water quality criteria listed in Table 12. The comparisons show that a number of the constituent concentrations in catapult trough runoff exceed Federal and state acute water quality criteria, in addition to discharging oil exceeding the Federal discharge limits.[28] Chromium concentrations exceed the most stringent state's water quality criteria. The detected metals that exceed the Federal and most stringent state water quality criteria are: cadmium, nickel, and lead. In addition, two metals, silver and copper, which were not detected, have reported limits that are more than an order of magnitude higher than their corresponding Federal and state water quality criteria. The reported phenols concentration exceeded the most stringent state criteria. The oil and grease concentration exceeds the Federal criterion and the concentrations reported are also likely to cause a visible sheen on receiving waters. Discharges of oil that cause a visible sheen on receiving waters must be reported.[28]

4.3 Potential For Introducing Non-Indigenous Species

The potential for non-indigenous species transport is insignificant. The runoff due to rainfall and washdown has a low potential to contain non-indigenous species, and the runoff from green water is discharged in the same location from which it came aboard.

5.0 CONCLUSION

Oil in the deck runoff discharge has the potential to cause an adverse environmental effect. This conclusion is based upon observations of oil sheens on the water surface surrounding certain vessels during and after rainfalls.

6.0 DATA SOURCES AND REFERENCES

Table 13 shows the sources of data used to develop this NOD report.

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Table 1. Listing of Ships and Vessels for Deck Runoff
Navy, MSC, USCG and Army

Vessel Category	Homeported In U.S.*	Additional Projected	Ship Dimensions Length (ft)	Ship Dimensions Beam (ft)	Helo Pad Dimensions Length (ft)	Helo Pad Dimensions Width (ft)	Weather Deck Area (sq ft)	Days within 12 n.m.
* Where ships of this class are homeported in foreign ports, their number appears in parentheses, e.g., 8 (2) indicates 8 ships in the class, 2 homeported overseas, therefore only six are considered in calculating the deck runoff in that class.								
** Denotes ships which do not embark helicopters as part of their normal complement, so helocopter flight deck area is included in weather deck area								
*** DDG 51-78 do not have helos embarked; DDG 79 and Follow will have two embarked helos.								
Navy Ships								
Aircraft Carriers								
Forrestal Class Carrier (CV 59)	1 (1)	0	1052	130			220,000	0
Kitty Hawk Class Carriers (CV 63)	3	0	1063	130			220,000	139
Enterprise Class Carriers (CVN 65)	1	0	1123	133			230,000	78
Nimitz Class Carriers (CVN 68)	7	2	1092	134			230,000	149
Amphibious Assault Ships								
Wasp Class Assault Ship (LHD 1)	4	3	819	106			86,814	188
Tarawa Class Assault Ship (LHA 1)	5 (1)	0	820	118			92,800	175
Iwo Jima Class Assault Ship (LPH 2)	2	0	602	104			62,608	189
Submarines								
Ohio Class Ballistic Missile Submarines (SSBN 726)	17	0	560	42			15,288	185
Sturgeon Class Attack Submarine (SSN 637)	13	0	302.2	31.8			6,246	185
Los Angeles Class Attack Submarine (SSN 688)	56	0	362	33			7,765	185
Narwhal Class Submarine (SSN 671)	1	0	314.6	37.7			7,709	185
Benjamin Franklin Class Submarines (SSN 640)	2	0	425	33			9,116	185
Surface Ships								
Virginia Class Cruisers (CGN 38)	1	0	585	63	20**	27	28,747	164
California Class Cruisers (CGN 36)	2	0	596	61	43**	38	28,358	146
Ticonderoga Class Cruisers (CG 47)	27 (2)	0	567	55	54	40	22,164	169
Kidd Class Destroyers (DDG 993)	4	0	563.3	55	52**	41	24,166	104
Arleigh Burke Class Destroyers (DDG 51)***	18 (2)	30	504.5	66.9	49**	42	26,326	178
Spruance Class Destroyers (DD 963)	31 (3)	0	563.2	55.1	52	42	22,021	181
Oliver Hazard Perry Class Frigates (FFG 7)	43 (2)	0	445	45	54	36	13,676	170
Blue Ridge Class Command Ships (LCC 19)	2 (1)	0	636.5	107.9	72**	74	53,569	181
Austin Class Amphibious Transport Dock (LPD 4)	3	0	570	100	209**	61	44,460	181
Austin Class Amphibious Transport Dock (LPD 7)	3 (1)	0	570	100	199**	61	44,460	191
Austin Class Amphibious Transport Dock (LPD 14)	2	0	570	100	203**	75	44,460	195
Whidbey Class Dock Landing Ships (LSD 41)	8 (2)	0	609.5	84	189**	71	39,934	171
Harpers Ferry Class Dock Landing Ships (LSD 49)	3	1	609.5	84	188**	72	39,934	216
Anchorage Class Dock Landing Ships (LSD 36)	5	0	553.3	84	78**	78	36,252	218
Newport Class Tank Landing Ships (LST 1179)	3	0	522.3	69.5	49**	54	28,314	183
Avenger Class Mine Countermeasures Ship (MCM 1)	14 (2)	0	224	39			6,814	239
Osprey Class Coastal Minehunters (MHC 51)	12	6	188	35.9			5,264	239
Cyclone Class Patrol Ships (PC 1)	13	1	170.3	24.9			3,308	110

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* Where ships of this class are homeported in foreign ports, their number appears in parentheses, e.g., 8 (2) indicates 8 ships in the class, 2 homeported overseas, therefore only six are considered in calculating the deck runoff in that class.								
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Patrol and Landing Craft								
Pegasus Class Mk V Patrol Boats (SOC/PBF)	7	14	82	17.5			1,119	320
Mk III Patrol Boats (PB)	14		68	18			955	320
Stinger Class Patrol Boats (PB)	10		65	18			955	320
Mk II River Patrol Boats (PBR)	25		35	9.3			246	320
Landing Craft Air Cushion (LCAC)	91 (3)		81	43			3,483	320
LCU 1600 Class Utility Landing Craft (LCU)	40		134.9	29			3,912	320
LCM 8 Class Mechanized Landing Craft (LCM)	100		73.7	21			575	320
LCM 6 Class Mechanized Landing Craft (LCM)	60		56.2	14			300	320
Landing Craft Personnel (LCPL)	130		36	12.1			160	320
Armored Troop Carriers (AT)	21		36	12.7			365	365
Auxiliaries								
Jumboised Cimmaron Class Oilers (AO 177)	5	0	709	88	59**	76	48,666	191
Sacramento Class Fast Combat Support (AOE 1)	4	0	793	107	83	71	60,291	186
Supply Class Fast Combat Support (AOE 6)	3	1	754	107	70	95	56,279	116
Raleigh Class Command ship (AGF 3)	1 (1)		522	90**	90**	76	34,201	0
Austin Class Command Ship (AGF 11)	1	0	570	100	195	78	29,250	186
Safeguard Class Salvage Ships (ARS 50)	4	0	255	51	20**	20	10,144	214
Simon Lake Class Submarine Tender (AS 33)	1 (1)		644	85	39**	65	42,697	0
Emory S Land Class Submarine Tenders (AS 39)	3	0	643.8	85	31**	34	42,684	295
Iwo Jima Class MCM Support Ship (MCS 12)	1	0	602	104			62,608	189
Diving Tenders (YDT)	3		50	12			600	320
Harbor Utility Craft (YFU)	2		134.9	29			3,912	365
Patrol Craft (YP)	28		108	24			2,022	365
Torpedo Trials Craft (YTT)	3		186.5	40			5,819	320
Torpedo Retrievers, 65 ft (TR)	3		65	14			710	320
Torpedo Retrievers, 72 ft (TR)	5		72	15			842	320
Torpedo Retrievers, 85 ft (TR)	5		85	18			1,193	320
Torpedo Retrievers, 100 ft (TR)	3		100	21			1,638	320
Torpedo Retrievers, 120 ft (TR)	6		120	25			2,340	320
Large Harbor Tugs (YTB)	72		109	30			2,551	320
Ashville Class Research Ships (YAG)	3		164.5	23.8			3,054	320
Fuel Oil Barge, Nonselfpropelled (YON)	40		165	40			6,600	365
Fuel Gasoline Barge, Nonselfpropelled (YOGN)	9		165	40			6,600	365
Fuel Oil Storage Barge (YOS)	5		165	40			6,600	365
Miscellaneous Boats and Craft	3000+		Various dimensions				-	365
Military Sealift Command								
Kilauea Class Ammunition Ships (T-AE)	8	0	564	81	69	60	31,494	45

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Mars Class Combat Stores Ship (T-AFS)	5	0	581	79	70	62	31,461	45
Sirius Class Combat Stores Ship (T-AFS)	3	0	524	72	64	67	25,140	45
Henry J. Kaiser Oilers (T-AO)	12	0	677	97	67**	73	51,222	50
Hayes Class Acoustic Research Ship (T-AG)	1	0	256.5	75			15,005	45
Mission Class Navigation Research Ship (T-AG)	1	0	595	75			34,808	45
Observation Is. Class (T-AGM)	1	0	563	76			33,375	45
Stalwart Class Ocean Surveillance Ship (T-AGOS)	5	0	224	43			7,513	60
Victorious Class Ocean Surveillance Ships (T-AGOS)	4	0	234.5	93.6	20**	20	21,949	120
Silas Bent Class Surveying Ships (T-AGS)	2	0	285.3	48			10,682	45
Waters Class Surveying Ship (T-AGS)	1	0	455	68.9			24,453	45
McDonnell Class Surveying Ships (T-AGS)	2	0	208	45			7,301	45
Pathfinder Surveying Ships (T-AGS)	4	1	328.5	58			14,861	45
Mercy Class Hospital Ships (T-AH)	2	0	894	105.6	80**	80	73,637	365
Maersk Class Strategic Sealift Ships (T-AKR)	3	0	946	106	80**	80	78,215	320
Gordon Class Strategic Sealift Ships (T-AKR)	2	1	956	106	80**	80	79,042	320
Algol Class Fast Sealift Ships (T-AKR)	8	0	946.2	106	81**	84	78,232	320
Zeus Class Cable Repairing Ship (T-ARC)	1	0	502.5	73			28,612	45
Powhatan Class Fleet Ocean Tugs (T-ATF)	7	0	240.2	42	25**	20	7,869	120
USCG								
Hamilton Class High Endurance Cutters (WHEC)	12	0	378	42	50	35	10,633	154
Famous Class Medium Endurance Cutters (WMEC)	4	0	270	38	40	30	6,803	139
Famous Class Medium Endurance Cutters (WMEC)	9	0	270	38	40	30	6,803	166
Reliance Class Medium Endurance Cutters (WMEC)	5	0	210.5	34	48**	30	5,582	238
Reliance Class Medium Endurance Cutters (WMEC)	11	0	210.5	34	48**	30	5,582	151
Polar Class Icebreaker (WAGB)	2	0	399	86	65	82	21,435	365
Bay Class Tugs (WTGB)	9	0	140	37.6			4,106	365
Point Class Patrol Craft (WPB)	36	0	83	17.2			1,114	320
Island Class Patrol Boats (WPB)	49	0	110	21			1,802	320
Juniper Class Seagoing Buoy Tender (WLB)	2	1	225	46			8,073	287
Balsam Class Buoy Tenders (WLB)	23	0	180	37			5,195	295
Keeper Class Buoy Tenders (WLM)	2	12	175	36			4,914	227
Red Class Buoy Tenders (WLM)	9		157	33			4,041	227
White Sumac Class Buoy Tenders (WLM)	4		133	31			3,216	227
Inland Buoy Tenders (WLI)	2		100	24			1,872	365
Inland Buoy Tenders (WLI)	4		65	17			862	365
River Buoy Tenders, 65 ft (WLR)	6		65	22			1,115	365
River Buoy Tenders, 75 ft (WLR)	13		75	22			1,287	365

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River Buoy Tenders, 115 ft (WLR)	1		115	30			2,691	365
Pamlico Class Construction Tenders (WLIC)	4		160.9	30			3,765	365
Cosmos Class Construction Tenders (WLIC)	3		100	24			1,872	365
Anvil/Clamp Class Construction Tenders (WLIC)	9		75	22			1,287	365
Harbor Tugs (WYTL)	11		65	19			963	365
Motor Lifeboats	26	94	47.9	14			523	365
Misc. Rescue and Utility Craft	1400+		Various Sizes					365
Army Vessels								
Frank Besson Class Logistic Support Ship (LSV)	6		272.8	60			6,547	183
Mechanized Landing Craft (LCM 8)	104		73.7	21			511	320
Utility Landing Craft (LCU 2000)	34		174	42			2,412	320
Utility Landing Craft (LCU 1600)	14		135	29			1,292	320
Lighter Amphibious Resupply, Cargo (LARC)	23		35	8			92	365
Large Tug (LT 128)	10		128	36			3,594	320
Large Tug (LT 100)	15		107	26.5			2,212	320
Barge Derrick, 115T (BD)	5		175	75			13,125	365
Barge Derrick, 89T (BD)	7		140	70			9,800	365
Barge Cargo (BC)	3		110	32			3,520	365

Table 2. Estimate of Annual Weather Deck Runoff From Precipitation
Navy Surface Ships, By Port

Ship Class		Home Port:	Bremerton, WA	Everett, WA	Ingleside, TX	Little Creek, VA	Mayport, FL
	Average Annual Rainfall (in):		50	31	30	45	52
	Weather Deck Area (sq ft)	Days within 12 n.m.	No. Ships	No. Ships	No. Ships	No. Ships	No. Ships
Virginia Class Cruisers (CGN 38)	28,747	164	1				
California Class Cruisers (CGN 36)	28,358	146	1				
Ticonderoga Class Cruisers (CG 47)	22,164	169					5
Kidd Class Destroyers (DDG 993)	24,166	104		2			
Arleigh Burke Class Destroyers (DDG 51)	26,326	178					2
Spruance Class Destroyers (DD 963)	22,021	181		2			6
Oliver Hazard Perry Class Frigates (FFG 7)	13,676	170		3			10
Blue Ridge Class Command Ships (LCC 19)	53,569	181					
Austin Class Transport Docks (LPD 4)	44,460	181					
Austin Class Transport Docks (LPD 7)	44,460	191					
Austin Class Transport Docks (LPD 14)	44,460	195					
Whidbey Class Dock Landing Ships (LSD 41)	39,934	171				4	
Harpers Ferry Class Dock Landing Ships (LSD 49)	39,934	216				2	
Anchorage Class Dock Landing Ships (LSD 36)	36,252	218				2	
Newport Class Tank Landing Ships (LST 1179)	28,314	183				1	
Avenger Class Mine Countermeasures Ship (MCM 1)	6,814	239			12		
Osprey Class Coastal Minehunters (MHC 51)	5,264	239			9		
Cyclone Class Patrol Ships (PC 1)	3,308	110				9	
Austin Class Command Ship (AGF 11)	29,250	186					
Safeguard Class Salvage Ships (ARS 50)	10,144	214				2	
Emory S Land Class Submarine Tenders (AS 39)	42,684	295					
Estimated Surface Runoff, (gal/yr):			756,138	1,057,434	1,581,483	5,623,465	6,684,183

Table 2. Estimate of Annual Weather Deck Runoff From Precipitation
Navy Surface Ships, By Port

Ship Class		Home Port:	Norfolk, VA	Pearl Hr, HI	Pascagoula, MS	San Diego, CA
	Average Annual Rainfall (in):		45	25	72	10
	Weather Deck Area (sq ft)	Days within 12 n.m.	No. Ships	No. Ships	No. Ships	No. Ships
Virginia Class Cruisers (CGN 38)	28,747	164				
California Class Cruisers (CGN 36)	28,358	146	1			
Ticonderoga Class Cruisers (CG 47)	22,164	169	7	3	2	8
Kidd Class Destroyers (DDG 993)	24,166	104	2			
Arleigh Burke Class Destroyers (DDG 51)	26,326	178	7	2		5
Spruance Class Destroyers (DD 963)	22,021	181	9	4		6
Oliver Hazard Perry Class Frigates (FFG 7)	13,676	170	12	2	2	12
Blue Ridge Class Command Ships (LCC 19)	53,569	181	1			
Austin Class Transport Docks (LPD 4)	44,460	181	1			2
Austin Class Transport Docks (LPD 7)	44,460	191	1			1
Austin Class Transport Docks (LPD 14)	44,460	195	2			
Whidbey Class Dock Landing Ships (LSD 41)	39,934	171				3
Harpers Ferry Class Dock Landing Ships (LSD 49)	39,934	216				1
Anchorage Class Dock Landing Ships (LSD 36)	36,252	218				3
Newport Class Tank Landing Ships (LST 1179)	28,314	183		1		
Avenger Class Mine Countermeasures Ship (MCM 1)	6,814	239				
Osprey Class Coastal Minehunters (MHC 51)	5,264	239				
Cyclone Class Patrol Ships (PC 1)	3,308	110				4
Austin Class Command Ship (AGF 11)	29,250	186				1
Safeguard Class Salvage Ships (ARS 50)	10,144	214		2		
Emory S Land Class Submarine Tenders (AS 39)	42,684	295	1			1
Estimated Surface Runoff, (gal/yr):			14,458,310	2,165,816	1,492,969	3,451,692
					Estimated Total, All Ports (gal/yr):	**37,271,490**

Table 3. Estimate of Annual Weather Deck Runoff From Precipitation
MSC, Army and USCG Surface Ships

Average Annual Rainfall (in): 40 Vessel Category	Weather Deck Area (sq ft)	Days within 12 n.m.	Number of Vessels	Estimated Runoff, (gal):
Military Sealift Command				
Kilauea Class Ammunition Ships (T-AE)	31,494	45	8	774,534
Mars Class Combat Stores Ship (T-AFS)	31,461	45	5	483,587
Sirius Class Combat Stores Ship (T-AFS)	25,140	45	3	231,853
Henry J. Kaiser Oilers (T-AO)	51,222	50	12	2,099,533
Hayes Class Acoustic Research Ship (T-AG)	15,005	45	1	46,129
Mission Class Navigation Research Ship (T-AG)	34,808	45	1	107,004
Observation Is. Class (T-AGM)	33,375	45	1	102,600
Stalwart Class Ocean Surveillance Ship (T-AGOS)	7,513	60	5	153,975
Victorious Class Ocean Surveillance Ships (T-AGOS)	21,949	120	4	719,741
Silas Bent Class Surveying Ships (T-AGS)	10,682	45	2	65,674
Waters Class Surveying Ship (T-AGS)	24,453	45	1	75,172
McDonnell Class Surveying Ships (T-AGS)	7,301	45	2	44,888
Pathfinder Surveying Ships (T-AGS)	14,861	45	4	182,746
Mercy Class Hospital Ships (T-AH)	73,637	365	2	3,672,277
Maersk Class Strategic Sealift Ships (T-AKR)	78,215	320	3	5,129,551
Gordon Class Strategic Sealift Ships (T-AKR)	79,042	320	2	3,455,850
Algol Class Fast Sealift Ships (T-AKR)	78,232	320	8	13,681,694
Zeus Class Cable Repairing Ship (T-ARC)	28,612	45	1	87,959
Powhatan Class Fleet Ocean Tugs (T-ATF)	7,869	120	7	451,557
USCG				
Hamilton Class High Endurance Cutters (WHEC)	10,633	154	12	1,342,412
Famous Class Medium Endurance Cutters (WMEC)	6,803	139	4	258,392
Famous Class Medium Endurance Cutters (WMEC)	6,803	166	9	694,312
Reliance Class Medium Endurance Cutters (WMEC)	5,582	238	5	453,826
Reliance Class Medium Endurance Cutters (WMEC)	5,582	151	11	633,449
Polar Class Icebreaker (WAGB)	21,435	365	2	1,068,959
Bay Class Tugs (WTGB)	4,106	365	9	921,430
Point Class Patrol Craft (WPB)	1,114	320	36	876,335
Island Class Patrol Boats (WPB)	1,802	320	49	1,930,053
Juniper Class Seagoing Buoy Tender (WLB)	8,073	287	2	316,565
Balsam Class Buoy Tenders (WLB)	5,195	295	23	2,407,882
Keeper Class Buoy Tenders (WLM)	4,914	227	2	152,408
Red Class Buoy Tenders (WLM)	4,041	227	9	564,018
White Sumac Class Buoy Tenders (WLM)	3,216	227	4	199,485
Inland Buoy Tenders (WLI)	1,872	365	2	93,357
Inland Buoy Tenders (WLI)	862	365	4	85,966
River Buoy Tenders, 65 ft (WLR)	1,115	365	6	166,875
River Buoy Tenders, 75 ft (WLR)	1,287	365	13	417,187
River Buoy Tenders, 115 ft (WLR)	2,691	365	1	67,100
Pamlico Class Construction Tenders (WLIC)	3,765	365	4	375,527
Cosmos Class Construction Tenders (WLIC)	1,872	365	3	140,035
Anvil/Clamp Class Construction Tenders (WLIC)	1,287	365	9	288,822
Harbor Tugs (WYTL)	963	365	11	264,219
Motor Lifeboats	523	365	26	339,110
Army				
Frank Besson Class Logistic Support Ship (LSV)	6,547	183	6	491,105
Mechanized Landing Craft (LCM 8)	511	320	104	1,161,183
Utility Landing Craft (LCU 2000)	2,412	320	34	1,792,495
Utility Landing Craft (LCU 1600)	1,292	320	14	395,403
Lighter Amphibious Resupply, Cargo (LARC)	92	365	23	52,992
Large Tug (LT 128)	3,594	320	10	785,730
Large Tug (LT 100)	2,212	320	15	725,240
Barge Derrick, 115T (BC)	13,125	365	5	1,636,359
Barge Derrick, 89T (BD)	9,800	365	7	1,710,541
Barge Cargo (BC)	3,520	365	3	263,314
		Estimated Total Annual Runoff (gals):		**54,638,410**

Table 4. Estimate of Annual CV/CVN Flight Deck Runoff From Precipitation

Homeport	CV/CVN Flt Deck Area (sq.ft.)	Estimated Days within 12 n.m.	Avg. Annual Precip. (in)			Estimated Annual Runoff (gal)
Bremerton, WA:						
USS Carl Vinson (CVN 70)	230,000	149	50			2,926,455
USS Nimitz (CVN 68)	230,000	149	50			2,926,455
Everett, WA:						
USS Abraham Lincoln (CVN 72)	230,000	149	31			1,814,402
Mayport, FL:						
USS John F. Kennedy (CV 67)	220,000	139	52			2,715,804
Norfolk, VA:						
USS Dwight D. Eisenhower (CVN 69)	230,000	149	45			2,633,809
USS Enterprise (CVN 65)	230,000	78	45			1,378,773
USS George Washington (CVN 73)	230,000	149	45			2,633,809
USS John C. Stennis (CVN 74)	230,000	149	45			2,633,809
USS Theodore Roosevelt (CVN 71)	230,000	149	45			2,633,809
San Diego, CA:						
USS Constellation (CV 64)	220,000	139	10			522,270
USS Kitty Hawk (CV 63)	220,000	139	10			522,270
			Total Annual Gallons:			**23,341,665**

Table 5. Estimate of Annual Helicopter Flight Deck Runoff from Precipitation
Navy Amphibious Assault and MCM Support Ships

Ship Class		Home Port:	Norfolk, VA		San Diego, CA		Ingleside, TX	
	Flt Deck Area (sq ft)	Days within 12 n.m.	No. Ships	Avg. Ann. Rain (in)	No. Ships	Avg. Ann. Rain (in)	No. Ships	Avg. Ann. Rain (in)
Wasp Class (LHD)	86,814	188	2	45	2	10	0	0
Tarawa Class (LHA)	92,800	175	2	45	2	10	0	0
Iwo Jima Class (LPH)	62,608	189	1	45	1	10	0	0
Iwo Jima Class (MCS)	62,608	320	0	45	0	10	1	30
Estimated Runoff, gal:				5,914,333		1,314,296		1,026,497
Total Amphibious Assault Ship Runoff:								**7,228,629**
Total Mine Countermeasure Runoff:								**1,026,497**
Total Runoff, gallons:								**8,255,126**

Table 6. Estimate of Annual Helicopter Flight Deck Runoff from Precipitation
Navy Surface Ships

Ship Class		Home Port:	Bremerton WA	Earle, NJ	Everett, WA	Mayport, FL	Norfolk, VA	Pascagoula MS	Pearl, HI	San Diego, CA
		Avg.Annual Rainfall (in):	50	42	31	52	45	72	25	10
Navy Surface Ships:	**Flt Deck Area (sq ft)**	**Days within 12 n.m.**	**No. Ships**	**No. Ships**	**No. Ships**	**No. Ships**	**No. Ships**	**No. Ships**	**No. Ships**	**No. Ships**
Ticonderoga Class Cruisers (CG)	2,160	169				5	7	2	3	8
Spruance Class Destroyers (DD)	2,184	181			2	6	9		4	6
Oliver Hazard Perry Class Frigates (FFG)	1,944	170			3	10	12	2	2	12
Austin Class Command Ships (AGF)	15,210	186								1
Sacramento Class Fst Combat Spt (AOE1)	5,893	186	2	2						
Supply Class Fst Combat Spt (AOE6)	6,650	116	1				2			
Annual Flight Deck Runoff (gals):			253,073	157,248	94,349	666,234	893,170	171,052	142,492	206,430
									Total Annual Flight Deck Runoff (gals):	**2,584,049**

Table 7. Estimate of Annual Flight Deck Runoff From Precipitation
MSC and USCG Surface Ships

	No. Ships	Flight Deck Area (sq ft)	Avg Days within 12 n.m.	U.S. Avg. An. Prec.(in)	Estimated Annual Runoff (gal)
Military Sealift Command					
Kilauea Class Ammunition Ships (T-AE)	8	4,140	45	40	101,817
Mars Class Combat Stores Ship (T-AFS)	5	4,340	45	40	66,710
Sirius Class Combat Stores Ship (T-AFS)	3	4,288	45	40	39,546
Henry J. Kaiser Oilers (T-AO)*	12	0	50	40	0
				Estimated Subtotal (gals/yr):	**208,073**
USCG					
Hamilton Class High Endurance Cutters (WHEC)	12	1,750	154	40	220,931
Famous Class Medium Endurance Cutters (WMEC)	4	1,200	139	40	45,580
Famous Class Medium Endurance Cutters (WMEC)	9	1,200	166	40	122,475
Polar Class Icebreaker (WAGB)	2	5,330	365	40	265,807
				Estimated Subtotal (gals/yr):	**654,793**
				Estimated Total (gal/yr):	**862,866**

* Denotes ships having helicopter flight decks but do not embark helicopters as part of their normal complement. Flight deck area included in deck area listed in Table 1.

Table 8. Estimate of Annual Helicopter Flight Deck Runoff From Washdowns
USCG Surface Ships

Ship Class	Flt Deck Area (sq ft)	Volume (gals/wash)			No. Ships U.S. Ports	In Port Washdowns	Totals
		Cleaner	Rinseate	Total			
Hamilton Class High Endurance Cutters (WHEC)	1,750	18	72	90	12	22	23,760
Famous Class Medium Endurance Cutters (WMEC)	1,200	12	48	60	4	20	4,800
Famous Class Medium Endurance Cutters (WMEC)	1,200	12	48	60	9	24	12,960
Polar Class Icebreaker (WAGB)	5,330	54	216	270	2	52	28,080
						Estimated Total (gals/yr):	**69,600**

* Assumes flight deck washed as a result of visiting helicopter operations.

Table 9a. Estimate of Annual Weather Deck Runoff From Precipitation
Oiler Weather Decks

		U.S. Home Port:	Bremerton WA	Earle NJ	Norfolk VA	Pearl Harbor HI
	Average Annual Rainfall (in):		50	42	45	25
Ship Class	Deck Area	Days within 12 n.m.	No. Ships	No. Ships	No. Ships	No. Ships
Jumboised Cimarron Class Oilers (AO)	48,666	191			3	2
Sacramento Class Fast Combat Support Ships (AOE 1)	60,291	186	2	2		
Supply Class Fast Combat Support Ships (AOE 6)	56,279	116	1	1	1	
Henry J Kaiser Class Oilers (TAO187)*	0	50				
Estimated Runoff, (gal):			2,472,708	2,077,075	2,644,856	793,749
* See Tables 1 and 3					**Estimated Annual Total, All Ports (gal):**	**7,988,388**

Table 9b. Estimate of Annual Weather Deck Runoff From Precipitation
Navy Auxiliary Service Craft Oilers

Service Craft Category	Deck Area (sq ft)	Days within 12 n.m.	No. Ships	U.S. Avg. An. Rainfall (in)	Estimated Annual Runoff (gal)
Fuel Oil Barge, Nonself Propelled (YON)	6,600	365	40	40	6,582,840
Fuel Gasoline Barge, Nonself Propelled (YOGN)	6,600	365	9	40	1,481,139
Fuel Oil Storage Barge (YOS)	6,600	365	5	40	822,855
				Estimated Annual Total (gal):	**8,886,834**

Table 10. Summary of Annual Runoff Estimates

Weather Deck Runoff from Precipitation		Totals (gal/yr)
	Navy Surface Ships	37,271,490
	MSC, Army, and USCG Surface Ships	54,638,410
	Navy Oilers	7,988,388
	Navy Service Craft, Oilers	8,886,834
Flight Deck Runoff from Precipitation		
	Navy Aircraft Carriers	23,341,665
	Navy Amphibious Assault Ships	7,228,629
	Navy Mine Countermeasure Support Ship	1,026,497
	Navy Surface Ships	2,584,049
	MSC and USCG Surface Ships	862,866
Flight Deck Runoff from Freshwater Washdowns		
	USCG Surface Ships	69,600
	Estimated Annual Total (gal/yr)	143,898,427

Table 11. Laboratory Results, Catapult Trough Drains Aqueous Phase Discharge*

Constituent	Sample Results (mg/L)	
Date:	**4/13/94**	**4/14/94**
Phenols	4.6	5.3
Oil and grease	9,683	13,919
Silver	<0.050	<0.050
Cadmium	0.155	0.141
Chromium	0.l03	0.088
Copper	<0.050	<0.050
Nickel	1.90	1.81
Lead	26.1	76.3
Zinc	<0.050	<0.050

Source: NNS Laboratory Services, 1994[28]

* Data represent concentrations prior to processing through an oil water separator.

Table 12. Comparison of Catapult Trough Drains Discharge to Water Quality Criteria[27]

Constituent	Sample Results (mg/L)		Federal Acute WQC (mg/L)	Most Stringent State Acute WQC (mg/L)
Date:	4/13/94	4/14/94		
Phenols	4.6	5.3	none	0.17 (HI)
Oil and grease	9,683	13,919	Visible sheen [1]/15[2]	5 (FL)
Silver	<0.050	<0.050	0.0019	0.0012 (WA)
Cadmium	0.155	0.141	0.042	0.0093 (FL, GA)
Chromium	0.103	0.088	1.1	0.05 (FL, GA)
Copper	<0.050	<0.050	0.0024	0.0025 (WA)
Lead	26.1	76.3	0.210	0.0056 (FL, GA)
Nickel	1.90	1.81	0.074	0.0083 (FL, GA)

Notes:
Refer to federal criteria promulgated by EPA in its National Toxics Rule, 40 CFR 131.36 (57 FR 60848; Dec. 22, 1992 and 60 FR 22230; May 4, 1995)
Where historical data were not reported as dissolved or total, the metals concentrations were compared to the most stringent (dissolved or total) state water quality criteria.

FL = Florida
GA = Georgia
HI = Hawaii
WA = Washington

1. *The Federal Pollution Control Act*, 40CFR110, defines a prohibited discharge of oil as any discharge sufficient to cause a sheen on the receiving waters.
2. *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78). MARPOL 73/78 is implemented by the *Act to Prevent Pollution From Ships* (APPS).

Table 13. Data Sources

	Data Source			
NOD Section	Reported	Sampling	Estimated	Equipment Expert
2.1 Equipment Description and Operation				X
2.2 Releases to the Environment				X
2.3 Vessels Producing the Discharge	UNDS Database			X
3.1 Locality				X
3.2 Rate			X	
3.3 Constituents				X
3.4 Concentrations		X		
4.1 Mass Loadings			X	
4.2 Environmental Concentrations			X	
4.3 Potential for Introducing Non-Indigenous Species				X