NATURE OF DISCHARGE REPORT

Non-oily Machinery Wastewater

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 non-oily machinery wastewater 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

The primary purpose of the non-oily machinery wastewater system is to segregate machinery wastewater from the wastes that collect in bilges so that non-oily machinery wastewater can be directly discharged overboard. This reduces the amount of bilgewater that needs to be treated with oil water separators (OWS) prior to discharge. Dedicated drip pans, funnels, and deck drains comprise the non-oily machinery wastewater system and collect non-oily machinery wastewater that is generated below the ship's waterline in machinery spaces. Non-oily machinery wastewater from systems and equipment located above a ship's waterline is often drained directly overboard. By separately collecting and preventing non-oily machinery wastewater from mixing with oily wastewater, non-oily wastewater is discharged without going through an OWS system.

For the systems below the waterline, non-oily machinery wastewater drains into the non-oily machinery wastewater drain tanks (generally one per machinery space) which have dedicated pumps that discharge directly overboard. These pumps normally operate automatically under control of high- and low-level sensors. Non-oily machinery wastewater tanks range in size from 100 gallons for smaller ships to 2,500 gallons for aircraft carriers.

The main sources of water to the non-oily machinery wastewater are:

- distilling plants start-up discharge,
- bleed air system leaks,
- chilled water condensate drains,
- fresh and saltwater pump drains,
- potable water tank overflows,
- leaks from propulsion shaft seals,
- low & high pressure air compressor condensate,
- leaks from valve stems and manifolds,
- seawater and freshwater relief valve leaks,
- leaks from pump packing gland seals,
- seawater duplex strainer leaks,
- propulsion engine jacket water cooler drains.

Figure 1 is a diagram of a typical non-oily machinery wastewater system.

Of these listed non-oily machinery wastewater sources, distilling plants may be the major source of non-oily machinery wastewater. Distilling plants desalinate seawater to produce potable, boiler feed, and equipment cooling water. The freshwater initially produced by the distilling plants during start-up is normally discharged either overboard or to the non-oily machinery wastewater system until acceptable specified salinity levels are achieved. This period normally lasts about 15 minutes, at which time the discharge is discontinued. Also, the quality of the water produced during the normal operation of the distiller plants may occasionally be unsatisfactory; this water is discharged in the same manner as during start-up.

2.2 Releases to the Environment

The constituents of this discharge include potable water and seawater, metals from contact with tanks and piping, and other constituents associated with the construction and operation of the non-oily machinery wastewater system and equipment served by the system. The discharge either drains directly overboard continuously as it is produced, or is pumped overboard intermittently from non-oily machinery wastewater tanks.

2.3 Vessels Producing the Discharge

Non-conventionally powered Navy surface vessels and all newly constructed and some older conventionally-powered vessels have dedicated non-oily machinery wastewater systems. Most Military Sealift Command vessels and some of the older conventionally powered Navy ships do not have a separate non-oily machinery wastewater system, so the non-oily wastewater drains to the bilge.[1] U.S. Coast Guard vessels and small boats and craft of the Armed Forces do not have any dedicated non-oily machinery wastewater collection systems; instead, the non-oily machinery wastewater, which is mixed with bilgewater, is generally collected for shore side treatment as bilgewater. In addition, Army and Air Force vessels do not have separate non-oily machinery wastewater systems; this type of wastewater is drained directly to the bilge.

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 occurs in port, during transit, and at sea.

3.2 Rate

The generation rate and discharge frequency of non-oily machinery wastewater varies considerably according to the mode of ship operation and its equipment operating status. This was demonstrated by the results of the recent flow characterization study of non-oily machinery wastewater onboard the following vessels: CVN 74, DDG 67, LHD 5, and LSD 44.[2] A cumulative discharge flow rate of 97,057,740 gallons/year was estimated for the vessel classes that these vessels represent. Non-oily machinery wastewater flow rates by vessel class were established by using the following formula:

Vessel Class Flow Rate = (# vessels/ship class)(flow rate)(# of days in port/ year)
CVN 68 Class = (7 vessels)(41,200 gal/day)(147 days in port/year) = 42,394,800 gal/year

Machine-specific non-oily machinery wastewater sources can generate volumes ranging from a few drips per minute in the case of small pumps and valves, to several thousand gallons per hour (gph) in the case of distilling units releasing their output during plant start-up. The volume of distillate directed to the non-oily machinery wastewater system during start-up ranges from less than 100 gph to about 4,000 gph depending on the size of the plant.

3.3 Constituents

Non-oily machinery wastewater discharge samples were obtained from four Navy ships. Samples were collected aboard an aircraft carrier (CVN 74), an amphibious assault ship (LHD 1), a dock landing ship (LSD 51) and a guided missile destroyer (DDG 57).[3] See Table 1 for the concentrations of constituents detected in shipboard non-oily machinery wastewater discharge samples. Table 2 lists a bioaccumulator and constituents that were detected in the non-oily machinery wastewater samples at concentrations that exceed Federal and/or state ambient water quality criteria (WQC). The priority pollutants bis(2-ethylhexyl) phthalate, copper, nickel, silver, and zinc were identified as being present in concentrations exceeding WQC. The only bioaccumulator identified in the discharge was mercury.

3.4 Concentrations

Concentrations of constituents detected in non-oily machinery wastewater samples collected from an aircraft carrier (CVN 74), an amphibious assault ship (LHD 1), a dock landing ship (LSD 51) and a guided missile destroyer (DDG 57) are presented in Table 1. Concentrations of a known bioaccumulator and the constituents that exceeded Federal and/or most stringent state WQC are presented in Table 2.

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 mass loadings and the concentrations of discharge constituents after release to the environment are discussed in Sections 4.1 and 4.2, respectively. In Section 4.3, the potential for the transfer of non-indigenous species is discussed.

4.1 Mass Loadings

Non-oily machinery wastewater discharge volumes (recorded by pump running time meters/event counters) were recorded daily aboard four ships from different ship classes over periods of time ranging from 22 to 29 consecutive days.[2] These were the same four ship classes that were sampled. The discharge flow data and log-normal mean concentrations were used to estimate mass loadings for those analytes detected. Mass loadings of all constituents detected are presented in Table 1. Table 2 shows mass loadings for constituents with log-normal mean concentrations that exceed water quality criteria and for the loan bioaccumulator detected, mercury. A sample calculation of the estimated mass loading for copper is shown below:

Mass Loading for Copper (Total):

Mass Loading = (Log-normal mean concentration)(Flow Rate)

= (599.96 mg/L)(97,057,740 gal/yr)(3.785 L/gal)(1kg/10^9mg)(2.2 lb/1 kg)

= 485 lbs/yr

Mass loadings were determined using log-normal averages because the concentration data are expected to follow a log-normal distribution.

4.2 Environmental Concentrations

The log-normal mean discharge concentrations are compared to the Federal and most stringent state WQC in Table 3. Copper, nickel, silver, zinc, bis(2-ethylhexyl) phthalate, ammonia, nitrogen (as nitrate/nitrite and total kjeldahl nitrogen), and total phosphorous were present in shipboard non-oily machinery wastewater discharge samples, with log-normal mean concentration levels in excess of the most stringent established water quality criteria. Mercury was detected in two of four shipboard samples, but the log-normal mean concentration did not exceed WQC.

4.3 Potential for Introducing Non-Indigenous Species

The discharge from freshwater non-oily machinery wastewater originates from the potable water system and therefore, cannot introduce, transport, or release non-indigenous species. Non-oily machinery wastewater of seawater origin is pumped overboard in the same geographical area in which the seawater was taken. Therefore, transporting aquatic species from one geographic area to another as a result of this discharge is unlikely.

5.0 CONCLUSION

It is not clear whether non-oily machinery wastewater has the potential to cause an adverse environmental effect. Copper, nickel, silver, zinc, bis(2-ethylhexyl) phthalate, ammonia, nitrogen, and phosphorous exceed federal or most stringent state water quality criteria. However, flow rate data are not adequate for estimating the fleetwide generation rate for this discharge, and consequently, the mass loadings of these constituents for the fleet could not be calculated.

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 discharge volume. 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 4 shows the source of the data used to develop this NOD report.

Specific References

1. Point Paper, "Supplemental Information for Miscellaneous UNDS Discharge Streams", P. Weersing, Military Sealift Command Central Technical Activity, Code N72PC1, January 9, 1997.

2. Uniform National Discharge Standards Non-Oily Machinery Wastewater (NOMWW) Flow Characterization Report, CDNSWC-TM-63-98/62, March 1998.

3. UNDS Phase 1 Sampling Data Report, Volumes 1 - 13, October 1997.

General References

USEPA. Toxics Criteria for Those States Not Complying with Clean Water Act Section 303(c)(2)(B). 40 CFR Part 131.36.

USEPA. Interim Final Rule. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance – Revision of Metals Criteria. 60 FR 22230. May 4, 1995.

USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants. 57 FR 60848. December 22, 1992.

USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, Proposed Rule under 40 CFR Part 131, Federal Register, Vol. 62, Number 150. August 5, 1997.

Connecticut. Department of Environmental Protection. Water Quality Standards. Surface Water Quality Standards Effective April 8, 1997.

Florida. Department of Environmental Protection. Surface Water Quality Standards, Chapter 62-302. Effective December 26, 1996.

Georgia Final Regulations. Chapter 391-3-6, Water Quality Control, as provided by The Bureau of National Affairs, Inc., 1996.

Hawaii. Hawaiian Water Quality Standards. Section 11, Chapter 54 of the State Code.

Mississippi. Water Quality Criteria for Intrastate, Interstate and Coastal Waters. Mississippi Department of Environmental Quality, Office of Pollution Control. Adopted November 16, 1995.

New Jersey Final Regulations. Surface Water Quality Standards, Section 7:9B-1, as provided by The Bureau of National Affairs, Inc., 1996.

Texas. Texas Surface Water Quality Standards, Sections 307.2 - 307.10. Texas Natural Resource Conservation Commission. Effective July 13, 1995.

Virginia. Water Quality Standards. Chapter 260, Virginia Administrative Code (VAC) , 9 VAC 25-260.

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

UNDS Equipment Expert Meeting Minutes - Non-oily Machinery Wastewater. 12 September 1996.

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.

UNDS Ship Database, August 1, 1997.

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

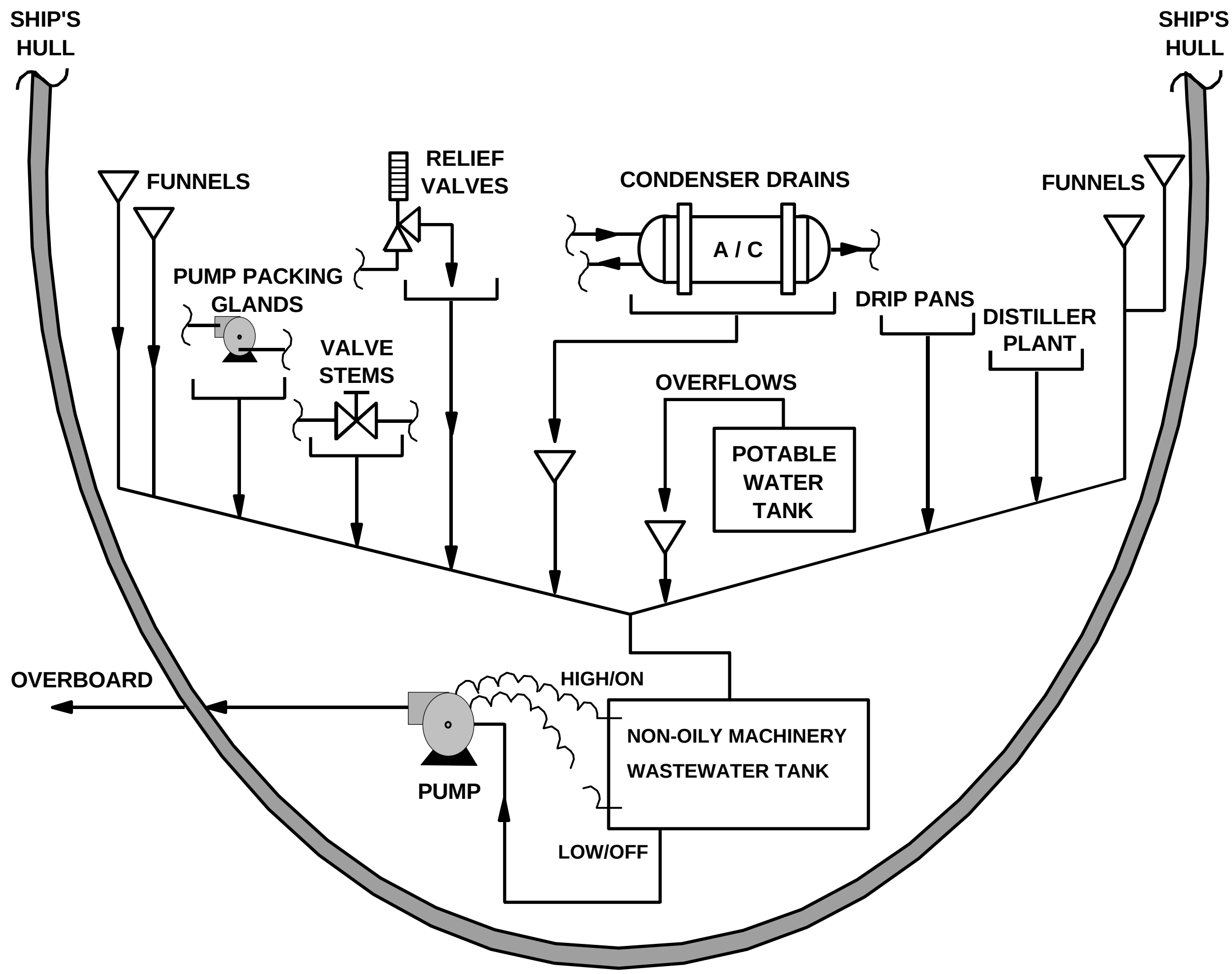

FIGURE 1
TYPICAL NON-OILY MACHINERY WASTEWATER SYSTEM

Table 1. Summary of Detected Analytes

Constituent	Log Normal Mean	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mass Loading
CLASSICALS	(mg/L)		(mg/L)	(mg/L)	(lbs/yr)
Alkalinity	13.96	4 of 4	6	62	11284
Ammonia as Nitrogen	0.34	4 of 4	0.1	1	275
Biochemical Oxygen Demand	4.76	1 of 3	BDL	12	3696
Chemical Oxygen Demand	63.89	3 of 4	BDL	285	49608
Chloride	94.29	4 of 4	2	3050	73213
Hexane Extractable Material	5.02	1 of 4	BDL	40.5	3898
Nitrate/Nitrite	0.38	4 of 4	0.19	0.56	295
SGT-HEM	5.91	1 of 3	BDL	33	4589
Sulfate	139.13	4 of 4	9.8	1710	112457
Total Dissolved Solids	431.32	4 of 4	46	6300	348630
Total Kjeldahl Nitrogen	1.05	4 of 4	0.55	2.3	8.49
Total Organic Carbon (TOC)	4.27	3 of 4	BDL	21	3451
Total Phosphorous	1.03	4 of 4	.14	11	833
Total Recoverable Oil and Grease	4.73	4 of 4	.6	19.75	3823
Total Sulfide (Iodometric)	6.45	4 of 4	2	16	5213
Total Suspended Solids	11.34	3 of 4	BDL	46	9166
Volatile Residue	287.25	4 of 4	54	6350	232180
MERCURY	(ng/L)		(ng/L)	(ng/L)	(lbs/yr)
Mercury	4.48	2 of 4	BDL	2135	0.0036
METALS	(µg/L)		(µg/L)	(µg/L)	(lbs/yr)
Aluminum					
Dissolved	30.83	1 of 4	BDL	68	24.92
Total	53.47	1 of 4	BDL	372.5	43.22
Antimony					
Dissolved	2.81	1 of 4	BDL	7.55	2.27
Total	2.57	1 of 4	BDL	5.5	2.08
Arsenic					
Dissolved	0.94	1 of 4	BDL	1.8	0.760
Total	0.57	1 of 4	BDL	1.2	0.461
Barium					
Dissolved	5.17	3 of 4	BDL	21.8	4.18
Total	7.03	3 of 4	BDL	34.95	5.68
Boron					
Dissolved	80.88	3 of 4	BDL	754	65.4
Total	89.19	3 of 4	BDL	833	72.1
Cadmium					
Dissolved	2.78	1 of 4	BDL	5.2	2.25
Total	2.80	1 of 4	BDL	5.4	2.26
Calcium					
Dissolved	3587.66	4 of 4	131.5	74650	2900
Total	4117.59	4 of 4	173	97950	3328
Copper					
Dissolved	148.76	4 of 4	34.35	1065	120

Total	599.96	4 of 4	34.2	3045	485
Iron					
Dissolved	20.90	2 of 4	BDL	89.15	16.9
Total	110.28	3 of 4	BDL	2505	89.1
Lead					
Dissolved	4.59	1 of 4	BDL	19.3	3.71
Total	5.10	1 of 4	BDL	29.35	4.12
Magnesium					
Dissolved	7775.80	4 of 4	316	196500	6285
Total	9258.79	4 of 4	455	251500	7484
Manganese					
Dissolved	7.40	3 of 4	BDL	26.15	6.0
Total	9.91	3 of 4	BDL	69.05	8.0
Molybdenum					
Dissolved	2.47	1 of 4	BDL	17.2	2.0
Total	2.79	1 of 4	BDL	31	2.26
Nickel					
Dissolved	76.10	3 of 4	BDL	237	61.5
Total	92.63	3 of 4	BDL	404	74.9
Silver					
Total	5.41	1 of 4	BDL	54.85	4.37
Sodium					
Dissolved	69616.18	4 of 4	3365	1750000	56270
Total	62604.54	4 of 4	1948.75	1955000	50602
Thallium					
Dissolved	4.72	3 of 4	BDL	15.7	3.82
Total	1.43	1 of 4	BDL	1.6	1.16
Tin					
Total	4.14	1 of 4	BDL	36.7	3.35
Titanium					
Total	4.05	2 of 4	BDL	9.75	3.27
Zinc					
Dissolved	140.24	4 of 4	23	847	113
Total	621.47	4 of 4	90.85	6125	502
ORGANICS	(µg/L)		(µg/L)	(µg/L)	(lbs/yr)
2-Propanone	36.00	1 of 4	BDL	107.5	29.1
Bis(2-Ethylhexyl) Phthalate	10.78	1 of 4	BDL	75	8.71
Chloroform	6.93	1 of 4	BDL	18.5	5.6
N,N-Dimethylformamide	6.67	1 of 4	BDL	11	5.39
N-Hexacosane	6.06	1 of 4	BDL	10	4.9
Toluene	10.91	1 of 4	BDL	113.5	8.82

Notes:
(1) BDL = Below Detection Limit
(2) Mass loadings were calculated based upon the results of the UNDS Non-Oily Machinery Wastewater Flow Characterization Report involving four vessels: CVN 74, DDG 67, LHD 5, and LSD 44.[2]
(3) Log normal means were calculated using measured analyte concentrations. When a sample set contained one or more samples with the analyte below detection levels (i.e., "non-detect" samples), estimated analyte concentrations equivalent to one-half of the detection levels were used to calculate the mean. For example, if a "non-detect" sample was analyzed using a technique with a detection level of 20 mg/L, 10 mg/L was used in the log normal mean calculation.

Table 2. Estimated Annual Mass Loadings of Constituents

Constituent	Log Normal Mean	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mass Loading
CLASSICALS	(mg/L)		(mg/L)	(mg/L)	(lbs/yr)
Ammonia as Nitrogen	0.34	4 of 4	0.1	1	275
Nitrate/Nitrite	0.38	4 of 4	0.19	0.56	295
Total Kjeldahl Nitrogen	1.05	4 of 4	0.55	2.3	8.49
Total Nitrogen[A]	1.43	-			303
Total Phosphorous	1.03	4 of 4	0.14	11	833
ORGANICS	(µg/L)		(µg/L)	(µg/L)	(lbs/yr)
Bis(2-Ethylhexyl) Phthalate	10.78	1 of 4	BDL	75	8.71
MERCURY	(ng/L)		(ng/L)	(ng/L)	(lbs/yr)
*Mercury**	4.48	2 of 4	BDL	2135	.0036
METALS	(µg/L)		(µg/L)	(µg/L)	(lbs/yr)
Copper					
Dissolved	148.76	4 of 4	34.35	1065	120
Total	599.96	4 of 4	34.2	3045	485
Nickel					
Dissolved	76.10	3 of 4	BDL	237	61.5
Total	92.63	3 of 4	BDL	404	74.9
Silver					
Total	5.41	1 of 4	BDL	54.85	4.37
Zinc					
Dissolved	140.24	4 of 4	23	847	113
Total	621.47	4 of 4	90.85	6125	502

BDL = Below Detection Limit
A - Total Nitrogen is the sum of Nitrate/Nitrite and Total Kjeldahl Nitrogen.

* Mercury was not found in excess of WQC; mass loading is shown only because it is a bioaccumulator.

Mass loadings were calculated based upon the results of the UNDS Non-Oily Machinery Wastewater Flow Characterization Report involving four vessels: CVN 74, DDG 67, LHD 5, and LSD 44.[2]

Table 3. Mean Concentrations of Constituents that Exceed Water Quality Criteria

Constituent	Log-normal Mean	Minimum Concentration	Maximum Concentration	Federal Acute WQC	Most Stringent State Acute WQC
CLASSICALS (mg/L)					
Ammonia as Nitrogen	0.34	0.1	1	None	0.006 (HI)[A]
Nitrate/Nitrite	0.38	0.19	0.56	None	0.008 (HI)[A]
Total Kjeldahl Nitrogen	1.05	0.55	2.3	None	-
Total Nitrogen[B]	1.43			None	0.2 (HI)[A]
Total Phosphorous	1.03	0.14	11	None	0.025 (HI)[A]
ORGANICS (µg/L)					
Bis(2-Ethylhexyl) Phthalate	10.78	BDL	75	None	5.92 (GA)
Mercury (ng/L)					
*Mercury**	4.48	BDL	2135	1800	25 (FL, GA)
Metals (µg/L)					
Copper					
Dissolved	148.76	34.35	1065	2.4	2.4 (CT, MS)
Total	599.96	34.2	3045	2.9	2.5 (WA)
Nickel					
Dissolved	76.10	BDL	237	74	74 (CA, CT)
Total	92.63	BDL	404	74.6	8.3 (FL, GA)
Silver					
Total	5.41	BDL	54.85	1.9	1.2 (WA)
Zinc					
Dissolved	140.24	23	847	90	90 (CA, CT, MS)
Total	621.47	90.85	6125	95.1	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)
A - Nutrient criteria are not specified as acute or chronic values.
B - Total Nitrogen is the sum of Nitrate/Nitrite and Total Kjeldahl Nitrogen.

* - Mercury was not found in excess of WQC; concentration is shown only because it is a bioaccumulator.

CA = California
CT = Connecticut
FL = Florida
GA = Georgia
HI = Hawaii
MS = Mississippi
WA = Washington

Table 4. 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		X
2.3 Vessels Producing the Discharge	UNDS Database			X
3.1 Locality				X
3.2 Rate		X		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