NATURE OF DISCHARGE REPORT

Graywater

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 graywater 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).

2.1 Equipment Description and Operation

Graywater is defined in section 312(a) of the Clean Water Act as wastewater from showers, baths and galleys. On vessels of the Armed Forces, drainage from laundry, interior deck drains, lavatory sinks, water fountains, and miscellaneous shop sinks is often collected together with graywater. Therefore, this discharge covers graywater as well as mixtures of graywater with wastewater from these additional sources.[1] In this report, the term "graywater" will be used to describe all of these related discharges. Graywater is distinct from "blackwater", the sewage generated by toilets and urinals.

While pierside, most classes of Navy vessels direct graywater to the vessel's blackwater Collection, Holding, and Transfer (CHT) tanks, via segregated graywater plumbing drains. Some recently built ships (such as CVN 73 and CVN 74) do not have segregated blackwater/graywater drains. These ships collect the blackwater/graywater mixture while inside 3 nautical miles (n.m.). The blackwater and graywater mixture is then pumped to pierside connections for treatment ashore. A typical CHT system is shown in Figure 1. Most navy surface vessels without CHT systems have dedicated graywater tanks and pumps to collect and transfer this discharge to shore facilities. Some vessels lack the means to collect all the graywater that is generated while pierside. On these vessels a portion of the graywater plumbing drains run directly overboard.[1-4]

While operating away from the pier, most Navy surface vessels that collect graywater in CHT tanks divert graywater drains overboard to preserve holding capacity for blackwater in the tanks. Vessels equipped with separate graywater collection and transfer systems are not designed to hold graywater for extended periods of time and therefore drain or pump their graywater overboard while operating away from the pier.

Submarines collect their graywater in the ship's sanitary tank while pierside and within 3 n.m. of land. Pierside, graywater mixed with blackwater is discharged to a shore facility for treatment; when outside 3 n.m., graywater is discharged directly overboard. Unlike surface vessels, holding capacity in the submarines' sanitary tanks is generally sufficient to allow collection of graywater and blackwater up to 12 n.m. from shore.[1]

All Military Sealift Command (MSC) vessels are equipped with U.S. Coast Guard (USCG) certified Marine Sanitation Devices (MSDs) designed to treat sewage to EPA and USCG standards. On some MSC vessels, graywater can be collected and sent to the MSD for processing, or diverted overboard. On other MSC vessels, graywater is neither collected nor treated, but is discharged directly overboard.

Most USCG vessels are similar to Navy vessels since they can collect graywater while pierside. However, some USCG vessels currently cannot collect graywater, but continually discharge it overboard.

The majority of Army vessels collect graywater together with blackwater (sewage)[*] for treatment by a USCG certified MSD. The MSD effluent is either sent overboard, held in an effluent holding tank, or discharged to a shore facility.

2.2 Releases to the Environment

Contributions to graywater are described below. Three sources comprise the majority of graywater flow: Galley and scullery (18% in port, 22% at sea); laundry (22% in port, 33% at sea); and showers and sinks (60% in port and 45% at sea).[5] In addition, other minor sources include: filter cleaning discharges, deck drains, and medical/dental waste discharges.[1]

2.2.1 Galley

Food preparation occurs in a vessel's galley. Large Navy vessels have several galley compartments. In smaller vessels, the galley can be a shared space with related functions (e.g., the scullery), and have a single sink through which wastewater is discharged. Galley discharges specifically exclude food/garbage grinder wastes. Garbage grinders are required to be secured inside 3 n.m.[6]

Wastewater from the galley is generated through food preparation, disposal of cooking liquids, and cleaning of surfaces (bulkheads, appliances, sinks, and working surfaces). The generation and discharge are periodic, with the majority of the flow occurring during the hours preceding meal times. Galley graywater can contain highly biodegradable organics, oil and grease, and detergent residuals.

2.2.2 Scullery

The scullery can be separate from or integral with the galley and is used for the cleaning of dishes and cookware. Scullery wastewater also specifically excludes garbage grinder wastes, as garbage grinders are required to be secured inside 3 n.m.[6] Scullery graywater can contain food residuals and detergents.

2.2.3 Showers and Lavatory Sinks

Lavatory sinks and showers drain to the vessel's graywater system and can contain soap residues, shampoos, shaving cream, and other products resulting from personal hygiene. Detergent residuals similar to those used in the galley can also be present.

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[*] The Army usually refers to bilgewater as "blackwater" and sewage as "sewage".

2.2.4 Laundry

Graywater derived from laundering crew uniforms, linens, and other articles of clothing can contain laundry detergents, bleaches, oils and greases, and traces of other constituents. Detergent residuals similar to those used in the galley, lavatory sinks, and showers can also be present.

2.2.5 Other Discharges

Other minor discharges which are collected with graywater include filter cleaning discharges, deck drains, and medical/dental waste discharges. These discharges combined represent less than 1% of the total shipboard generated graywater.[5] Filter cleaning discharges consist of detergents and small amounts of oil from commercial dishwashing machines or sinks used to wash ship ventilation system air filters. Deck drains contribute small and intermittent flows which can include detergents used for floor cleaning and other general space cleaning. Small amounts of medical/dental wastes are collected with graywater on only a few Navy ships with extensive medical and dental facilities such as aircraft carriers (CV/CVNs) and amphibious assault ships (LHD/LHA/LPHs). This would include wastes from dental spit sinks and small blood samples less than 7.5 milliliters (mL).[7]

2.3 Vessels Producing the Discharge

Vessels in the Navy, MSC, Army, Air Force, and USCG generate graywater. However, there are some vessels that do not produce a separate and distinct graywater discharge. These are the vessels not equipped with segregated graywater collection systems. Instead, they collect graywater together with blackwater for combined treatment with a MSD.

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

Discharges of graywater incidental to normal operations occur under three circumstances: (1) at the pier, for the ship classes lacking the means to collect graywater for shore treatment; (2) between 0 and 3 n.m. for most Navy and USCG vessels and for some MSC vessels; and (3) outside 3 n.m., where most graywater is discharged overboard.

3.2 Rate

The Navy uses a design figure of 30 gallons per capita-day (gal/cap/day) when designing graywater collections systems.[8]

Table 1 presents estimates of discharge rates by vessel class for Navy, MSC, USCG, and Army ships. The following assumptions are inherent in the table:

- With the few exceptions noted in Section 2.1 and 2.3, vessels discharge graywater overboard at all times when not pierside. It is assumed, for purposes of calculation, that USCG, MSC, and Army vessels also discharge graywater overboard at all times when not pierside.

- A typical vessel is estimated to require about four hours to transit 12 n.m. from shore, with a per capita average rate of 1.25 gallons/hour (30 gal/cap/day). If this vessel undergoes 20 transits a year and has a crew size of 400, the annual graywater discharge rate while in transit would be:

(20 transits/year) (4 hours/transit) (1.25 gal/capita-hour) (400 personnel) = 40,000 gallons/year

Some vessels of the USCG and Army operate on a routine basis within 12 n.m. of shore. Annual graywater discharge rate calculations for these vessels are based, in part, on the number of days each ship operates within 12 n.m. A vessel's graywater discharge that results from operating within 12 n.m. is calculated by using the following general formula:

(personnel) (hours in operation/year) (1.25 gal/capita-hour) = gallons/year

USCG vessels that operate within 12 n.m. include: Mackinaw Class Icebreakers (approx. 150 days/year, 24 hours/day), Bay Class Icebreaking Tugs (approx. 150 days/year, 24 hours/day), and Balsam Class Seagoing Buoy Tenders (approx. 100 days/year, 24/hours/day). Army vessels that operate within 12 n.m. include: Logistic Support Vessels (approx. 30 days/year, 10 hours/day) and Landing Craft Utility (approx. 60 days/year, 10 hours/day). Due to the fact that the majority of Army vessels collect most of their graywater with blackwater, approximately only 10% of the graywater generated is discharged separately.[9]

As shown in Table 1, the total estimated amount of graywater discharged overboard annually inside 12 n.m. is 39 million gallons. Of that volume, 15.3 million gallons are discharged pierside.

3.3 Constituents

In graywater, soaps, shampoos, detergents, and cleaners contribute organics as well as inorganic compounds such as nitrogen and phosphorous. Food waste will contribute oxygen demand (as measured by Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)), nutrients, and oil and grease. Metals, pesticides, and organics from adhesives, sealants, lubricants, and cleaners can also be present in graywater. The constituents that have been measured in previous graywater studies are shown in Tables 2 and 3. The priority pollutants cadmium, chromium, copper, lead, nickel, silver, and zinc were identified. Mercury, a bioaccumulator, was also identified. It is possible that certain parameters not tested for, and thus not listed in Tables 2 and 3, could also be present in graywater.

3.4 Concentrations

Table 2 shows the average values measured for classical water quality parameters in various shipboard streams that contribute to graywater based on samples collected from three classes of vessels. Data are shown for the following graywater discharge components: wash basins and showers, food preparation, laundry, and dishwasher and deep sink. The ranges of the average measured values are: pH (6.74 - 10), total suspended solids (TSS)(94 - 4,695 milligrams per liter (mg/L)), total dissolved solids (TDS)(225 - 8,064 mg/L), BOD (144 - 2618 mg/L), COD (304 - 7,839 mg/L), total organic carbon (TOC)(59 - 1,133 mg/L), oil and grease (5 - 1,210 mg/L), methylene blue active substances (MBAS) (0.1 - 4.1 mg/L), ammonia nitrogen (0.17 - 669 mg/L), phosphate (1.03 - 28.2 mg/L), and coliform bacteria (178 - >2,000,000 per 100 mL). Flow-weighted average concentrations of these constituents are calculated in Table 2, based upon the data presented therein and the relative contribution of the three major sources of graywater.

Table 3 shows the mean concentrations of metals in various graywater components based on samples collected from three classes of vessels. Data are shown for the following graywater components: potable water sink, galley drains, sink, and scullery. The ranges of the average measured values are: silver (.007 - 0.012 mg/L), cadmium (0.004 - 0.017 mg/L), chromium (0.002 - 0.03 mg/L), copper (0.25 - 3.4 mg/L), lead (0.042 - 1.56 mg/L), mercury (.0002 - .0095 mg/L), nickel (0.025 - 0.113 mg/L), and zinc (0.19 - 2.36 mg/L). Flow-weighted average concentrations of these metals are calculated in Table 3, based upon the data presented therein and the relative contribution of graywater sources involved.

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. The estimated mass loadings are presented in Section 4.1. In Section 4.2, the concentrations of discharge constituents after release to the environment are estimated and compared with the water quality criteria. In Section 4.3, the potential for the transfer of non-indigenous species is discussed.

4.1 Mass Loadings

Total flow, and therefore mass loadings, are influenced by the number of personnel aboard, time spent in transit, and time spent operating within 12 n.m. Total loadings can be estimated by multiplying concentration data by the total annual flow of graywater. Based on typical constituent concentrations and the estimated total flow calculated in Table 1, annual loadings of constituents are presented in Table 4.

4.2 Environmental Concentrations

Screening for constituents was accomplished by comparing measured levels of constituents to the lowest applicable water quality criteria. For graywater, the only constituents for which both data and water quality criteria are available are metals. Parameters such as BOD and nutrients are at levels that would be expected to cause localized adverse environmental effects.

As shown in Table 5, concentrations of the priority pollutants copper, lead, nickel, silver, and zinc (measured as total metals), in one or more graywater components, exceed the most stringent water quality criteria. The bioaccumulator, mercury, exceeds the most stringent water quality criteria. Ammonia also exceeds the most stringent water quality criteria.

4.3 Potential for Introducing Non-Indigenous Species

Graywater originates from potable water rather than seawater. Therefore, the potential for introduction of non-indigenous species is not significant.

5.0 CONCLUSIONS

Graywater has the potential to cause adverse environmental effects because measured concentrations and estimated loadings of nutrients and oxygen-demanding substances are significant.

6.0 DATA SOURCES AND REFERENCES

To characterize this discharge, information from various sources was obtained. Process information and assumptions were used to estimate the rate of discharge. Based on this estimate and on the reported concentrations of constituents, the mass loadings to the environment resulting from this discharge were then estimated. Table 6 shows the source of the data used to develop this NOD report.

Specific References

1. UNDS Equipment Expert Meeting Minutes - Graywater Discharge. 29 July 1996.

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3. Aivalotis, Joyce, USCG. Personal Communication: USCG Ship Description for Medical/Dental Waste Discharge, 14 April 1997, David Eaton, M. Rosenblatt & Son, Inc.

4. Cassidy, Brian. "Zero Discharge Study." February 1996.

5. Whelan, Mary. "Graywater Characterization." TM-28-89-01. March 1989.

6. Naval Ship's Technical Manual (NSTM), Chapter 593, Pollution Control (Revision 3), page 2-2. 1 September 1991.

7. UNDS Equipment Expert Meeting Minutes - Medical/Dental Waste Discharges. 15 October 1996.

8. NAVSEA Design Practices and Criteria Manual for Surface Ship Freshwater Systems, Chapter 532. NAVSEA T9500-AA-PRO-120. October 1987.

9. SSG Huckabee, U.S. Army 7th Transportation Group, Fort Eustis. Personal Communication: Information on Army Vessels' Graywater Discharge, 16 March 1998, Russell Fisher, Booz, Allen & Hamilton.

10. UNDS Ship Database, August 1, 1997.

11. Pentagon Ship Movement Data for Years 1991 - 1995, Dated March 4, 1997.

12. Talts, A. and D. R. Decker. Naval Ship Research and Development Center. "Nonoily Aqueous Waste Streams on the USS Sierra (AD18), Volume 1." Bethesda, Maryland. Report 4182, April 1974.

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Washington. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A, Washington Administrative Code (WAC).

Committee Print Number 95-30 of the Committee on Public Works and Transportation of the House of Representatives, Table 1.

The Water Quality Guidance for the Great Lakes System, Table 6A. Volume 60 Federal Register, p. 15366. March 23, 1995.

Table 1. Ships of the Navy, MSC, USCG, and Army; Annual Graywater Discharge

Class	Description	Vessels[10]	Crew Size	Transits per Year[11]	Estimated Total Time in Transit (hr)	Graywater Discharge, in Transit (gal/yr)	Vessels Discharging Overboard at Pier	Days in Port, per year[11]	Graywater Discharged Pierside (gal/yr)	Total Graywater Generation, 0 to 12 n.m. (gal/year)	Total Discharge, 0 to 12 n.m. (gal/yr)
	Navy Ships										
CG 47	Ticonderoga Class Cruiser	27	409	24	96	1,325,160				1,325,160	1,325,160
CGN 36	California Class Guided Missile Cruiser	2	603	22	88	132,660				132,660	132,660
CV 62	Forrestal Class Aircraft Carrier	1	5,624	6	24	168,720				168,720	168,720
CVN 65	Enterprise Class Aircraft Carrier	1	5,815	12	48	348,900				348,900	348,900
CV 63	Kitty Hawk Class Aircraft Carrier	3	5,624	14	56	1,181,040				1,181,040	1,181,040
CVN 68	Nimitz Class Aircraft Carrier	7	6,286	14	56	3,080,140				3,080,140	3,080,140
CGN 40	Virginia Class Guided Missile Cruiser	1	600	22	88	66,000				66,000	66,000
DDG 993	Kidd Class Guided Missile Destroyers	4	386	24	96	185,280				185,280	185,280
DDG 51	Arleigh Burke Class Guided Missile Destroyers	18	303	22	88	599,940				599,940	599,940
DD 963	Spruance Class Destroyers	31	396	24	96	1,473,120	4	175	1,663,200	3,136,320	3,136,320
FFG 7	Oliver Hazard Perry Guided Missile Frigates	43	220	26	104	1,229,800				1,229,800	1,229,800
LCC 19	Blue Ridge Class Amphibious Command Ships	2	1,516	16	64	242,560				242,560	242,560
LHD 1	Wasp Class Amphibious Transport Docks	4	3,151	26	104	1,638,520				1,638,520	1,638,520
LHA 1	Tarawa Class Amphibious Assault Ships	5	2,292	18	72	1,031,400	4	173	9,516,384	10,547,784	10,547,784
MCS 12	Iwo Jima Class Assault Ships	2	1,746	*18*	72	314,280				314,280	314,280
LPD 4	Austin Class Amphibious Transport Docks	3	1,487	22	88	490,710				490,710	490,710
LSD 41	Whidbey Island Class Dock Landing Ships	8	852	26	104	886,080				886,080	886,080
LSD 36	Anchorage Class Dock Landing Ships	5	794	26	104	516,100				516,100	516,100
MCM 1	Mine Countermeasures Ship Avenger Class	14	72	56	224	282,240				282,240	282,240
MHC 51	Mine Countermeasures Ship Osprey Class	12	50	*50*	200	150,000				150,000	150,000
PC 1	Cyclone Class Coastal Defense Ships	13	4	36	144	9,360				9,360	9,360
SSN 640	Benjamin Franklin Class Attack Submarines	2	120	*16*	64	0				19,200	0
SSN 671	Narwhal Class Attack Submarine	1	129	*16*	64	0				10,320	0
SSN 688	Los Angeles Class Attack Submarines	56	120	*16*	64	0				537,600	0
SSN 637	Sturgeon Class Attack Submarines	13	107	*16*	64	0				111,280	0
SSBN 726	Ohio-Class Ballistic Missile Submarines	17	136	*16*	64	0				184,960	0
	Navy Auxiliary Ships										
AE 28	Kilauea Class Ammunition Ships	8	383	8	32	122,560		26	477,984	600,544	600,544
AO 177	Cimarron Class Oilers	12	135	20	80	162,000		188	1,827,360	1,989,360	1,989,360
AOE 6	Supply Class Fast Combat Support Ships	3	667	12	48	120,060				120,060	120,060
AOE 1	Sacramento Class Fast Combat Support Ship	4	601	22	88	264,440				264,440	264,440
ARS 50	Safeguard Class Savage Ships	4	90	44	176	79,200				79,200	79,200
AS 36	LY Spear and Emory S Land Class Submarine Tenders	3	604	10	40	90,600				90,600	90,600
AS 33	Simon Lake Class Submarine Tenders	1	915	12	48	54,900				54,900	54,900
	Military Sealift Command										
T-AE	Kilauea Class Ammunition Ships	8	187	*40*	160	299,200		45	403,920	703,120	703,120
T-AFS	Mars Class Combat Stores Ships	5	135	*40*	160	135,000				135,000	135,000
T-AFS	Sirius Class Combat Stores Ships	3	165	*40*	160	99,000				99,000	99,000
T-ATF	Powhatan Class Fleet Ocean Tugs	7	23	*40*	160	32,200				32,200	32,200

T-AO	Henry J Kaiser Class Oilers	12	137	*40*	160	328,800		45	443,880	772,680	772,680
T-AGM	Haskell Class Missile Instrumentation Ship	1	124	*40*	160	24,800				24,800	24,800
T-AGM	Compass Island Class Missile Instrumentation Ship	1	143	*40*	160	28,600				28,600	28,600
T-AH	Mercy Class Hospital Ships	2	1,275	*4*	16	51,000				51,000	51,000
T-ARC	Zeus Class Cable Repairing Ship	1	126	*40*	160	25,200				25,200	25,200
T-AKR	Selandia Class Fast Sealift Ships	3	90	*40*	160	54,000				54,000	54,000
T-AKR	Bob Hope Class Fast Sealift Ships	8	90	*40*	160	144,000				144,000	144,000
T-AGOS	Stalwart Class Ocean Surveillance Ship	4	33	*40*	160	26,400				26,400	26,400
T-AGOS	Victorious Class Ocean Surveillance Ship	4	34	*40*	160	27,200				27,200	27,200
T-AG	Navigation Research Ship	2	204	*40*	160	81,600				81,600	81,600
T-AGS	Silas Bent Class Surveying Ships	2	65	*40*	160	26,000				26,000	26,000
T-AGS	Waters Class Surveying Ships	1	95	*40*	160	19,000				19,000	19,000
T-AGS	McDonnel Class Surveying Ships	2	33	*40*	160	13,200				13,200	13,200
T-AGS	Pathfinder Class Surveying Ships	4	52	*40*	160	41,600				41,600	41,600
T-AGOR	Gyre Class Oceanographic Research Ships	1	32	*40*	160	6,400				6,400	6,400
T-AGOR	Thompson Class Oceanographic Research Ships	2	59	*40*	160	23,600				23,600	23,600
	U.S. Coast Guard										
WHEC	Hamilton and Hero Class High Endurance Cutters	12	176	26	104	274,560				274,560	274,560
WMEC	Storis Class Medium Endurance Cutters	1	92	18	72	8,280		167	92,184	100,464	100,464
WMEC	Diver Class Medium Endurance Cutters	1	136	18	72	12,240		98	79,968	92,208	92,208
WMEC	Famous Class Medium Endurance Cutters	13	98	18	72	114,660				114,660	114,660
WMEC	Reliance Class Medium Endurance Cutters	16	71	18	72	102,240				102,240	102,240
WAGB	Mackinaw Class Icebreakers* (150 d, 24 hr/d)	1	85		(3600)	(382,500)		*150*	76,500	459,000	459,000
WAGB	Polar Class Icebreakers	2	140	8	32	11,200				11,200	11,200
WTGB	Bay Class Icebreaking Tugs* (150 d, 24 hr/d)	9	17		(3600)	(688,500)		8	7,344	695,844	695,844
WPB 110	110' Class Patrol Craft	49	10	14	56	34,300		*140*	411,600	445,900	445,900
WLB	Juniper Class Seagoing Buoy Tenders	1	40	36	144	7,200				7,200	7,200
WLB	Balsam Class Seagoing Buoy Tenders* (100 d, 24 hr/d)	24	53		(2400)	(3,816,000)				3,816,000	3,816,000
WIX	Eagle Class Sail Training Cutter	1	245	*12*	48	14,700		188	276,360	291,060	291,060
	U.S. Army **										
LSV	Logistic Support Vessel* (30 d, 10 hr/d)	6	32	*40*	160 (300)	3,840 (+7,200)				110,400	11,040
LCU	Landing Craft Utility* (60 d, 10 hr/d)	48	13	*6*	24 (600)	1,872 (+46,800)				486,720	48,672
	Total Volume (Gallons):					18,311,950			15,276,684	39,936,114	38,535,346

Notes:

Values in italics are estimated.

At-pier discharge presented only for classes without or with inadequate capability to capture graywater for shore treatment

At-pier discharge based on 20% occupancy by crew.

* Vessel classes that operate within 12 n.m. of U.S. shore on a routine basis (days of operation within 12 n.m. per year and hours per day)

** The majority of Army vessels collect graywater with blackwater. Approximately 10% of the graywater generated is discharged separately.[9]

Table 2. Classicals Concentration in Graywater (mg/L)[12-14] (Arithmetic Average)

Parameter	DD 889 Wash Basins and Showers[14]	DD 889 Comb. Food Prep[14]	DD 889 Laundry[14]	AOE 3 Wash Basins and Showers[13]	AOE 3 Dishwasher and Deep Sink[13]	AOE 3 Laundry[13]	AD 18 Wash Basins and Showers[12]	Galley Weighted Average	Sink and Shower Weighted Average	Laundry Weighted Average	Flow Weighted Average**
No. Samples	*114*	*134*	*28*	*7*	*60*	*20*	*91*				
pH	7.3	6.88	9.99	7.12	6.74	8.33	6.86				
TSS	404	4,695	221	94	194	176	119	3303	271.4	202.3	802
TDS	1,445	8,064	1,006	237	752	583	225	5803	881.4	829.8	1756
BOD	230	2,618	419	226	503	190	144	1964	193	323.6	540
COD	348	7,839	721	509	2,380	469	304	6150	334.4	616	1443
TOC	70	1,133	165	82	251	59	-	860	70.7	120.8	224
Oil & grease	12.06	1,210	8.11	20.65	82.46	4.56	-	861.3	12.6	6.6	164
MBAS *	0.96	0.09	0.84	0.12	0.14	4.12	-	0.11	0.9	2.2	1.1
N-ammonia	15.4	669	80.48	0.58	0.64	0.17	-	462.3	14.5	47	102.3
N-nitrate	2.73	10.85	1.16	0.89	2.08	0.29	-	8.1	2.6	0.8	3.2
N-nitrite	-	-	-	0.09	0.11	-	-	-	-	-	-
N-Kjeldahl	187	99.84	164	4.31	4.84	0.43	-	70.5	176.4	95.8	140
P (phosphate)	1.36	20.78	1.3	1.03	6.34	28.25	-	16.3	1.3	12.5	6.5
Total coliforms (microorg/100mL)	707,000	257,000	178	8,300	2,360,000	3,890	60,600	907,412	406,466	1725	407,593
Fecal coliforms (microorg/100mL)	178,000	103,000	-	200	1,250,000	21,000	7,900	457,742	99,115	-	141,862

(-) no data reported for this parameter
(*) MBAS - Methylene Blue Active Substances
(**) Weighted averages for galley, showers/sinks, and laundry based on data presented herein. Flow-weighted average for graywater based on in-port contribution of major graywater sources (galley 18%, showers/sinks 60%, and laundry 22% of total)[5]

Table 3. Metals Concentrations in Graywater (mg/L)[15] (Mean Values)

Metal (total)	CVN 73 Potable Water Sink[15]	CVN 73 Galley Drains[15]	AS 39 Sink[15]	AD 38 Scullery[15]	Galley Weighted Average	Sink & Shower Weighted Average	Flow-Weighted Average
No. Samples	*12*	*13*	*8*	*11*			
Cadmium	0.004	0.017	0.005	0.004	0.011	0.004	0.006
Chromium*	0.002	0.03	0.007	0.01	0.01	0.004	0.005
Copper	0.754	3.404	0.443	0.250	1.96	0.630	0.936
Lead	0.042	1.560	0.047	0.182	0.928	0.044	0.247
Mercury	0.0003	0.0004	0.0002	0.0095	0.0046	0.0003	.0013
Nickel	0.037	0.113	0.025	0.031	0.075	0.032	0.042
Silver	0.007	0.012	0.008	0.011	0.012	0.007	0.008
Zinc	0.194	2.363	0.305	0.216	1.38	0.238	0.501

Note:

(*) Sample readings below the lower detection limit for chromium were treated as zero. For all the other metals listed above, when samples were measured at < LDL, the LDL was used in calculating the average.

(**) Weighted averages for galley and showers/sinks based on data presented herein. Flow-weighted average for graywater based on in-port contribution of graywater sources (galley 23%, showers/sinks 77% of total)

Table 4. Mass Loadings of Constituents*

Parameter	Flow-Weighted Average Concentration (mg/L)	Loading (lb/yr.)
Copper	0.936	304
Lead	0.247	80.3
Mercury	0.0013	.423
Nickel	0.042	13.7
Silver	0.008	2.60
Zinc	0.501	163
TSS	802	260,900
BOD	540	175,600
COD	1443	469,400
Oil and Grease	164	53,340
MBAS	1.1	358
N-Ammonia	102	33,180
N-NO_3	3.2	1,040
N- Kjeldahl	140	45,540
P- Phosphate	6.5	2110

* Based on flow-weighted average constituent concentrations. See Tables 2 and 3.

Table 5. Comparison of Graywater Concentration Data Versus Acute Water Quality Criteria (μg/L)

Parameter	Concentration*	Federal Acute WQC	Most Stringent State Acute WQC (State)
Ammonia	102	None	6 (HI)[A]
Copper	3,404	2.4	2.4 (CT, MS)
Lead	1,559	210	5.6 (FL, GA)
Mercury**	9.5	1.8	0.025 (FL, GA)
Nickel	113	74	8.3 (FL, GA)
Silver	12	1.9	1.2 (WA)
Zinc	2,363	90	84.6 (WA)

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.
A - Nutrient criteria are not specified as acute or chronic values.

CT = Connecticut
FL = Florida
GA = Georgia
MS = Mississippi
WA = Washington
(*) Highest concentration for any individual component from Table 3.
(**) Bioaccumulator

Table 6. 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	Data call responses		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

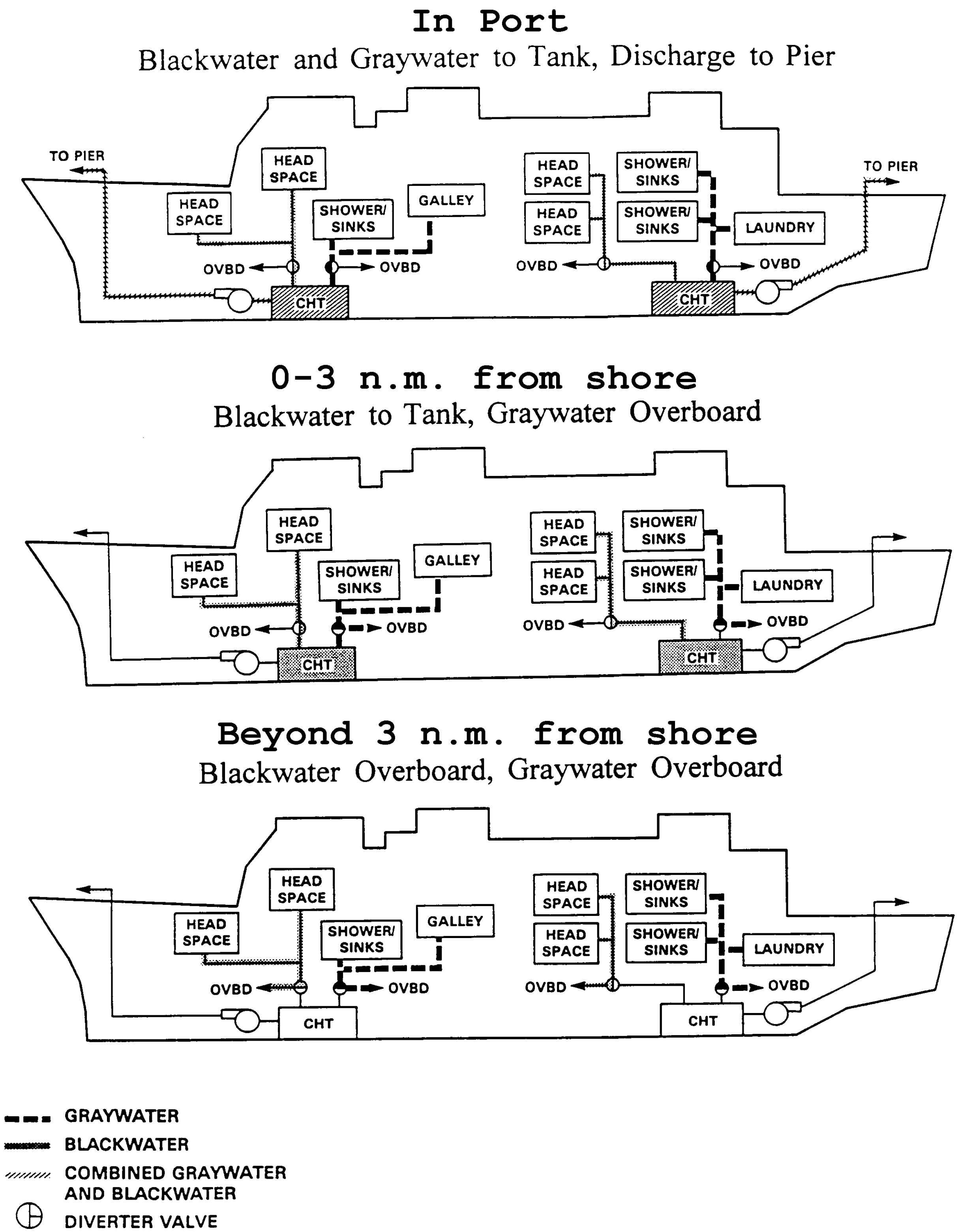

Figure 1. A Typical Collection, Holding, and Transfer System