Assessment of Cruise Ship and Ferry Wastewater Impacts in Alaska

Alaska Department of Environmental Conservation

Commercial Passenger Vessel Environmental Compliance Program

January 26, 2004

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Executive Summary

Cruise ships by their sheer size and passenger number are a highly visible industry in Alaska. Concerns about cruise ship pollution led to the creation of the Alaska Cruise Ship Initiative (ACSI) in 2000. Wastewater samples taken as part of the ACSI in 2000 indicated that the blackwater[1] treatment systems were not working properly and that graywater[2] quality was similar to blackwater. This information led to state and federal laws that now regulate cruise ship and ferry blackwater and graywater discharge in Alaska.

Before the passage of the state cruise ship law, blackwater and graywater from large cruise ships did not meet Alaska Water Quality Standards for ammonia, free chlorine, fecal coliform, copper, and zinc at the end of pipe. These ships would have exceeded Alaska Water Quality Standards for free chlorine, fecal coliform, and dissolved copper if they discharged while stationary. However, Alaska Water Quality Standards, except fecal coliform, were probably met in the receiving water while ships discharged underway due to substantial dilution.

Since the passage of the state law in 2001 and federal cruise ship law in 2000, most large cruise ships discharging into Alaska waters[3] have installed advanced wastewater treatment systems. The effluent quality produced by the advanced systems has dramatically improved from waste water discharged from most ships in 2000-2002. Therefore, ADEC considered the 2003 data to assess the impact of large cruise ship effluent in receiving waters. In 2003, these systems produced wastewater that met Alaska Water Quality Standards for most tested pollutants at the end of pipe. After applying a conservative dilution factor, Alaska Water Quality Standards were met in receiving water for all tested pollutants. Whole Effluent Toxicity (WET) testing conducted during 2003 in conjunction with dilution estimates indicates that effluent from ships with advanced wastewater treatment systems does not pose a risk to aquatic organisms, even during stationary discharge. No tested pollutant is present in concentrations that cause risks to human health.

Small cruise ships and Alaska Marine Highway System (AMHS) ferries use traditional treatment, not advanced systems to treat their blackwater. The quality of small ship effluent has remained relatively consistent from 2001 to 2003. Therefore, ADEC used all the data available to assess the impact of small vessel effluent on receiving waters. The wastewater produced by small vessels frequently exceeds eight (ammonia, free chlorine, fecal coliform, arsenic, copper, nickel, selenium, and zinc) Alaska Water Quality Standards at the end of pipe. After applying a conservative dilution factor, four (free chlorine, fecal coliform, copper, and zinc) Alaska Water Quality Standards may be exceeded in receiving water during stationary discharge. The discharge met Alaska Water Quality Standards for all tested pollutants in the receiving water during underway discharge due to the large dilution factor. In addition, WET testing conducted on six small vessels in conjunction with the sampling results indicates that small ship stationary effluent does pose some risk to the marine environment. Due to the high concentration of fecal coliform, the effluent from some small ships may pose a risk to human health in areas where aquatic life is harvested for raw consumption.

[1] Black water is sewage.
[2] Graywater originates from showers, galley, laundry, etc.
[3] Alaska water is defined as 3 nautical miles from shore and the waters of the Alexander Archipelago defined in AS 46.03.490(18).

The wastewater samples taken from large and small vessels to date indicate that hazardous chemicals are not being discharged through these wastewater systems.

ADEC recommends that small vessels remain in the commercial passenger vessel program. Small vessels were granted three years to come into compliance with the cruise ship wastewater effluent standards. Further, in 2004, these vessels may submit an interim protection plan that, if approved by ADEC, extends the time for compliance with the effluent standards. This plan must detail the steps that the owner is taking to comply with the wastewater discharge limits including a description of the practices used to limit the adverse impacts of their discharges. Violations and fines could be levied against ships that are found violating the terms of their approved plan.

1. INTRODUCTION

1.1. Assessment Report

The 2001 state cruise ship legislation directed the Alaska Department of Environmental Conservation (ADEC) to submit a report to the Governor assessing commercial passenger vessels' discharges in Alaska marine waters. Using information from the 2000 – 2003 cruise ship seasons and other sources, this report satisfies the requirements to:

1. Characterize, to the extent possible, the risks to the marine and human environments posed by the discharge of sewage and graywater from commercial passenger vessels;

2. Evaluate the sewage and graywater treatment systems and technologies on the vessels, including an evaluation of whether small commercial passenger vessels should be made subject to the discharge limitations in AS 46.03.463; and

3. Recommend further action by the state in relation to the matters discussed in the report.

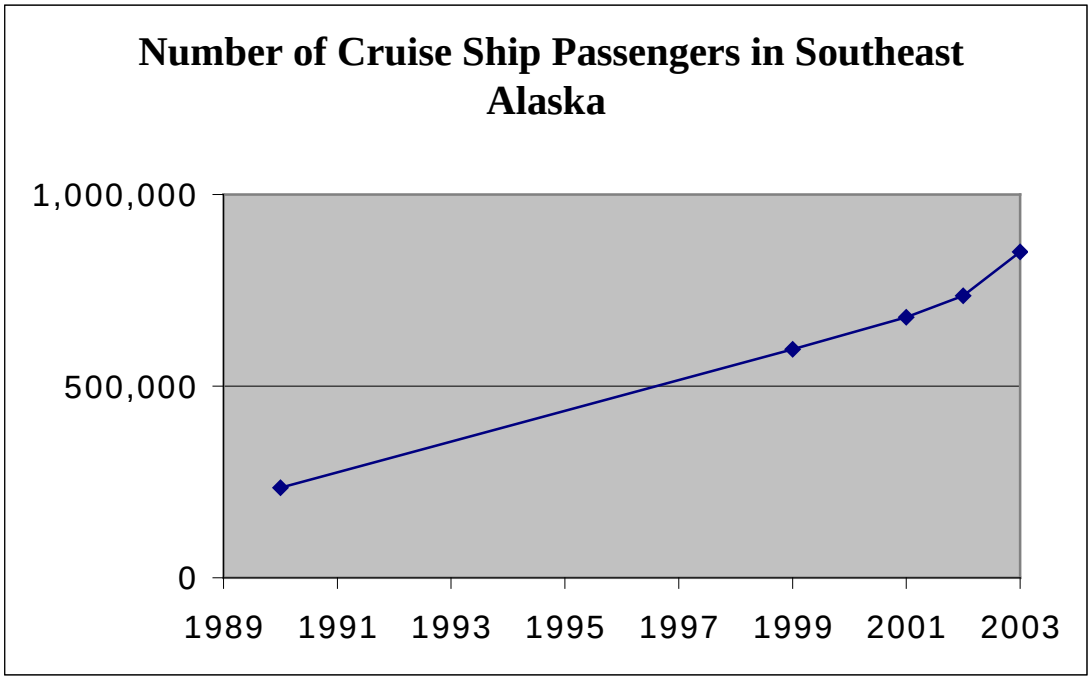
This report also presents general background information and detailed appendices of wastewater sampling data, in response to the numerous requests received by ADEC staff from industry, environmental groups, and other government agencies. Bilge and ballast water issues are a maritime wide concern and are beyond the scope of the 2001 legislation and this report.

1.2. Cruise Ship Industry Trends in Alaska

The first steamships began carrying tourists to Alaska in 1884,[4] making tourism one of Alaska's oldest industries. The number of cruise ship passengers that visit Alaska has increased by almost three and a half times since 1990. In 1990, 235,000 passengers traveled to Southeast Alaska. By 2003, the number of cruise ship passengers in Southeast Alaska increased to roughly 800,000[5] with tens of thousands of crew (Figure 1). By comparison, the state's population is approximately 650,000.[6] Roughly 95% of the current cruise ship traffic is concentrated in Southeast Alaska, a region with a population of approximately 73,000 people.[7] This makes the cruise ship industry extremely visible in the region. For example, Skagway - with a summer population of 1,200 people – often has more than 12,000 people visiting in a day. The other 5% of cruise ship traffic is directed primarily toward Southcentral Alaska, but a few small cruise ships visit Western Alaska.

[4] Alaska Permanent Fund Corporation Alaska History Page http://www.apfc.org/library/AKHistoryD.cfm?s=5
[5] ADEC 2003 registration information
[6] Alaska Department of Labor and Workforce Development, Workforce Info Home Page http://almis.labor.state.ak.us/?PAGEID=67&SUBID=115
[7] Alaska Department of Labor and Workforce Development, Borough & Census Area Estimates 2000 – 2003, http://146.63.75.50/research/pop/estimates/02T2-1.xls

Figure 1. Cruise Ship Passenger Increase in Southeast Alaska



Source: Southeast Conference Report and ADEC Registration Statistics

The three most popular large cruise ship ports are Juneau, Ketchikan, and Skagway. Large ships tend to stop at the main Southeast Alaska ports and a large tidewater glacier (Glacier Bay or Hubbard). Some large cruise lines have trips that start in Southcentral Alaska (Seward) travel through southeast Alaska and end in Vancouver. The next voyage is reversed.

Alaska Marine Highway System (AMHS) ferries travel between Southeastern Alaska communities including Ketchikan, Juneau, and Skagway. These calls generally only last an hour or two. Small cruise lines explore remote bays and channels. They call on smaller Alaska ports and Native villages as well as the larger ports for most of a day. The small ships may venture from Alaska ports across the Bering Sea to the Russian Far East. The most popular ports for small ships are Sitka, Bartlett Cove, Skagway, Ketchikan, and Juneau.

Table 1 shows the number of cruise ship visits per port per year in 2003.[8] There are often multiple ships in a port in a single day.

[8] These numbers are derived from the 2003 Cruise Line Agencies of Alaska ship schedule. The actual visits may have varied slightly.

Table 1. Cruise Ship Visits Per Port in 2003

Place Name	Description	Number of small ship visits per year	Number of large ship visits per year
Adak	Port in Aleutian Islands	1	0
Anchorage	Port in Southcentral Alaska	8	0
Attu	Port in the Aleutian Islands	5	
Baranof Warm Springs	Port in Southeast Alaska	1	0
Bartlett Cove	Port inside Glacier Bay National Park	122	0
Cold Bay	Remote site	1	0
College Fiord	Tidewater Glacier in South central Alaska	7	147
Cordova	Port in Southcentral Alaska	16	0
Dutch Harbor	Unalaska Island (one of the Fox Is.) in the Aleutian Is.	7	3
Elfin Cove	Port in Southeast Alaska	25	0
Glacier Bay	Tidewater Glaciers, National Park in SE AK	See Bartlett Cove	207
Haines	Port in Southeast Alaska (Northern Lynn Canal)	67	13
Homer	Port in Southcentral (western Kenai Peninsula)	10	2
Hubbard Glacier	Tidewater Glacier near Yakutat on Gulf of Alaska	0	151
Icy Bay	Tidewater Glacier near Yakutat on Gulf of Alaska	0	2
Juneau	Port in Southeast Alaska	96	448
Ketchikan	Port in Southeast Alaska	100	408
Kodiak	Port in Kodiak Island (South central Alaska)	4	3
Misty Fiords	National Monument near Ketchikan	50	33
Nome	Western Alaska	2	3
Petersburg	Port in Southeast Alaska	96	0
Seward	Port in South Kenai Peninsula	0	98
Sitka	Port in Southeast Alaska (outside coast)	140	140
Skagway	Port in Southeast Alaska (Northern Lynn Canal)	100	328

Place Name	Description	Number of small ship visits per year	Number of large ship visits per year
St. Matthew	Island in the Bering Sea	9	0
St. Paul	Island in the Bering Sea	9	0
Tracy Arm	Tidewater Glacier in Southeast Alaska (between Juneau& Wrangell)	100	128
Valdez	Port in South central Alaska	16	0
Whittier	Port in South central Alaska	32	0
Wrangell	Port in Southeast Alaska	32	8

1.3. Concern about Cruise Ship Industry Environmental Practices

Tourism shares the rich marine environment with commercial fisheries, one of Alaska's largest private employers. Over 50% of America's seafood (5.1 billion of 9.4 billion pounds) is harvested from Alaska's waters.[9] The commercial fishing industry depends on the perception and actuality that Alaskan fish come from uncontaminated waters.

Alaska's Native peoples subsist off the bounty of the sea, relying heavily upon marine resources for nutrition, sustenance, cultural integrity, and spiritual well being. Alaska Natives were alarmed over potential cruise ship pollution and the fouling of especially vulnerable food items such as filter feeding mollusks.

In July 1999, Royal Caribbean Cruise Lines (RCCL) entered a federal criminal plea agreement involving total penalties of $6,500,000 for 1994 and 1995 environmental violations in Alaska including knowingly discharging oil and hazardous substances (dry-cleaning and photo processing chemicals) and making false entries in federally required Oil Record Books. RCCL admitted to a "fleet-wide practice of discharging oil contaminated bilge waste" and to submitting false statements in numerous jurisdictions. The $6,500,000 for Alaska violations was part of a larger $18,000,000 total federal plea agreement. In January 2000, RCCL entered into a state civil settlement for the Alaska violations. The state settlement required RCCL expenditures of over $3,325,000. This illegal discharge outraged many Alaskans, who began to question whether cruise ships met Alaska Water Quality Standards enforced by the Alaska Department of Environmental Conservation (ADEC).

Because of its international nature, the cruise industry was excluded from many of the U.S. environmental laws and regulations that land-based industries are required to meet. EPA did not issue a permit under the federal Clean Water Act for cruise ship wastewater discharges because of a marine vessels exemption that dates from the 1970s. The U.S. Coast Guard certifies marine sanitation devices (MSDs) for American flagged ships and checks to ensure that all applicable vessels have certified MSDs during ship inspections. They did not, however, monitor the wastewater effluent quality.

Large cruise ships operate under MARPOL (International Convention for the Prevention of Pollution from Ships), an environmental treaty drafted by the International Maritime Organization (IMO), an agency of the United Nations. Annex IV of MARPOL addresses the

[9] "Fisheries of the United States 2002." September 2003. National Marine Fisheries Service, NOAA, U.S. Dept. of Commerce.

disposal of sewage. Since the United States did not sign Annex IV, it is not mandatory, that ships follow Annex IV in the United States.[10]

1.4. Alaska Cruise Ship Initiative (ACSI)

In December 1999, ADEC responded to public concern and convened a forum to review and discuss the cruise industry's waste management and disposal practices in Alaska. The participants included the U.S. Coast Guard, the U.S. Environmental Protection Agency (EPA), Southeast Alaska communities, industry, Tribes, environmental groups, and concerned Alaskans. This effort became known as the Alaska Cruise Ship Initiative (ACSI). Goals of the ACSI included:

(1) identifying cruise ship waste streams,

(2) developing pollution prevention and waste management solutions,

(3) assessing and verifying compliance of volunteer wastewater sampling, and

(4) keeping the Alaskan public informed.

Voluntary sampling of large cruise ships in 2000 indicated that the marine sanitation devices (MSD) on most ships did not function well. U.S. Coast Guard regulations require that effluent from the type II MSD treatment systems installed on cruise ships contain no more than 200 fecal coliforms per 100 ml and 150 mg/l total suspended solids at installation.[11] Surprisingly, the fecal coliform results were as high as 16 million[12] in blackwater and 32 million in graywater.[13]

1.5. Alaska Specific Legislation

As a result of the ACSI efforts, the U.S. Congress enacted Title XIV – Certain Alaskan Cruise Ship Operations on December 21, 2000.[14] The law creates wastewater standards for vessels with 500 or more overnight passengers, and prohibits cruise ships from discharging raw sewage in areas that are more than 3 nautical miles from shore but still within the Inside Passage. These "donut holes" are now closed to discharge. (See Figure 2.) The regulations to implement the law became effective in July 2001[15] and are enforced by the U.S. Coast Guard.

[10] EPA MARPOL 73/78 overview http://www.epa.gov/OWOW/OCPD/marpol.html
[11] 33 CFR Part 159 – Marine Sanitation Devices
http://www.uscg.mil/d14/units/msohono/references/cfrs/sub%20o/part%20159.htm
[12] The geometric mean of fecal coliform samples was 12,824 for blackwater and 1,163,188 for graywater. See Appendix B. Large Ship Sampling Data Tables 47B & 51.
[13] Blackwater originates in toilets. Graywater comes from showers, sinks, kitchens, and laundry.
[14] "Title XIV—Certain Alaskan Cruise Ship Operations" of the Miscellaneous Appropriations Bill (H.R. 5666) on December 21, 2000 in the Consolidated Appropriations Act of 2001 (P.L. 106-554).
[15] 33 CFR Part 159 Subpart E – Discharge of Effluents in Certain Alaskan Waters by Cruise Vessel Operations.

Figure 2. Donut Holes Closed by Federal Cruise Ship Legislation

Under the federal legislation, large cruise ships may discharge blackwater and graywater in Alaska while underway.[16] During an underway discharge, blackwater effluent must contain no more than 200 fecal coliforms per 100 ml and no more than 150 mg/l total suspended solids. There are currently no federal effluent standards for underway graywater discharges.[17] Ships that discharge blackwater in Alaska while underway must take at least two blackwater samples per cruise ship season. The federal law allows continuous discharge of blackwater and graywater that meet more stringent standards (Table 2). A ship approved by the U.S. Coast Guard to discharge continuously must sample their wastewater twice per month

State of Alaska cruise ship legislation, AS 46.03.460 – AS 46.03.490,[18] was passed during a 2001 special session of the Alaska Legislature and became effective on July 1, 2001. The legislation establishes the Commercial Passenger Vessel Environmental Compliance (CPVEC) program in the ADEC. The regulations to implement the program, 18 AAC 69, were effective November 15, 2002.[19]

The state law sets standards and sampling requirements for the underway discharge of blackwater in Alaska that are identical to the blackwater standards in the federal law (Table 2). Because of the high fecal coliform counts detected in graywater during 2000, the state law also set graywater standards (Table 2). It also has provisions regarding the disclosure of solid waste and hazardous waste disposal information.

[16] Traveling at least 6 knots while at least 1 nautical mile from shore.

[17] The Administrator of the EPA may promulgate different wastewater effluent standards in the future. EPA recently began the process of evaluating whether the current federal standards are consistent with Alaska Water Quality Standards.

[18] Available at: http://old-www.legis.state.ak.us/cgi-bin/folioisa.dll/stattx01/query=as+46!2E03!2E460/doc/{@17677}?

[19] Regulations were drafted by stakeholder committee and brought through formal rule making process. They are available at http://www.state.ak.us/dec/title18/wpfiles/69mas.doc

The CPVEC program applies to both large and small commercial passenger vessels. A small commercial passenger vessel provides overnight accommodations for 50 to 249 passengers. State law defines a large commercial passenger vessel as one that provides overnight accommodations for 250 or more passengers.[20] Several key aspects of the CPVEC program, such as payment of environmental compliance fees and compliance with wastewater discharge standards, did not apply to small commercial passenger vessels until January 1, 2004.[21] These vessels did, however, have to adhere to the wastewater sampling, record keeping, and reporting requirements as soon as the law was effective.

Table 2. Comparison of State and Federal Laws

<table>
<tr><th>Law</th><th>State</th><th>Federal</th></tr>
<tr><td># Overnight Passengers</td><td>50+</td><td>500+</td></tr>
<tr><td>Discharge Limits</td><td colspan="2">At Least 1 mile from shore @ min. 6 knots</td></tr>
<tr><td></td><td>BW & GW</td><td>BW only</td></tr>
<tr><td>Fecal Coliform/100 ml</td><td>Geometric Mean of 200</td><td>200</td></tr>
<tr><td>Total Suspended Solids (mg/l)</td><td>150</td><td>150</td></tr>
<tr><td>Discharge Limits</td><td colspan="2">Continuous Discharge (at anchor)</td></tr>
<tr><td></td><td>BW & GW</td><td>BW & GW</td></tr>
<tr><td>Fecal Coliform/100 ml</td><td rowspan="3">Refers to Fed Law</td><td>Geometric Mean of 20</td></tr>
<tr><td>Chlorine (mg/l)</td><td>10</td></tr>
<tr><td>Total Suspended Solids (mg/l)</td><td>30</td></tr>
</table>

1.6. Science Advisory Panel

During the ACSI, a Science Advisory Panel was organized to independently address the scientific questions surrounding the impact of cruise ship waste in Alaska. The Science Advisory Panel is a group of scientists and engineers whose work and conclusions are not subject to government or industry approval. The nine core members of the Panel include an oceanography professor, NOAA physical oceanographer, ADEC environmental engineer, civil engineering professor, oceanographer for a law firm, microbiologist, NOAA senior staff scientist, chemistry professor, and an EPA senior toxicologist. While Panel members were not compensated, a paid facilitator, who is a retired U.S. Coast Guard Captain-of-the-Port and industrial toxicologist, supported the Panel's work.

[20] AS 46.03.490

[21] Small ship owners/operators may obtain an extension of time for compliance with AS 46.03.463(a) - (d) by submitting an approved plan for interim protective measures. See 18 AAC 69.045 for details.

The North West Cruiseship Association funded the facilitator and travel expenses for non-governmental panel members in 2000 - 2001. ADEC funded the facilitator and travel expenses for non-governmental panel members in 2002. The efforts of the Science Advisory Panel culminated in the publication of *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters*[22] in November 2002 and several other papers available on the following website: http://www.state.ak.us/dec/press/cruise/documents/sciencepanel.htm Science Advisory Panel work is referenced throughout this report.

[22] http://www.state.ak.us/dec/press/cruise/documents/impactcruise.htm

2. WASTEWATER SAMPLING DESIGN, RATIONALE, and STATISTICS

2.1. Data Reliability and Representative Nature

It is crucial that wastewater sample data is reliable[23] and representative.[24] This data is used to determine compliance with the cruise ship laws and to conduct scientific analysis. Large vessels that discharge in Alaska take at least two compliance samples per cruise ship season to satisfy both state and federal cruise ship laws. ADEC, U.S. Coast Guard, and the Northwest Cruiseship Association have established a Quality Assurance/Quality Control (QAQC) plan that ensures that the sample results are reliable.[25]

The QAQC plan includes standard sampling and laboratory quality control elements with additional instructions tailored to a maritime facility. It lists all the pollutants to be tested and the EPA analytical methods to be used. The QAQC requirements include duplicate sampling, sampling audits, and a lab technical systems audit. The U.S. Coast Guard cruise ship regulations require third party sampling. ADEC regulations are consistent with other state wastewater programs and allow industry to collect samples using their own staff. However, large cruise ships sample to satisfy the requirements of both the federal and state law. Therefore, a third party sampler takes all required large vessel wastewater samples. Small ship operators are not bound by the federal law but have also chosen to use third party samplers.

ADEC also performs independent compliance sampling and analysis. ADEC tests for pollutants listed in the QAQC plan as well as other pollutants of concern.

Because each ship is configured differently and follows unique wastewater management practices, the state also requires the owner/operator to submit a vessel specific sampling plan (VSSP). The VSSP plan, approved by ADEC before sampling begins, must demonstrate that the sample will be representative of the wastewater discharged from the particular ship.

From 2001 through 2002, wastewater sampling on large cruise ships was dictated by the ability to discharge underway and to get the samples to the laboratory within the EPA mandated six hour holding time for fecal coliform analysis. This frequently meant that wastewater samples were taken in the middle of the night when the volume of wastewater was low. The ideal wastewater sample would have been taken during daytime when the volume of wastewater production was high. These samples did not sample the treatment abilities at normal flow conditions and therefore are not representative. By 2003, only large cruise ships with advanced wastewater treatment systems discharged wastewater in Alaska. These vessels were approved for continuous discharge and were sampled during the day in port while the vessel was discharging into receiving water. These continuous discharge samples should be representative of the wastewater effluent produced by the wastewater treatment systems and discharged into receiving water.

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[23] Reliability reflects the degree of certainty.

[24] The objective of representative sampling is to ensure a sample or group of samples accurately characterizes site conditions. ASTM Method 6044-96 Standard Guide for Representative Sampling for Management of Wastes and Contaminated Media. http://www.astm.org/cgi-bin/SoftCart.exe/DATABASE.CART/PAGES/D6044.htm?L+mystore+nhpu4885

[25] The most current version, "Northwest CruiseShip Association, Discharge of Effluents in Certain Alaska Waters by Cruise Vessel Operations, 2003 Operating Season Quality Assurance/Quality Control Plan For Sampling and Analysis of Treated Sewage and Graywater From Commercial Passenger Vessels," is available at: http://www.state.ak.us/dec/press/cruise/pdf/03qaqc.pdf

Small cruise ships are sampled in port because of the economic hardship it would cause if third party samplers traveled with the vessels. The time spent in Juneau, where small cruise ships do their wastewater sampling, is often used to disembark passengers and to get ready for the next cruise. There is usually little to no wastewater produced during this day. State cruise ship regulations[26] effective November 2002 gave small ships the ability to have their crew sample their wastewater and submit it to a laboratory for analysis. This would enable underway sampling; however, none of the ships have exercised this option. Despite these issues, the data obtained over the last three seasons, when considered in its entirety, does provide a reasonable picture of the pollutants that are present in small cruise ship wastewater discharges.

Alaska Marine Highway System ferries were usually sampled in port; however, there were usually passengers still aboard the vessel. The wastewater samples from the ferries were therefore representative of the wastewater effluent produced by its wastewater treatment system.

2.2. Sampling Program Evolution from 2000 - 2003

The sampling strategy that guided the voluntary sampling program in 2000 differs from the regulatory program existing today. Table 3 and Table 4 highlight the evolution of the sampling program. The pollutants with asterisks are defined as conventional pollutants in 40 CFR Part 401.16 and are typically tested in the effluent of wastewater treatment plants. On the advice of the Science Advisory Panel, ADEC expanded this sampling list. This group is referred to as conventional pollutants throughout this report. Priority pollutants refer to an EPA list of 126 specific pollutants that include heavy metals and specific organic chemicals.

Table 3. Conventional Pollutants

Pollutant	2000	2001	2002	2003
Ammonia	√	√	√	√
pH*	√	√	√	√
Biochemical Oxygen Demand (BOD)*	√	√	√	√
Chemical Oxygen Demand (COD)	√	√	√	√
Total Suspended Solids (TSS)*	√	√	√	√
Total and Free Chlorine	√	√	√	√
Fecal Coliform*	√	√	√	√
Settleable Solids		√	√	√
Oil and Grease*		√	√	√
Total Organic Carbon (TOC)		√	√	√
Conductivity		√	√	√
Alkalinity		√	√	√
Total Nitrogen[27]		√	√	√

[26] 18 AAC 69, http://www.state.ak.us/dec/title18/wpfiles/69mas.pdf

[27] Total nitrogen includes ammonia, nitrate, nitrite, and total kjeldahl nitrogen (TKN).

Pollutant	**2000**	**2001**	**2002**	**2003**
Total Phosphorus		√	√	√

Table 4. Priority Pollutants

Pollutant	2000	2001	2002	2003
Base, Neutral, Acids (BNAs)	√	√	√	√
Pesticides[28]	√			
Polychlorinated Biphenyls (PCBs)	√	√	√	
Volatile Organic Chemicals (VOC)	√	√	√	√
Trace Metals	√	√	√	√
Cyanide	√			

2000 Season's Voluntary Program

The voluntary ACSI program in 2000 applied to large ships only. The goals of the 2000 sampling program were to characterize wastewater quality and to determine if hazardous substances were discharged to receiving water through the wastewater systems. The voluntary program included two samples per season.

2001 Season - Moving from Voluntary Sampling to Compliance Sampling

In 2001, the purpose of the sampling shifted to assess compliance with the laws as well as conducting scientific impact analyses. All ships discharging in Alaska water are required by Alaska statute[29] to sample twice a year. On the advice of the Science Advisory Panel, ADEC increased conventional pollutants monitoring requirements. The pesticides and their metabolites on the 2000 priority pollutant list[30] have not been used in the U.S. for many years and were not detected in any of the 2000 samples. The U.S. Coast Guard and ADEC therefore removed pesticides from the priority pollutant list in 2001.

2002 Season

The sampling strategy for the majority of the large ships was the same as in 2001. However, six of seven large ships, with advanced wastewater treatment systems, had U.S. Coast Guard approval for continuous discharge and were sampled in port.[31] Small ships took their first priority pollutant samples in 2002 and began sampling for the expanded list of conventional pollutants.

[28] aldrin, chlordane, dieldrin, 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, alpha endosulfan, beta endosulfan, endosulfan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, alpha BHC, beta BHC, gamma BHC, delta BHC and toxaphene

[29] AS 46.03.465(d)

[30]

[31] The following ships had advanced wastewater treatment systems that were approved for continuous discharge by the U.S. Coast Guard: Celebrity *Mercury* and Holland America *Ryndam, Statendam, Volendam, Veendam,* and *Zaandam.* The Radisson *Seven Seas Mariner* had an advanced system, but it was not approved for continuous discharge.

2003 Season

In 2003, the wastewater data from large ships reflected the continued increase in the number of large vessels with advanced treatment technology, from seven of 25 (28%) in 2002 to eighteen[32] of 32 (56%) in 2003. Small vessels continued to discharge and be sampled in port.

As in previous years, one of the two sampling events included testing for priority pollutants. ADEC and U.S. Coast Guard dropped PCBs from the priority pollutant sampling list for 2003 season because of the 2000 - 2002 history of non-detects. The priority pollutants (Base/Neutrals & Acids, Volatile Organic Chemicals, and Trace Metals) analyzed in 2003 are listed in Appendix A.

At the recommendation of the Science Panel, ADEC also tested vessel wastewater for commonly used organophosphorus pesticides at the end of 2003 season. No pesticides were detected. ADEC will continue to test for organophosphorus during the 2004 cruise ship season.

[32] Princess - *Star Princess, Sun Princes, Dawn Princess, Coral Princess, Pacific Princess, Island Princess*
Celebrity - *Mercury*
Holland America – *Ryndam, Statendam, Maasdam, Volendam, Veendam, Zaandam*
Carnival – Carnival *Spiri*t (graywater only)
Norwegian – *Norwegian Sun, Norwegian Sky, Norwegian Wind*
Radisson - *Seven Seas Mariner*

3. APPLYING ALASKA WATER QUALITY STANDARDS TO RECEIVING WATER

The State of Alaska has Water Quality Standards adopted in regulation. These standards help protect human health and the environment. ADEC tested for pollutants in samples taken at the discharge point inside the vessel. These effluent samples are also referred to as "end of pipe" samples. Discharges from the ship mix with the receiving water. ADEC, therefore, applied modeled dilution factors to the vessels' end of pipe sample results to determine whether Water Quality Standards were met in receiving waters.

In this document, ADEC refers to the Water Quality Standards located in *ALASKA WATER QUALITY CRITERIA MANUAL FOR TOXIC AND OTHER DELETERIOUS ORGANIC AND INORGANIC SUBSTANCES* amended through May 15, 2003, TABLE IV. AQUATIC LIFE CRITERIA FOR MARINE WATERS.[33] ADEC took a conservative approach and applied the more stringent chronic rather than acute water quality standards.

[33] This document is available at http://www.state.ak.us/dec/dawq/wqs/documents/70wqsmanual.doc

4. WASTEWATER CHARACTERISTICS – LARGE SHIPS

4.1. Statistics

Since 2000, ADEC has collected substantial amounts of wastewater sampling data on cruise ships and ferries subject to the Commercial Passenger Vessel Environmental Compliance Program. In order to characterize the central tendency of the large quantity of data, the median was used. The median is the middle of a distribution: half the scores are above the median and half are below the median. The median is less sensitive to extreme scores than an average and is thus a better measure for skewed distributions. Medians are used to present all pollutant data in this report except for fecal coliform. Much of the fecal coliform data was highly skewed so a geometric mean was used to summarize this data.

Geometric Mean

When distributions are more highly skewed, a geometric mean is used. A geometric mean moderates the effect of a single high value. A geometric mean is computed as follows:

$(X_1X_2..X_n)^{1/n}$ =

Example:

$(1 \times 2 \times 10 \times 10{,}000)^{1/4} = 21$

4.2. Summary of Conventional Pollutant Data

2000 Sampling Data

Table 5 compares the median and geometric mean values of conventional pollutants tested in 2000 wastewater samples. Appendix B Large Ship Sampling Data presents the detailed sampling results from individual ships. Table 5 and subsequent tables also present the applicable Alaska Water Quality Standards[34] for comparison.

[34] ADEC, Alaska Water Quality Criteria Manual For Toxic and other Deleterious Organic & Inorganic Substances May 15, 2003, Table IV located at: http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/wqs/documents/70wqsmanual.doc. Fecal coliform standards and pH standards from ADEC Water Quality Standards, 18 AAC 70, http://www.state.ak.us/dec/title18/wpfiles/70mas.pdf. The most conservative standard is listed.

Table 5. 2000 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

Water Type (# samples) Large Ship Appendix B Table #	Collected from	Fecal Coliform (MPN/100 ml)	TSS mg/l	BOD mg/l	COD mg/l	Ammonia mg/l	pH	Total Cl mg/l	Free Cl mg/l
	AK WQS	14	n/a	n/a	n/a	17.00[35]	6.5-8.5	0.0075*	0.0075*
	MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
GW - Accommodations. & Laundry (3) Table 51.	CT	6	138.7	61	240.0	25.12	6.8	0.37	0.26
GW – Accommodations (3) Table 52.	CT	104	455.0	355	1,340.0	24.94	8.4	0.78	ND
GW - Laundry (10) Table 53.	CT	8	39.0	86	300.0	0.39	9.2	0.28	ND
GW – Galley (11) Table 54.	CT	13,750	223.5	850	940.0	2.19	6.9	ND	ND
Mixed GW (24) Table 55.	CT	118,052	92.0	170	405.0	1.40	6.8	ND	ND
Mixed GW (13) Table 56.	DB	1,163,188	250.0	450	940	0.20	5.95	ND	ND
BW&GW (11) Table 60.	DB	12,824	110.0	130	395.0	8.50	7.0	ND	ND
BW (22) Table 61.	MSD	18,213	407.0	130	1,210.0	100.00	7.6	0.33	ND

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater
CT= Collecting Tank DB =Double Bottom Tank
MSD = Marine Sanitation Device ND= Non Detect
*Note that the MDL for chlorine is higher than the chronic water quality standard.

The graywater sampled from accommodations & laundry, accommodations only, and laundry only had low fecal coliform counts. Galley graywater and mixed graywater had very high levels of fecal coliforms. Graywater sampled from double bottom tanks had higher fecal coliform results than the corresponding wastewater type sampled from collecting tanks. This is illustrated in Table 7.

[35] The ammonia Water Quality Standard is for unionized ammonia. All samples were analyzed for total ammonia. Salinity, temperature, and pH affect the unionized portion of total ammonia. ADEC used TABLE IX. TOTAL AMMONIA CHRONIC CRITERIA FOR SALTWATER AQUATIC LIFE to calculate the total ammonia that corresponds to the unionized ammonia Water Quality Standard. Southeast Alaska port conditions were used for this calculation: 10 psu salinity; pH of 7.0; and temperature of 12.5 degrees Celsius. Using these ambient conditions, the total ammonia equivalency to the unionized Water Quality Standard is 17 mg/L.

The treated blackwater results included two samples that had been treated with a reverse osmosis treatment system before being stored in the double bottom tank. These samples had results below the limit of detection for fecal coliforms, which lowered the geometric mean substantially. Even with the addition of these two samples, the treated blackwater had a high geometric mean of fecal coliform, 18,213 MPN/100ml, as well as a high median of ammonia, 100.0 mg/l, and COD, 1,210.0 mg/l. These results indicate that the blackwater treatment systems were not functioning properly.

2001 Sampling Data

The state cruise ship law was effective in the summer of 2001. From this year forward, blackwater samples were taken primarily to ensure compliance with effluent standards. (When blackwater and graywater are mixed, it is considered blackwater.) Graywater was phased into the state program. Any graywater discharged in the state needed to be sampled as of 2001 but was not subject to the effluent standards until 2003. This is the cause of the disparity between the graywater effluent samples and the blackwater effluent samples presented in Table 6.

The low fecal coliform and TSS level of the mixed black and graywater occurred because 12 of the 16 samples were taken from advanced wastewater treatment systems on the Celebrity *Mercury* and Holland America *Statendam*. No fecal coliforms or TSS were detected in the effluent from those systems. The other ship that sampled its mixed black and graywater discharged outside Alaska water and was sampled voluntarily.

Table 6. 2001 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

Water Type (# samples) Large Ship Appendix B Table #	Collected from	Fecal Coliform (MPN/ 100 ml)	TSS mg/l	BOD mg/l	COD mg/l	Ammonia mg/L	pH	Total Cl mg/L	Free Cl mg/l
	AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075*	0.0075*
	MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
GW – Accommodations (15) Table 32.	DB	10,896	66.0	217	460.0	0.11	6.8	ND	ND
GW – Accommodations (15) Table 33.	CT	2,189	55.5	170	300.0	0.99	7.6	3.00	0.30
GW - Galley (10) Table 34.	DB	784,072	383.0	1,300	1,707.0	0.65	4.4	ND	ND
GW – Galley (23) Table 35.	CT	402**	266.0	740	1,410.0	1.00	7.0	4.00	1.30
Mixed GW (4) Table 36.	DB	649,994	151.3	194	289.0	0.32	6.5	ND	ND
Mixed GW (13) Table 37.	CT	38,933	76.5	220	520.0	0.48	7.2	ND	ND
GW - Laundry (7) Table 38.	DB	651,460	43.0	160	410.0	0.40	8.3	0.20	ND
GW - Laundry (2) Table 39.	CT	30	22.0	100	650.0	Not taken	8.4	1.03	1.03
Mixed BW&GW (16) Table 46.	MSD	2	0.7	3	11.5	0.63	7.1	ND	ND

*Note that the MDL for chlorine is higher than the chronic water quality standard.

** Some samples did not meet the fecal coliform 6 hour holding time and were not analyzed.

Water Type (# samples) Large Ship Appendix B Table #	Alkalinity mg/l	Conductivity (Umhos/cm	Oil &Grease mg/l	Phosphorous Total mg/l	Nitrate as N mg/l	TOC mg/l	Total Kjeldahl Nitrogen mg/l	Settleable Solids mg/l
AK WQS								
MDL	0.5	1	1.5	0.01	1.0	1.0	1.0	0.1
GW (15) Table 40.	59.6	883	47.0	5.54	0.0	305.0	12.0	0.2
BW (5) Table 47.	125.4	3,590	0.2	9.05	0.6	100.0	27.8	4.5

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater
CT= Collecting Tank DB =Double Bottom Tank
MSD = Marine Sanitation Device ND= Non Detect

Table 7 compares 2000 and 2001 samples of wastewater that were held for up to 20 hours in double bottom (DB) tanks with wastewater collected and discharged immediately from collecting tanks (CT). The concentration of fecal coliform, TSS, and BOD increased when wastewater was stored in the double bottom tanks indicating a degradation of the effluent quality.

Table 7. Comparison of 2000 and 2001 Large Ship Wastewater Samples Held in Double Bottom vs. Collecting Tanks

# Samples	Sample Date	Sample From	Waste Type	Fecal[36]	TSS	BOD	COD	Ammonia	pH	Total Cl	Free Cl
			Units	MPN/100ml	mg/l	mg/l	mg/l	mg/l			mg/l
			AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075	0.0075
			MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
13	2000	DB	Mixed Graywater	1,163,188	250.0	450	940	0.20	5.95	ND	ND
15	2001	DB	GW accommodation	10,896	66.0	217	460.0	0.11	6.8	ND	ND
10	2001	DB	GW Galley	784,072	383.0	1,300	1,707.0	0.65	4.4	ND	ND
4	2001	DB	Mixed GW	649,994	151.3	194	289.0	0.32	6.5	ND	ND
7	2001	DB	GW laundry	651,460	43.0	160	410.0	0.40	8.3	0.20	ND
11	2000	DB	BW&GW	12,824	110.0	130	395.0	8.50	7.0	ND	ND
3	2000	CT	GW Accommodation and Laundry	6	138.7	61	240.0	25.12	6.8	0.37	0.26
3	2000	CT	GW accommodation	104	455.0	355	1,340.00	24.94	8.4	0.78	ND
10	2000	CT	GW laundry	8	39.0	86	300.0	0.39	9.2	0.28	ND
11	2000	CT	GW galley	13,750	223.5	850	940.0	2.19	6.9	ND	ND
24	2000	CT	Mixed GW	118,052	92.0	170	405.0	1.40	6.8	ND	ND
15	2001	CT	GW Accommodation	2,189	55.5	170	300.0	0.99	7.6	3.00	0.30
23	2001	CT	GW Galley	402	266.0	740	1,410.0	1.00	7.0	4.00	1.30
13	2001	CT	Mixed GW	38,933	76.5	220	520.0	0.48	7.2	ND	ND
2	2001	CT	GW laundry	30	22.0	100	650.0	Not taken	8.4	1.03	1.03
			Median DB	**194,343**	**130.7**	**206**	**435.0**	**0.36**	**6.7**	**ND**	**ND**
			Median CT	**587**	**92.0**	**170**	**520.0**	**1.20**	**7.2**	**.37**	**ND**

2002 Sampling Data

In 2002, the graywater from large ships was still exempt from the fecal coliform and total suspended solids standards. The graywater effluent quality that year was still quite poor. The median and geometric mean values of both the 2002 graywater and blackwater are presented in Table 8.

[36] This value is geometric mean not median.

Table 8. 2002 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

Water Type (# samples) Large Ship Appendix B Table #	Collected from	Fecal Coliform (MPN/100 ml)	TSS mg/l	BOD mg/l	COD mg/l	Ammonia mg/L	pH	Total Cl mg/l	Free Cl mg/l
	AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075*	0.0075*
	MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
GW - Galley (7) Table 21.	DB or CT	6,279	1,320.0	2,790	5,110.0	2.66	4.11	ND	ND
GW - Accom & Laundry (12) Table 23.	DB or CT	47,357	130.5	367	615.0	1.07	6.72	ND	ND
Mixed GW (19) Table 25.	CT or DB	38,603	190.0	328	621.0	1.00	6.14	ND	ND
BW (21) Table 15.	Various	5	0.1	3	61.6	18.80	7.5	ND	ND

Water Type (# samples) Large Ship Appendix B Table #	Collected From	Alkalinity mg/l	Conductivity (Umhos/cm	Oil &Grease mg/l	Phosphorous Total mg/l	Nitrate as N mg/l	TKN mg/L	TOC mg/l	Settleable Solids mg/l
	AK WQS								
	MDL	0.5	1	1.5	0.01	1.0	1.0	1.0	0.1
GW - Galley (7) Table 22.	DB or CT	0.25	1,810	520.0	14.10	0.2	0.2	1,600.0	44.0
Accom. & Laundry (12) Table 24.	DB or CT	73.5	5,090	140.0	5.50	0.2	0.2	209.5	0.1
Mixed GW (19) Table 26.	CT or DB	53.4	1,920	95.0	3.99	0.2	0.2	162.5	0.5
BW (21) Table 15.	DB, CT, or MSD	135.0	685	0.9	3.21	0.1	0.1	23.0	0.1

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater
CT= Collecting Tank DB =Double Bottom Tank
MSD = Marine Sanitation Device ND= Non Detect
*Note that the MDL for chlorine is higher than the chronic water quality standard.

Galley graywater showed lower levels of fecal coliform bacteria than the accommodations or mixed graywater but the levels of BOD, COD, and TSS are much higher. Galley graywater is a more complex wastewater to treat than laundry or domestic wastewater because of the high amount of oil, grease, and solids.

The conventional pollutant results for blackwater were much lower than the graywater results with the exception of a high ammonia median of 18.80 mg/l. The seven ships that discharged blackwater in Alaska had advanced wastewater treatment systems,[37] which resulted in a low fecal coliform geometric mean of 5 MPN/100ml and median TSS of 0.1 mg/L.

2003 Sampling Data

In 2003, large cruise ship graywater and blackwater were subject to the fecal coliform and total suspended solids standards. The median and geometric mean values of pollutants detected in graywater and blackwater are presented in Table 9.

[37] The following ships had advanced wastewater treatment systems that were approved for continuous discharge by the U.S. Coast Guard: Celebrity *Mercury* and Holland America *Ryndam, Statendam, Volendam, Veendam,* and *Zaandam.* The Radisson *Seven Seas Mariner* had an advanced system, but it was not approved for continuous discharge.

Table 9. 2003 Large Ship Conventional Pollutant Data

The values for all pollutants, except fecal coliforms, are medians. Fecal coliform information is represented as a geometric mean.

Water Type (# samples) Large Ship Appendix B Table #	Fecal Coliform (MPN/100 ml)	TSS mg/l	BOD mg/l	COD mg/l	Ammonia mg/l	pH	Total Cl mg/l	Free Cl mg/l
AK WQS	14	n/a	n/a	n/a	17.00	6.5-8.5	0.0075*	0.0075*
MDL	2	1.3	2	3.0	0.03	0.1	0.10	0.10
Graywater (3) Table 3.	7	0.0	23	67.0	1.30	7.3	ND	ND
Blackwater (57) Table 1.	1	0.0	4	72.0	25.10	7.4	ND	ND

Water Type (# samples) Large Ship Appendix B Table #	Alkalinity mg/l	Conductivity (Umhos/cm	Oil &Grease mg/l	Phosphorous Total mg/l	Nitrate as N mg/l	TOC mg/l	Total Kjeldahl Nitrogen mg/l	Settleable Solids mg/l
AK WQS								
MDL	0.5	1	1.5	0.01	1.0	1.0	1.0	0.1
Graywater (3) Table 4.	34.1	199	6.2	0.23	0.0	12.7	4.8	0.0
Blackwater (57) Table 2.	219.5	987	0.0	3.60	0.0	19.4	29.0	0.0

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater

CT= Collecting Tank DB =Double Bottom Tank

MSD = Marine Sanitation Device ND= Non Detect

*Note that the MDL for chlorine is higher than the chronic water quality standard.

Only one ship, the Carnival *Spirit*, discharged graywater in Alaska. The graywater from this ship was treated through a reverse osmosis advanced wastewater treatment system. This was the cause of the dramatic improvement in the 2003 graywater quality. It should be noted, however, that the COD level was still high.

In 2003, the number of ships with advanced wastewater treatment systems increased to 18.[38] These ships discharged their wastewater in Alaska. Most of these ships mixed their graywater

[38] Princess - *Star Princess, Sun Princes, Dawn Princess, Coral Princess, Pacific Princess, Island Princess*
Celebrity - *Mercury*
Holland America – *Ryndam, Statendam, Maasdam, Volendam, Veendam, Zaandam*
Carnival – Carnival *Spirit* (graywater only)
Norwegian – *Norwegian Sun, Norwegian Sky, Norwegian Wind*
Radisson - *Seven Seas Mariner*

and blackwater together resulting in blackwater. The blackwater effluent was of high quality but still had elevated levels of ammonia and COD.

4.3. Pollutants in Effluent that Exceed Alaska Water Quality Standards

The medians of most pollutants in effluent were below Alaska Water Quality Standards. Table 10 draws upon Table 5 – 9 for conventional pollutants and Appendix C. Summary of Large Ship Sampling for Priority Pollutants to highlight the medians that do not meet Alaska Water Quality Standards at the end of pipe. A shaded cell indicates that the concentration in effluent was below the standard.

Table 10. End of Pipe - Large Ship Pollutant Medians that Do Not Meet Alaska Water Quality Standards

			Blackwater				Graywater			
Pollutant	**Units**	**AWQS**	**2003**	**2002**	**2001**	**2000**	**2003**	**2002**	**2001**	**2000**
Ammonia	mg/l	17.00	25.10	18.80		100.00				25.12
Free Chlorine	mg/l	0.0075							1.30	0.26
Fecal Coliform	MPN/100 ml	14.0				18,213		47,357	784,072	1,163,188
Copper, dissolved	ug/l	3.1	10.70	7.72	133.85	225.00		31.65	255	31.01
Nickel, dissolved	ug/l	8.2	12.60	16.70	20.50			12.70	15.0	
Zinc, dissolved	ug/l	81.0	109.5	195.5	169.5	425.0		262.0	270.0	

Note: Fecal coliform information is a geometric mean.

4.4. Pollutants that Exceed Alaska Water Quality Standards in Receiving Water

The Science Advisory Panel concluded in their November 2002 *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters* report that even the wastewater discharged in 2000 from vessels moving at a minimum of 6 knots, 1 mile from shore, met Alaska Water Quality Standards in the receiving water.[39] For large ships, this is due to a minimum underway dilution factor of 50,000.[40]

ADEC therefore focused on the impact that cruise ship wastewater effluent has on the receiving waters during stationary discharge. ADEC modeled the dilution of large cruise ship effluent during stationary discharge during a very conservative scenario, a neap tide[41] in Skagway, using the EPA approved Visual Plumes model and information provided by operators in their Vessel Specific Sampling Plans. ADEC calculated a dilution factor for each ship's discharge. (More detailed information on the model used to calculate the dilution factor is included in Appendix D. Cruise Ship Stationary Discharge Modeling.) The lowest dilution factor calculated by the model was 8 for blackwater and 5 for graywater. The concentration of a pollutant in Table 10 was divided by these factors to arrive at the pollutant concentration that is expected in the receiving waters (Table 11). If the pollutant concentration met the Alaska Water Quality Standards in receiving water after applying the dilution factor, the cell is shaded.

Table 11. Modeled Large Ship Median Pollutant Concentrations in Receiving Waters during Stationary Discharge (Fecal coliform information is a geometric mean.)

			Blackwater				Graywater			
Pollutant	Units	AWQS	2003	2002	2001	2000	2003	2002	2001	2000
Free Chlorine	mg/l	0.0075							0.26	0.052
Fecal Coliform	MPN/100 ml	14.0				2,276.63		9,471	156,814	232,638
Copper, dissolved	ug/l	3.1			16.73	28.13		6.33	51.0	6.2

Of the many (176) pollutants that were tested in effluent during 2003, none are expected to exceed Alaska Water Quality Standards in the receiving water during stationary discharge.

4.5. Whole Effluent Toxicity Testing

Whole Effluent Toxicity (WET) testing is an alternative to directly analyzing environmental samples for individual constituents. WET testing addresses the effect that simultaneous exposure to a mixture of pollutants has on an organism.

There are two ways to perform the WET test: static non-renewal and static renewal. In a static non-renewal test, organisms are exposed to a single portion of the solution for the duration of the

[39] Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters", November 2002 http://www.state.ak.us/dec/press/cruise/documents/impact/executivesummary.htm

[40] Large Cruise Ship Dilution factor = 4 x (ship width x ship draft x ship speed)/(volume discharge rate)4x (30 m x 8 m x 3.10 m sec-1)/(0.06 m3sec-1) ≈ 50,000

[41] A tide of minimum range occurring at the first and the third quarters of the moon.

test. In a static renewal test, organisms are exposed to fresh changes of the test water every day. This testing method is more conservative because the organisms are exposed to the effluent at the same strength for a longer time period. ADEC conducted WET testing using the static renewal method on commercial passenger vessels in 2002[42] and again in 2003.[43]

2002 Testing

This test was designed to simulate exposure to the concentration of pollutants that could be found in the receiving waters behind a moving cruise ship. Because of the high dilution rates associated with moving cruise ships, the dilution series started at 50% effluent and increased by a factor of 10 such that the percent effluent progressively decreased. The concentrations tested were 50%, 5%, 0.5%, 0.05%, 0.005%, and 0.0005% effluent. The dilution series represented concentrations that are attained in receiving waters with dilution factors (df) of 2, 20, 200, 2,000, 20,000, and 200,000. A typical large cruise ship discharging 200 cubic meters per hour while traveling at 6 knots (11 km/hour) would have a dilution factor of about 50,000.[44]

WET results are presented in Table 12. The percentages represent the highest effluent concentration at which the tests exhibited no observable acute or chronic effects. Values in parentheses show dilution factors associated with the no observed effect concentrations (NOEC).

Table 12. Large Ship 2002 No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC	Echinoderm Fertilization NOEC
Dawn Princess Graywater	Chlorine added to collection tanks	5% (df=20)	5% (df=20)	0.5% (df=200)	0.5% (df=200)
Mercury Mixed Effluent	Reverse Osmosis	50% (df=2)	50% (df=2)	50% (df=2)	50% (df=2)
Volendam Mixed Effluent	Aerated Membrane (Ultrafiltration)	50% (df=2)	5% (df=20)	5% (df=20)	5% (df=20)

The *Dawn Princess* graywater demonstrated some effect at 50% concentration (one part sea water to one part wastewater) in the acute test and some effect at 5% wastewater concentration in the chronic tests. This limited toxicity occurred despite the fact that no residual chlorine was found in the sample. However, the ammonia concentration was 10 mg/L. Samples from the *Mercury* did not demonstrate any toxicity, even at a 1:2 dilution. The *Volendam* sample demonstrated an effect at 50% for the Topsmelt acute test and on both chronic test species but had no effect on the Mysid acute test with as little as a 1:2 dilution.

[42] Science Advisory Panel "Review and Comment Regarding Whole Effluent Toxicity Test Results for Five Commercial Passenger Vessels in Alaska July 2002" http://www.state.ak.us/dec/press/cruise/documents/wetfinal.htm and "Lab results for Whole Effluent Toxicity test (WET) – August 2002" http://www.state.ak.us/dec/press/cruise/documents/wetreport.htm

[43] ADEC "2003 Whole Effluent Toxicity Results for Commercial Passenger Vessels in Alaska" http://www.state.ak.us/dec/press/cruise/documents/wet/2003%20Whole%20Effluent%20Toxicity%20(WET)%20Test%20Discussion.pdf

[44] The Panel has developed a formula for predicting dilution/dispersion in the wake of large cruise ships.
Dilution factor = 4 x (ship width x ship draft x ship speed)/(volume discharge rate)

The observed WET values would not be of concern during underway discharge because dilution factors of greater than 1:200 would be easily achieved in the receiving water. During 2002, *Dawn Princess* discharged its graywater underway a minimum one nautical mile from shore going at least 6 knots. The vessel held its blackwater until it was outside Alaska waters. As of 2003, this vessel mixes its accommodations graywater with its blackwater and then treats it through an advanced wastewater treatment system that meets the stringent standards for continuous discharge. (See Table 2.) Wastewater from the *Mercury* and *Volendam* continue to be discharged in port. *Mercury* effluent is diluted by a factor of 18 and *Volendam* effluent is diluted by a factor of 60, even during stationary discharge during a neap tide. (See Appendix D. Cruise Ship Stationary Discharge Modeling Table 4.) Therefore, the effluent from these three ships is not expected to cause toxicity to marine organisms.

2003 Testing

From the period of June through September 2003, ADEC conducted WET testing on the following large vessels: *Norwegian Wind, Sun Princess, Carnival Spirit,* and *Ryndam*. These ships represented all four of the advanced treatment systems operated on cruise ships in Alaska. These large vessels had obtained U.S. Coast Guard certification to discharge wastewater any time anywhere, including in port.

ADEC designed the 2003 WET test to determine if there are any negative effects to the marine environment during stationary discharges when dilution factor will be low. Therefore, the dilution series only increased by a factor of 2 instead of 10. The dilution series was 50%, 25%, 12.5%, 6.25%, 3.125%, and 1.5% effluent. This series represented concentrations that are attained in receiving waters with dilution factors (df) of 2, 4, 8, 16, 32, and 66.7.

ADEC calculated the ship specific dilution factors during a worst case scenario, a stationary discharge during a neap tide in Skagway, using the Visual Plumes model.[45] (See Appendix D. Cruise Ship Stationary Discharge Modeling.) When the ship specific dilution factor calculated by the Visual Plumes model is greater than the No Observed Effect Concentration dilution factor (df), no toxicity is expected.

[45] ADEC used the Visual Plumes mode UM3 with the Brooks far field solution. For more information on this model go to http://www.epa.gov/ceampubl/swater/vplume/

Table 13. Large Ship 2003 Whole Effluent Toxicity Test Results & Ship Specific Dilution Factor during Neap Tide

No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Ship Specific Dilution Factor from Visual Plumes model	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC		Echinoderm Fertilization NOEC
					Normality[46]	Survival	
Norwegian Wind Mixed Effluent	Scanship Bioreactor/ultra-filtration	24	>50% (df=2)	12.5% (df=8)	6.25% (df=16)	50% (df=2)	25% (df=4)
Ryndam Mixed Effluent	Aerated Membrane (Ultrafiltration)	60	>50% (df=2)	50% (df=2)	12.5% (df=8)	50% (df=2)	50% (df=2)
Sun Princess Mixed Effluent	Hamworthy Bioreactor and Ultrafiltration	15	12.5% (df=8)	12.5% (df=8)	<1.5%[47] (unknown)	50% (df=2)	<1.5% (unknown)
Spirit Graywater	Reverse Osmosis	5	>50% (df=2)	50% (df=2)	25% (df=4)	50% (df=2)	Unable to run[48]

These results indicate that **large ships' wastewater effluent will not cause toxicity in receiving waters, even during periods of minimal tidal flux**.

4.6. Summary of Large Ship Data 2000 – 2003

Wastewater production volumes depend primarily on the number of passengers and crew on a vessel. The volumes are also affected by ship waste management practices and configuration. The average large cruise ship with 2,500 people (including crew) produces 800 cubic meters or 211,200 gallons of wastewater per day. Between 90-95% of that wastewater is graywater.

Before the passage of the state cruise ship law, blackwater and/or graywater from large cruise ship samples taken at the end of pipe did not meet Alaska Water Quality Standards for ammonia, free chlorine, fecal coliform, copper, and zinc (Table 10). Wastewater effluent is diluted by a small factor during stationary discharge. If large ships discharged while stationary, the Water Quality Standards would have been exceeded for free chlorine, fecal coliform, and copper in the receiving water. However due to substantial dilution, all Alaska Water Quality Standards, except fecal coliform, were met in the receiving water while ships discharged underway.

The state cruise ship law, effective in July 2001, allowed large cruise ships to seek interim protective measures that extended the time for compliance with the graywater standards until

[46] Normality measures the normal development of the bivalve larvae.
[47] S. propuratus gametes is not a bivalve but was substituted because the mussels and oysters would not spawn due to elevated summer temperatures.
[48] The organisms were not available when the sample arrived in September.

January 1, 2003.[49] All ships that discharged graywater in state water from 2000 through 2002 sought and were granted this extension. Under the interim protective measures, the ships could only discharge graywater while underway. In contrast, the blackwater discharged from large ships was subject to the state effluent standards in July 2001. This is the cause of the drastic difference in the effluent quality of the gray and blackwater until 2003 when the standards applied to both wastewater types.

In 2001, the data reflect that 21 of the 24 large ships stopped discharging blackwater into Alaska water. The fecal coliform levels in blackwater fall drastically because the two ships[50] that continued to discharge blackwater in Alaska waters had advanced wastewater treatment technology. The other ship[51] treated blackwater through a traditional macerator chlorination system. The graywater results, especially the galley water, continued to indicate poor effluent quality.

The 2000 and 2001 data also indicate that holding water in double bottom tanks for later discharge increases the concentration of fecal coliform, TSS, and BOD. It is possible that the double bottom tanks were contaminated with blackwater and that fecal coliform multiplied in the warm holding environment.

In 2002, the overall quality of the graywater was still poor. Seven ships[52] had advanced wastewater treatment systems and discharged blackwater in Alaska. The blackwater quality was dramatically better than the graywater but still had elevated levels of ammonia.

In 2003, the only large ships that discharged wastewater in Alaska had advanced wastewater treatment systems. Most of these systems treated blackwater but one system treated graywater. Most tested pollutants met Water Quality Standards at the end of pipe without dilution. Even considering the minimal dilution that occurs during stationary discharge during a neap tide, the concentration of tested pollutants met all Alaska Water Quality Standards in receiving water. (See Table 11.)

The quality of large cruise ship wastewater reflected the continued increase in the number of vessels that installed advanced treatment technology, from two of 24 (8%) in 2001 to seven of 25 (28%) in 2002 to eighteen[53] of 32 (56%) in 2003.

Risk Characterization

[49] AS 46.03.463(c)
[50] Celebrity *Mercury* and Holland America *Statendam*
[51] Universe Explorer
[52] The following ships had advanced wastewater treatment systems that were approved for continuous discharge by the U.S. Coast Guard: Celebrity *Mercury* and Holland America Ryndam, Statendam, Volendam, Veendam, Zaandam. The Radisson *Seven Seas Mariner* had an advanced system, but it was not approved for continuous discharge.
[53] Princess - Star Princess, Sun Princes, Dawn Princess, Coral Princess, Pacific Princess, Island Princess
Celebrity - Mercury
Holland America – Ryndam, Statendam, Maasdam, Volendam, Veendam, Zaandam
Carnival – Carnival Spirit (graywater only)
Norwegian – Norwegian Sun, Norwegian Sky, Norwegian Wind
Radisson - Seven Seas Mariner

ADEC expects that only large cruise ships with advanced wastewater treatment systems will discharge wastewater in Alaska in the future. WET testing results and a comparison of sample results with Alaska Water Quality Standards indicate that the effluent from these advanced systems is not expected to cause toxicity to the marine environment. No human health risk is posed by the low concentration of tested pollutants found in wastewater samples.

The wastewater samples indicate that hazardous materials are not being discharged through these wastewater treatment systems.

5. WASTEWATER CHARACTERISTICS – SMALL SHIPS

5.1. Statistics

Since 2001, ADEC has collected substantial amounts of wastewater sampling data on cruise ships and ferries subject to the Commercial Passenger Vessel Environmental Compliance Program. In order to characterize the central tendency of the large quantity of data, the median was used. The median is the middle of a distribution: half the scores are above the median and half are below the median. The median is less sensitive to extreme scores than an average and is thus a better measure for skewed distributions. Medians are used to present all pollutant data in this report. Much of the fecal coliform data was highly skewed so a geometric mean was used to summarize this data.

Geometric Mean

When distributions are more highly skewed, a geometric mean is used. A geometric mean moderates the effect of a single high value. A geometric mean is computed as follows:

$(X_1X_2..X_n)^{1/n}$ =

Example:

$(1 \times 2 \times 10 \times 10{,}000)^{1/4} = 21$

5.2. Summary of Conventional Pollutant Data

There were only three small ship wastewater samples taken in 2000, too few to analyze. Only a short list of conventional pollutants was sampled during 2001. In 2002 and 2003, small ship wastewater samples were analyzed for the expanded list of conventional pollutants as well as for priority pollutants.

Small vessel conventional pollutant data taken in 2001 through 2003 is summarized according to wastewater effluent type in Table 14. Detailed sampling results from individual ships can be found in Appendix E: Small Ship Sampling Data.

Table 14. Small Ship Conventional Pollutants

The values for all pollutants, except fecal coliform, are medians. Fecal coliform information is represented as a geometric mean.

	Number of Samples	Ammonia total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
Year Wastewater Type Small Ship Appendix E Table #		**mg/l**		**mg/l**	**mg/l**	**mg/l**	**mg/l**	**MPN/100**	**Mg/l**
MDL		0.03	0.10	2	3.0	1.3	0.10	2	0.10
AK WQS		17.00	6.5 – 8.5	n/a	n/a	n/a	0.0075*	14	0.0075*
2001 GW Table 30	25	1.03	7.5	212	525.0	49.6	ND	103	ND
2002 GW Table 16	11	0.31	7.2	175	400.0	54.1	0.65	222[54]	ND
2003 GW Table 1	23	0.46	7.3	199	330.0	55.6	0.70	48	ND
2001 BW Table 32	16	3.30	7.8	60	863.0	115.8	0.03	10,561	ND
2002 BW Table 20	12	16.15	7.5	137	805.5	133.0	ND	11,582	ND
2003 BW Table 5	21	11.50	7.9	39	625.0	87.1	ND	500	ND
2001 BW&GW Mixed Table 31	10	7.72	7.3	130	814.0	108.0	1.00	3,720	0.10
2002 BW&GW Mixed (Table 18)	17	16.80	7.5	154	835.0	77.0	0.25	5,487	1.10[55]
2003 BW&GW Mixed Table 3	18	29.00	7.0	346	545.0	128.5	ND	56,513	ND

*Note that the MDL for chlorine is higher than the chronic water quality standard.

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater

ND= Non Detect

[54] Results skewed by one result of 16,000,000.

[55] In several instances only free chlorine was tested. This resulted in higher medians for free than total chlorine.

	Number of Samples	Conductivity	Oil & Grease	Total Organic carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MDL		1.0	1.5	1.0	0.5	1.0	0.01	1.0	0.1
WQS		n/a							
2002 GW (Table 17)	1	369	52.0	352.0	61.0	0.5	0.86	0.4	0.1
2003 GW (Table 2)	23	429	15.0	68.9	76.3	0.0	1.60	6.3	0.0
2002 BW (Table 21)	1	34,500	8.5	299.0	116.0	0.5	2.33	5.7	0.1
2003 BW (Table 6)	21	28,800	7.3	29.7	125.0	0.0	3.30	39.0	2.0
2002 BW&GW Mixed (Table 19)	4	29,750[56]	20.0	305.0	77.9	0.5	1.36	23.2	0.1
2003 BW&GW (Table 4)	18	17,900	62.0	158.5	204.5	0.0	3.50	35.0	2.4

MPN = Most Probable Number MDL = Method Detection Limit GW = Graywater BW = Blackwater
ND= Non Detect

Fecal coliform was at its lowest level in graywater and blackwater during 2003.

In the mixed black and graywater, there is a substantial increase in the concentration of fecal coliform from 3,720 MPN/100 ml in 2001 to 56,513 MPN/100 ml in 2003.

5.3. Pollutants in Effluent that Exceed Alaska Water Quality Standards

The medians of most pollutants in effluent were below Alaska Water Quality Standards. Table 15 draws from Table 14 for conventional pollutants and Appendix F. Summary of Small Ship Sampling for Priority Pollutants to highlight the pollutant medians that do not meet Alaska Water Quality Standards at the end of pipe. A shaded cell indicates that the concentration in the effluent was below the standard.

[56] Eight samples were analyzed for conductivity.

Table 15. End of Pipe - Small Ship Pollutants Medians that Do Not Meet Alaska Water Quality Standards

			Graywater		Treated Blackwater		Treated Blackwater & Graywater Mixed	
Pollutant	Units	AWQS	2003	2002	2003	2002	2003	2002
Ammonia	mg/l	17.00					29.00	
Free Chlorine	mg/l	0.0075	ND	ND				1.10
Fecal Coliform	MPN/100 ml	14	48	222	500	11,582	56,513	5,487
Arsenic	ug/l	36.0			42.8	44.9		
Copper	ug/l	3.1	74.8	27.4	6.4	11.1	22.0	76.3
Nickel	ug/l	8.2			13.0	14.9	12.2	16.6
Selenium	ug/l	71.0			171.0	170.0	98.2	134.0
Zinc	ug/l	81.0	150.0	86.9			98.5	165.0

Note: Fecal coliform information is a geometric mean.

5.4. Pollutants that Exceed Alaska Water Quality Standards in Receiving Water

The Science Advisory Panel concluded in *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters* report that the wastewater discharges from vessels moving at a minimum of 6 knots, 1 mile from shore, would meet Alaska Water Quality Standards in the receiving water.[57]

ADEC therefore focused on the impact that cruise ship wastewater effluent has on receiving waters during stationary discharge. ADEC modeled the dilution of small ship effluent during stationary discharge during a very conservative scenario, a neap tide[58] in Skagway, using the EPA approved Visual Plumes model and the information provided by operators in their Vessel Specific Sampling Plans. ADEC calculated a dilution factor for each ship's discharge. (More detailed information on the model used to calculate the dilution factor can be found in Appendix D Cruise Ship Stationary Discharge Modeling.) The lowest dilution factor calculated by the model was 1.5 for graywater, 38 for blackwater, and 8 for mixed wastewater. The concentration of a pollutant in Table 15 was divided by these factors to arrive at the pollutant concentration that is expected in the receiving waters (Table 16). If the predicted pollutant concentration met the Alaska Water Quality Standards in receiving water after applying the dilution factor, the cell is shaded.

[57] Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters," November 2002 http://www.state.ak.us/dec/press/cruise/documents/impact/executivesummary.htm

[58] A tide of minimum range occurring at the first and the third quarters of the moon.

Table 16. Modeled Small Ship Median Pollutant Concentrations in Receiving Waters during Stationary Discharge

			Graywater		Treated Blackwater		Mixed Blackwater & Graywater	
Pollutant	**Units**	**AKWQS**	**2003**	**2002**	**2003**	**2002**	**2003**	**2002**
Free Chlorine	mg/l	.0075						0.14
Fecal Coliform	MPN/100 ml	14	32	148		305	7,064	686
Copper	ug/l	3.1	49.8	18.3				9.5
Zinc	ug/l	81.0	100.0					

Note: Fecal coliform information is a geometric mean

In 2003, of all the pollutants that were tested (176), only three pollutants are expected to regularly exceed Water Quality Standards during stationary discharge.

5.5. Whole Effluent Toxicity Testing

Whole Effluent Toxicity (WET) testing is an alternative to directly analyzing environmental samples for individual constituents. WET testing addresses the effect that simultaneous exposure to a mixture of pollutants has on an organism.

There are two ways to perform the WET test: static non-renewal and static renewal. In a static non-renewal test, test organisms are exposed to a single portion of the solution for the duration of the test. In a static renewal test, test organisms are exposed to fresh changes of water every day for the duration of the test. Static renewal testing is more conservative because the test organisms are exposed to the effluent at the same strength for a longer time period. ADEC conducted WET testing using the static renewal method on commercial passenger vessels in 2002[59] and again in 2003.[60]

2002

This test was designed to simulate exposure to the concentration of pollutants that would likely be found in the receiving waters behind a moving ship. Because of the high dilution rates associated with moving ships, the dilution series started at 50% effluent and increased by a factor of 10 such that the percent effluent tested progressively decreased. The concentrations tested were 50%, 5%, 0.5%, 0.05%, 0.005%, and 0.0005% effluent. The dilution series represented concentrations that are attained in receiving waters with dilution factors (df) of 2, 20, 200, 2,000,

[59] Science Advisory Panel "Review and Comment Regarding Whole Effluent Toxicity Test Results for Five Commercial Passenger Vessels in Alaska July 2002" http://www.state.ak.us/dec/press/cruise/documents/wetfinal.htm and "Lab results for Whole Effluent Toxicity test (WET) – August 2002" http://www.state.ak.us/dec/press/cruise/documents/wetreport.htm

[60] ADEC "2003 Whole Effluent Toxicity Results for Commercial Passenger Vessels in Alaska" http://www.state.ak.us/dec/press/cruise/documents/wet/2003%20Whole%20Effluent%20Toxicity%20(WET)%20Test%20Discussion.pdf

20,000, and 200,000. For comparison, a small cruise ship with a width of 10 meters and a draft of 1 meter, discharging 0.4 cubic meters per hour (0.0001 cubic meters per second) while traveling at 6 knots (3.09 m/s) multiplied by the small ship factor of 3 would give a dilution factor of about 927,000.[61]

WET test results are presented in Table 17. The percentages represent the highest effluent concentration at which the tests exhibited no observable acute or chronic effects. Values in parentheses show dilution factors associated with the no observed effect concentrations (NOEC).

Table 17. Small Ship 2002 No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC	Echinoderm Fertilization NOEC
Kennicott Mixed Effluent	Macerator/ Chlorinator	5% (df=20)	5% (df=20)	5% (df=20)	0.5% (df=200)
Yorktown Clipper Blackwater	Macerator/ Chlorinator	50% (df=:2)	50% (df=2)	50% (df=2)	50% (df=2)
Yorktown Clipper Graywater	Chlorine injection	0.5% (df=200)	0.5% (df=200)	0.5% (df=200)	0.05% (df=2,000)

The WET tests indicated that acute or chronic toxic effects on marine organisms are not expected to occur in receiving water when vessels discharge underway. However, the *Kennicott* mixed effluent could cause chronic effects (echinoderm fertilization) during stationary discharge, even when considering the ship specific dilution factor of 23 calculated by the Visual Plumes model. The *Yorktown Clipper* blackwater effluent would not cause toxicity even during stationary discharge. The *Yorktown Clipper* graywater effluent could cause both chronic and acute toxicity during stationary discharge, even when ship specific dilution factor of 1.5 is applied. (See Appendix D. Cruise Ship Stationary Discharge Modeling Table 5 for ship specific dilution factors.) The chronic toxicity of the *Kennicott* mixed effluent and the *Yorktown Clipper* graywater may be explained by the excessive chlorination of the effluent. Alaska's Water Quality Standard for total residual chlorine is 7.5 ug/l. The total residual chlorine in the *Kennicott* mixed effluent and the *Yorktown Clipper* graywater was 30,300 ug/l and 16,200 ug/l respectively.

[61] The Science Panel has developed a formula for predicting dilution/dispersion in the wake of small cruise ships.
Dilution factor = 3 x (ship width x ship draft x ship speed)/(volume discharge rate);
http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm
The dilution factor is large for small ships compared to large ships because of the much smaller volume discharge rate.

2003

ADEC designed the 2003 WET test to determine the likelihood of negative effects to the marine environment during stationary discharges when dilution factor will be low. Therefore, the dilution series only increased by a factor of 2 instead of 10. The dilution series was 50%, 25%, 12.5%, 6.25%, 3.125%, and 1.5% effluent. This series represented concentrations that are attained in receiving waters with dilution factors of 2, 4, 8, 16, 32, and 66.7.

ADEC calculated the dilution factors during a worst case scenario, a stationary discharge during a neap tide in Skagway, using the Visual Plumes model.[62] (See Appendix D. Cruise Ship Stationary Discharge Modeling.) When the ship specific dilution factor calculated by the Visual Plumes model is greater than the No Observed Effect Concentration dilution factor (df), no toxicity is expected.

Table 18. Small Ship 2003 Whole Effluent Toxicity Test Results & Dilution Factor during Neap Tide

No Observed Effect Concentration (NOEC) and Dilution Factor (df)

Vessel	Treatment System	Ship Specific Dilution Factor from Visual Plumes model	Mysid Acute NOEC	Topsmelt Acute NOEC	Bivalve Larvae NOEC		Echinoderm Fertilization NOEC
					Normality[63]	Survival	
Spirit of Oceanus Mixed Effluent	BW Biological GW untreated	8	25% (df=4)	12.5% (df=8)	<1.5% (unknown)	12.5% (df=8)	<1.5% (unknown)
Spirit of Columbia Blackwater	Macerator/ Chlorinator	50[64]	>50% (df=2)	50% (df=2)	50% (df=2)	50% (df=2)	25% (df=4)
Spirit of Columbia Graywater	Untreated	2.5[65]	12.5% (df=8)	25% (df=4)	6.25% (df=16)	25% (df=4)	<1.5% (unknown)

On the *Spirit of Oceanus*, the blackwater is treated with a biological system and the graywater is untreated. The effluent is mixed before it is discharged. The mixed effluent is only expected to receive a dilution factor of 8 in the receiving water during stationary discharge. We do not expect the mixed effluent would cause acute toxicity even at this small dilution factor. The tests show that the effluent exhibits some chronic toxicity (bivalve larvae normality and echinoderm

[62] ADEC used the Visual Plumes mode UM3 with the Brooks far field solution. For more information on this model go to http://www.epa.gov/ceampubl/swater/vplume/

[63] Normality is the normal development of the bivalve larvae.

[64] *Spirit of Columbia's* blackwater is discharged from a pump under the waterline, which increases dilution.

[65] *Spirit of Columbia's* graywater is discharged directly from drains by means of gravity, which decreases dilution.

fertilization) at this dilution rate. However, in practice this vessel only discharges while underway when the effluent is expected to be diluted by a factor of approximately 100,000.[66] Therefore no toxicity to marine organisms is expected to result under normal operating procedures.

The *Spirit of Columbia* blackwater should not cause acute or chronic effects to marine organisms in receiving waters, even during stationary discharge.

The *Spirit of Columbia* graywater may cause acute and chronic effects on marine organisms while discharging in port. There is little dilution of its graywater because it is discharged above waterline. Graywater from this vessel is not expected to cause toxicity in receiving water during underway discharge because of the high dilution factor experienced while underway.

5.6. Summary of Small Ship Data 2001 – 2003

The state defines small ships as vessels that carry between 50 and 249 overnight passengers for hire. The average small cruise ship with 100 people (including crew) produces 9.5 cubic meters or 2,500 gallons of waste water per day. Of that amount 830 gallons is seawater used for toilets. There is roughly 16.7 gallons of graywater used per person or 1,670 gallons total.[67]

Small cruise ships and Alaska Marine Highway System (AMHS) ferries treat their blackwater with marine sanitation device (MSD). Some mix their blackwater and graywater together and then treat the wastewater through a MSD. Some vessels treat their graywater with chlorine before discharge while others discharge untreated graywater.

In 2001, small ships were only sampled for a short list of conventional pollutants. In 2002 and 2003, small ships sampled for the expanded list of conventional pollutants as well as for priority pollutants. Graywater effluent usually met the fecal coliform and total suspended solids effluent standards established by the state law. Blackwater and mixed black and graywater usually met the total suspended solids standards but exceeded the fecal coliform standard.

Risk Characterization

The wastewater samples indicate that hazardous chemicals are not being discharged through these wastewater systems. However, small ship effluent may not meet Alaska Water Quality Standards for free chlorine, fecal coliform, copper, and zinc in receiving water during stationary discharge.

The 2003 WET results were less toxic than those of 2002. In both years, the level of toxicity did not present a concern during underway discharge but graywater would, in all likelihood, cause marine toxicity during stationary discharge.

During stationary discharge, small ship effluent may pose a risk to human health in areas where aquatic life is harvested for raw consumption due to the high concentration of fecal coliform.

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[66] Dilution calculation for small ships Dilution factor = 3 x (ship width x ship draft x ship speed)/(volume discharge rate) =3 x (_____m x _____m x _____m sec^{-1})/(_____m^3sec^{-1}), the vessel's width is 15.3 m with a maximum draft of 4.15 m. ADEC assumed ship speed at 6 knots (3.09 m sec^{-1}) and the discharge rate of .0057 m^3sec^{-1}
Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters" November 2002, Section I located at http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm

[67] Figures taken from Wilderness Discoverer 2003 VSSP. Small ship water production varies with ship capacity and configuration.

6. EVALUATION OF WASTEWATER TREATMENT TECHNOLOGY

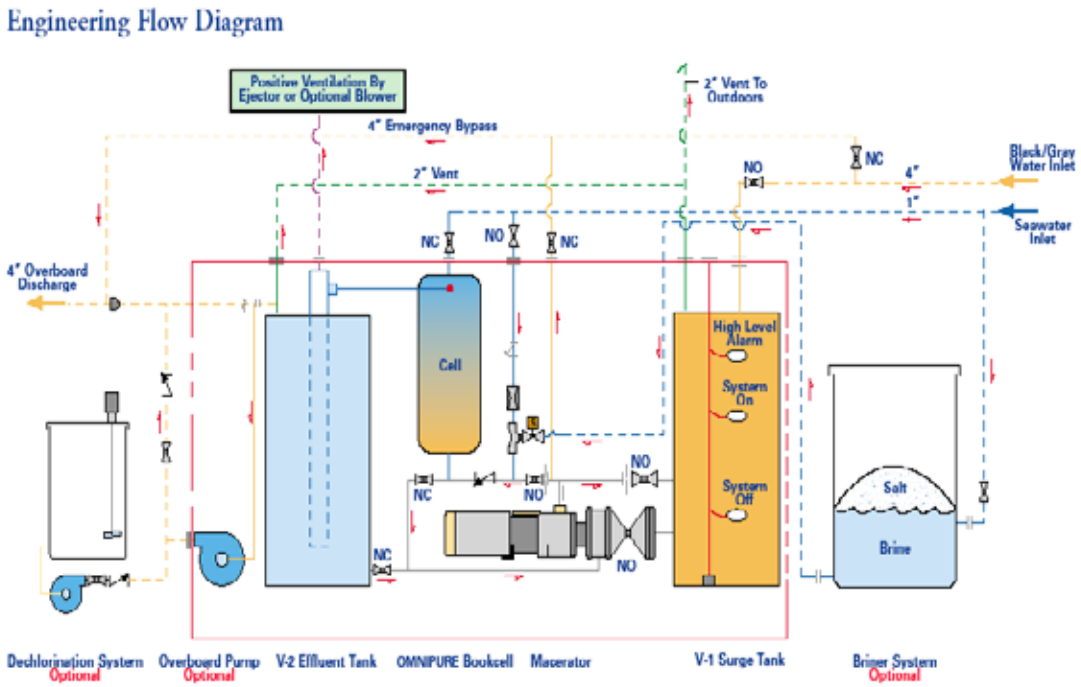
6.1. TRADITIONAL TREATMENT SYSTEMS

Prior to 2001, vessels used one of two marine sanitation devices (MSDs) to treat sewage on ships: maceration-chlorination or biological-chemical disinfection systems.

Maceration-chlorination systems

Maceration-chlorination systems are installed on most of the small cruise ships and ferries that ply Alaska waters.[68] This system reduces bio-solids through maceration, internal dilution, oxidation, and chlorine disinfection. The macerator pump breaks up solids in the sewage influent to a maximum particle size of 1.5 mm. The wastewater is then mixed with ambient seawater and passed between charged cell plates where a number of reactions occur simultaneously. The reactions cause the electrolytic breakdown of organic molecules. The electrocatalytic process also produces sodium hypochlorite from the salt in the seawater. This disinfectant continues to oxidize the waste stream in a contact tank with a 90-95% oxidation rate that kills total bacterial within minutes.[69] The treated water remains in the contact tank, usually for a minimum of 30 minutes. In low salt brackish water, some operators add chlorine to the tank to ensure disinfection is complete or add salt to the waste stream. Material that is not oxidized (i.e. cellulose) is returned for further treatment. No sludge is produced. Gases produced from reactions are mixed with ambient air and exhausted. (Figure 3.)

Figure 3. Maceration-Chlorination System



[68] ADEC, 2003 Small Commercial Passenger Vessel Wastewater Treatment Table, http://www.state.ak.us/dec/press/cruise/documents/2003smallshiptable.htm
[69] Information from Exceltech website http://www.21mainstreet.com/alpha/exceltec.asp

Maceration-chlorination systems often produce effluent that does not meet the Alaska commercial passenger vessel fecal coliform standard. (See Section 4 "Wastewater Characteristics - Small Ships.") Another disadvantage of this system is that operators tend to chlorinate in excess of the manufacturer's recommendations in order to meet this standard. Marine life is very sensitive to chlorine. The chlorine concentration in ambient water must be less than 7.5 ug/l to protect aquatic life.[70] Whole Effluent Toxicity (WET) Testing conducted in July 2002 demonstrated that chlorine level in wastewater effluent can be toxic to marine life.[71]

Alaska Marine Highway System (AMHS) ferries present an interesting case study on the importance of properly operating maceration-chlorination systems as well as sampling in the proper location in the treatment cycle. In April 2002, AMHS engineers discovered that their wastewater had been sampled before it had sufficient chlorine contact time, and subsequently began sampling in the correct location. This explains the high geometric mean of fecal coliform in samples taken prior to May 1, 2002 (4,212 MPN/100 ml) versus those samples taken during the remainder of 2002 (94 MPN/100 ml).[72] (See Table 19.) Samples taken from May through December 2002 also had lower chemical oxygen demand (COD) and total suspended solids (TSS) and higher chlorine residual.

In 2003 however, wastewater samples had the highest level of fecal coliform and lowest level of chlorine of all three years. ADEC audited the samplers during a July 29, 2003 sampling event. The sampler took the sample 15 minutes into the pumping cycle and the fecal coliform result was 11,000 MPN/100 ml. This seems to suggest that the timing of the sample did not make any difference as was suggested comparing the 2001 with the 2002 data. The AMHS information indicates that maceration-chlorination treatment systems are sensitive devices that produce variable results depending upon operation. However, the 2002 data demonstrated that maceration-chlorination systems can achieve fecal coliform levels that are in compliance with the state cruise ship law.

[70] ADEC Saltwater Aquatic Life Criteria Comparison
http://www.state.ak.us/dec/dawq/wqs/documents/saltwateraquaticlifecriteria.htm

[71] The Science Panel interpretation of the WET test is located at http://www.state.ak.us/dec/press/cruise/documents/wetfinal.htm. The laboratory results for the WET test are located at http://www.state.ak.us/dec/press/cruise/documents/wetreport.htm.

[72] This number is different than the number in Section 9 of "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters" November 2002 by Science Advisory Panel. ADEC wrote Section 9 with all sampling data received by September 30, 2002. This report includes additional data points for 2002.

Table 19. Alaska Marine Highway System Samples

All values are medians except fecal coliform which is expressed as a geometric mean.

Date (Table in Appendix E)	Number of Samples	Total Ammonia as N	BOD 5-Day	COD	Fecal coliform	Free chlorine	pH	Total chlorine	TSS
		mg/L	mg/L	mg/L	MPN/100 ml	mg/L		mg/L	mg/L
	MDL	0.03	2.0	3.0	2	0.10	0.1	0.10	1.3
January 2001 - April 2002 (Table 38)	8	7.61	99	765.0	4,212	0.55	7.5	1.10	89.4
May 2002 - December 2002 (Table 37)	10	9.50	102	557.0	94	2.25	7.5	1.78	64.8
January – December 2003 (Table 36)	9	11.00	185	365.0	13,990	0.00	7.2	0.00	99.2

Biological And Chemical Disinfecting Systems

Marine biological treatment systems are similar to land based municipal treatment systems. A marine biological treatment system has three steps: (1) aeration; (2) clarification & filtration; and (3) final chemical disinfecting.[73] All sludge is re-circulated to the activated sludge aeration section.[74]

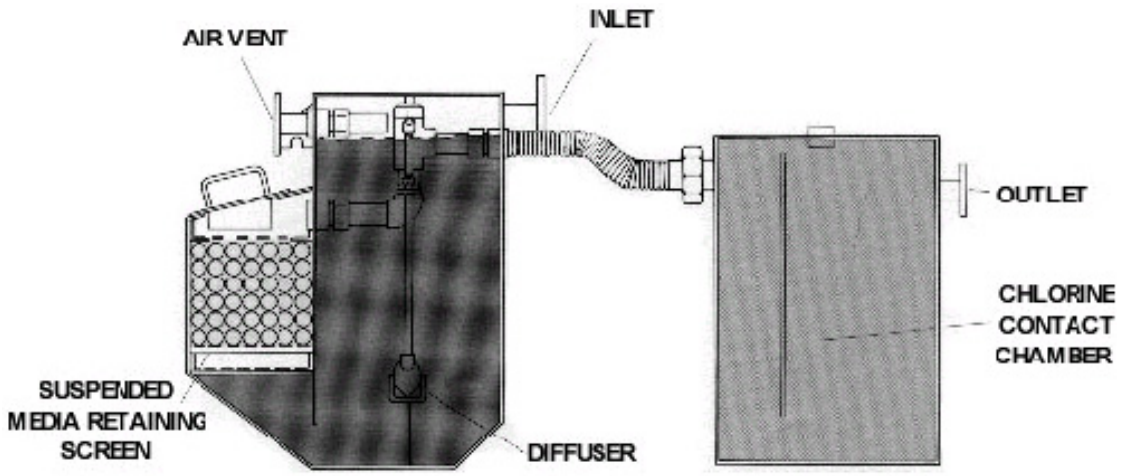
The raw sewage passes through a screen, which removes grit, then enters the marine sanitation device (MSD) aeration chamber. The raw sewage mixes with a large concentration of active aerobic bacteria that consume the organic waste in the sewage. The chamber contains air diffusers that provide oxygen to keep the aerobic bacteria healthy.

The wastewater flows from the aeration chamber into the clarification and filtration chambers. The filter media removes larger pieces of organic waste not consumed by bacteria in the aeration chamber. The aerobic bacteria also consume the biomass on the filter. After clarification and filtration, wastewater flows into the chlorine contact chamber. The wastewater stays in this chamber until virtually all bacteria are killed resulting in a chlorine residual of 1 – 2 mg/l (ppm).

Unlike a land based biological system, marine systems process a concentrated blackwater stream without dilution from graywater or storm water. Biological systems thrive on a constant, even flow of nutrients and constant pH. This constant flow is difficult to achieve since the demand on a ship's treatment system is intermittent with periods of low or no flow.

Figure 4. Biological and Chemical Disinfection System[75]

[73] Fox-Pac MSD home page http://www.redfoxenviro.com/foxpacmarinemsd.html
[74] Waste treatment systems: http://www.hamworthykse.com/docGallery/29.PDF
[75] Fox-Pac MSD home page http://www.redfoxenviro.com/foxpacmarinemsd.html



6.2. Advanced Treatment Systems

The fecal coliform and total suspended solids standards in the state and federal cruise ship laws have prompted large ships to either install advanced treatment systems that meet secondary treatment standards or to hold all of their wastewater for discharge outside of Alaska. Large cruise ship operators have evaluated several advanced wastewater treatment designs. These include chemical treatment and mechanical decanting; activated oxidation and oxidant disinfection; reverse osmosis filtration, and bio-reactor/filtration. The overall value and efficiency of each system, which includes evaluation of the installation cost, maintenance, operator training and monitoring, continues to be a subject of research by the cruise lines.

Generally, cruise ships using advanced technology have combined enhanced aerobic digestion with filtration to clean shipboard wastewater. These treatment systems do not use chlorine in the normal treatment process; however, some ships may use chlorine to control fecal re-growth that occurs in the discharge piping.

These treatment systems all produce solid sludge, which is discharged 12 miles from shore, incinerated, or offloaded it to land based disposal sites.

Chemical treatment and mechanical decanting

This system uses chemical treatment and a mechanical decanter, followed up by a UV purifier. The design is used successfully in shore-based applications and showed promise in large-scale laboratory tests. However, the pilot program on a cruise ship indicated that modifications were necessary for a fully operational treatment system.[76] No additional information is available to ADEC on this system.

[76] From a wastewater technology paper prepared by David Eley for the Governor's Briefing Papers and Alaska Regional Response Team updated June 2002. For more information contact Mr. Eley at 907-586-2685 or capedec@alaska.com

Activated Oxidation Process

This treatment process is currently operated on ten small ferries in British Columbia.[77] It has four major components: (1) a primary screening system, (2) a primary solids separation and oxidizing system, (3) a secondary oxidation tank, and (4) oxidant generation equipment, which eliminate the need for chlorine disinfection. Ozone disinfection presents fewer known environmental and health effects than chlorine and its byproducts.[78] It is more effective than chlorine at killing bacteria and viruses. In addition, ozone is unstable in the environment and decomposes to oxygen in a short period of time.[79]

An enhanced system with a biological oxidation component has been installed on Royal Caribbean's *Vision of the Seas*.[80] A polymer is also added to the preliminary stage to cause the solids to clump together and for a sludge "mat". The process removes the mat before the effluent enters the treatment system.[81] The treatment system is comprised of six main system components: (1) primary solids separation/oxidation tank; (2) bioreactors (Hydroxyl-F^{3}R); (3) secondary solids separation; (4) oxidation/disinfection tank; (5) controls and oxidant generation equipment; and (6) sludge dewatering and drying equipment.

The sludge is dewatered and incineration onboard or offloaded to shore. No discharge at sea is necessary. The system manufacturer is conducting tests on the *Vision of the Seas* to ensure that it meets U. S. Coast Guard discharge standards for stationary discharge in Alaska. ADEC has not yet received wastewater effluent data from this system.

Reverse Osmosis Filtration

Osmotic theory dictates that pure water will move across a semi-permeable membrane into wastewater until the contaminant concentrations of both liquids are equal. However, if external pressure is exerted on the contaminant solution, water will flow in the reverse direction from the wastewater into the pure water. This phenomenon is known as reverse osmosis (RO). Reverse osmosis treatment systems have been installed on two ships[82] operating in Alaska. Both systems use ultraviolet (UV) disinfection after the RO unit and were approved by the U.S. Coast Guard for stationary discharge during 2003. The effluent from both systems has a slightly low pH which requires some buffering. *Mercury's* treatment system includes a final run through activated charcoal canisters before discharge. The sample points are both ships are less than 50 feet from the overboard discharge point.

[77] Hydroxyl Systems B.C Ferry Services Inc. case study website: http://www.hydroxyl.com/marine/index.html
[78] EPA/625/1-86/021 EPA Design Manual Municipal Wastewater Disinfection
[79] EPA 832F99063, EPA Ozone Fact Sheet, September 1999. http://www.epa.gov/npdes/pubs/ozon.pdf
[80] Hydroxyl Systems *Vision of the Seas* case study website: http://www.hydroxyl.com/marine/index.html
[81] Hydroxyl system described on website http://www.hydroxyl.com/index.html
[82] Celebrity *Mercury* blackwater and Carnival *Spirit* graywater

Table 20. Samples Taken after RO/UV Treatment Unit (2003)

	pH	BOD5	TSS	total chlorine residual	free chlorine residual	fecal coliform
Number of Samples = 21		mg/L	mg/L	Mg/L	mg/L	MPN/100
Minimum	6.6	0	0.0	0.00	0.00	0
Median	7.3	15	0.0	0.00	0.00	0
Maximum	9.1	27	0.0	0.00	0.00	4

Large Ship Sampling Data Appendix B, Table 5

Bio-reactor/filtration

These units employ an integrated system of enhanced aerobic digestion and low-pressure membrane filtration to treat blackwater and graywater. Currently, sixteen large cruise ships operating in Alaska have installed this process using Zenon, Scanship, or Hamworthy systems.[83]

After only a brief holding period in the bio-reactor, the Zenon system passes the influent through membrane filtration modules that have very large surface area and an extremely small pore size (0.035 micron or 0.035 X 10^{-6} meters).[84] Wastewater then passes through a UV disinfection unit. Samples are taken immediately after the UV unit. The distance from the UV unit to the discharge point varies from vessel to vessel.

Table 21. Zenon/UV Treatment System (2003)[85]

Number of Samples = 24	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		Mg/L	mg/L	mg/L	mg/L	MPN/100
Minimum	7.2	0	0.0	0.00	0.00	0
Median	7.6	0	0.0	0.00	0.00	0
Maximum	8.4	5	0.0	0.00	0.00	0

Large Ship Sampling Data Appendix B, Table 6.

The Scanship system relies more heavily on biological digestion. This unit enhances the capacity and effectiveness of the bio-reactor with plastic carrier elements (biofilm) suspended in the wastewater to increase reactor surface area with eventual polishing microfiltration and UV

[83] ADEC, 2003 Large Commercial Passenger Vessels Discharge Status and Wastewater Treatment, http://www.state.ak.us/dec/press/cruise/documents/2003largeshipwwtable.htm

[84] From a wastewater technology paper prepared by David Eley for the Governor's Briefing Papers and Alaska Regional Response Team, updated June 2002 and discussions with Rick Softye former VP of Holland America.. For more information contact Mr. Eley at 907-586-2685 or capedec@alaska.com.

[85] Holland America *Maasdam, Ryndam, Statendam, Veendam, Volendam,* and *Zaandam*

disinfection.[86] At the beginning of the season, samples were taken after the UV. By mid-season, the samples were taken at the end of the discharge line before the overboard port.

Table 22. Scanship/UV (2003)[87]

Number of Samples = 18	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**MPN/100**
Minimum	6.3	5	0.0	0.00	0.00	0
Median	6.9	11	7.0	0.00	0.00	0
Maximum	7.6	26	28.6	0.00	0.00	240

Large Ship Sampling Data Appendix B, Table 7

In a Hamworthy system, wastewater is passed through an aerobic biological treatment system and ultrafiltration units. It is then chlorinated to kill remaining bacteria. The chlorine levels in the effluent were occasionally over the 10 mg/l limit for continuous discharge allowed by the U.S. Coast Guard and the Alaska Water Quality Standard of 7.5 ug/l. Princess has installed UV on two of their ships with the Hamworthy system and is considering substituting UV for chlorine disinfection on all ships in the future. Samples of this system were taken on the discharge line near the overboard port. Some samples indicated that there was fecal contamination within the discharge line.

Hamworthy (2003)[88]

Number of Samples = 58	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**MPN/100**
Minimum	6.6	0	0.0	0.00	0.00	0
Median	7.3	2	0.0	0.00	0.00	0
Maximum	8.1	86	19.1	55.00	50.00	220

Large Ship Sampling Data Appendix B, Table 8.

All four of the treatment systems listed above regularly satisfy the requirements necessary to maintain U.S. Coast Guard continuous discharge certification. (See Table 2.)

[86] Scanship Environmental website: http://www.scanship.no/
[87] Norwegian *Sky*, *Sun*, and *Wind*
[88] Princess *Dawn, Island, Pacific, Star* and *Sun;* Radisson *Seven Seas Mariner*

Table 23. Comparison of Advanced Treatment System Medians

Number of Samples = 58	pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**MPN/100**
RO (21)	7.28	14.9	0.0	0.00	0.00	0
Zenon (24)	7.64	0.0	0.0	0.00	0.00	0
Scanship (18)	6.94	10.9	7.0	0.00	0.00	0
Hamworthy (58)	7.33	2.2	0.0	0.00	0.00	0

Sample data demonstrated that fecal coliform contamination of the effluent sometimes occurred in the discharge pipe. The probability of fecal contamination increased as the pipe length increased. ADEC will therefore require that samples be taken within 50 feet of the overboard discharge location in the future.

7. RISK CHARACTERIZATION

7.1. Toxicological Profile of Detected Pollutants

Sections 3 and 4 discuss the large ship and small ship wastewater data. Table 11 and Table 16 list the pollutants that exceed water quality standards in receiving water. This section will discuss those pollutants in greater detail.

CONVENTIONAL POLLUTANTS

Ammonia

Ammonia is present in two forms in saltwater: un-ionized ammonia (NH_3) and the ammonium ion (NH_4+). The un-ionized ammonia form has been demonstrated to be the more toxic form of ammonia.[89] Ammonia affects the life cycle as well as survival of some species.[90] Water quality parameters, particularly pH and temperature, but also salinity, affect the proportion of un-ionized ammonia.

Ammonia at concentrations slightly less than those chronically toxic to animals may stimulate growth and reduce reproduction of a red macroalgal species.[91]

Ammonia has a strong and suffocating odor. Ammonia's short term human health effects include lung irritation, causing coughing and/or shortness of breath. Higher exposures cause fluid buildup in the lungs (pulmonary edema), which can cause death. In addition, ammonia is a corrosive chemical, which can severely burn the eyes and skin. Repeated exposure to ammonia can cause chronic irritation of the eyes, nose, mouth, and throat.

Chlorine

Free residual chlorine is described as the portion of the chlorine injected into water that remains as molecular chlorine, hypochlorous acid, or hypochlorite ions after the solution has reached a state of equilibrium. Combined residual chlorine is described as the portion of chlorine injected into water that remains combined with ammonia or nitrogenous compounds after the equilibrium has been reached. Both free and residual chlorine have a very short half-life in marine waters; therefore, it is difficult to assess the effects of chlorine on aquatic life.[92] ADEC saltwater criteria for chlorine are 13 µg/L (acute criterion) and 7.5 µg/L (chronic criterion).[93]

In humans, ingestion of large doses of chlorine may cause gastrointestinal irritation, including vomiting and nausea. If dehydration occurs, body temperature increases and circulatory and central nervous system damage may result. Exposure of the eyes to sodium chloride may cause

[89] EPA 440/5-88-004 Ambient Aquatic Life Water Quality Criteria. page 7

[90] Details of the testing results is located in EPA 440/5-88-004 located at http://www.epa.gov/waterscience/pc/ambientwqc/ammoniasalt1989.pdf

[91] EPA 1989, Ambient Water Quality Criteria for Ammonia (Saltwater)-1989, EPA Office of Water, Regulations and Standards Division, Washington DC, EPA 440/5-88-004

[92] EPA January 1985, Ambient Water Quality Criteria for Chlorine, Office of Water, EPA 440/5-84/030

[93] ADEC, Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic & Inorganic Substances, May 15, 2003, Table IV or V available at http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/wqs/pdf/70wqsmanual.pdf

stinging while exposure to other forms of chlorine, including free and residual chlorine, may cause stinging or irritation of the skin.

Fecal Coliform

Bacteria water quality standards are set to protect human health from diseases associated with water that has been contaminated with feces. The presence of fecal coliforms usually indicates the presence of pathogens. Shellfish concentrate fecal coliform bacteria and other pathogens that may be present with coliform bacteria. Shellfish beds are closed to harvesting when the geometric mean of fecal coliform bacteria exceeds 14 colonies per 100 milliliters of water. While most fecal coliform bacteria are harmless to humans, exposure to some may cause short-term adverse effects, including rash, ear infections, gastrointestinal pain, nausea, diarrhea, vomiting, and fever.[94]

PRIORITY POLLUTANTS

Copper

Copper is highly toxic in aquatic environments. Copper will bio-concentrate in many different organs in fish and mollusks. Copper is an effective algaecide. Free ions of copper are the lethal agent. Single cell and filamentous algae and cyanobacteria are more susceptible to the acute effects, which include reductions in photosynthesis and growth, loss of photosynthetic pigments, disruption of potassium regulation, and mortality. Mammals are not as sensitive to copper as are other aquatic organisms. The predominant mammalian effects include hepatic and renal toxicity, and fetal mortality.[95] However, high doses are usually required to elicit these effects in mammals.

Alaska has a water quality standard of 3.1 µg/L dissolved copper in saltwater based on chronic effects to aquatic life.

Low levels of copper are essential for humans. Exposure to high levels of copper may cause mouth and eye irritation and may induce vomiting, nausea, and intestinal pain.[96]

Zinc

Zinc is very soluble in water and is almost never found free in nature. It is one of the most mobile of the heavy metals. Most of the zinc introduced into the aquatic environment is partitioned into the sediments by sorption onto hydrous iron, manganese oxides, clay, and organic materials.[97] Variables affecting the mobility of zinc include the concentration and composition of suspended and bed sediments, dissolved and particulate iron and manganese concentrations, pH, salinity, concentration of ions or molecules that bind to transition-metal ions, and the concentration of zinc.

[94] Washington State Department of Ecology, March 2002, *Focus: Fecal coliform bacteria and Washington's water quality standards*, Publication No. 02-10-010.
[95] EPA, 2002a, National Recommended Water Quality Criteria – Correction, EPA Office of Water, Washington, DC, EPA 822-Z-99-001.
[96] Agency for Toxic Substances and Disease Registry (ATSDR), United States Department of Health and Human Services, Center for Disease Control, September 2002, ToxFAQs for Copper.
[97] EPA 440/5-87-003 EPA Ambient Water Quality Criteria for Zinc February 1987.

Most organisms need some minimum concentration of zinc to function properly. Toxicity of zinc to an organism depends on feeding habits. Plants and most fish would not be adversely affected, but many invertebrates could be affected by ingestion of sufficient quality of particulates containing zinc. The toxicity of zinc, as well as other metals, is reported to be influenced by a number of chemical factors including cadmium, magnesium, hardness, pH, and ionic strength. These factors appear to affect the toxicity of zinc by influencing the proportion of available zinc or by inhibiting the sorption or binding available by biological tissues. Alaska has a water quality standard of 81.0 µg/L of dissolved zinc in saltwater based on chronic effects to aquatic life.

As with copper, zinc is an essential element in humans at low doses. Human ingestion of zinc is generally not a concern. The Recommended Daily Allowances for adults is 15 mg/day.[98]

7.2. Cumulative Impact

Large Ships

Since the passage of the Alaska cruise ship laws, large cruise ships installed advanced wastewater treatment systems that meet the stringent U.S. Coast Guard requirements for continuous discharge. The quality of the wastewater on large ships has therefore improved dramatically. During 2003, all the large cruise ships that discharged wastewater in Alaska had these advanced systems. Ships that did not have advanced systems discharged outside 3 nautical miles. The 2003 data is the most representative of the wastewater quality that ADEC expects in the future. Therefore, we will focus on the risks presented by the 2003 data.

In 2003, ships were sampled for 16 conventional pollutants and 160 priority pollutants. **The vast majority of these pollutants were not detected.** Only ammonia, copper, nickel, and zinc did not regularly meet Alaska Water Quality Standards at the end of pipe (Table 10).

The Science Advisory Panel concluded in *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters* that effluent from a typical large ship will be diluted by a factor of at least 50,000 during underway discharge.[99] By applying this dilution factor, the concentration of all pollutants would meet Alaska Water Quality Standards in the receiving water during underway discharge.

ADEC was concerned about the impacts on the receiving water caused by stationary wastewater discharge. In order to address this issue, ADEC calculated the dilution factor during stationary discharge for each large ship during a worst case scenario. (See Appendix D Cruise Ship Stationary Discharge Modeling for more information.) The lowest dilution value for each effluent type was then used to calculate the anticipated concentration of each pollutant in receiving water during stationary discharge (Table 11). After applying the dilution factor, no tested pollutant would exceed Water Quality Standards.

Whole Effluent Toxicity (WET) testing was done in 2003 on 4 of the 18 large ships that discharged in Alaska. Test results indicate that **wastewater effluent from large ships with advanced wastewater treatment systems does not pose a risk to aquatic organisms, even**

[98] EPA 440/5-80-079 October 1980 Ambient Water Quality Criteria for Zinc.
[99] Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters," November 2002 http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm

during stationary discharges. ADEC will continue WET testing on the advanced wastewater treatment systems during 2004. This test gives insight into the wastewater's effect on marine organisms. This test indicates that exceedances of ammonia, copper, nickel and zinc Water Quality Standards at the end of pipe are not harming aquatic life.

None of the pollutants mentioned above are present in concentrations should cause risks to human health.

Small Ships

ADEC reviewed data collected from small commercial passenger vessels from 2001 through 2003. These ships have not installed new wastewater treatment systems on their vessels and the effluent quality has remained relatively consistent.

During the evolution of the sampling protocol, pollutants have been added and deleted as appropriate. In 2003, ships were sampled for 16 conventional pollutants and 160 priority pollutants. **The vast majority of these pollutants were not detected**. The eight (8) pollutants that did not regularly meet Alaska Water Quality Standards at the end of pipe are included in Table 15.

The Science Advisory Panel concluded that the dilution factor caused by the underway discharge by a small ship would be based on the width, draft, and speed of the vessel divided by the discharge rate and multiplied by a factor of 3.[100] With the aid of this dilution, we would expect all pollutants to meet Alaska Water Quality Standards during underway discharge.

ADEC was concerned about the impacts on the receiving water caused by stationary wastewater discharge. In order to address this issue, ADEC calculated the dilution factor caused by stationary discharge for each small ship during a worst case scenario. (See Appendix D Cruise Ship Stationary Discharge Modeling for more information.) The lowest dilution value for each effluent type was then used to calculate the expected concentration of each pollutant in receiving water during stationary discharge (Table 16). Even with the benefit of dilution, we predict the stationary discharge of wastewater from small ships contain concentrations of free chlorine, fecal coliform, copper, and zinc that exceed Alaska Water Quality Standards.

The marine environment is very sensitive to the concentrations of free chlorine. In fact the water quality standards are below the methods of detection for chlorine. The concentration of chlorine in mixed blackwater and graywater during 2002 was found in excess of 100 times the Alaska Water Quality Standards. The predicted concentration of chlorine from this discharge was 10 times the standard in receiving water and therefore did pose a risk to aquatic life during stationary discharges.

The fecal coliform concentrations in receiving water indicate that it is important for these ships to avoid anchoring in areas used for shellfish aquaculture or areas frequently used for subsistence and recreational shellfish harvesting. Most of the shellfish farms in Southeast Alaska are located between Ketchikan and Petersburg. ADEC evaluated the small ship routes and the location of

[100] The Science Panel has developed a formula for predicting dilution/dispersion in the wake of small cruise ships.
Dilution factor = 3 x (ship width x ship draft x ship speed)/(volume discharge rate);
http://www.state.ak.us/dec/press/cruise/documents/impact/dilutionwastewater.htm

registered commercial shell fish beds and found that small ships do not currently moor or dock near these sites.

Copper is highly toxic in aquatic environments. This toxicity is reflected in the low Alaska Water Quality Standard of 3.1 µg/L dissolved copper in saltwater. The predicted concentration of copper in receiving water during small ship stationary discharge can be as high as 10 times this standard and therefore does pose a likely risk to aquatic life.

Most organisms need a minimum concentration of zinc to function properly. Alaska has a water quality standard of 81.0 µg/L for dissolved zinc in saltwater based on chronic effects to aquatic life. In 2003, the level of dissolved zinc found in receiving water during graywater discharge slightly exceeds Water Quality Standards, and therefore poses some risk to aquatic life.

The Whole Effluent Toxicity (WET) testing done in 2002 and 2003 in conjunction with the information above indicates that **the wastewater effluent from small ships poses some risk to the marine environment during stationary discharges.**

The concentration of fecal coliform in the effluent during stationary discharge would pose a risk to human health in areas where aquatic life is harvested for raw consumption.

7.3. Comparison to other Marine Discharges

Cruise ship's wastewater systems can be compared to municipal treatment systems that serve small Alaskan cities. Cruise ships are excluded from obtaining permits under the Clean Water Act. However, their marine sanitation devices (MSDs) must meet effluent standards set in Section 312. This section set the Type II MSD standards for blackwater at 200 fecal coliform/100 ml and 150 mg/L total suspended solids (TSS). In Alaska, cruise ships must also adhere to state and federal wastewater effluent standards and discharge conditions (Table 2).

Municipalities must obtain permits under the Clean Water Act before discharging wastewater. The Act uses both water quality effluent standards and technology based limits to protect water quality.[101] It has been termed a technology-forcing statute because of the rigorous demands placed on the regulated community to improve effluent quality through treatment technology. The Act required municipalities to upgrade systems to secondary treatment, (85% removal of biological oxygen demand (BOD) and total suspended solids (TSS)), by July 1, 1988. Eighty-six percent (86%) of municipalities met that date. Cities that discharged wastes into the marine environment were eligible for case-by-case EPA waivers of the secondary treatment requirement. These waivers, referred to as 301(h) waivers, require 30% removal of BOD and TSS. In order to be eligible for these waivers, natural factors such as tides and currents must provide significant elimination of traditional forms of pollution, protect shell fish, fish, and other aquatic life, and comply with water quality standards. Waivers were only granted, with certain exceptions, if a waiver application was filed by December 29, 1982.

Juneau and most other Alaskan cities adhere to secondary treatment standards and have limits that do not allow the exceedance of a monthly geometric mean of 200 fecal coliforms per 100 ml if chlorine is used for disinfection and a monthly geometric mean of 400 fecal coliform bacteria if ultraviolet light is used for disinfection. However, many communities in Southeast Alaska including the popular cruise ship ports of Ketchikan, Skagway, and Sitka have waivers from secondary treatment. These treatment systems have been assigned very large mixing zones to

[101] Copeland, Claudia. CRS Report for Congress, Clean Water Act: A Summary of the Law, January 20, 1999

allow for dilution in the receiving water. These cities have effluent limits with a daily maximum of 1.5 million fecal coliforms/100 ml and a monthly geometric mean of 1 million fecal coliforms/100 ml. These are the highest limits that have been allowed in Alaska.

Domestic and industrial discharges in Alaska usually exceed water quality standards at the end of pipe. Under the State of Alaska and the National Pollutant Discharge Elimination System (NPDES) permit systems, these entities are granted mixing zones - areas where they may legally exceed water quality standards while dilution and decay or die-off occur. Outside of the mixing zone, water quality standards must be met. ADEC uses information from the discharge source such as wastewater volume, velocity, temperature, and salinity as well as pipe diameter and depth, and receiving water uses and sensitivity to determine the size of the mixing zone. These dischargers must monitor at the edge of mixing zone specified in their permit to ensure that they are meeting the water quality standards. Because other dischargers are typically granted a mixing zone, ADEC considered the effect of dilution on cruise ship effluent to assess its impact on water quality.

There are numerous potential sources of pollution that impact the Alaska marine environment. They include private vessels, commercial fishing vessels, day trip charter vessels, commercial passenger vessels that have less than 50 overnight passengers for hire, yachts, residential shore based dischargers, runoff and wildlife, (including marine animals). The effects of these other sources have not yet been quantified.

8. ADEC RECOMMENDATIONS

8.1. Recommendations for future study

Sampling

At the recommendation of the Science Advisory Panel, ADEC tested vessel wastewater for commonly used organophosphorus pesticides at the end of 2003 season. No pesticides were detected in the four samples. The ADEC will continue organophosphorus testing during the 2004 season.

Cyanide was dropped from the Quality Assurance/Quality Control (QAQC) Plan after 2000 even though there were high concentrations in some of the 2000 samples. We believe the exclusion from the sampling protocol was premature. ADEC will resume sampling for cyanide in 2004 when the state goes on board and samples the ship wastewater discharges.

In general, fecal coliforms survive for shorter periods than other enteric microorganisms in marine water. The absence of fecal coliform bacteria does not guarantee the absence of viruses and other pathogens.[102] EPA recommends using enterococci for bacteria monitoring in marine waters.[103] ADEC will sample vessel wastewater for *Escherichia coli* (E. *coli*) and enterococci, in 2004.

The current method detection limits (MDL) for chlorine exceeds Alaska Water Quality Standards. As part of the QAQC Plan for 2004, ADEC will require using a more sensitive test that can measure as low as 20 ug/l, instead of the current MDL of 100 ug/l. This sensitive method, however, will still not be able to detect the Alaska Water Quality chronic standard of 7.5 ug/l.

During 2003, some large ship samples were taken from the sampling port right after the treatment system but at a distance between 50 to 400 feet from the overboard discharge port. The 2003 data indicated that fecal contamination and growth occasionally occurs during the transit from the treatment system to the overboard port. In 2004, ADEC will only approve Vessel Specific Sampling Plans where samples are taken from sample ports located within 50 feet of the overboard discharge port.

State cruise ship regulations,[104] effective November 2002, allowed small ships to have a qualified crew member sample the vessel's wastewater. ADEC will encourage small vessel operators to use their own staff to sample their vessel as it comes into port. These samples will be more representative since ships will still be full with passengers and the treatment system will be operating normally. ADEC can provide sampling training to operators upon request. ADEC would audit the vessel samplers.

[102] Commission on Geosciences, Environment and Resources, 1993 "Managing Wastewater in Coastal Urban Areas" pg. 67 http://books.nap.edu/books/0309048265/html/67.html

[103] EPA 440/5-88/007 Bacteria Water Quality Standards Criteria Summaries: A Compilation of State/Federal Criteria. September 1988.

[104] 18 AAC 69.090, http://www.state.ak.us/dec/title18/wpfiles/69mas.pdf

Section 5.1 discusses traditional treatment systems. The sampling results from the Alaska Marine Highway System (AMHS) ferries' macerator chlorinating systems were extremely variable from 2001 through 2003. ADEC recommends that AMHS sample for fecal coliform, total suspended solids (TSS) and chlorine at timed intervals such as: 1) at the discharge pump start; 2) 5 minutes into the pumping cycle; 3) 10 minutes into the pumping cycle; 4) 15 minutes into the pumping cycle; and 5) at the end of the discharge cycle. This experiment would check the fecal coliform variability throughout the pumping cycle. This information may indicate the correct location for the sample port in the treatment cycle.

New Studies

ADEC made assumptions about ambient water quality for the dilution model. It is important to check these assumptions with real data. ADEC will conduct ambient marine monitoring in Southeast Alaska in coordination with the Western States Coastal Environmental Monitoring and Assessment Program (EMAP) project during the summer of 2004.[105] The EMAP project will also include sediment and fish tissue sampling for heavy metals and PCBs. ADEC will use this information in future modeling efforts.

After applying the dilution factor calculated by the Visual Plumes model to effluent data, small ships exceed four Alaska Water Quality Standards (free chlorine, fecal coliform, copper, and zinc) in receiving water during stationary discharge. When a ship discharges above the waterline, the dilution factor is decreased, exacerbating the problem. The Visual Plumes model that is used to estimate the dilution factors in this report was not designed to model discharges from vessels. ADEC may perform a dye study in the future to determine the dilution factor caused by small ships during stationary discharge.

8.2. Recommendations for Best Management Practices

When large and small vessels discharge wastewater underway, they are able to meet all Alaska Water Quality Standards. The 2003 data indicates that large vessels with advanced wastewater treatment systems meet Alaska Water Quality Standards for all tested pollutants in receiving water during stationary discharges. Large vessels should use discharge ports that are less than 12 inches in diameter to create a jet like propulsion that will increase dilution. Large vessels should avoid discharging above the water line because this decreases dilution. ADEC also wants to encourage the continued use of ultraviolet light instead of chlorine as a disinfectant on large ships. It is also important that the discharge port be located within 50 feet of the wastewater treatment system to decrease the likelihood of fecal coliform contamination in the discharge line.

Small ships regularly exceed four Alaska Water Quality Standards in receiving water during stationary discharge. Vessels that have holding capacity should not discharge while stationary. Holding water while in port is ideal. Most small ships can hold their blackwater and mixed blackwater and graywater for up to 24 hours while stationary (Table 24). This is important since blackwater and mixed blackwater and graywater have the highest fecal coliform counts.

However, only one ship can hold their graywater, the majority of wastewater volume, for even 12 hours while stationary (Table 24). According to the Vessel Specific Sampling Plans,

[105] For more information on EMAP, visit the EPA EMAP Research Strategy Report, July 2002 at: http://www.epa.gov/emfjulte/html/pubs/docs/resdocs/EMAP_Research_Strategy.pdf

graywater is not plumbed to blackwater holding tanks. Therefore, excess blackwater holding capacity can not be used to store graywater.

Small ships need to develop strategies to limit their graywater discharge while stationary. Small vessels should not do laundry to minimize their waste water production. Small vessels could also schedule to arrive in port or at anchor after the morning high water usage periods (8-10 a.m.) or leave before the evening high water usage (6-8 pm).

Table 24. Small Ship Holding Tank Capacity

			Blackwater (gallons per day)				Graywater (gallons per day)			
Company	Ship Name	Number of passengers and crew	Produced	Holding capacity	Hold 24hr	Hold 12 hr	Produced	Holding capacity	Hold 24hr	Hold 12 hr
AMHS	Columbia	223	6,690	23,800	Yes	Yes	GW is mixed with BW. See BW.			
AMHS	Kennicott	204	6,120	8,800	Yes	Yes	GW is mixed with BW. See BW.			
AMHS	Malaspina	188	5,640	8,006	Yes	Yes	GW is mixed with BW. See BW.			
AMHS	Matanuska	186	5,580	8,281	Yes	Yes	GW is mixed with BW. See BW.			
AMHS	Taku	97	2,910	3,360	Yes	Yes	GW is mixed with BW. See BW.			
Glacier Bay	Wilderness Adventurer	95	2,920	2,400	No	Yes	GW is mixed with BW. See BW.			
Glacier Bay	Wilderness Discoverer	120	3,130	2,400	No	Yes	GW is mixed with BW. See BW.			
America West Steamshp	Empress of the North	320	8,730	26,800	Yes	Yes	GW is mixed with BW. See BW.			
CruiseWest	Spirit of Discovery	105	500	1,700	Yes	Yes	2,500	30	No	No
CruiseWest	Spirit of Alaska	99	495	334	No	Yes	2,250	182	No	No
CruiseWest	Spirit of Columbia	99	400	3,600	Yes	Yes	2,260	478	No	No
CruiseWest	Spirit of Endeavour	130	600	934	Yes	Yes	3,600	934	No	No
CruiseWest	Spirit of 98	120	3,600	12,700	Yes	Yes	3,000	0	No	No
CruiseWest	Spirit of Oceanus	178	19,875	14,460	No	Yes	GW is mixed with BW. See BW.			
Lindblad	Sea Bird	96	3,000[106]	1,150	No	No	2,100	735	No	No
Lindblad	Sea Lion	98	3,000[107]	1,255	No	No	2,100	735	No	No
New World Ship Management	Clipper Odyssey	204	612	606	Yes	Yes	16,500	28,800	Yes	Yes
New World Ship Management	Yorktown Clipper	175	2,728[108]	2,996	Yes	Yes	12,000 [109]	2,996	No	No

Source: Table created from information submitted by small ship owner and operators in their 2003 Vessel Specific Sampling Plans.

[106] Includes saltwater for flushing.
[107] Includes saltwater for flushing.
[108] Includes saltwater for flushing.
[109] This vessel does laundry which accounts for 2,000 gallons per day. This vessel should not do laundry in port.

8.3. Evaluation of Whether Small Ships Should Remain in the Program

Based on the wastewater testing results, ADEC recommends that small ships remain in the Commercial Passenger Vessel Environmental Compliance program. The Science Advisory Panel recommended in their November 2002 report that these ships should avoid stationary discharge, particularly in small fjords and embayments where the movement or flux of water is limited, because of the high levels of fecal coliform and suspended solids in their wastewater.[110] ADEC WET test results in conjunction with conventional and priority pollutant testing indicate that these small ships pose some risk to the marine environment during stationary discharge. Small ships that discharge blackwater or blackwater and graywater mixed while stationary may pose a risk to human health in areas where people collect shellfish for raw consumption.

Small vessels were granted three years to come into compliance with the state cruise ship law wastewater effluent standards.[111] As of March 1, 2004, these vessels may submit an interim protection plan that, if approved by ADEC, extends the time for compliance with the effluent standards. This plan should include a description of Best Management Practices, such as avoiding stationary discharges in areas of limited water movement, that the operator is undertaking to limit the adverse impacts of their discharges.[112] Violations and fines could be levied against ships that are found violating the terms of their approved plan.

[110] Science Advisory Panel, November 2002, "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters," Executive Summary, http://www.state.ak.us/dec/press/cruise/documents/impact/executivesummary.htm
[111] Alaska Statute 46.03.460 – 490 Section 7
[112] 18 AAC 69.045 Interim Protective Measures Plan**,**
http://www.state.ak.us/local/akpages/ENV.CONSERV/title18/wpfiles/69mas.pdf

Appendix A. 2003 List of Priority Pollutants

Table 1. List of Priority Pollutants

Base Neutrals and Acids			
1,2,4-Trichlorobenzene	3,3'-Dichlorobenzidine	Benzo(g,h,i)perylene	Fluoranthene
1,2-Dichlorobenzene	3-Nitroaniline	Benzo(k)fluoranthene	Fluorene
1,3-Dichlorobenzene[1]	4,6-Dinitro-2-Methylphenol	Benzoic Acid	Hexachlorobenzene
2,4,5-Trichlorophenol	4-Bromophenyl-Phenylether	Benzyl Alcohol	*Hexachlorobutadiene*
2,4,6-Trichlorophenol	4-Chloro-3-Methylphenol	Bis (2-Chloroethoxy) Methane	Hexachlorocyclopentadiene
2,4-Dichlorophenol	4-Chloroaniline	Bis (2-chloroisopropyl) ether	Hexachloroethane
2,4-Dimethylphenol	4-Chlorophenyl methylsulfone	Bis(2-Chloroethyl) Ether	Indeno(1,2,3-cd)pyrene
2,4-Dinitrophenol	4-Chlorophenyl-Phenylether	Bis(2-Ethylhexyl)Phthalate	Isophorone
2,4-Dinitrotoluene	4-Nitroaniline	Butylbenzylphthalate	*Naphthalene*
2,6-Dinitrotoluene	4-Nitrophenol	Chrysene	Nitrobenzene
2-Chloronaphthalene	Acenaphthene	Dibenzo(a,h)anthracene	N-Nitroso-Di-N-Propylamine
2-Chlorophenol	Acenaphthylene	Dibenzofuran	N-Nitrosodiphenylamine
2-Methylnaphthalene	Anthracene	Diethylphthalate	Pentachlorophenol
2-Methylphenol	Benzidine	Dimethylphthalate	Phenanthrene
2-Nitroaniline	Benzo(a)anthracene	Di-n-Butylphthalate	Phenol
2-Nitrophenol	Benzo(a)pyrene	Di-n-Octylphthalate	Pyrene
3&4-Methylphenol	Benzo(b)fluoranthene		

[1] Pollutants in italics are on both the VOC and BNA list.

Volatile Organic Compounds (VOCs)		
1,1,1,2-Tetrachloroethane	2-Hexanone	Hexachlorobutadiene
1,1,1-Trichloroethane	4-Chlorotoluene	Iodomethane
1,1,2,2-Tetrachloroethane	4-Isopropyltoluene	Isopropylbenzene
1,1,2-Trichloroethane	4-Methyl-2-Pentanone	m&p Xylenes
1,1-Dichloroethane	Acetone	Methylene Chloride
1,1-Dichloroethene	Acrylonitrile	Naphthalene
1,1-Dichloropropene	Benzene	n-Butylbenzene
1,2,3-Trichlorobenzene	Bromobenzene	n-Propylbenzene
1,2,3-Trichloropropane	Bromochloromethane	O-Xylene
1,2,4-Trichlorobenzene	Bromodichloromethane	sec-Butylbenzene
1,2,4-Trimethylbenzene	Bromoform	Styrene
1,2-Dibromo-3-Chloropropane	Bromomethane	tert-Butyl Methyl Ether
1,2-Dibromoethane	Carbon Disulfide	tert-Butylbenzene
1,2-Dichlorobenzene	Carbon Tetrachloride	Tetrachloroethene
1,2-Dichloroethane	Chlorobenzene	Toluene
1,2-Dichloropropane	Chloroethane	trans-1,2-Dichloroethene
1,3,5-Trimethylbenzene	Chloroform	trans-1,3-Dichloropropene
1,3-Dichlorobenzene	Chloromethane	trans-1,4-Dichloro-2 Buten
1,3-Dichloropropane	Cis-1,2-Dichloroethene	Trichloroethene
1,4-Dichlorobenzene	Cis-1,3-Dichloropropene	Trichlorofluoromethane
2,2-Dichloropropane	Dibromochloromethane	Trichlorotrifluoroethane
2-Butanone	Dibromomethane	Vinyl Acetate
2-Chloroethyl Vinyl Ether	Dichlorodifluoromethane	Vinyl Chloride
2-Chlorotoluene	Ethylbenzene	

Trace Metals (total recoverable and dissolved)			
Antimony	Chromium	Nickel	Zinc
Arsenic	Copper	Selenium	
Beryllium	Lead	Silver	
Cadmium	Mercury	Thallium	

Appendix B. Large Ship Sampling Data

MDL = Method Detection Limit

ND = Non Detect

Note: ½ MDL is substituted for non-detects in order to calculate a geometric mean. This is not done for chlorine because the MDL is greater than the Alaska water quality standard. These values are left as ND.

Table 1. 2003 Blackwater Conventional Pollutants

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.10	2.0	3.0	1.3	0.10	2	0.10
VESSEL_ID	Sample Date								
Coral Princess	5/21/2003	188.00	7.9	5	135.0	0.0	ND	9	ND
Coral Princess	6/24/2003	110.00	7.5	33	130.0	0.0	ND	240	ND
Coral Princess	8/23/2003	66.00	7.5	0	40.0	0.0	ND	0	ND
Dawn Princess	6/5/2003	8.64	6.7	6	87.0	0.0	ND	0	ND
Dawn Princess	6/23/2003	22.20	7.1	0	55.0	0.0	ND	0	ND
Dawn Princess	6/24/2003	20.90	6.9	0	14.0	0.0	ND	0	ND
Dawn Princess	8/14/2003	33.00	7.2	0	45.0	0.0	ND	0	ND
Dawn Princess	8/14/2003	38.00	7.2	21	44.0	0.0	ND	0	ND
Island Princess	7/19/2003	7.47	7.9	0	77.0	0.0	ND	0	ND

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.10	2.0	3.0	1.3	0.10	2	0.10
VESSEL_ID	Sample Date								
Island Princess	7/29/2003	33.10	7.4	4	68.0	0.0	ND	0	ND
Island Princess	9/3/2003	29.00	7.4	3	38.0	0.0	2.50	0	2.00
Maasdam	5/17/2003	16.80	7.8	0	80.0	0.0	ND	0	ND
Maasdam	7/26/2003	23.20	7.7	0	72.0	0.0	ND	0	ND
Maasdam	8/9/2003	47.00	8.0	3	70.0	0.0	ND	0	ND
Mercury	5/15/2003	2.34	7.1	0	0.0	0.0	ND	2	ND
Norwegian Sky	5/20/2003	35.70	6.8	9	68.0	10.8	ND	0	ND
Norwegian Sky	5/20/2003	42.00	6.8	7	112.0	5.8	ND	0	ND
Norwegian Sky	7/29/2003	56.50	7.3	8	64.0	5.1	ND	0	ND
Norwegian Sky	7/29/2003	61.70	7.2	7	63.0	0.0	ND	0	ND
Norwegian Sun	6/17/2003	110.00	7.6	19	104.0	8.8	ND	0	ND
Norwegian Sun	6/24/2003	61.10	6.9	21	40.0	5.7	ND	0	ND
Norwegian Sun	9/9/2003	92.00	7.3	13	73.0	4.9	ND	0	ND
Norwegian Wind	6/18/2003	27.00	7.0	9	60.0	4.2	ND	0	ND
Norwegian Wind	6/18/2003	49.00	6.9	8	71.0	11.2	ND	0	ND

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.10	2.0	3.0	1.3	0.10	2	0.10
VESSEL_ID	Sample Date								
Norwegian Wind	7/23/2003	25.10	7.3	17	86.0	10.9	ND	0	ND
Norwegian Wind	7/23/2003	24.50	7.3	16	83.0	10.3	ND	0	ND
Pacific Princess	6/26/2003	58.00	7.8	9	93.0	0.0	ND	0	ND
Pacific Princess	8/31/2003	39.00	7.5	0	64.0	0.0	ND	0	ND
Pacific Princess	9/12/2003	37.00	7.2	3	81.0	0.0	ND	0	ND
Ryndam	5/27/2003	0.49	7.7	0	62.0	0.0	ND	0	ND
Ryndam	6/20/2003	10.60	7.7	3	52.0	0.0	ND	0	ND
Ryndam	7/1/2003	23.00	7.9	4	59.0	0.0	ND	0	ND
Seven Seas Mariner	7/19/2003	5.74	7.5	0	106.0	0.0	ND	11	ND
Seven Seas Mariner	8/9/2003	16.00	7.2	10	70.0	0.0	ND	0	ND
Seven Seas Mariner	8/27/2003	0.00	7.2	52	86.0	0.0	ND	0	ND
Seven Seas Mariner	8/27/2003	0.00	7.1	13	140.0	0.0	ND	0	ND
Star Princess	6/2/2003	47.20	7.6	0	59.0	0.0	ND	0	ND
Star Princess	8/11/2003	20.00	7.1	0	15.0	0.0	ND	0	ND
Star Princess	8/25/2003	22.00	6.5	42	61.0	0.0	ND	0	ND

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.10	2.0	3.0	1.3	0.10	2	0.10
VESSEL_ID	Sample Date								
Statendam	8/6/2003	30.00	7.9	11	430.0	0.0	ND	0	ND
Statendam	8/6/2003	0.00	8.0	6	88.0	0.0	ND	0	ND
Statendam	8/20/2003	25.00	7.3	25	110.0	0.0	ND	0	ND
Statendam	9/7/2003	0.14	7.5	0	73.0	0.0	ND	0	ND
Statendam	9/7/2003	0.14	7.5	0	73.0	0.0	ND	0	ND
Sun Princess	5/23/2003	92.70	7.5	4	150.0	0.0	0.40	0	0.30
Sun Princess	6/16/2003	141.00	7.3	20	162.0	0.0	Not taken	0	Not taken
Sun Princess	8/1/2003	88.80	7.4	0	82.0	0.0	ND	0	ND
Sun Princess	8/1/2003	92.20	7.3	0	80.0	0.0	ND	0	ND
Veendam	5/29/2003	10.40	7.8	0	58.0	0.0	ND	0	ND
Veendam	7/2/2003	42.00	7.4	5	68.0	0.0	ND	0	ND
Veendam	7/20/2003	139.00	7.8	0	101.0	0.0	ND	0	ND
Volendam	5/21/2003	20.20	7.4	0	84.0	0.0	ND	0	ND
Volendam	7/9/2003	20.00	8.1	0	45.0	0.0	ND	0	ND

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	**0.03**	**0.10**	**2.0**	**3.0**	**1.3**	**0.10**	**2**	**0.10**
VESSEL_ID	**Sample Date**								
Volendam	7/23/2003	3.89	8.0	0	66.0	0.0	ND	0	ND
Zaandam	5/19/2003	20.00	7.9	0	54.0	0.0	ND	0	ND
Zaandam	6/30/2003	9.80	7.7	4	260.0	0.0	ND	0	ND
Zaandam	7/28/2003	11.40	7.8	0	73.0	0.0	ND	0	ND
	Minimum	**0.00**	**6.5**	**0**	**0.0**	**0.0**	**ND**	**0**	**ND**
	Median	**25.10**	**7.4**	**4**	**72.0**	**0.0**	**ND**	**0**	**ND**
	Maximum	**188.00**	**8.1**	**52**	**430.0**	**11.2**	**2.50**	**240**	**2.00**
	Geometric Mean							**1**	

Table 2. Blackwater Conventional Pollutants (continued)

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.0	0.5	1.0	0.01	1.0	0.1
VESSEL_ID	Sample Date								
Coral Princess	5/21/2003	3330	5.5	28.7	597.0	0.0	13.40	160.0	0.0
Coral Princess	6/24/2003	1160	9.7	44.2	340.0	0.0	14.00	98.0	0.0
Coral Princess	8/23/2003	1050	0.0	13.1	273.0	0.0	4.90	66.0	0.0
Dawn Princess	6/5/2003	1190	0.0	25.2	73.3	9.8	15.60	9.9	0.0
Dawn Princess	6/23/2003	1170	0.0	19.2	158.0	0.0	9.20	25.0	0.0
Dawn Princess	6/24/2003	1170	0.0	19.4	151.0	0.0	8.80	25.0	0.0
Dawn Princess	8/14/2003	1280	0.0	13.4	129.0	4.1	7.00	22.0	0.0
Dawn Princess	8/14/2003	1280	0.0	14.7	137.0	3.8	7.00	31.0	0.0
Island Princess	7/19/2003	2930	0.0	29.0	599.0	0.0	3.06	160.0	0.0
Island Princess	7/29/2003	1740	0.0	22.3	173.0	0.0	16.60	39.0	0.0
Island Princess	9/3/2003	611	0.0	10.1	128.0	0.9	10.00	26.0	0.0
Maasdam	5/17/2003	1760	0.0	18.8	232.0	0.0	0.27	19.0	0.0
Maasdam	7/26/2003	800	0.0	19.2	250.0	0.0	0.31	28.0	0.0
Maasdam	8/9/2003	1040	0.0	22.9	412.0	0.0	3.80	35.0	0.0

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.0	0.5	1.0	0.01	1.0	0.1
VESSEL_ID	Sample Date								
Mercury	5/15/2003	62	0.0	0.0	9.8	0.5	0.07	3.9	0.0
Norwegian Sky	5/20/2003	Not taken	Not taken	Not taken	Not taken	Not taken	Not taken	Not taken	Not taken
Norwegian Sky	5/20/2003	859	0.0	23.2	102.0	0.0	0.26	41.0	0.0
Norwegian Sky	7/29/2003	956	0.0	21.2	184.0	0.0	0.48	65.0	0.0
Norwegian Sky	7/29/2003	973	0.0	20.5	163.0	0.0	0.34	66.0	0.0
Norwegian Sun	6/17/2003	1280	0.0	28.4	254.0	0.0	0.35	79.0	0.0
Norwegian Sun	6/24/2003	1080	5.8	22.3	192.0	0.0	0.66	62.0	0.0
Norwegian Sun	9/9/2003	971	0.0	16.9	222.0	0.0	0.23	65.0	0.7
Norwegian Wind	6/18/2003	995	0.0	15.4	48.9	0.0	0.11	41.0	0.0
Norwegian Wind	6/18/2003	937	0.0	15.4	78.3	0.0	0.16	35.0	0.0
Norwegian Wind	7/23/2003	978	0.0	20.8	50.5	0.0	0.47	30.0	0.0
Norwegian Wind	7/23/2003	957	0.0	21.5	52.1	0.0	0.46	30.0	0.0
Pacific Princess	6/26/2003	829	5.8	25.8	159.0	7.1	13.30	40.0	0.0
Pacific Princess	8/31/2003	691	0.0	19.4	75.7	41.0	12.00	34.0	0.0
Pacific Princess	9/12/2003	1030	0.0	17.7	78.0	35.0	4.10	34.0	0.0

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.0	0.5	1.0	0.01	1.0	0.1
VESSEL_ID	Sample Date								
Ryndam	5/27/2003	789	0.0	19.7	293.0	0.0	0.87	1.5	0.0
Ryndam	6/20/2003	823	0.0	14.5	308.0	0.0	2.10	12.0	0.0
Ryndam	7/1/2003	777	11.0	18.8	318.0	0.0	0.71	17.0	0.0
Seven Seas Mariner	7/19/2003	733	0.0	4.6	112.0	0.0	4.70	7.3	0.0
Seven Seas Mariner	8/9/2003	581	9.0	22.7	146.0	0.0	9.60	14.0	0.0
Seven Seas Mariner	8/27/2003	765	0.0	21.1	242.0	0.0	12.00	33.0	0.0
Seven Seas Mariner	8/27/2003	766	0.0	22.7	241.0	0.0	11.00	33.0	0.0
Star Princess	6/2/2003	3070	0.0	15.4	226.0	0.0	6.60	44.0	0.0
Star Princess	8/11/2003	3000	0.0	16.8	89.9	13.0	1.10	15.0	0.0
Star Princess	8/25/2003	3000	0.0	13.1	20.0	35.0	15.00	8.8	0.0
Statendam	8/6/2003	1450	0.0	26.4	122.0	0.0	0.65	27.0	0.0
Statendam	8/6/2003	1410	0.0	26.1	128.0	0.0	0.40	28.0	0.0
Statendam	8/20/2003	1730	0.0	33.5	278.0	0.0	1.60	28.0	0.0
Statendam	9/7/2003	1350	5.4	24.8	261.0	0.0	0.72	2.2	0.0
Statendam	9/7/2003	1350	5.4	24.8	261.0	0.0	0.72	2.2	0.0

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	**1**	**1.5**	**1.0**	**0.5**	**1.0**	**0.01**	**1.0**	**0.1**
VESSEL_ID	**Sample Date**								
Sun Princess	5/23/2003	2670	7.8	26.0	278.0	0.0	8.35	87.0	0.0
Sun Princess	6/16/2003	2920	0.0	44.5	539.0	0.0	13.40	120.0	0.0
Sun Princess	8/1/2003	1700	5.9	19.4	217.0	0.0	10.70	85.0	0.0
Sun Princess	8/1/2003	1280	0.0	17.0	243.0	0.0	10.50	140.0	0.0
Veendam	5/29/2003	579	5.2	16.5	138.0	0.0	3.32	12.0	0.0
Veendam	7/2/2003	813	0.0	21.4	262.0	0.0	12.00	30.0	0.0
Veendam	7/20/2003	658	0.0	22.8	231.0	0.0	11.70	11.0	0.0
Volendam	5/21/2003	684	0.0	17.0	224.0	0.0	1.64	19.0	0.0
Volendam	7/9/2003	612	0.0	14.5	199.0	0.0	0.37	15.0	0.0
Volendam	7/23/2003	830	0.0	19.0	313.0	0.0	0.56	8.2	0.0
Zaandam	5/19/2003	62	11.0	15.5	297.0	0.0	6.10	22.0	0.0
Zaandam	6/30/2003	789	6.3	15.5	287.0	0.0	3.40	9.9	0.0
Zaandam	7/28/2003	724	0.0	16.6	268.0	0.8	4.25	15.0	0.0
	Minimum	**62**	**0.0**	**0.0**	**9.8**	**0.0**	**0.07**	**1.5**	**0.0**
	Median	**987**	**0.0**	**19.4**	**219.5**	**0.0**	**3.60**	**29.0**	**0.0**

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.0	0.5	1.0	0.01	1.0	0.1
VESSEL_ID	Sample Date								
	Maximum	3330	18.0	44.5	599.0	41.0	16.60	160.0	0.7

Table 3. 2003 Large Ship Graywater Conventional Pollutants

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
VESSEL_ID	Sample_Date								
Carnival Spirit	8/30/2003	0.92	7.3	14	35.0	0.0	ND	0	ND
Carnival Spirit	9/12/2003	2.30	7.0	23	67.0	0.0	ND	23	ND
Carnival Spirit	9/12/2003	1.30	10.1	32	95.0	0.0	ND	17	ND
	Minimum	**0.92**	**7.0**	**14**	**35.0**	**0.0**	**ND**	**0**	**ND**
	Median	**1.30**	**7.3**	**23**	**67.0**	**0.0**	**ND**	**17**	**ND**
	Maximum	**2.30**	**10.1**	**32**	**95.0**	**0.0**	**ND**	**23**	**ND**
	Geometric Mean							**7**	

Table 4. 2003 Large Ship Graywater Conventional Pollutants (continued)

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	Mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1.00	1.5	1.0	1.7	1.0	.01	1.0	0.1
VESSEL_ID	Sample Date								
Carnival Spirit	8/30/2003	246	0.0	10.7	34.1	0.0	0.12	4.1	0.0
Carnival Spirit	9/12/2003	199	18.0	17.7	62.4	0.0	0.23	4.8	0.0
Carnival Spirit	9/12/2003	131	6.2	12.7	32.7	0.0	0.30	6.0	0.0
	Minimum	**131**	**0.0**	**10.7**	**32.7**	**0.0**	**0.12**	**4.1**	**0.0**
	Median	**199**	**6.2**	**12.7**	**34.1**	**0.0**	**0.23**	**4.8**	**0.0**
	Maximum	**246**	**18.0**	**17.7**	**62.4**	**0.0**	**0.30**	**6.0**	**0.0**

2003 Large Ship Continuous Compliance Samples

Samples Taken after Treatment System, Not As Being Discharged

Table 5. Reverse Osmosis/UV Treatment System

		pH	BOD 5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Carnival Spirit	8/23/2003	7.3	16	0.0	0.00	0.00	0
Carnival Spirit	8/23/2003	9.1	15	0.0	0.00	0.00	4
Carnival Spirit	8/23/2003	6.9	17	0.0	0.00	0.00	0
Carnival Spirit	8/30/2003	7.8	14	0.0	0.00	0.00	0
Carnival Spirit	8/30/2003	7.1	16	0.0	0.00	0.00	0
Carnival Spirit	8/30/2003	7.3	15	0.0	0.00	0.00	0
Carnival Spirit	9/6/2003	7.0	21	0.0	0.00	0.00	0
Carnival Spirit	9/6/2003	7.0	23	0.0	0.00	0.00	0
Carnival Spirit	9/6/2003	7.1	21	0.0	0.00	0.00	0
Carnival Spirit	9/19/2003	7.2	27	0.0	0.00	0.00	0
Carnival Spirit	9/19/2003	7.3	24	0.0	0.00	0.00	0
Carnival Spirit	9/19/2003	7.2	26	0.0	0.00	0.00	0
Mercury	5/8/2003	7.0	3	0.0	0.00	0.00	0
Mercury	5/22/2003	7.9	0	0.0	0.00	0.00	
Mercury	6/12/2003	7.7	0	0.0	0.00	0.00	0
Mercury	6/26/2003	6.6	2	0.0	0.00	0.00	0
Mercury	7/17/2003	6.6	5	0.0	0.00	0.00	0
Mercury	7/31/2003	8.1	6	0.0	0.00	0.00	0
Mercury	8/14/2003	7.8	7	0.0	0.00	0.00	0

		pH	BOD 5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Mercury	9/4/2003	7.6	9	0.0	0.00	0.00	0
Mercury	9/18/2003	8.8	9	0.0	0.00	0.00	0
	Minimum	**6.6**	**0**	**0.0**	**0.00**	**0.00**	**0**
	Median	**7.3**	**15**	**0.0**	**0.00**	**0.00**	**0**
	Maximum	**9.1**	**27**	**0.0**	**0.00**	**0.00**	**4**

Table 6. Zenon/UV Treatment System

		pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Ryndam	5/27/2003	7.6	0	0.0	0.00	0.00	0
Ryndam	6/3/2003	7.4	0	0.0	0.00	0.00	0
Ryndam	7/8/2003	8.3	0	0.0	0.00	0.00	0
Ryndam	7/22/2003	7.8	0	0.0	0.00	0.00	0
Ryndam	8/12/2003	7.8	0	0.0	0.00	0.00	0
Ryndam	8/19/2003	7.5	0	0.0	0.00	0.00	0
Ryndam	9/2/2003	8.2	3	0.0	0.00	0.00	0
Ryndam	9/16/2003	8.0	0	0.0	0.00	0.00	0
Statendam	9/11/2003	7.6	0	0.0	0.00	0.00	0
Veendam	5/21/2003	7.2	0	0.0	0.00	0.00	0
Veendam	6/6/2003	7.4	0	0.0	0.00	0.00	0
Veendam	6/18/2003	8.1	0	0.0	0.00	0.00	0
Veendam	7/2/2003	7.4	5	0.0	0.00	0.00	0
Veendam	7/24/2003	8.1	5	0.0	0.00	0.00	0
Veendam	8/13/2003	7.5	4	0.0	0.00	0.00	0
Veendam	8/27/2003	7.4	0	0.0	0.00	0.00	0
Veendam	9/10/2003	8.4	0	0.0	0.00	0.00	0
Veendam	9/23/2003	7.6	0	0.0	0.00	0.00	0

		pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Veendam	5/21/2003	7.2	0	0.0	0.00	0.00	0
Volendam	6/11/2003	7.5	4	0.0	0.00	0.00	0
Volendam	6/25/2003	7.8	3	0.0	0.00	0.00	0
Volendam	7/9/2003	8.1	0	0.0	0.00	0.00	0
Volendam	7/23/2003	8.1	0	0.0	0.00	0.00	0
Volendam	8/6/2003	7.5	0	0.0	0.00	0.00	0
Volendam	9/3/2003	7.7	0	0.0	0.00	0.00	0
	Minimum	**7.2**	**0**	**0.0**	**0.00**	**0.00**	**0**
	Median	**7.6**	**0**	**0.0**	**0.00**	**0.00**	**0**
	Maximum	**8.4**	**5**	**0.0**	**0.00**	**0.00**	**0**

Table 7. Scanship/UV Treatment System

		pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Norwegian Sky	7/8/2003	7.3	5	0.0	0.00	0.00	0
Norwegian Sky	7/22/2003	6.8	6	0.0	0.00	0.00	0
Norwegian Sky	8/5/2003	7.2	11	5.4	0.00	0.00	0
Norwegian Sky	8/19/2003	7.3	7	7.0	0.00	0.00	0
Norwegian Sky	9/9/2003	6.9	19	28.6	0.00	0.00	240
Norwegian Sky	9/22/2003	7.5	9	0.0	0.00	0.00	0
Norwegian Sky	9/22/2003	7.3	8	0.0	0.00	0.00	0
Norwegian Sun	7/8/2003	7.1	26	18.7	0.00	0.00	0
Norwegian Sun	7/29/2003	7.1	10	15.2	0.00	0.00	0
Norwegian Sun	8/12/2003	6.9	14	24.0	0.00	0.00	0
Norwegian Sun	8/19/2003	6.9	11	8.3	0.00	0.00	0
Norwegian Wind	6/18/2003	7.0	8	7.1	0.00	0.00	0
Norwegian Wind	7/30/2003	6.5	12	15.3	0.00	0.00	0
Norwegian Wind	8/13/2003	6.5	9	0.0	0.00	0.00	0
Norwegian Wind	8/20/2003	6.3	13	0.0	0.00	0.00	0
Norwegian Wind	9/17/2003	6.8	14	7.4	0.00	0.00	0
Norwegian Wind	7/9/2003	7.6	12	15.0	0.00	0.00	5
Norwegian Wind	9/10/2003	6.6	22	4.6	0.00	0.00	0

		pH	BOD5	TSS	Total Chlorine Residual	Free Chlorine Residual	Fecal Coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
	Minimum	**6.3**	**5**	**0.0**	**0.00**	**0.00**	**0**
	Median	**6.9**	**11**	**7.0**	**0.00**	**0.00**	**0**
	Maximum	**7.6**	**26**	**28.6**	**0.00**	**0.00**	**240**

Table 8. Hamworthy Treatment System

		pH	BOD5	TSS	total chlorine residual	free chlorine residual	fecal coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Coral Princess	6/10/2003	7.3	0	0.0	0.00	0.00	23
Coral Princess	6/18/2003	7.9	20	0.0	0.20	0.00	0
Coral Princess	7/2/2003	7.1	4	0.0	0.00	0.00	220
Coral Princess	7/16/2003	7.8	2	0.0	0.00	0.00	0
Coral Princess	8/5/2003	6.7	3	0.0	44.00	7.50	0
Coral Princess	8/19/2003	8.1	7	0.0	0.00	0.00	0
Coral Princess	9/2/2003	7.8	0	0.0	0.00	0.00	0
Coral Princess	9/10/2003	7.8	3	0.0	0.00	0.00	0
Dawn Princess	5/22/2003	7.1	6	19.1	0.00	0.00	0
Dawn Princess	5/30/2003	7.7	9	0.0	0.00	0.00	0
Dawn Princess	6/13/2003	6.6	0	0.0	0.00	0.00	0
Dawn Princess	6/27/2003	7.1	11	0.0	0.00	0.00	0
Dawn Princess	7/11/2003	7.2	0	0.0	0.00	0.00	0
Dawn Princess	7/25/2003	7.2	0	0.0	0.00	0.00	0
Dawn Princess	8/8/2003	7.1	0	0.0	0.00	0.00	0
Dawn Princess	8/22/2003	7.0	0	0.0	0.00	0.00	0
Dawn Princess	9/5/2003	7.7	0	0.0	0.00	0.00	0
Dawn Princess	9/19/2003	7.3	0	0.0	0.00	0.00	0

		pH	BOD5	TSS	total chlorine residual	free chlorine residual	fecal coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Island Princess	7/15/2003	7.5	4	0.0	0.00	0.00	0
Island Princess	8/12/2003	7.4	19	0.0	1.30	0.25	0
Island Princess	8/26/2003	7.2	0	0.0	2.80	1.60	0
Island Princess	9/9/2003	7.2	14	0.0	0.70	0.15	0
Island Princess	9/17/2003	7.6	11	0.0	4.50	4.00	0
Island Princess	7/29/2003	7.4	6	0.0	0.00	0.00	0
Pacific Princess	7/19/2003	8.0	18	0.0	0.00	0.00	0
Pacific Princess	7/24/2003	7.8	3	0.0	0.20	0.00	0
Pacific Princess	8/8/2003	7.8	4	0.0	0.50	0.50	0
Pacific Princess	8/31/2003	7.1	0	0.0	0.00	0.00	0
Pacific Princess	9/12/2003	6.7	0	0.0	5.00	2.50	0
Seven Seas Mariner	7/26/2003	7.2	0	0.0	0.00	0.00	0
Seven Seas Mariner	8/9/2003	7.3	3	0.0	0.00	0.00	0
Seven Seas Mariner	8/30/2003	7.3	14	0.0	0.00	0.00	0
Seven Seas Mariner	9/6/2003	7.3	7	0.0	0.00	0.00	0
Seven Seas Mariner	9/14/2003	7.4	0	13.9	0.00	0.00	0
Star Princess	5/19/2003	7.2	0	0.0	0.00	0.00	8
Star Princess	5/26/2003	7.8	0	0.0	0.00	0.00	0
Star Princess	6/9/2003	7.3	13	0.0	0.00	0.00	0

		pH	BOD5	TSS	total chlorine residual	free chlorine residual	fecal coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Star Princess	6/16/2003	7.4	68	0.0	0.00	0.00	0
Star Princess	6/23/2003	7.7	3	0.0	0.00	0.00	0
Star Princess	7/7/2003	7.1	0	0.0	0.00	0.00	0
Star Princess	7/21/2003	7.6	2	0.0	0.00	0.00	0
Star Princess	8/4/2003	6.9	0	0.0	0.00	0.00	0
Star Princess	8/18/2003	7.2	0	0.0	0.00	0.00	0
Star Princess	9/8/2003	6.9	0	0.0	0.00	0.00	0
Star Princess	9/15/2003	6.8	0	0.0	0.00	0.00	0
Sun Princess	5/15/2003	7.5	11	0.0	2.00	2.00	0
Sun Princess	5/29/2003	7.9	4	6.4	0.00	0.00	0
Sun Princess	6/12/2003	7.6	6	0.0	0.00	0.00	0
Sun Princess	6/20/2003	7.7	86	0.0	0.00	0.00	0
Sun Princess	6/26/2003	7.8	0	0.0	55.00	50.00	0
Sun Princess	7/10/2003	7.9	0	0.0	3.50	2.50	0
Sun Princess	7/24/2003	7.6	0	0.0	0.50	0.40	0
Sun Princess	8/7/2003	7.6	0	0.0	1.00	1.00	0
Sun Princess	8/18/2003	7.2	0	0.0	0.00	0.00	0
Sun Princess	8/21/2003	7.4	0	0.0	1.40	1.20	0
Sun Princess	9/4/2003	7.2	3	4.3	0.80	0.70	11

		pH	BOD5	TSS	total chlorine residual	free chlorine residual	fecal coliform
			mg/L	mg/L	mg/L	mg/L	MPN/100
VESSEL_ID	Sample_Date	0.1	2	1.3	0.10	0.10	2
Sun Princess	9/12/2003	6.8	0	0.0	1.30	0.70	0
	Minimum	**6.6**	**0**	**0.0**	**0.00**	**0.00**	**0**
	Median	**7.3**	**2**	**0.0**	**0.00**	**0.00**	**0**
	Maximum	**8.1**	**86**	**19.1**	**55.00**	**50.00**	**220**

Table 9. 2003 Large Ship Graywater Priority Pollutant Results

		Arsenic, dissolved	Chromium, dissolved	Copper, dissolved	Lead, dissolved	Nickel, dissolved	Zinc, dissolved	1,2,4-trimethylbenzene	Acetone	m&p Xylenes	O-xylene	Benzyl Alcohol
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
VESSEL_ID	Sample_Date	0.15	0.15	0.15	0.15	0.15	0.15	0.50	0.15	0.15	0.50	0.50
Carnival Spirit	8/30/2003	0.277	0.328	1.31	0.146	1.34	35.70	0.00	27.00	1.70	0.57	73.00
Carnival Spirit	9/12/2003	1.51	0.392	2.59	0.129	3.07	47.00	1.70	41.00	13.00	2.80	300.00
	Minimum	**0.28**	**0.33**	**1.31**	**0.13**	**1.34**	**35.70**	**0.00**	**27.00**	**1.70**	**0.57**	**73.00**
	Median	**0.89**	**0.36**	**1.95**	**0.14**	**2.21**	**41.35**	**0.85**	**34.00**	**7.35**	**1.69**	**186.50**
	Maximum	**1.51**	**0.39**	**2.59**	**0.15**	**3.07**	**47.00**	**1.70**	**41.00**	**13.00**	**2.80**	**300.00**

Table 10. 2003 Large Ship Blackwater Priority Pollutants, Excluding Metals

Median = > MDL or at Least One Sample 10X MDL

		1,4-dichlorobenzene	chloroform	tetrachloroethene	trichloroethene	2,4-dichlorophenol	2,4,6-trichlorophenol	bromomethane, methyl bromide	chloromethane, methyl chloride	methylene chloride
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	1.00	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00
VESSEL_ID	Sample_Date									
Coral Princess	8/23/03	0.00	2.00	0.53	0.00	2.70	0.00	0.00	0.00	0.00
Dawn Princess	6/23/03	0.00	0.00	0.00	0.00	4.10	1.90	0.00	0.00	1.10
Dawn Princess	6/24/03	0.00	0.00	0.00	0.00	7.50	2.30	0.00	0.00	1.20
Dawn Princess	8/14/03	0.00	0.71	0.00	0.00	1.20	0.00	0.00	0.00	0.00
Dawn Princess	8/14/03	0.00	0.72	0.00	0.00	1.20	0.00	0.00	0.00	0.00
Island Princess	7/19/03	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Island Princess	9/3/03	0.00	2.30	0.00	0.00	2.10	0.00	0.00	0.00	0.00
Maasdam	7/26/03	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maasdam	8/9/03	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norwegian Sky	7/29/03	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norwegian Sun	6/24/03	0.00	2.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norwegian Sun	9/9/03	0.00	7.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		1,4-dichlorobenzene	chloroform	tetrachloroethene	trichloroethene	2,4-dichlorophenol	2,4,6-trichlorophenol	bromomethane, methyl bromide	chloromethane, methyl chloride	methylene chloride
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	1.00	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00
VESSEL_ID	Sample_Date									
Norwegian Wind	6/18/03	0.00	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norwegian Wind	7/23/03	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norwegian Wind	7/23/03	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pacific Princess	8/31/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pacific Princess	9/12/03	7.10	0.00	0.00	0.00	0.00	0.00	7.20	2.70	0.00
Ryndam	6/20/03	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Ryndam	7/1/03	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seven Seas Mariner	8/9/03	0.00	7.20	0.74	0.00	0.00	0.00	0.00	0.00	0.00
Seven Seas Mariner	8/27/03	0.00	1.30	1.10	0.00	0.00	0.00	0.00	0.00	0.00
Seven Seas Mariner	8/27/03	0.00	1.30	1.20	0.00	0.00	0.00	0.00	0.00	0.00
Star Princess	8/11/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Star Princess	8/25/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Statendam	8/20/03	0.00	4.80	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Statendam	9/7/03	0.00	3.10	0.57	0.00	0.00	0.00	0.00	0.00	0.96
Statendam	9/7/03	0.00	3.10	0.57	0.00	0.00	0.00	0.00	0.00	0.96

		1,4-dichlorobenzene	chloroform	tetrachloroethene	trichloroethene	2,4-dichlorophenol	2,4,6-trichlorophenol	bromomethane, methyl bromide	chloromethane, methyl chloride	methylene chloride
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	1.00	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00
VESSEL_ID	Sample_Date									
Sun Princess	6/16/03	0.00	4.10	0.00	0.00	0.00	0.00	13.00	0.00	0.00
Sun Princess	8/1/03	0.00	1.10	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Veendam	7/2/03	0.00	1.80	7.10	0.00	0.00	0.00	0.00	0.00	0.00
Veendam	7/20/03	0.00	1.30	29.00	2.10	0.00	0.00	0.00	0.00	1.30
Volendam	7/9/03	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Volendam	7/23/03	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zaandam	7/28/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zaandam	6/30/03	0.00	0.49	0.00	0.00	Not taken	Not taken	0.00	0.00	0.00
	Minimum	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Median	**0.00**	**1.30**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Maximum	**7.10**	**7.30**	**29.00**	**2.10**	**7.50**	**2.30**	**13.00**	**2.70**	**1.30**

Table 11. 2003 Large Ship Blackwater Priority Pollutants, Excluding Metals (continued)

Median = > MDL or at Least One Sample 10X MDL

		ethylbenzene	naphthalene	toluene	n-nitrosodimethylamine	n-nitroso-di-n-proplyamine	phenol	bis(2-ethylhexyl)phthalate	diethylphthalate	di-n-butylphthalate
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	2.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00
VESSEL_ID	Sample_Date									
Coral Princess	8/23/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dawn Princess	6/23/03	0.00	0.00	0.00	0.00	0.00	2.60	0.00	0.00	1.30
Dawn Princess	6/24/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dawn Princess	8/14/03	1.10	0.00	0.00	0.00	0.00	4.10	0.00	0.00	0.00
Dawn Princess	8/14/03	1.10	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Island Princess	7/19/03	0.00	0.00	0.00	0.00	0.00	2.20	0.00	0.00	0.00
Island Princess	9/3/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
Maasdam	7/26/03	0.00	0.00	0.00	0.00	0.00	3.30	0.00	0.00	1.40
Maasdam	8/9/03	0.00	0.00	0.73	0.00	0.00	3.80	0.00	0.00	0.00
Norwegian Sky	7/29/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50	2.30
Norwegian Sun	6/24/03	0.00	1.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00

		ethylbenzene	naphthalene	toluene	n-nitrosodimethylamine	n-nitroso-di-n-proplyamine	phenol	bis(2-ethylhexyl)phthalate	diethylphthalate	di-n-butylphthalate
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	2.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00
VESSEL_ID	Sample_Date									
Norwegian Sun	9/9/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.50	0.00
Norwegian Wind	6/18/03	0.00	0.00	0.59	0.00	0.00	0.00	1.20	5.80	1.70
Norwegian Wind	7/23/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norwegian Wind	7/23/03	0.00	0.00	0.00	0.00	0.00	0.00	1.20	8.60	0.00
Pacific Princess	8/31/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pacific Princess	9/12/03	0.00	0.00	0.00	26.32	0.00	0.00	0.00	0.00	0.00
Ryndam	6/20/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ryndam	7/1/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seven Seas Mariner	8/9/03	0.00	0.00	0.00	0.00	0.00	4.90	0.00	0.00	0.00
Seven Seas Mariner	8/27/03	0.00	0.00	0.00	0.00	0.00	3.80	0.00	0.00	0.00
Seven Seas Mariner	8/27/03	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Star Princess	8/11/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Star Princess	8/25/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		ethylbenzene	naphthalene	toluene	n-nitrosodimethylamine	n-nitroso-di-n-proplyamine	phenol	bis(2-ethylhexyl)phthalate	diethylphthalate	di-n-butylphthalate
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	2.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00
VESSEL_ID	Sample_Date									
Statendam	8/20/03	0.00	0.00	2.20	0.00	0.00	0.00	0.00	0.00	0.00
Statendam	9/7/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Statendam	9/7/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sun Princess	6/16/03	0.00	0.00	0.00	0.00	14.00	0.00	0.00	0.00	0.00
Sun Princess	8/1/03	0.00	0.00	0.00	0.00	0.00	8.90	0.00	0.00	0.00
Veendam	7/2/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10
Veendam	7/20/03	0.00	0.00	3.20	0.00	0.00	2.90	0.00	0.00	0.00
Volendam	7/9/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.30
Volendam	7/23/03	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00
Zaandam	7/28/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60
Zaandam	6/30/03	0.00	0.00	0.00						
	Minimum	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Median	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

		ethylbenzene	naphthalene	toluene	n-nitrosodimethylamine	n-nitroso-di-n-proplyamine	phenol	bis(2-ethylhexyl)phthalate	diethylphthalate	di-n-butylphthalate
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	2.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00
VESSEL_ID	Sample_Date									
	Maximum	**1.10**	**1.00**	**3.20**	**26.32**	**14.00**	**8.90**	**1.20**	**10.00**	**3.10**

Table 12. 2003 Large Ship Blackwater Priority Pollutants, Excluding Metals (continued)

Median = > MDL or at Least One Sample 10X MDL

		1,1-dichloroethene	1,2,4-trimethylbenzene	2-butanone	4-methyl-2-pentanone	Acetone	m&p Xylenes	3&4-Methylphenol	Chloroform
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	0.48	1.5	0.36	2.5	0.28	0.61	0.50
VESSEL_ID	Sample_Date								
Coral Princess	8/23/03	0.00	0.00	8.9	0.00	20.0	0.00	0.0	2.00
Dawn Princess	6/23/03	0.00	0.00	0.0	0.00	3.6	0.00	2.2	0.00
Dawn Princess	6/24/03	0.00	0.00	0.0	0.00	0.0	0.00	1.4	0.00
Dawn Princess	8/14/03	0.00	0.71	5.6	0.00	12.0	5.30	56.0	0.71
Dawn Princess	8/14/03	0.00	0.00	0.0	0.00	4.4	5.50	7.2	0.72
Island Princess	7/19/03	0.00	0.00	0.0	0.00	3.3	0.57	0.0	0.00
Island Princess	9/3/03	0.00	0.00	0.0	0.00	4.3	0.00	0.0	2.30
Maasdam	7/26/03	0.00	0.00	0.0	0.00	5.0	0.00	0.0	1.20
Maasdam	8/9/03	0.00	0.00	0.0	0.00	33.0	0.00	0.0	1.40
Norwegian Sky	7/29/03	0.00	0.00	0.0	0.00	28.2	0.00	0.0	1.20
Norwegian Sun	6/24/03	0.00	1.70	17.0	6.00	160.0	0.89	0.0	2.80

		1,1-dichloroethene	1,2,4-trimethylbenzene	2-butanone	4-methyl-2-pentanone	Acetone	m&p Xylenes	3&4-Methylphenol	Chloroform
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	0.48	1.5	0.36	2.5	0.28	0.61	0.50
VESSEL_ID	Sample_Date								
Norwegian Sun	9/9/03	0.00	0.00	0.0	0.00	65.3	0.00	0.0	7.30
Norwegian Wind	6/18/03	0.00	0.00	0.0	8.20	52.0	0.00	0.0	1.70
Norwegian Wind	7/23/03	0.00	0.00	0.0	0.00	0.0	0.00	0.0	1.40
Norwegian Wind	7/23/03	0.00	0.00	0.0	0.00	0.0	0.00	0.0	1.30
Pacific Princess	8/31/03	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Pacific Princess	9/12/03	0.00	0.00	0.0	0.00	6.7	0.00	0.0	0.00
Ryndam	6/20/03	0.00	0.00	980.0	0.00	200.0	0.00	0.0	1.40
Ryndam	7/1/03	0.00	0.00	1.9	0.00	14.0	0.00	0.0	2.30
Seven Seas Mariner	8/9/03	0.00	0.00	0.0	0.00	0.0	0.00	0.0	7.20
Seven Seas Mariner	8/27/03	0.00	0.00	0.0	0.00	5.9	0.00	19.0	1.30
Seven Seas Mariner	8/27/03	0.00	0.00	0.0	0.00	9.0	0.00	10.0	1.30
Star Princess	8/11/03	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Star Princess	8/25/03	0.00	0.00	0.0	0.00	45.0	0.00	0.0	0.00

		1,1-dichloroethene	1,2,4-trimethylbenzene	2-butanone	4-methyl-2-pentanone	Acetone	m&p Xylenes	3&4-Methylphenol	Chloroform
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	0.48	1.5	0.36	2.5	0.28	0.61	0.50
VESSEL_ID	Sample_Date								
Statendam	8/20/03	0.00	0.00	6.2	0.00	61.0	0.00	0.0	4.80
Statendam	9/7/03	0.00	0.00	0.0	0.00	8.6	0.00	0.0	3.10
Statendam	9/7/03	0.00	0.00	0.0	0.00	8.6	0.00	0.0	3.10
Sun Princess	6/16/03	0.00	0.00	0.0	0.00	3.9	0.00	0.0	4.10
Sun Princess	8/1/03	0.00	0.00	0.0	0.00	9.1	0.00	0.0	1.10
Veendam	7/2/03	0.00	0.00	9.5	0.00	32.0	0.00	0.0	1.80
Veendam	7/20/03	2.80	0.00	0.0	0.00	22.0	0.29	20.0	1.30
Volendam	7/9/03	0.00	0.00	0.0	0.00	6.4	0.45	0.0	0.79
Volendam	7/23/03	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.69
Zaandam	7/28/03	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Zaandam	6/30/03	0.00	0.00	0.0	0.00	0.0	0.00		0.49
	Minimum	**0.00**	**0.00**	**0.0**	**0.00**	**0.0**	**0.00**	**0.0**	**0.00**
	Median	**0.00**	**0.00**	**0.0**	**0.00**	**6.7**	**0.00**	**0.0**	**1.30**

		1,1-dichloroethene	1,2,4-trimethylbenzene	2-butanone	4-methyl-2-pentanone	Acetone	m&p Xylenes	3&4-Methylphenol	Chloroform
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.50	0.48	1.5	0.36	2.5	0.28	0.61	0.50
VESSEL_ID	Sample_Date								
	Maximum	**2.80**	**1.70**	**980.0**	**8.20**	**200.0**	**5.50**	**56.0**	**7.30**

Table 13. 2003 Large Ship Blackwater Priority Pollutants, Metals A - L

At Least One Sample 10X the Method Detection Limit (MDL)

		Arsenic (TR)	Arsenic, dissolved	Chromium (TR)	Chromium, dissolved	Copper (TR)	Copper, dissolved	Lead (TR)	Lead, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
VESSEL_ID	Sample_Date								
Coral Princess	8/23/03	2.65	2.73	1.01	1.55	28.90	12.50	1.52	0.61
Dawn Princess	6/23/03	3.20	3.19	5.40	3.47	12.70	9.96	0.59	0.58
Dawn Princess	6/24/03	3.14	3.22	6.51	3.08	10.60	10.70	0.46	0.55
Dawn Princess	8/14/03	2.05	2.26	1.01	12.20	13.90	6.78	1.35	0.40
Dawn Princess	8/14/03	2.10	0.00	0.82	1.43	10.60	0.00	0.91	0.00
Island Princess	7/19/03	7.93	7.83	1.42	1.24	83.90	116.00	0.45	0.47
Island Princess	9/3/03	1.38	1.22	3.03	0.00	13.50	12.20	0.79	0.59
Maasdam	7/26/03	0.57	0.57	1.54	1.11	11.60	11.50	3.17	2.70
Maasdam	8/9/03	0.90	0.83	0.95	0.90	2.11	1.93	0.00	0.00
Norwegian Sky	7/29/03	1.84	1.71	0.55	0.45	27.90	22.00	1.02	0.82
Norwegian Sun	6/24/03	0.90	1.05	0.72	2.26	34.20	34.00	2.01	1.95
Norwegian Sun	9/9/03	0.94	0.99	0.38	4.90	41.70	25.20	2.55	2.22
Norwegian Wind	6/18/03	1.21	1.17	0.95	0.45	4.54	3.41	0.32	0.32
Norwegian Wind	7/23/03	1.46	1.38	0.52	0.64	5.02	2.42	0.24	0.22
Norwegian Wind	7/23/03	1.44	1.21	0.69	0.54	11.10	2.14	0.25	0.13
Pacific Princess	8/31/03	0.95	0.90	1.17	1.12	24.60	23.60	0.27	0.26

		Arsenic (TR)	Arsenic, dissolved	Chromium (TR)	Chromium, dissolved	Copper (TR)	Copper, dissolved	Lead (TR)	Lead, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
VESSEL_ID	Sample_Date								
Pacific Princess	9/12/03	2.75	1.25	17.60	1.54	42.50	31.00	0.18	0.25
Ryndam	6/20/03	0.70	0.80	0.86	3.62	7.66	7.21	0.13	0.20
Ryndam	7/1/03	1.02	1.04	0.82	0.94	11.60	11.40	0.17	0.14
Seven Seas Mariner	8/9/03	1.02	0.96	1.45	1.29	5.42	4.77	0.20	0.18
Seven Seas Mariner	8/27/03	1.08	1.14	0.98	1.48	10.20	12.60	0.66	0.19
Seven Seas Mariner	8/27/03	1.12	1.15	1.01	1.03	12.70	9.33	0.32	0.30
Star Princess	8/11/03	6.37	5.56	3.18	2.07	115.00	115.00	0.85	0.00
Star Princess	8/25/03	4.38	4.30	23.60	24.60	189.00	177.00	0.99	1.25
Statendam	8/20/03	2.09	2.09	2.98	3.10	116.00	83.70	4.78	6.33
Statendam	9/7/03	1.69	1.64	11.40	11.30	4.89	5.90	0.27	0.28
Statendam	9/7/03	1.69	1.64	11.40	11.30	4.89	5.90	0.27	0.28
Sun Princess	6/16/03	3.48	3.28	4.97	6.92	21.30	18.90	0.37	0.33
Sun Princess	8/1/03	2.91	2.60	0.85	0.80	30.60	21.00	0.33	0.26
Veendam	7/2/03	1.56	ND	0.92	ND	6.69	0.08	0.12	0.8
Veendam	7/20/03	1.47	1.45	1.23	1.00	7.05	5.63	0.11	0.13
Volendam	7/9/03	0.66	0.67	0.72	1.43	5.49	4.89	0.25	0.31
Volendam	7/23/03	0.65	0.68	1.06	2.04	9.51	7.42	0.20	0.23

		Arsenic (TR)	Arsenic, dissolved	Chromium (TR)	Chromium, dissolved	Copper (TR)	Copper, dissolved	Lead (TR)	Lead, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
VESSEL_ID	Sample_Date								
Zaandam	7/28/03	1.05	0.94	1.06	1.06	15.20	14.70	0.12	0.11
Zaandam	6/30/03	0.69	0.71	1.21	1.36	13.30	7.36	7.63	0.92
	Minimum	**0.57**	**0.00**	**0.38**	**0.00**	**2.11**	**0.00**	**0.00**	**0.00**
	Median	**1.46**	**1.22**	**1.06**	**1.43**	**12.70**	**10.70**	**0.33**	**0.29**
	Maximum	**7.93**	**7.83**	**23.60**	**24.60**	**189.00**	**177.00**	**7.63**	**6.33**
	10XMDL	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

Table 14. 2003 Large Ship Blackwater Priority Pollutants, Metals N - Z

At Least One Sample 10X the Method Detection Limit (MDL)

		Nickel (TR)	Nickel, dissolved	Selenium (TR)	Selenium, dissolved	Silver (TR)	Silver, dissolved	Zinc (TR)	Zinc, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
VESSEL_ID	Sample_Date								
Coral Princess	8/23/03	7.47	8.64	1.84	2.03	0.30	0.00	49.10	62.30
Dawn Princess	6/23/03	6.32	6.17	4.37	5.00	0.08	0.00	119.00	137.00
Dawn Princess	6/24/03	6.13	6.19	4.57	5.25	0.00	0.00	121.00	140.00
Dawn Princess	8/14/03	5.47	4.80	6.26	5.22	1.63	0.00	129.00	141.00
Dawn Princess	8/14/03	4.75	0.34	5.79	0.00	1.27	0.00	129.00	7.12
Island Princess	7/19/03	12.30	12.30	6.63	6.39	1.06	0.55	113.00	100.00
Island Princess	9/3/03	10.20	9.90	1.07	0.00	0.00	0.00	144.00	159.00
Maasdam	7/26/03	16.70	16.50	0.74	0.64	0.00	0.00	84.10	95.10
Maasdam	8/9/03	16.30	16.40	0.86	0.74	1.84	1.69	6.59	27.90
Norwegian Sky	7/29/03	12.80	12.60	0.64	0.69	0.50	0.00	164.00	188.00
Norwegian Sun	6/24/03	6.48	6.55	0.64	2.11	0.00	0.00	241.00	272.00
Norwegian Sun	9/9/03	5.20	5.16	0.27	0.00	0.99	0.00	364.00	230.00
Norwegian Wind	6/18/03	39.20	39.70	1.11	1.05	0.00	0.00	66.60	106.00

		Nickel (TR)	Nickel, dissolved	Selenium (TR)	Selenium, dissolved	Silver (TR)	Silver, dissolved	Zinc (TR)	Zinc, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
VESSEL_ID	Sample_Date								
Norwegian Wind	7/23/03	34.80	33.00	1.78	1.76	0.14	0.00	38.40	61.00
Norwegian Wind	7/23/03	34.10	29.70	1.66	1.62	0.04	0.00	42.70	50.10
Pacific Princess	8/31/03	23.00	23.30	0.77	0.74	0.29	0.32	117.00	155.00
Pacific Princess	9/12/03	33.60	18.70	10.00	1.38	0.00	0.47	120.00	134.00
Ryndam	6/20/03	22.00	22.40	0.72	0.66	0.97	0.00	116.00	124.00
Ryndam	7/1/03	27.80	28.80	0.48	0.00	0.29	0.52	78.30	83.10
Seven Seas Mariner	8/9/03	15.70	15.00	0.78	0.74	2.21	1.55	77.90	100.00
Seven Seas Mariner	8/27/03	11.40	12.10	0.39	0.00	0.74	1.45	6.57	16.60
Seven Seas Mariner	8/27/03	11.70	11.60	0.48	0.63	0.85	1.02	4.89	15.20
Star Princess	8/11/03	18.80	19.20	18.10	14.40	0.91	1.95	128.00	132.00
Star Princess	8/25/03	28.00	27.30	10.70	10.90	0.33	0.36	350.00	359.00
Statendam	8/20/03	31.00	33.80	4.85	4.84	0.44	0.28	212.00	265.00
Statendam	9/7/03	35.10	35.60	2.86	3.08	0.00	0.00	41.90	52.00
Statendam	9/7/03	35.10	35.60	2.86	3.08	0.00	0.00	41.90	52.00
Sun Princess	6/16/03	8.16	8.05	5.06	3.42	0.00	0.00	111.00	103.00
Sun Princess	8/1/03	6.33	6.25	4.44	4.74	0.84	0.82	124.00	137.00

		Nickel (TR)	Nickel, dissolved	Selenium (TR)	Selenium, dissolved	Silver (TR)	Silver, dissolved	Zinc (TR)	Zinc, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
VESSEL_ID	Sample_Date								
Veendam	7/2/03	9.00	0.8	0.86	ND	0.68	ND	131.00	ND
Veendam	7/20/03	10.10	9.46	0.42	0.00	0.51	0.98	163.00	156.00
Volendam	7/9/03	7.78	7.27	0.61	0.72	0.43	0.00	98.40	113.00
Volendam	7/23/03	7.97	8.02	0.74	0.73	0.53	0.00	96.60	135.00
Zaandam	7/28/03	14.70	14.50	1.47	0.68	0.53	0.00	58.00	71.10
Zaandam	6/30/03	13.50	14.10	1.06	1.04	0.24	0.00	127.00	79.30
	Minimum	**4.75**	**0.34**	**0.27**	**0.00**	**0.00**	**0.00**	**4.89**	**7.12**
	Median	**12.80**	**12.60**	**1.11**	**1.05**	**0.43**	**0.00**	**116.00**	**109.50**
	Maximum	**39.20**	**39.70**	**18.10**	**14.40**	**2.21**	**1.95**	**364.00**	**359.00**
	10XMDL	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

2002

Table 15. 2002 Data from Large Ships - Blackwater Conventional Pollutants

Sample Name	Sample Date	Alkalinity	Ammonia as N	BOD	COD	Conductivity	Fecal coliform	Total CL	Free Cl	Oil& Grease	Nitrate as N	TKN	pH	Phosphorous	TOC	Settleable Solids	TSS
		CaCO3															
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**Umhos/cm**	**MPN**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**Mg/L**	**mg/L**
MDL		**0.5**	**0.03**	**2**	**3.0**	**1**	**2**	**0.10**	**0.10**	**1.5**	**1.0**	**0.1**	**0.1**	**0.01**	**1.0**	**0.1**	**1.3**
Mercury Rochem	5/23/02	Not taken	1.00	1	1.7	Not taken	1	ND	ND	Not taken	Not taken	Not taken	7.7	Not taken	Not taken	Not taken	0.1
Mercury Rochem	6/27/02	33.3	1.90	1	1.7	64	1	ND	ND	0.9	1.9	7.0	7.5	0.11	265.0	0.1	0.1
7 Seas Navigator C	8/10/02	70.9	43.80	1	169.0	1,940	1	ND	ND	13.0	56.9	43.9	6.7	18.20	32.0	0.1	0.1
7 Seas Navigator Ballast Tank	8/10/02	102.0	0.11	11	1,040.0	42	1	ND	ND	150.0	0.1	2.0	8.1	0.06	Not taken	0.1	65.2
7 Seas Navigator Ballast Tank	8/10/02	127.0	27.00	45	324.0	16,100	80	ND	ND	19.0	12.9	28.5	7.3	13.00	8.0	0.8	126.0
Seven Seas TWW-C	7/1/02	329.0	87.20	1	147.0	4,450	1	ND	ND	7.1	0.1	59.1	7.6	19.40	48.0	0.1	0.1
Seven Seas TWW-E	7/1/02	135.0	0.01	12	1,210.0	47,000	1	ND	ND	280.0	0.1	2.1	7.6	0.40	29.0	0.1	152.0
Seven Seas	7/1/02	507.0	130.00	231	536.0	7,730	2,200	ND	ND	15.0	0.1	11.4	7.5	16.10	153.	0.1	11.

Sample Name	Sample Date	Alkalinity	Ammonia as N	BOD	COD	Conductivity	Fecal coliform	Total CL	Free Cl	Oil& Grease	Nitrate as N	TKN	pH	Phosphorous	TOC	Settleable Solids	TSS
		CaCO3															
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**Umhos/cm**	**MPN**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**Mg/L**	**mg/L**
MDL		**0.5**	**0.03**	**2**	**3.0**	**1**	**2**	**0.10**	**0.10**	**1.5**	**1.0**	**0.1**	**0.1**	**0.01**	**1.0**	**0.1**	**1.3**
TWW-F															0		2
Statendam	6/12/02	114.0	6.17	2	68.2	638	70	ND	0.05	0.9	0.1	6.8	7.1	3.04	23.0	0.1	0.1
Statendam	6/12/02	108.0	5.73	3	61.6	602	1	ND	0.05	0.9	0.1	8.9	7.0	1.71	23.0	0.1	0.1
Ryndam	8/17/02	174.0	18.80	1	31.0	588	1	ND	ND	0.9	0.1	21.0	7.7	0.61	13.0	0.1	0.1
Ryndam	6/24/02	135.0	18.60	4	52.9	2,000	900	ND	ND	0.1	0.1	27.0	7.4	2.28	16.0	0.1	0.1
Statendam	5/29/02	151.0	8.83	114	101.0	795	2	ND	ND	not taken	0.1	10.7	7.2	3.37	28.0	0.1	0.1
Statendam	8/21/02	208.0	27.70	1	59.4	854	1	ND	ND	0.9	0.1	33.0	7.7	5.00	20.0	0.1	0.1
Veendam	7/17/02	161.0	29.40	1	48.5	632	1	ND	ND	0.9	0.1	18.9	7.4	2.31	247.0	0.1	0.1
Volendam	6/6/02	60.1	0.60	5	46.3	375	900	ND	ND	0.9	5.0	1.9	7.5	2.86	12.0	0.1	7.1
Volendam	6/6/02	68.2	0.01	1	28.9	371	1	ND	ND	0.9	3.4	1.5	7.5	2.66	12.0	0.1	0.1

Sample Name	Sample Date	Alkalinity	Ammonia as N	BOD	COD	Conductivity	Fecal coliform	Total CL	Free Cl	Oil& Grease	Nitrate as N	TKN	pH	Phosphorous	TOC	Settleable Solids	TSS
		CaCO3															
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**Umhos/cm**	**MPN**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**		**mg/L**	**mg/L**	**Mg/L**	**mg/L**
MDL		**0.5**	**0.03**	**2**	**3.0**	**1**	**2**	**0.10**	**0.10**	**1.5**	**1.0**	**0.1**	**0.1**	**0.01**	**1.0**	**0.1**	**1.3**
Volendam	8/21/02	189.0	24.20	11	83.5	593	1	ND	ND	8.4	0.1	26.6	7.5	8.47	25.0	0.1	0.1
Volendam	8/21/02	202.0	23.60	10	70.4	623	1	ND	ND	12.0	0.1	27.8	7.5	7.64	28.0	0.1	0.1
Zaandam	8/19/02	52.1	22.70	3	52.9	732	1	ND	ND	0.9	0.1	27.7	7.8	4.51	16.0	0.1	0.1
Zaandam	6/5/02	238.0	36.50	1	44.2	797	1	ND	ND	12.0	0.1	39.3	7.8	5.59	19.0	0.1	0.1
Minimum		**52.0**	**0.01**	**1**	**28.9**	**371**	**1**	**ND**	**ND**	**0.1**	**0.1**	**1.5**	**7.4**	**0.40**	**12.0**	**0.1**	**0.1**
Maximum		**507.0**	**130.00**	**231**	**1,210.0**	**47,000**	**2,200**	**ND**	**ND**	**280.0**	**5.0**	**59.1**	**7.8**	**19.40**	**247.0**	**0.1**	**152.0**
Geometric Mean		**157.0**	**7.00**	**3**	**83.0**	**1,302**	**5**	**ND**	**ND**	**3.0**	**0.1**	**14.0**	**7.6**	**3.70**	**28.0**	**0.1**	**0.2**
Median		**135.0**	**18.80**	**3**	**61.6**	**685**	**1**	**ND**	**ND**	**0.9**	**0.1**	**20.0**	**7.5**	**3.21**	**23.0**	**0.1**	**0.1**

Table 16. 2002 Data from Large Ships - Blackwater Metals Total & Dissolved (A-C)

Sample Name	Sample Date	Antimony-D	Antimony-T	Arsenic-D	Arsenic-T	Chromium-D	Chromium-T	Copper-D	Copper-T
Units		**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
MDL		**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
7 Seas Navigator TWW-C MBR	7/1/2002	0.298	0.255	3.38	3.13	2.27	1.82	131	135
7 Seas Navigator TWW-F Ballast Tank	7/1/2002	0.014	3.37	61.5	23.4	198	11	140	3970
Ryndam TWW	8/17/02	0.014	0.202	0.576	0.729	7.35	0.641	5.16	5.5
Statendam TWW	8/21/02	0.667	0.721	0.893	0.987	5.45	0.715	1.67	2.04
Veendam Zenon 71702-WW	7/17/02	0.181	0.255	1.26	1.45	3.36	0.856	5.9	6.49
Volendam TWW-1	8/21/02	0.106	0.255	0.552	0.82	5.72	0.972	7.52	7.9
Volendam TWW-2	8/21/02	0.014	0.255	0.569	0.801	5.83	1.42	7.91	7.66
Zaandam TWW	8/19/02	0.255	0.366	0.662	0.944	4.72	0.596	8.3	8.31
Minimum		**0.01**	**0.2**	**0.55**	**0.73**	**2.27**	**0.6**	**1.67**	**2.04**
Maximum		**0.67**	**3.37**	**61.5**	**23.4**	**198**	**11**	**140**	**3970**
Geometric mean		**0.08**	**0.41**	**1.52**	**1.62**	**7.45**	**1.26**	**12.1**	**19.35**
Median		**0.14**	**0.26**	**0.78**	**0.97**	**5.59**	**0.91**	**7.72**	**7.78**

Table 17. 2002 Data from Large Ships - Blackwater Metals Total & Dissolved (L-Z)

Sample Name	Date	Lead-D	Lead-T	Nickel-D	Nickel-T	Selenium-D	Selenium-T	Zinc-D	Zinc-T
Units		**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
MDL		**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
7 Seas Navigator TWW-C MBR	8/10/02	2.220	5.010	17.700	18.000	9.55	8.35	466.000	446.000
7 Seas Navigator TWW-F Ballast Tank	8/10/02	4.660	62.400	112.000	94.800	231.00	90.70	2470.000	7660.000
Ryndam TWW	8/17/02	1.220	1.350	22.900	22.100	0.95	1.54	208.000	183.000
Statendam TWW	8/21/02	0.236	1.430	23.300	22.200	1.27	1.63	24.800	23.600
Veendam Zenon 71702-WW	7/17/02	0.358	0.323	15.700	17.100	0.94	1.37	196.000	201.000
Volendam TWW-1	8/21/02	0.975	2.090	8.960	9.820	0.76	1.87	195.000	176.000
Volendam TWW-2	8/21/02	0.963	2.480	9.400	9.730	0.76	1.43	194.000	174.000
Zaandam TWW	8/19/02	2.090	3.300	7.360	7.190	0.92	1.95	195.000	152.000
Minimum		**0.24**	**0.320**	**7.36**	**7.190**	**0.76**	**1.37**	**24.80**	**23.600**
Maximum		**4.66**	**62.400**	**112.00**	**94.800**	**231.00**	**90.70**	**2470.00**	**7660.000**
Geometric Mean		**1.10**	**2.760**	**17.85**	**17.750**	**2.45**	**3.29**	**232.66**	**246.890**
Median		**1.10**	**2.285**	**16.70**	**17.550**	**0.94**	**1.75**	**195.50**	**179.500**

Table 18. 2002 Data from Large Ships - Blackwater Priority Pollutants excluding Metals

Sample_Name	Sample Date	1,2,4-Trimethylbenzene	2-Butanone	Acetone	Bis(2-Ethylhexyl)Phthalate	Chloroform	Di-n-Butyl phthalate	M&p Xylenes	Tetrachloroethene	Toluene
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	Ug/L	ug/L	ug/L
MDL		**0.48**	**1.5**	**3.2**	**0.83**	**0.50**	**1.0**	**0.28**	**0.45**	**0.50**
7 Seas Navigator TWW-C MBR	8/10/02	0.45	0.5	4.3	2.2	2.1	0.7	1.1	0.06	0.51
7 Seas Navigator TWW-F Ballast	8/10/02	2.2	0.5	6.2	5.2	3.1	0.7	3	0.06	1.2
Mercury Rochem Sample Port	6/27/02	0.15	0.5	1.25	0.335	0.65	0.7	0.075	0.06	0.125
Ryndam TWW	8/17/02	0.15	0.5	4.9	3.3	0.85	1.8	0.075	0.06	0.125
Statendam TWW	8/21/02	0.15	0.5	11	0.335	1.3	2.4	0.075	3.4	0.53
Veendam Zenon 71702-WW	7/17/02	0.15	0.5	21	0.335	1.3	3.4	0.075	0.06	0.92
Volendam TWW-1	8/21/02	0.15	2.8	25	0.335	1.2	1.8	0.075	0.06	1.1
Volendam TWW-2	8/21/02	0.15	3.1	26	0.335	1.2	3.1	0.075	0.06	0.96
Zaandam TWW	8/19/02	0.15	0.86	6.1	0.335	1.1	0.7	0.075	0.06	0.125
Min		**0.15**	**0.5**	**1.25**	**0.34**	**0.65**	**0.7**	**0.08**	**0.06**	**0.13**
Max		**2.2**	**3.1**	**26**	**5.2**	**3.1**	**3.4**	**3**	**3.4**	**1.2**
Geometric Mean		**0.22**	**0.77**	**6.61**	**0.72**	**1.21**	**1.39**	**0.14**	**0.09**	**0.43**
Median		**0.15**	**0.50**	**6.15**	**0.34**	**1.20**	**1.80**	**0.08**	**0.06**	**0.55**

Table 19. 2002 Data from Large Ships Graywater Conventional Pollutants

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine	Free chlorine
Units		mg/L		Mg/L	mg/L	mg/L	MPN	mg/L	Mg/L
MDL		0.03	0.1	2.0	3.0	1.3	2	0.1	0.1
Dawn Princess GW-11 Galley	9/3/02	2.56	4.82	2130.0	3060	1070	60,000	0.05	0.05
Dawn Princess GW-A-15	9/12/02	1	6.7	403.0	460	92.5	1,600,000	0.05	0.05
Dawn Princess GW-A-4 Dom/Laundry	9/12/02	0.97	7.59	50.6	240	68.2	300,000	0.05	0.05
Dawn Princess GW-A-4 Domestic	6/20/02	0.836	6.76	158.0	372	70.2	2,400,000	0.05	0.05
Dawn Princess GW-A-8 Domestic	6/20/02	0.64	7.17	62.3	180	71.1	130,000	0.05	0.05
Dawn Princess GW-A-8 Domestic	9/12/02	1.99	6.25	388.0	752	292	220,000	0.05	0.05
Dawn Princess GW-D-11 Galley	6/20/02	8.88	3.88	6920.0	18100	7,700	30,000	0.05	0.05
Sea Princess GW - A	5/30/02	1.71	4.46	1800.0	3280	604	24,000	0.2	0.05
Sea Princess GW – B	5/30/02	2.35	7.06	328.0	503	122	2,400,000	0.1	0.05
Sea Princess GW – D	5/30/02	1.11	5.87	799.0	1660	356	240,000	0.05	0.05

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine	Free chlorine
Units		mg/L		Mg/L	mg/L	mg/L	MPN	mg/L	Mg/L
MDL		0.03	0.1	2.0	3.0	1.3	2	0.1	0.1
Norwegian Wind GW-1 C Laundry	5/24/02	4.21	6.68	194.0	643	43.8	110,000	0.05	0.05
Norwegian Wind GW-2 Mixed GW	5/24/02	0.008	6.92	199.0	652	128	3,000,000	0.05	0.05
Norwegian Wind GW-3 Mixed GW	5/24/02	0.008	6.86	178.0	639	122	5,000,000	0.05	0.05
Norwegian Sky GW-A	5/16/02	2.2	6.53	158.0	374	79.5	3,000,000	0.05	0.05
Ocean Princess GW-A-DB4 Domestic	5/21/02	0.768	7.1	263.0	553	48.5	300	3	0.2
Ocean Princess GW-A-DB8 Galley	5/21/02	1.26	4.3	1490.0	2680	144	500	0.05	0.05
Norwegian Sky GW-B	5/16/02	2.51	6.89	146.0	300	56.5	3,000,000	0.05	0.05
Ocean Princess GW-C Collection Tanks	7/19/02	0.191	7.28	110.0	389	46.6	300	0.05	0.05
Star Princess GW-C DB#8 Graywater	5/28/02	1.11	6.78	122.0	374	86.4	1,700,000	2	0.3

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine	Free chlorine
Units		mg/L		Mg/L	mg/L	mg/L	MPN	mg/L	Mg/L
MDL		0.03	0.1	2.0	3.0	1.3	2	0.1	0.1
Star Princess GW-D DB#10 Galley	5/28/02	3.68	3.73	3660.0	6170	2660	300	0.05	0.05
Norwegian Sky GW-A Mixed	8/2/02	1.56	4.79	987.0	2600	333	2,090	1	0.05
Norwegian Sky GW-B Mixed	8/2/02	1.86	4.75	1310.0	3540	566	2,910	1.5	0.2
Norwegian Wind GW-2 Mixed GW	9/13/02	0.081	6.82	326.0	430	210	1,600	0.05	0.05
Norwegian Wind GW-3 Mixed GW	9/13/02	0.15	7.05	163.0	170	107	1,600	0.05	0.05
Ocean Princess GW-C Overboard	7/19/02	0.008	7.76	260.0	228	145	1	8	5.5
Ocean Princess GW-C-H Overboard	7/19/02	0.658	4.86	7660.0	4200	5470	1	7	4
Regal Princess GW-AD Overboard	7/13/02	23.4	7.16	151.0	509	82.6	800,000	0.5	0.05
Regal Princess GW-ADC Overboard	7/13/02	0.008	4.36	1170.0	1900	464	800,000	0.05	0.05

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine	Free chlorine
Units		mg/L		Mg/L	mg/L	mg/L	MPN	mg/L	Mg/L
MDL		0.03	0.1	2.0	3.0	1.3	2	0.1	0.1
Regal Princess GW-AFT Mixed	7/23/02	0.878	5.06	1940.0	2260	1230	110,000	0.05	0.05
Regal Princess GW-FWD Mixed	7/23/02	4.17	7.02	330.0	621	64.8	500,000	0.05	0.05
Sea Princess GW-A-11 Galley	9/17/02	1.54	4.38	1370.0	2080	346	8,000	0.3	0.05
Sea Princess GW-D-6 Domestic	9/17/02	1.37	6.45	555.0	556	125	500,000	0.05	0.05
Sea Princess GW-D-8 Domestic	9/17/02	3.98	4.65	1310.0	1840	560	110,000	0.05	0.05
Sea Princess GW-D-9 Domestic	9/17/02	1.46	6.5	541.0	674	136	800,000	0.05	0.05
Star Princess GW-C (accom)	8/29/02	2.76	6.68	152.0	254	44.1	240	3.5	3.1
Star Princess GW-D (galley & laundry)	8/29/02	4.29	3.85	4280.0	17800	13,000.0	198,000	0.3	0.1
Sun Princess GW-A2 accomodations	6/7/02	0.632	6.21	875.0	1540	591.0	130,000	0.2	0.1

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine	Free chlorine
Units		**mg/L**		**Mg/L**	**mg/L**	**mg/L**	**MPN**	**mg/L**	**Mg/L**
MDL		**0.03**	**0.1**	**2.0**	**3.0**	**1.3**	**2**	**0.1**	**0.1**
Sun Princess GW-A3 accomodations	6/7/02	0.776	7.58	346.0	793	212.0	500	4	3.5
Sun Princess GW-A4 accomodations	6/7/02	1.16	7.19	669.0	1220	333.0	30,000	4	1.7
Sun Princess GW-C galley	7/11/02	2.66	4.11	2790.0	5110	1320.0	900	0.3	0.1
Minimum		**0.008**	**3.73**	**50.6**	**170**	**43.8**	**1**	**0.05**	**0.05**
Maximum		**23.4**	**7.76**	**7660.0**	**18100**	**13,000.0**	**5,000,000**	**8**	**5.5**
Geometric Mean		**0.87**	**5.88**	**521.9**	**1,009.43**	**247.0**	**32,833**	**0.17**	**0.1**
Median		**1.3**	**6.605**	**395.5**	**663.0**	**144.5**	**110,000**	**0.1**	**0.1**

Table 20. 2002 Large Ship Graywater Conventional Pollutants (continued)

Sample Name	Sample Date	Conductivity	Oil & Grease	TOC	Alkalinity, as CaCO3	Nitrate as N	Phosphorous	Settleable Solids
Units		**Umhos/cm**	**mg/L**	**mg/L**	**Mg/L**	**Mg/L**	**mg/L**	**Mg/L**
MDL		**1**	**1.5**	**1**	**0.5**	**1.0**	**0.01**	**0.1**
Dawn Princess GW-11 Galley	9/3/02	3270	520.0	1070	0.25	0.15	14.10	23
Dawn Princess GW-A-15	9/12/02	1920	150.0	156	69.3	0.15	2.20	0.32
Dawn Princess GW-A-4 Domestic/Laundry	9/12/02	36500	140.0	149	113	0.15	1.60	0.05
Dawn Princess GW-A-4 Domestic	6/20/02	15100	51.0	106	70.7	0.15	6.07	0.05
Dawn Princess GW-A-8 Domestic	6/20/02	29600	46.0	41	80.2	0.15	1.90	0.21
Dawn Princess GW-A-8 Domestic	9/12/02	14600	110.0	233	58.9	0.15	2.74	6
Dawn Princess GW-D-11 Galley	6/20/02	13800	5500.0	5090	0.25	0.15	52.20	280
Sea Princess GW – A	5/30/02	7640	360.0	770	0.25	0.15	20.60	10

Sample Name	Sample Date	Conductivity	Oil & Grease	TOC	Alkalinity, as CaCO3	Nitrate as N	Phosphorous	Settleable Solids
Units		**Umhos/cm**	**mg/L**	**mg/L**	**Mg/L**	**Mg/L**	**mg/L**	**Mg/L**
MDL		**1**	**1.5**	**1**	**0.5**	**1.0**	**0.01**	**0.1**
Sea Princess GW – B	5/30/02	528	120.0	114	53.4	0.15	3.06	0.66
Sea Princess GW – D	5/30/02	2500	270.0	358	52.2	0.15	9.36	6.5
Norwegian Wind GW-1 C Laundry	5/24/02	646	50.0	160	59.7	0.15	3.39	0.53
Norwegian Wind GW-2 Mixed GW	5/24/02	31100	56.0	83	94.8	0.15	1.86	0.05
Norwegian Wind GW-3 Mixed GW	5/24/02	32200	52.0	85	81.2	0.15	2.16	0.22
Norwegian Sky GW-A (overboard line)	5/16/02	3440	70.0	97	69.8	0.15	1.88	0.22
Ocean Princess GW-A-DB4 Domestic	5/21/02	617	87.0	148	54.6	0.15	2.80	0.05
Ocean Princess GW-A-DB8 Galley	5/21/02	1810	57.0	843	0.25	0.15	3.46	0.05
Norwegian Sky GW-B (overboard line)	5/16/02	344	37.0	82	75.3	0.15	2.14	0.05
Ocean Princess GW-C Collection Tanks	5/21/02	188	33.0	98	40.6	0.15	8.46	2.2

Sample Name	Sample Date	Conductivity	Oil & Grease	TOC	Alkalinity, as CaCO3	Nitrate as N	Phosphorous	Settleable Solids
Units		**Umhos/cm**	**mg/L**	**mg/L**	**Mg/L**	**Mg/L**	**mg/L**	**Mg/L**
MDL		**1**	**1.5**	**1**	**0.5**	**1.0**	**0.01**	**0.1**
Star Princess GW-C DB#8 Graywater	5/28/02	8100	39.0	72	44.6	0.15	1.77	0.05
Star Princess GW-D DB#10 Galley	5/28/02	1190	950.0	2070	0.25	0.15	3.11	44
Norwegian Sky GW-A Mixed	8/2/02	558	not taken	1260	38.1	0.15	12.00	1.1
Norwegian Sky GW-B Mixed	8/2/02	606	not taken	849	32.2	0.15	17.60	6
Norwegian Wind GW-2 Mixed GW	9/13/02	22700	170.0	174	78.8	0.15	2.50	0.2
Norwegian Wind GW-3 Mixed GW	9/13/02	23200	61.0	72	80.8	0.15	2.50	0.05
Ocean Princess GW-C Overboard	7/19/02	499	290.0	470	78.5	0.15	0.86	0.05
Ocean Princess GW-C-H Overboard	7/19/02	4800	780	996	35.5	0.15	13.00	22
Regal Princess GW-AD Overboard	7/13/02	4660	34	128	129	0.15	4.59	0.8

Sample Name	Sample Date	Conductivity	Oil & Grease	TOC	Alkalinity, as CaCO3	Nitrate as N	Phosphorous	Settleable Solids
Units		**Umhos/cm**	**mg/L**	**mg/L**	**Mg/L**	**Mg/L**	**mg/L**	**Mg/L**
MDL		**1**	**1.5**	**1**	**0.5**	**1.0**	**0.01**	**0.1**
Regal Princess GW-ADC Overboard	7/13/02	808	290	469	0.25	12.1	27.00	0.51
Regal Princess GW-AFT Mixed	7/23/02	509	440	579	0.25	0.15	27.30	9.2
Regal Princess GW-FWD Mixed	7/23/02	1060	63	165	36.2	0.15	7.59	0.42
Sea Princess GW-A-11 Galley	9/17/02	2000	72	669	0.25	0.15	17.10	90
Sea Princess GW-D-6 Domestic	9/17/02	834	160	257	76.2	0.15	8.94	0.05
Sea Princess GW-D-8 Domestic	9/17/02	6100	310	597	20.6	0.15	10.30	15
Sea Princess GW-D-9 Domestic	9/17/02	820	170	283	70.3	0.15	8.96	0.05
Star Princess GW-C (accom)	8/29/02	392	68	78	68.8	0.15	2.68	0.05
Star Princess GW-D (galley & laundry)	8/29/02	1250	2800	1730	0.25	0.15	13.80	370

Sample Name	Sample Date	Conductivity	Oil & Grease	TOC	Alkalinity, as CaCO3	Nitrate as N	Phosphorous	Settleable Solids
Units		**Umhos/cm**	**mg/L**	**mg/L**	**Mg/L**	**Mg/L**	**mg/L**	**Mg/L**
MDL		**1**	**1.5**	**1**	**0.5**	**1.0**	**0.01**	**0.1**
Sun Princess GW-A2 accommodations	6/7/02	4080	230	369	83.3	0.15	9.12	9
Sun Princess GW-A3 accommodations	6/7/02	7270	140	186	92.3	0.15	4.93	2.6
Sun Princess GW-A4 accommodations	6/7/02	1060	240	381	89.4	0.15	8.49	6
Sun Princess GW-C galley	7/11/02	1680	9.9	1600	0.25	0.15	21.30	32
Minimum		**188**	**9.9**	**41**	**0.25**	**0.15**	**0.86**	**0.05**
Maximum		**36,500**	**5,500**	**5090**	**129**	**12.1**	**52.20**	**370**
Geometric Mean		**2,627.33**	**138.46**	**292**	**15.8**	**0.17**	**5.72**	**1.05**
Median		**1,960.0**	**130**	**245**	**56.8**	**0.15**	**5.50**	**0.595**

Table 21. 2002 Large Ship Galley Graywater Conventional Pollutants

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine	Free chlorine residual
Units		mg/L		mg/L	mg/L	mg/L	MPN	mg/L	mg/L
MDL		0.03	0.10	2	3.0	1.3	2	0.1	0.1
Dawn Princess GW-11 Galley	9/3/02	2.56	4.82	2130	3060	1070	60,000	ND	ND
Dawn Princess GW-D-11 Galley	6/20/02	8.88	3.88	6920	18100	7700	30,000	ND	ND
Ocean Princess GW-A-DB8 Galley	5/21/02	1.26	4.3	1490	2680	144	500	ND	ND
Star Princess GW-D DB#10 Galley	5/28/02	3.68	3.73	3660	6170	2660	300	ND	ND
Sea Princess GW-A-11 Galley	9/17/02	1.54	4.38	1370	2080	346	8,000	0.30	ND
Star Princess GW-D (galley & laun)	8/29/02	4.29	3.85	4280	17800	13000	198,000	0.30	0.10
Sun Princess GW-C Galley	7/11/02	2.66	4.11	2790	5110	1320	900	0.30	0.10
Minimum		**1.26**	**3.73**	**1,370**	**2,080**	**144**	**300**	**ND**	**ND**
Maximum		**8.88**	**4.82**	**6,920**	**18,100**	**13,000**	**198,000**	**0.30**	**0.10**
Geo metric Mean		**2.93**	**4.14**	**2,790**	**5,603**	**1,520**	**6,279**	**0.11**	**0.06**
Median		**2.66**	**4.11**	**2,790**	**5,110**	**1,320**	**8,000**	**ND**	**ND**

Table 22. 2002 Large Ship Galley Graywater Conventional Pollutants (continued)

Sample Name	Sample Date	Conductivity	Oil & Grease	TOC	Alkalinity, as CaCO3	Nitrate as N	Phosphorous, Total	Settleable Solids
Units		Umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	Mg/L
MDL		1	1.5	1.0	0.5	1.0	0.01	0.1
Dawn Princess GW-11 Galley	9/3/02	3270	520.0	1,070.0	0.25	0.2	14.10	23.0
Dawn Princess GW-D-11 Galley	6/20/02	13800	5,500.0	5,090.0	0.25	0.2	52.20	280.0
Ocean Princess GW-A-DB8 Galley	5/21/02	1810	57.0	843.0	0.25	0.2	3.46	0.1
Star Princess GW-D DB#10 Galley	5/28/02	1190	950.0	2,070.0	0.25	0.2	3.11	44.0
Sea Princess GW-A-11 Galley	9/17/02	2000	72.0	669.0	0.25	0.2	17.10	90.0
Star Princess GW-D (galley & laun)	8/29/02	1250	2,800.0	1,730.0	0.25	0.2	13.80	370.0
Sun Princess GW-C Galley	7/11/02	1680	9.9	1,600.0	0.25	0.2	21.30	32.0
Minimum		**1,190**	**9.9**	**669.0**	**0.25**	**0.2**	**3.11**	**0.1**
Maximum		**13,800**	**5,500.0**	**5,090.0**	**0.25**	**0.2**	**52.20**	**370.0**
Geo metric Mean		**2,360**	**315.0**	**1,506.0**	**0.25**	**0.2**	**12.18**	**28.5**
Median		**1,810**	**520.0**	**1,600.0**	**0.25**	**0.2**	**14.10**	**44.0**

Table 23. 2002 Large Ship Accommodations & Laundry Graywater Conventional Pollutants

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform bacteria by MPN	Total chlorine residual	Free chlorine residual
Units		mg/L		mg/L	mg/L	mg/L	MPN	mg/L	mg/L
MDL		0.03	0.1	2	3.0	1.3	2	0.10	0.10
Dawn Princess GW-A-4 Domestic/Laun	9/12/02	0.97	7.59	51	240.0	68.2	300,000	ND	ND
Dawn Princess GW-A-4 Domestic	6/20/02	0.84	6.76	158	372.0	70.2	2,400,000	ND	ND
Dawn Princess GW-A-8 Domestic	9/12/02	0.64	7.17	62	180.0	71.1	130,000	ND	ND
Dawn Princess GW-A-8 Domestic	6/20/02	1.99	6.25	388	752.0	292.0	220,000	ND	ND
Ocean Princess GW-A-DB4 Domestic	5/21/02	0.77	7.1	263	553.0	48.5	300	3.00	0.20
Sea Princess GW-D-6 Domestic	9/17/02	1.37	6.45	555	556.0	125.0	500,000	ND	ND
Sea Princess GW-D-8 Domestic	9/17/02	3.98	4.65	1,310	1,840.0	560.0	110,000	ND	ND
Sea Princess GW-D-9 Domestic	9/17/02	1.46	6.5	541	674.0	136.0	800,000	ND	ND

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform bacteria by MPN	Total chlorine residual	Free chlorine residual
Units		mg/L		mg/L	mg/L	mg/L	MPN	mg/L	mg/L
MDL		0.03	0.1	2	3.0	1.3	2	0.10	0.10
Star Princess GW-C (accom)	8/29/02	2.76	6.68	152	254.0	44.1	240	3.50	3.10
Sun Princess GW-A2 accommodations	6/7/02	0.63	6.21	875	1,540.0	591.0	130,000	0.20	0.10
Sun Princess GW-A3 accommodations	6/7/02	0.78	7.58	346	793.0	212.0	500	4.00	3.50
Sun Princess GW-A4 accommodations	6/7/02	1.16	7.19	669	1,220.0	333.0	30,000	4.00	1.70
Minimum		**0.63**	**4.65**	**51**	**180.0**	**44.0**	**240**	**ND**	**ND**
Maximum		**3.98**	**7.59**	**1,310**	**1,840.0**	**591.0**	**2,400,000**	**4.00**	**3.50**
Geometric Mean		**1.21**	**6.63**	**304**	**589.0**	**145.0**	**47,357**	**0.23**	**0.16**
Median		**1.07**	**6.72**	**367**	**615.0**	**130.5**	**130,000**	**ND**	**ND**

Table 24. 2002 Large Ship Accommodations & Laundry Graywater Conventional Pollutants (continued)

Sample Name	Sample Date	Conductivity	Oil& Grease	TOC	Alkalinity, Total as CaCO3	Nitrate as N	Phosphorous, Total	Total Settleable Solids
Units		Umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MDL		1	1.5	1.0	0.5	1.0	0.01	0.1
Dawn Princess GW-A-4 Domestic/Laun	9/12/02	36500	140.0	149.0	113	0.2	1.60	0.1
Dawn Princess GW-A-4 Domestic	6/20/02	15100	51.0	106.0	70.7	0.2	6.07	0.1
Dawn Princess GW-A-8 Domestic	9/12/02	29600	46.0	41.0	80.2	0.2	1.90	0.2
Dawn Princess GW-A-8 Domestic	6/20/02	14600	110.0	233.0	58.9	0.2	2.74	6.0
Ocean Princess GW-A-DB4 Domestic	5/21/02	617	87.0	148.0	54.6	0.2	2.80	0.1
Sea Princess GW-D-6 Domestic	9/17/02	834	160.0	257.0	76.2	0.2	8.94	0.1
Sea Princess GW-D-8 Domestic	9/17/02	6100	310.0	597.0	20.6	0.2	10.30	15.0
Sea Princess GW-D-9 Domestic	9/17/02	820	170.0	283.0	70.3	0.2	8.96	0.1

Sample Name	Sample Date	Conductivity	Oil& Grease	TOC	Alkalinity, Total as CaCO3	Nitrate as N	Phosphorous, Total	Total Settleable Solids
Units		Umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MDL		1	1.5	1.0	0.5	1.0	0.01	0.1
Star Princess GW-C (accom)	8/29/02	392	68.0	78.0	68.8	0.2	2.68	0.1
Sun Princess GW-A2 accommodations	6/7/02	4080	230.0	369.0	83.3	0.2	9.12	9.0
Sun Princess GW-A3 accommodations	6/7/02	7270	140.0	186.0	92.3	0.2	4.93	2.6
Sun Princess GW-A4 accommodations	6/7/02	1060	240.0	381.0	89.4	0.2	8.49	6.0
Minimum		**392**	**46.0**	**41.0**	**20.6**	**0.2**	**1.60**	**0.1**
Maximum		**36,500**	**310.0**	**597.0**	**113**	**0.2**	**10.30**	**15.0**
Geometric Mean		**3,743**	**125.0**	**188.0**	**68.5**	**0.2**	**4.71**	**0.4**
Median		**5,090**	**140.0**	**209.5**	**73.5**	**0.2**	**5.50**	**0.1**

Table 25. 2002 Large Ship Mixed Graywater Conventional Pollutants

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine residual	Free chlorine residual
Units		mg/L		Mg/L	mg/L	mg/L	MPN	mg/L	mg/L
MDL		0.03	0.1	2	3.0	1.3	2	0.10	0.10
Dawn Princess GW-A-15	9/12/02	1	6.7	403	460.0	92.5	1600000	0.05	0.05
Sea Princess GW - A	5/30/02	1.71	4.46	1800	3280.0	604.0	24000	0.2	0.05
Sea Princess GW – B	5/30/02	2.35	7.06	328	503.0	122.0	2400000	0.1	0.05
Sea Princess GW – D	5/30/02	1.11	5.87	799	1660.0	356.0	240000	0.05	0.05
Norwegian Wind GW-2 Mixed GW	5/24/02	0.008	6.68	199	652.0	43.8	3000000	0.05	0.05
Norwegian Wind GW-3 Mixed GW	5/24/02	0.008	6.92	178	639.0	128.0	5000000	0.05	0.05
Norwegian Sky GW-A (overboard line)	5/16/02	2.2	6.86	158	374.0	122.0	3000000	0.05	0.05
Norwegian Sky GW-B (overboard line)	5/16/02	2.51	6.53	146	300.0	79.5	3000000	0.05	0.05
Ocean Princess GW-C Collection Tanks	5/21/02	0.191	6.89	110	389.0	56.5	300	0.05	0.05

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine residual	Free chlorine residual
Units		mg/L		Mg/L	mg/L	mg/L	MPN	mg/L	mg/L
MDL		0.03	0.1	2	3.0	1.3	2	0.10	0.10
Norwegian Sky GW-A Mixed	8/2/02	1.56	7.28	987	2600.0	46.6	2090	1	0.05
Norwegian Sky GW-B Mixed	8/2/02	1.86	4.79	1310	3540.0	333.0	2910	1.5	0.2
Norwegian Wind GW-2 Mixed GW	9/13/02	0.081	4.75	326	430.0	566.0	1600	ND	ND
Norwegian Wind GW-3 Mixed GW	9/13/02	0.15	6.82	163	170.0	210.0	1600	ND	ND
Ocean Princess GW-C Overboard	7/19/02	0.008	7.05	260	228.0	107.0	1	8	5.5
Ocean Princess GW-C-H Overboard	7/19/02	0.658	7.76	7660	4200.0	145.0	1	7	4
Regal Princess GW-AD Overboard	7/13/02	23.4	4.86	151	509.0	5470.0	800000	0.5	ND
Regal Princess GW-ADC Overboard	7/13/02	0.008	7.16	1170	1900.0	82.6	800000	ND	ND
Regal Princess GW-AFT Mixed	7/13/02	0.878	4.36	1940	2260.0	464.0	110000	ND	ND

Sample Name	Sample Date	Ammonia as N	pH	BOD	COD	TSS	Fecal coliform	Total chlorine residual	Free chlorine residual
Units		mg/L		Mg/L	mg/L	mg/L	MPN	mg/L	mg/L
MDL		0.03	0.1	2	3.0	1.3	2	0.10	0.10
Regal Princess GW-FWD Mixed	7/23/02	4.17	5.06	330	621.0	1230.0	500000	ND	ND
Minimum		**0.008**	7.02	**110**	**170.0**	64.8	**1**	**ND**	**ND**
Maximum		**23.4**	**4.36**	**7,660**	**4200.0**	**43.8**	**5,000,000**	**8**	**5.5**
Geometric Mean		**0.46**	**7.76**	**432**	**805.0**	**5470.0**	**38,603**	**0.14**	**0.08**
Median		**1.00**	**6.14**	**328**	**621.0**	**190.0**	**240,000**	**ND**	**ND**

Table 26. 2002 Large Ship Mixed Graywater Conventional Pollutants (continued)

Sample Name	Sample Date	Conductivity	Oil & Grease	Phosphorous, Total	Alkalinity, Total as CaCO3	Nitrate as N	TOC	Total Settleable Solids
Units		Umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	Mg/L
MDL		1	1.5	0.01	0.5	1.0	1.0	0.1
Dawn Princess GW-A-15	9/12/02	1920	150.0	2.20	69.3	0.2	156.0	0.3
Sea Princess GW - A	5/30/02	7640	360.0	20.60	0.25	0.2	770.0	10.0
Sea Princess GW – B	5/30/02	528	120.0	3.06	53.4	0.2	114.0	0.7
Sea Princess GW – D	5/30/02	2500	270.0	9.36	52.2	0.2	358.0	6.5
Norwegian Wind GW-2 Mixed GW	5/24/02	31100	50.0	3.39	94.8	0.2	160.0	0.5
Norwegian Wind GW-3 Mixed GW	5/24/02	32200	56.0	1.86	81.2	0.2	83.0	0.1

Sample Name	Sample Date	Conductivity	Oil & Grease	Phosphorous, Total	Alkalinity, Total as CaCO3	Nitrate as N	TOC	Total Settleable Solids
Units		Umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	Mg/L
MDL		1	1.5	0.01	0.5	1.0	1.0	0.1
Norwegian Sky GW-A (overboard line)	5/16/02	3440	52.0	2.16	69.8	0.2	85.0	0.2
Norwegian Sky GW-B (overboard line)	5/16/02	344	70.0	1.88	75.3	0.2	97.0	0.2
Ocean Princess GW-C Collection Tanks	5/21/02	188	37.0	2.14	40.6	0.2	82.0	0.1
Norwegian Sky GW-A Mixed	8/2/02	558	33.0	8.46	38.1	0.2	98.0	2.2
Norwegian Sky GW-B Mixed	8/2/02	606	Not taken	12.00	32.2	0.2	1,260.0	1.1
Norwegian Wind GW-2 Mixed GW	9/13/02	22700	Not taken	17.60	78.8	0.2	849.0	6.0

Sample Name	Sample Date	Conductivity	Oil & Grease	Phosphorous, Total	Alkalinity, Total as CaCO3	Nitrate as N	TOC	Total Settleable Solids
Units		Umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	Mg/L
MDL		1	1.5	0.01	0.5	1.0	1.0	0.1
Norwegian Wind GW-3 Mixed GW	9/13/02	23200	170.0	2.50	80.8	0.2	174.0	0.2
Ocean Princess GW-C Overboard	7/19/02	499	61.0	2.50	78.5	0.2	72.0	0.1
Ocean Princess GW-C-H Overboard	7/19/02	4800	290.0	0.86	35.5	0.2	470.0	0.1
Regal Princess GW-AD Overboard	7/13/02	4660	780.0	13.00	129	0.2	996.0	22.0
Regal Princess GW-ADC Overboard	7/13/02	808	34.0	4.59	0.25	0.2	128.0	0.8
Regal Princess GW-AFT Mixed	7/23/02	509	290.0	27.00	0.25	12.1	469.0	0.5

Sample Name	Sample Date	Conductivity	Oil & Grease	Phosphorous, Total	Alkalinity, Total as CaCO3	Nitrate as N	TOC	Total Settleable Solids
Units		Umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	Mg/L
MDL		1	1.5	0.01	0.5	1.0	1.0	0.1
Regal Princess GW-FWD Mixed	7/23/02	1060	440.0	27.30	36.2	0.2	579.0	9.2
Ocean Princess GW-C Collection Tanks	5/21/02	188	63.0	7.59	0.25	0.2	165.0	0.4
Minimum		**188**	**33.0**	**0.86**	**0.25**	**0.2**	**72.0**	**0.1**
Maximum		**32,200**	**780.0**	**27.30**	**129.00**	**12.1**	**1,260.0**	**22.0**
Geo metric Mean		**2,085**	**116.0**	**5.22**	**26.54**	**0.2**	**229.0**	**0.7**
Median		**1,920**	**95.0**	**3.99**	**53.40**	**0.2**	**162.5**	**0.5**

Table 27. 2002 Large Ship Mixed Graywater Total & Dissolved Metals A - L

	Sample Date	Antimony-D	Antimony-T	Arsenic-D	Arsenic-T	Chromium-D	Chromium-T	Copper-D	Copper-T	Lead-D	Lead-T
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Dawn Princess GW-A-4	9/12/02	0.0135	0.025	3.12	0.06	4.5	5.81	46.3	144	11.7	18.00
Dawn Princess GW-A-8	9/12/02	4.1300	0.025	59.5	39.8	3.3	0.04	11.4	73.6	6.17	15.80
Norwegian Sky GW-A	8/2/02	0.9230	4.490	0.54	2.54	2.25	10.6	5.61	318	17	60.00
Norwegian Sky GW-B	8/2/02	3.9300	3.690	1.61	1.74	6.58	10.7	2.59	195	14.5	26.50
Norwegian Wind GW-2	9/13/02	0.0135	0.025	43.6	44.8	4.15	7.15	9.31	77.4	12.8	22.90
Norwegian Wind GW-3	9/13/02	0.0135	0.025	39.1	50	7.52	6.44	9.81	84.3	23.6	24.30
Ocean Princess GW-C	7/19/02	0.2420	0.303	0.209	2.32	0.79	3.83	79.2	129	0.654	7.22

	Sample Date	Antimony-D	Antimony-T	Arsenic-D	Arsenic-T	Chromium-D	Chromium-T	Copper-D	Copper-T	Lead-D	Lead-T
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Ocean Princess GW-C-H	7/19/02	0.5280	0.199	3.43	3.52	4.83	5.77	50.3	109	1.18	2.81
Regal Princess GW-AFT	7/23/02	0.1890	0.025	1.22	1.03	4.24	6.99	302	71.2	0.57	5.31
Regal Princess GW-FWD	7/23/02	0.1220	0.128	1.62	1.41	3.05	4.65	114	294	0.672	4.50
Sea Princess GW-A-11	9/17/02	0.0135	0.025	1.62	0.06	8.33	15.7	2.93	55.1	3.21	20.80
Sea Princess GW-D-8	9/17/02	0.0135	0.025	9.93	10.7	10.6	10.1	3.72	60.5	1.07	12.80
Star Princess GW-C	8/29/02	0.5180	0.549	0.459	0.388	1.5	1.86	61.4	143	2.07	6.48
Star Princess GW-D	8/29/02	0.3780	0.025	3.3	5.48	30.5	47.3	17	1980	0.777	21.30
Sun Princess GW-A4	7/11/02	0.2710	0.272	0.878	0.979	2.35	3.7	58.1	76.9	2.18	3.84

	Sample Date	Antimony-D	Antimony-T	Arsenic-D	Arsenic-T	Chromium-D	Chromium-T	Copper-D	Copper-T	Lead-D	Lead-T
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Sun Princess GW-C galley	7/11/02	0.1760	0.199	2.43	2.58	17.1	15.8	53.7	74.5	0.937	5.49
Minimum		**0.01**	**0.03**	**0.21**	**0.06**	**0.79**	**0.04**	**2.59**	**55.10**	**0.57**	**2.81**
Maximum		**4.13**	**4.49**	**59.50**	**50.00**	**30.50**	**47.3**	**302.00**	**1,980.00**	**23.60**	**60.00**
Geometric Mean		**0.16**	**0.11**	**2.86**	**2.37**	**4.69**	**5.49**	**22.17**	**130.21**	**2.84**	**11.51**
Median		**0.22**	**0.08**	**2.03**	**2.43**	**4.37**	**6.72**	**31.65**	**96.65**	**2.13**	**14.30**

Table 28. 2002 Large Ship Mixed Graywater Total & Dissolved Metals N-Z

Sample Name	Sample Date	Nickel-D	Nickel-T	Selenium-D	Selenium-T	Silver-D	Silver-T	Zinc-D	Zinc-T
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.15	0.15	0.15	0.15	0.150	0.1500	0.15	0.15
Dawn Princess GW-A-4	9/12/02	5.19	6.12	13.60	14.00	0.014	0.0155	78.30	303.00
Dawn Princess GW-A-8	9/12/02	12.80	11.00	108.00	70.90	3.960	0.0155	60.60	71.10
Norwegian Sky GW-A	8/2/02	4.70	19.80	0.54	2.16	0.014	0.3810	522.00	1740.00
Norwegian Sky GW-B	8/2/02	11.30	12.60	1.24	1.36	0.014	0.1530	766.00	794.00
Norwegian Wind GW-2	9/13/02	33.80	25.50	74.90	88.60	0.014	0.0155	54.50	145.00
Norwegian Wind GW-3	9/13/02	29.60	32.80	91.20	83.60	0.014	0.0155	463.00	185.00
Ocean Princess GW-C	7/19/02	6.22	7.71	0.52	3.78	0.014	1.930	270.00	327.00
Ocean Princess GW-C-H	7/19/02	12.90	13.00	8.28	9.91	0.887	3.7400	22.10	224.00

Sample Name	Sample Date	Nickel-D	Nickel-T	Selenium-D	Selenium-T	Silver-D	Silver-T	Zinc-D	Zinc-T
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.15	0.15	0.15	0.15	0.150	0.1500	0.15	0.15
Regal Princess GW-AFT	7/23/02	17.00	14.80	1.66	0.54	0.205	0.7500	251.00	30.50
Regal Princess GW-FWD	7/23/02	12.60	14.40	3.74	3.45	0.197	0.2970	221.00	306.00
Sea Princess GW-A-11	9/17/02	9.47	11.90	5.89	6.83	0.014	0.0155	277.00	264.00
Sea Princess GW-D-8	9/17/02	11.60	13.00	42.00	26.10	0.014	1.3100	158.00	192.00
Star Princess GW-C	8/29/02	15.40	16.60	0.91	0.54	0.014	0.1740	599.00	742.00
Star Princess GW-D	8/29/02	53.00	64.50	4.65	9.34	0.014	4.080	1170.00	1390.00
Sun Princess GW-A4	7/11/02	7.59	8.61	2.12	2.42	0.373	0.1470	484.00	418.00
Sun Princess GW-C galley	7/11/02	20.00	15.20	2.98	4.24	0.014	1.5900	259.00	280.00
Minimum		**4.70**	**6.12**	**0.52**	**0.54**	**0.014**	**0.0155**	**55.00**	**31.00**
Maximum		**53.00**	**64.50**	**108.00**	**88.60**	**3.960**	**4.0800**	**1170.00**	**1740.00**

Sample Name	Sample Date	Nickel-D	Nickel-T	Selenium-D	Selenium-T	Silver-D	Silver-T	Zinc-D	Zinc-T
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.15	0.15	0.15	0.15	0.150	0.1500	0.15	0.15
Geometric Mean		**13.18**	**14.99**	**5.68**	**6.63**	**0.040**	**0.2100**	**266.00**	**295.00**
Median		**12.70**	**13.70**	**4.20**	**5.54**	**0.014**	**0.2355**	**264.50**	**291.50**

Table 29. 2002 Large Ship Mixed Graywater Priority Pollutants A - B

Sample Name	Sample Date	Acetone	1,2,4-Trimethyl benzene	2-Butanone	4-Isopropyl toluene	4-Methyl-2-Pentanone	Bromo dichloromethane	Bromoform	Butyl benzyl phthalate
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		3.2	0.50	1.50	0.55	0.36	0.50	0.50	1.00
Dawn Princess GW-A-4	9/12/02	72.0	0.08	4.20	0.055	0.08	0.48	0.16	1.90
Dawn Princess GW-A-8	9/12/02	38.0	0.08	2.90	0.055	0.08	0.12	1.8	0.18
Norwegian Sky GW-A	8/2/02	34.0	0.08	16.00	0.82	0.67	0.77	0.7	0.18
Norwegian Sky GW-B	8/2/02	35.0	0.08	13.00	0.87	1.7	0.89	0.94	0.18
Norwegian Wind GW-2	9/13/02	29.0	0.08	0.3	0.055	0.08	0.85	0.16	0.18
Norwegian Wind GW-3	9/13/02	18.0	0.08	0.3	0.055	0.08	0.86	0.16	0.18
Ocean Princess GW-C	7/19/02	140	0.08	24.00	0.055	0.08	4.2	0.16	0.18
Ocean Princess GW-C-H	7/19/02	120	0.08	0.3	0.055	0.08	7.5	0.16	0.18
Regal Princess GW-AFT	7/23/02	1.75	8.80	390.00	16	0.08	20	10	5.4

Sample Name	Sample Date	Acetone	1,2,4-Trimethyl benzene	2-Butanone	4-Isopropyl toluene	4-Methyl-2-Pentanone	Bromo dichloromethane	Bromoform	Butyl benzyl phthalate
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		3.2	0.50	1.50	0.55	0.36	0.50	0.50	1.00
Regal Princess GW-FWD	7/23/02	970	42.00	56.00	5.2	0.08	27	9.4	0.18
Sea Princess GW-A-11	9/17/02	54	0.08	0.3	2.2	0.08	4.3	1.2	0.18
Sea Princess GW-D-8	9/17/02	53	0.08	17.00	6.1	0.08	3.9	3.3	0.18
Star Princess GW-C (acc)	8/29/02	55	0.08	5.30	0.055	5.1	0.88	0.16	2.6
Star Princess GW-D (G&L)	8/29/02	130	0.08	0.3	0.055	0.08	7.6	2	7.7
Sun Princess GW-A4	7/11/02	93	0.08	8.90	0.055	0.08	7	0.16	6.4
Sun Princess GW-C galley	7/11/02	220	0.08	0.3	3.4	0.08	6.1	0.16	12
Minimum		**1.75**	**0.08**	**0.3**	**0.055**	**0.08**	**0.12**	**0.16**	**0.18**
Maximum		**970**	**42.00**	**390.0**	**16**	**5.1**	**27**	**10**	**12**
Geometric Mean		**59**	**0.16**	**3.4**	**0.32**	**0.14**	**2.5**	**0.61**	**0.63**
Median		**54.5**	**0.08**	**4.8**	**0.055**	**0.08**	**4.05**	**0.43**	**0.18**

Table 30. 2002 Large Ship Mixed Graywater Priority Pollutants C - Z

Sample Name	Sample Date	Chloroethane	Chloroform	Chloromethane	Dibromochloromethane	Diethylphthalate	Di-n-Butylphthalate	M&p Xylenes	O-Xylene	Phenol	Tetrachloroethene	Toluene
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.50	0.50	1.00	0.50	1.0	1.0	0.28	0.46	1.0	0.50	0.500
Dawn Princess GW-A-4	9/12/02	0.36	20	0.15	0.16	13	4.8	0.69	0.14	2.5	0.06	0.125
Dawn Princess GW-A-8	9/12/02	0.36	17	0.15	0.16	3.9	5.3	0.96	0.52	0.4	0.06	0.125
Norwegian Sky GW-A	8/2/02	0.36	18	0.15	0.16	3.8	0.7	0.08	0.14	0.4	0.06	0.125
Norwegian Sky GW-B	8/2/02	0.36	17	0.15	0.52	3.8	0.7	0.51	0.47	0.4	0.06	0.125
Norwegian Wind GW-2	9/13/02	0.36	3.1	0.15	0.16	3	9.6	1.2	1.2	0.4	0.85	0.125
Norwegian Wind GW-3	9/13/02	0.36	5.3	0.15	0.79	2.7	3.9	0.73	0.14	0.4	1.3	0.125
Ocean Princess GW-C	7/19/02	3.5	780	2.9	0.16	14	0.7	0.6	0.14	0.4	0.06	0.125
Ocean Princess GW-C-H	7/19/02	3.4	880	0.15	1.7	12	2.4	0.08	0.14	0.4	0.06	0.125

Sample Name	Sample Date	Chloroethane	Chloroform	Chloromethane	Dibromochloromethane	Diethylphthalate	Di-n-Butylphthalate	M&p Xylenes	O-Xylene	Phenol	Tetrachloroethene	Toluene
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.50	0.50	1.00	0.50	1.0	1.0	0.28	0.46	1.0	0.50	0.500
Regal Princess GW-AFT	7/23/02	0.36	140	0.15	18	2.2	0.7	14	0.14	4.3	0.06	93
Regal Princess GW-FWD	7/23/02	0.36	170	18	18	17	4.4	52	15	1.9	21	0.125
Sea Princess GW-A-11	9/17/02	0.36	140	0.15	1.6	3.9	0.7	1.9	0.83	3	1.8	0.125
Sea Princess GW-D-8	9/17/02	0.36	63	0.15	2.4	7.9	0.7	15	6	2.8	84	0.125
Star Princess GW-C (accom)	8/29/02	41	30	160	0.16	18	0.7	15	6.1	3.2	0.06	0.125
Star Princess GW-D (galley & laundry)	8/29/02	0.36	58	0.15	0.16	6.8	0.7	14	5	0.4	0.06	0.125
Sun Princess GW-A4	7/11/02	15	180	100	0.16	21	9.5	2.1	0.73	0.4	4.5	1.5

Sample Name	Sample Date	Chloroethane	Chloroform	Chloromethane	Dibromochloromethane	Diethylphthalate	Di-n-Butylphthalate	M&p Xylenes	O-Xylene	Phenol	Tetrachloroethene	Toluene
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		0.50	0.50	1.00	0.50	1.0	1.0	0.28	0.46	1.0	0.50	0.500
Sun Princess GW-C galley	7/11/02	5.3	180	17	0.16	3.5	7.7	0.08	0.14	0.4	0.06	1.4
Minimum		**0.36**	**3.1**	**0.15**	**0.16**	**2.2**	**0.7**	**0.08**	**0.14**	**0.4**	**0.06**	**0.125**
Maximum		**41**	**880**	**160**	**18**	**21**	**9.6**	**52**	**15**	**4.3**	**84**	**93**
Geometric Mean		**0.96**	**57**	**0.76**	**0.55**	**6.5**	**2**	**1.52**	**0.62**	**0.84**	**0.31**	**0.27**
Median		**0.36**	**60.50**	**0.15**	**0.16**	**5.35**	**1.55**	**1.08**	**0.495**	**0.4**	**0.06**	**0.125**

Table 31. 2002 Large Ship Mixed Graywater Priority Pollutants Base-Neutrals & Acids

Sample Name	Sample Date	Benzoic Acid	Benzyl Alcohol	3&4-Methyl phenol	Bis(2-Ethylhexyl)Phthalate	Butyl benzyl phthalate	Diethyl phthalate	Di-n-Butyl phthalate	Phenol
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		25	0.65	0.61	1.0	1.0	1.0	1.0	1.0
Dawn Princess GW-A-4	9/12/02	190	8.5	11	11	1.9	13	4.8	2.5
Dawn Princess GW-A-8	9/12/02	46	2.9	6.3	2.8	0.18	3.9	5.3	0.4
Norwegian Sky GW-A	8/2/02	240	20	21	51	0.18	3.8	0.7	0.4
Norwegian Sky GW-B	8/2/02	310	25	26	48	0.18	3.8	0.7	0.4
Norwegian Wind GW-2	9/13/02	45	4.1	2	56	0.18	3	9.6	0.4
Norwegian Wind GW-3	9/13/02	54	3.4	2.3	13	0.18	2.7	3.9	0.4
Ocean Princess GW-C	7/19/02	220	24	0.6	5.6	0.18	14	0.7	0.4
Ocean Princess GW-C-H	7/19/02	250	28	0.6	7.6	0.18	12	2.4	0.4

Sample Name	Sample Date	Benzoic Acid	Benzyl Alcohol	3&4-Methyl phenol	Bis(2-Ethylhexyl)Phthalate	Butyl benzyl phthalate	Diethyl phthalate	Di-n-Butyl phthalate	Phenol
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MDL		25	0.65	0.61	1.0	1.0	1.0	1.0	1.0
Regal Princess GW-AFT	7/23/02	40	23	31	13	5.4	2.2	0.7	4.3
Regal Princess GW-FWD	7/23/02	28	28	3.9	5.3	0.18	17	4.4	1.9
Sea Princess GW-A-11	9/17/02	900	19	36	4.6	0.18	3.9	0.7	3
Sea Princess GW-D-8	9/17/02	560	22	53	5.1	0.18	7.9	0.7	2.8
Star Princess GW-C (acc)	8/29/02	410	24	18	15	2.6	18	0.7	3.2
Star Princess GW-D (G&L)	8/29/02	840	46	9.8	31	7.7	6.8	0.7	0.4
Sun Princess GW-A4	7/11/02	76	0.28	5.9	18	6.4	21	9.5	0.4
Sun Princess GW-C galley	7/11/02	350	0.28	140	36	12	3.5	7.7	0.4
Minimum		**28**	**0.28**	**0.6**	**2.8**	**0.18**	**2.2**	**0.7**	**0.4**
Maximum		**900**	**46**	**140**	**56**	**12**	**21**	**9.6**	**4.3**
Geometric Mean		**169**	**9.21**	**9**	**13**	**0.63**	**6.5**	**2**	**0.84**
Median		**205**	**19.5**	**9.4**	**13**	**0.18**	**5.2**	**1.7**	**0.4**

2001

Table 32. 2001 Large Ship Graywater Accommodations - Conventional Pollutants from Double Bottom Tanks (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Sample Date	Sample Name	Fecal Coliform (f.c./100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**0.1**	**0.03**	**0.1**	**2**	**3.0**	**0.1**	**0.1**	**1**
N/A	6/5/2001	DB11 -	invalidated	56.0	not taken	6.8	97	240.0	ND	ND	4,100
N/A	6/5/2001	DB4 -	invalidated	230.0	not taken	4.2	1,000.00	2300.0	ND	ND	3,240
N/A	6/5/2001	DB8 -	invalidated	150.0	not taken	4.3	870	2100.0	ND	ND	4,320
Dawn Princess	7/23/2001	DB4	invalidated	102.0	0.01	5.2	373	765.0	ND	ND	2,060
N/A	5/31/2001	DB11	invalidated	66.0	not taken	7.6	190	450.0	2.00	0.20	440
N/A	5/31/2001	DB4	invalidated	66.0	not taken	7.1	210	460.0	0.10	ND	410
Ocean Princess	7/26/2001	DB 4	16,000,000	50.7	0.83	6.5	217	410.0	ND	ND	418
N/A	6/21/2001	DB 4P	invalidated	107.0	not taken	7.2	241	565.0	0.20	1.50	559
N/A	6/22/2001	DB 4S	600,000	67.2	not taken	6.7	182	382.0	0.10	1.20	867
Regal Princess	8/2/2001	DB 4P	1	31.0	0.01	7.7	151	295.0	3.50	0.70	953
Regal Princess	8/2/2001	DB 4S	1	39.2	0.01	7.3	158	327.0	14.00	14.00	857
Sea Princess	7/10/2001	DB 4	invalidated	52.4	0.72	7.0	157	342.0	0.30	ND	868
Sea Princess	7/10/2001	DB 8	invalidated	240.0	0.55	6.0	750	1470.0	0.30	ND	1,040
N/A	6/7/2001	DB8	invalidated	54.0	not taken	7.0	250	510.0	ND	ND	401
Sun Princess	8/22/2001	DB 8	16,000,000	74.6	0.11	6.3	281	582.0	0.30	ND	306
	Minimum		**1**	**31.0**	**0.01**	**4.2**	**97**	**240.0**	**ND**	**ND**	**306**

	Maximum		**16,000,000**	**240.0**	**0.83**	**7.7**	**1,000**	**2300.0**	**14.00**	**14.00**	**4,320**
	Geometric Mean		**10,896**	**77.0**	**0.08**	**6.4**	**266**	**573.0**	**0.21**	**0.15**	**939**
	Median		**600,000**	**66.0**	**0.11**	**6.8**	**217**	**460.0**	**0.30**	**1.20**	**867**

Table 33. 2001 Large Ship Graywater Accommodations - Conventional Pollutants from Collecting Tanks

Vessel Name	Sample Date	Sample Name	Fecal Coliform (fc/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
	8/21/2001	CT F	16,000,000	2,880.0	1.08	5.3	4,230	5,650.0	ND	ND	173
N/A	6/27/2001	CT 7 PT	Invalidated	49.0	not taken	6.9	150	270.0	ND	ND	334
N/A	6/27/2001	CT 7 SB	Invalidated	36.0	not taken	7.0	150	280.0	ND	ND	371
N/A	5/24/2001	CT G	300,000	79.0	not taken	6.7	230	300.0	2.50	ND	96
N/A	5/24/2001	CT E	300,000	38.0	not taken	6.6	130	200.0	3.00	2.00	100
Ocean Princess	7/26/2001	CT C	1	not found	1.09	9.8	487	825.0	4.00	3.50	441
N/A	5/25/2001	CT 4	22,000	22.0	not taken	7.4	130	220.0	3.50	0.30	470
N/A	5/25/2001	CT 5	350,000	56.0	not taken	7.6	170	300.0	1.80	0.40	270
N/A	5/25/2001	CT 6	33	55.0	not taken	7.5	450	1,200.0	2.00	0.10	430
Regal Princess	9/25/2001	CT	50,000	126.0	0.89	9.0	1,340	2,320.0	0.90	ND	536
N/A	6/5/2001	CT 3 E	170	100.0	not taken	9.2	500	970.0	3.50	0.30	1,080
N/A	6/5/2001	CT 4 D	1	22.0	not taken	7.9	100	250.0	70.00	50.00	4,220
N/A	6/5/2001	CT 6F	1	25.0	not taken	8.9	120	240.0	19.00	18.00	503

Vessel Name	Sample Date	Sample Name	Fecal Coliform (fc/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
Sea Princess	9/19/2001	CT C	50	56.6	0.25	7.6	296	765.0	5.00	0.70	891
N/A	6/8/2001	CT 8	170,000	87.0	not taken	9.4	170	390.0	8.00	4.00	418
		Minimum	**1**	**22.0**	**0.25**	**5.3**	**100**	**200.0**	**ND**	**ND**	**96**
		Maximum	**16,000,000**	**2,880.0**	**1.09**	**9.8**	**4,230**	**5,650.0**	**70.00**	**50.00**	**4,220**
		Geometric Mean	**2,189**	**67.0**	**0.72**	**7.7**	**282**	**527.0**	**1.82**	**0.50**	**420**
		Median	**22,000**	**55.5**	**0.99**	**7.6**	**170**	**300.0**	**3.00**	**0.30**	**430**

Table 34. 2001 Large Ship Graywater Galley - Conventional Pollutants from Double Bottom Tanks

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Sample Date	Sample Name	Fecal Coliform (MPN/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
N/A	5/31/2001	DB8 (galley)	Invalidated	270.0	Not taken	4	1,300	2,700.0	ND	ND	1,300
Dawn Princess	7/23/2001	DB 8 (galley)	Invalidated	383.0	0.01	4.1	1,150	1,290.0	ND	ND	2,870
Ocean Princess	7/26/2001	DB T and #8,11,13 domestic/galley	230,000	46.2	0.65	7.6	ND	521.0	ND	ND	521
N/A	6/21/2001	DB 15P (galley)	Invalidated	430.0	Not taken	6.2	1,440	1,920.0	0.10	1.70	509
N/A	6/22/2001	DB 15S (galley)	358,000	597.0	Not taken	4.4	1,520	2,270.0	0.10	2.00	757
Regal Princess	8/2/2001	DB 15P (galley)	Invalidated	368.0	0.88	5.1	980	1,550.0	3.30	3.00	885
Regal Princess	8/2/2001	DB 15S (galley)	15,300,000	ND	Not taken	5.3	1,080	1,620.0	ND	ND	883
Sea Princess	7/10/2001	DB 11 (Galley)	Invalidated	149.0	0.01	ND	814	1,520.0	ND	ND	803
N/A	6/7/2001	DB11 (Galley)	Invalidated	26000.0	Not taken	3.6	7,800	54,000.0	ND	ND	2,670
	8/22/2001	DB 11 (galley)	300,000	1390.0	1.38	4.05	2,900	3,950.0	ND	ND	863
		Minimum	**230,000**	**46.0**	**0.01**	**3.6**	**814**	**521.0**	**ND**	**ND**	**509**
		Maximum	**15,300,000**	**26000.0**	**1.38**	**7.6**	**7,800**	**54,000.0**	**3.30**	**3.00**	**2,870**

Vessel Name	Sample Date	Sample Name	Fecal Coliform (MPN/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	2	1.3	0.03	0.1	2	3.0	0.10	0.10	1
		Geometric Mean	784,072	512.0	0.14	4.8	1,587	2,404.0	0.12	0.23	1,008
		Median	329,000	383.0	0.65	4.4	1,300	1,770.0	ND	ND	873

Table 35. 2001 Large Ship Graywater Galley - Conventional Pollutants from Collecting Tanks

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Sample Date	Sample Name	Fecal Coliform MPN/100 ml	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
N/A	6/6/2001	CT (butcher)	16,000,000	804.0	Not taken	7.1	941	3,320.0	ND	ND	427
Dawn Princess	8/21/2001	CT (butcher)	80,000	148.0	9.27	6.5	530	1,030.0	3.50	0.10	692
Ocean Princess	7/26/2001	CT I (butcher)	1	141.0	1.35	7.0	311	712.0	100.00	ND	2,360
Regal Princess	8/2/2001	CT9 (butcher)	1	29.6	0.57	7.4	90	240.0	4.00	ND	915
N/A	6/12/2001	HT (butcher)	Missing	130.0	Not taken	7.5	720	1,500.0	4.00	ND	1,160
Sea Princess	9/19/2001	CT (butcher)	Missing	393.0	0.85	6.9	669	1,410.0	35.00	35.00	3,300
Dawn Princess	8/21/2001	CT (galley)	230,000	230.0	1.00	9.9	846	1,150.0	3.50	0.10	427
N/A	6/27/2001	HT 14PT (galley)	1,600,000	700.0	Not taken	4.8	2,200	3,500.0	ND	ND	1,090
N/A	6/27/2001	HT 3C (galley)	Missing	860.0	Not taken	4.7	1,700	2,700.0	ND	ND	672
N/A	5/24/2001	CT H – (galley)	5,000	2,300.0	Not taken	4.1	5,900	6,400.0	ND	ND	1,200
N/A	6/6/2001	CT (galley)	7,000	492.0	Not taken	9.4	1,460	2,360.0	0.40	0.20	665
Sea Princess	9/19/2001	CT (galley)	23	266.0	0.25	10.2	599	642.0	10.00	3.40	878
N/A	6/1/2001	CT (galley)	Missing	780.0	Not taken	9.6	1,600	2,300.0	3.50	ND	665

Vessel Name	Sample Date	Sample Name	Fecal Coliform MPN/100 ml	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
N/A	5/25/2001	CT 8 (galley)	50	880.0	Not taken	7.6	1,600	1,700.0	2.80	1.30	1,100
Ocean Princess	7/26/2001	CT H (galley)	170,000	2,520.0	0.86	4.8	ND	3,700.0	ND	ND	ND
Regal Princess	9/25/2001	CT (galley)	30	173.0	2.19	6.6	239	536.0	2.80	0.20	260
N/A	6/5/2001	CT (galley)	1	130.0	Not taken	9.3	760	1,400.0	30.00	1.00	1,180
Ocean Princess	7/26/2001	CT L (fish prep)	1	238.0	7.41	6.8	663	1,290.0	50.00	7.00	1,710
N/A	6/12/2001	HT (fish shop)	1	170.0	Not taken	8.2	550	1,100.0	4.00	1.50	1,150
Sea Princess	9/19/2001	CT (fish shop)	1	163.0	3.29	7.0	414	914.0	35.00	10.00	1,640
Regal Princess	8/2/2001	CT 10 (fish prep)	624	124.0	0.21	7.1	83	308.0	3.00	3.50	267
N/A	6/8/2001	CT (fish shop)	1	580.0	Not taken	7.0	1,000	1,900.0	2.00	0.10	1,850
N/A	6/6/2001	CT (fish shop)	500,000	1,610.0	Not taken	7.0	1,470	2,670.0	ND	ND	563
		Minimum	**1**	**30.0**	**0.21**	**4.1**	**83**	**240.0**	ND	ND	**260**
		Maximum	**16,000,000**	**2,520.0**	**9.27**	**10.2**	**5,900**	**6,400.0**	**100.00**	**35.00**	**3,300**
		Geometric Mean	**402**	**349.0**	**1.27**	**7.0**	**728**	**1,414.0**	**2.00**	**0.34**	**904**
		Median	**50**	**266.0**	**1.00**	**7.0**	**740**	**1,410.0**	**4.00**	**1.30**	**1,003**

Table 36. 2001 Large Ship Mixed Graywater – Conventional Pollutants from Double Bottom Tanks

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Sample Date	Sample Name	Fecal Coliform (MPN/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
Dawn Princess	8/20/2001	DB 11	500,000	259.0	0.63	6.3	216	982.0	ND	ND	30,500
Norwegian Sky	8/29/2001	DB3C	1,700,000	365.0	0.01	4.8	936	174.0	ND	ND	691
Norwegian Sky	8/29/2001	DB7P	700,000	40.3	0.01	6.8	130	Not taken	ND	ND	296
Norwegian Sky	8/29/2001	DB7S	300,000	43.6	1.92	7.0	171	289.0	ND	ND	355
		Minimum	**300,000**	**40.3**	**0.01**	**4.8**	**130**	**174.0**	**ND**	**ND**	**296**
		Maximum	**1,700,000**	**365.0**	**1.92**	**7.0**	**936**	**982.0**	**ND**	**ND**	**30,500**
		Geometric Mean	**649,994**	**113.5**	**0.09**	**6.1**	**259**	**367.0**	**ND**	**ND**	**1,220**
		Median	**600,000**	**151.3**	**0.32**	**6.5**	**194**	**289.0**	**ND**	**ND**	**523**

Table 37. 2001 Large Ship Mixed Graywater – Conventional Pollutants from Collecting Tanks

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Sample Date	Sample Name	Fecal Coliform (MPN/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
N/A	6/6/2001	CT B	2	21.0	not taken	7.8	87	155.0	0.80	ND	271
N/A	6/6/2001	CT C	70,000	4770.0	not taken	5.2	1,920	3,100.0	ND	ND	501
N/A	6/6/2001	CT E	90	45.0	not taken	7.9	101	151.0	ND	0.30	236
N/A	6/6/2001	CT F	50,000	40.4	not taken	7.4	56	144.0	ND	ND	174
N/A	5/30/2001	HT – 2102	1	260.0	not taken	9.8	110	540.0	3.00	0.60	3,970
N/A	5/30/2001	HT – 9149	9,000,000	710.0	not taken	6.4	770	1,100.0	ND	ND	1,020
N/A	5/30/2001	HT – 9249	9,000,000	370.0	not taken	6.5	510	690.0	ND	ND	1,310
Norwegian Wind	8/17/2001	HT – 2229	2,800,000	45.4	0.74	6.1	194	361.0	ND	ND	345
Norwegian Wind	8/17/2001	HT – 9149	3,500,000	144.0	0.30	6.3	325	722.0	ND	ND	1,710
Norwegian Wind	8/17/2001	HT – 9249	16,000,000	76.5	0.48	6.0	324	520.0	ND	ND	1,310
N/A	6/12/2001	HT E	Invalidated	27.0	not taken	7.5	110	230.0	2.50	ND	337
N/A	6/12/2001	HT F	Invalidated	94.0	not taken	7.2	600	1,200.0	4.00	1.80	399
N/A	6/12/2001	HT G	Invalidated	18.0	not taken	7.6	220	380.0	0.30	ND	183
		Minimum	**1**	**18.0**	**0.30**	**5.2**	**56**	**144.0**	**ND**	**ND**	**174**
		Maximum	**16,000,000**	**4770.0**	**0.74**	**9.8**	**1,920**	**3,100.0**	**4.00**	**1.80**	**3,970**
		Geometric Mean	**38,933**	**108.0**	**0.48**	**7.0**	**246**	**473.9**	**0.22**	**0.11**	**562**

		Median	**1,435,000**	**76.5**	**0.48**	**7.2**	**220**	**520.0**	**ND**	**ND**	**399**

Table 38. 2001 Large Ship Graywater Laundry – Conventional Pollutants from Double Bottom Tanks (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Sample Date	Sample Name	Fecal Coliform (MPN/100 ml)*	TSS (mg/l)	Ammonia (mg/l)	PH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
		MDL	**2**	**1.3**	**0.03**	**0.1**	**1**	**3.7**	**0.10**	**0.10**	**1**
N/A	5/31/2001	DB-Laundry)	Invalidated	23.0	not taken	9.9	120	410.0	0.20	0.10	350
Ocean Princess	7/26/2001	DB (laundry)	2,400,000	18.0	0.39	6.9	75	268.0	0.20	ND	153
N/A	6/21/2001	DB 9 (laundry)	Invalidated	68.0	not taken	9.7	160	410.0	0.40	0.70	465
Regal Princess	8/2/2001	DB Laundry	48,000	43.0	0.40	9.2	164	502.0	1.20	1.00	300
Sea Princess	7/10/2001	DB (Laundry)	Invalidated	14.6	0.13	8.3	79	310.0	0.30	ND	200
N/A	6/7/2001	DB6 (Laundry)	Invalidated	400.0	not taken	4.2	1,400	2,600.0	ND	ND	3,360
Sun Princess	8/22/2001	DB 6 (laundry)	2,400,000	743.0	7.35	6.7	1,320	2,250.0	0.10	0.05	2,830
		Minimum	**48,000**	**15.0**	**0.13**	**4.2**	**75**	**268.0**	**ND**	**ND**	**153**
		Maximum	**2,400,000**	**743.0**	**7.35**	**9.9**	**1,400**	**2,600.0**	**1.20**	**1.00**	**3,360**
		Geometric Mean	**651,460**	**66.0**	**0.62**	**7.6**	**230**	**634.0**	**0.22**	**0.12**	**545**
		Median	**2,400,000**	**43.0**	**0.40**	**8.3**	**160**	**410.0**	**0.20**	**ND**	**350**

Table 39. 2001 Large Ship Graywater Laundry – Conventional Pollutants from Collecting Tanks (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Sample Date	Sample Name	Fecal Coliform (MPN/100 ml)*	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
	MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
6/27/2001	HT 7PT (laundry)	30	24.0	not taken	9.2	150	340.0	2.00	2.00	647
6/27/2001	HT 7SB (laundry)	30	20.0	not taken	7.6	49	960.0	ND	ND	9,740
	Minimum	**30**	**20.0**	**not taken**	**7.6**	**49**	**340.0**	**ND**	**0.05**	**647**
	Maximum	**30**	**24.0**	**not taken**	**9.2**	**150**	**960.0**	**2.00**	**2.00**	**9,740**
	Geometric Mean	**30**	**22.0**	**not taken**	**8.4**	**86**	**571.0**	**0.32**	**0.32**	**2,510**
	Median	**30**	**22.0**	**not taken**	**8.4**	**100**	**650.0**	**1.03**	**1.03**	**5,194**

Table 40. 2001 Large Ship Graywater Conventional Pollutants taken with Priority Pollutants

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Tank Type	Water type	Sample Date	Ammonia mg/l	PH	BOD5 mg/l	COD mg/l	TSS mg/l	total CL mg/l	Fecal coliform MPU/100ml	Conductivity Umhos/cm	Free CL mg/l	Oil & grease mg/l	TOC mg/l	Alkalinity mg/l as CaCO3	Total N mg/l	phosphorus mg/l	TKN mg/l	Settable Solids mg/l
			MDL	0.03	0.1	2	3.0	1.3	0.1	2	1	0.1	1.5	1.0	0.5	1.0	0.22	0.1	0.1
Crystal Harmony	CT	Accomo	19-Sep-01	0.251	7.57	296	765	56.6	5	50	891	0.7	0.5	529	193	0.59	42.1	11.1	0.1
Crystal Harmony	CT	Galley	19-Sep-01	0.245	10.2	599	642	266	10	23	878	3.4	0.5	304	242	0.72	15.2	11.1	0.7
Norwegian Wind	CT	Mixed Gray	17-Aug-01	0.301	6.25	325	722	144	0.05	3500000	1710	0.05	130	885	65.5	0.01	5.4	12.9	2.8
Norwegian Wind	CT	Mixed Gray	17-Aug-01	0.481	6	324	520	76.5	0.05	16000000	1310	0.05	98	454	62.7	0.01	4.17	18.5	1.4
Norwegian Sky	DB	Mixed Gray	29-Aug-01	Na	Na	Na	Na	Na	Na	Na	Na	Na	46	Na	Na	Na	Na	Na	Na
Norwegian Sky	DB	Mixed Gray	29-Aug-01	Na	Na	Na	Na	Na	Na	Na	Na	Na	38	Na	Na	Na	Na	Na	Na
Norwegian Sky	DB	Mixed Gray	29-Aug-01	Na	6.75	130	Na	40.3	0.05	700000	296	0.05	Na	305	35.8	Na	1.04	3.7	0.1
Norwegian Sky	DB	Mixed Gray	29-Aug-01	1.92	7.01	171	289	43.6	0.05	300000	355	0.05	Na	279	67.2	0.01	2.76	9.1	0.1
Regal Princess	DB	Galley	2-Aug-01	Na	5.3	1080	1620	Na	0.5	15300000	883	0.5	290	480	33	0.01	7.96	22.2	0.7
Sun	DB	Galley	22-Aug-01	1.38	4.05	2900	3950	1390	0.05	300000	863	0.05	200	1570	Na	Na	19	61.1	35.0

Vessel Name	Tank Type	Water type	Sample Date	Ammonia mg/l	PH	BOD5 mg/l	COD mg/l	TSS mg/l	total CL mg/l	Fecal coliform MPU/100ml	Conductivity Umhos/cm	Free CL mg/l	Oil & grease mg/l	TOC mg/l	Alkalinity mg/l as CaCO3	Total N mg/l	phosphorus mg/l	TKN mg/l	Settable Solids mg/l
			MDL	**0.03**	**0.1**	**2**	**3.0**	**1.3**	**0.1**	**2**	**1**	**0.1**	**1.5**	**1.0**	**0.5**	**1.0**	**0.22**	**0.1**	**0.1**
Princess																			
Dawn Princess	DB	Galley	23-Jul-01	Na	4.1	1150	1290	383	0.05	invalid	2870	0.05	Na	336	0.095	0.01	6.1	50	1.3
Ocean Princess	DB	Acc/galley	26-Jul-01	0.65	7.6	Na	521	46.2	Na	230000	521	Na	Na	137	50.2	0.01	3.49	Na	0.2
Ocean Princess	DB	Laundry	26-Jul-01	0.394	6.9	75	268	18	0.2	2400000	153	0.05	Na	65	28.2	0.01	5.54	5.6	0.1
Dawn Princess	DB	Accomo	23-Jul-01	Na	5.2	373	765	102	0.05	invalid	2060	0.05	Na	231	56.5	0.01	5.89	20.9	0.1
Regal Princess	DB	Accomo	2-Aug-01	Na	7.7	151	295	31	3.5	Invalid	953	0.7	47	87	82	0.01	2.18	7.5	0.1
			Minimum	**0.016**	**0.1**	**1**	**3.4**	**1.3**	**0.05**	**2**	**1**	**0.05**	**0.5**	**0.3**	**0.019**	**0.01**	**0.22**	**0.1**	**0.1**
			Maximum	**1.92**	**10.2**	**2900**	**3950**	**1390**	**10**	**16,000,000**	**2870**	**3.4**	**290**	**1,570**	**242**	**0.72**	**42.1**	**61.1**	**35.0**
			Geometric Mean	**0.528**	**6.31**	**368.72**	**700.08**	**92.8**	**0.221**	**179,261**	**808.452**	**0.134**	**29.146**	**310.5**	**38.145**	**0.02**	**5.854**	**14.1**	**0.4**
			Median	**0.4375**	**6.75**	**324.5**	**682**	**66.55**	**0.05**	**500,000**	**883**	**0.05**	**47**	**305.0**	**59.6**	**0.01**	**5.54**	**12.0**	**0.2**

Table 41. 2001 Large Ship Graywater Volatile Organic Compounds (a-e)

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Sample Name	Water type	Sample Date	1,1-Dichloro Propene	Acrylonitrile	bromodichloromethane	bromoform	Chloroethane	Carbon Tetrachloride	Chloroform	dibromochloromethane	Ethyl Benzene
			MDL	**0.5**	**2.000**	**0.50**	**0.50**	**0.5**	**0.5**	**0.5**	**0.50**	**0.50**
Crystal Harmony	CT	Accomo	19-Sep-01	0.095	0.165	2.5	0.16	7.9	0.085	170	0.16	0.095
Crystal Harmony	CT	Galley	19-Sep-01	0.095	4.000	6	0.16	0.18	0.085	0.125	0.16	0.095
Norwegian Wind	CT	Mixed Gray	17-Aug-01	0.095	0.165	3	0.16	0.18	0.085	19	2.1	0.095
Norwegian Wind	CT	Mixed Gray	17-Aug-01	0.095	0.165	3.4	1.4	0.18	0.085	19	2.4	0.095
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.095	0.165	2.7	6.3	0.18	0.085	12	3.4	0.52
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.095	0.165	3.1	6.5	0.18	0.085	8.9	3.5	0.51
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.095	0.165	0.115	0.16	0.18	0.085	0.125	0.16	0.095
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.095	0.165	0.115	0.16	0.18	0.085	0.125	0.16	0.095
Regal Princess	DB	Galley	2-Aug-01	1.3	0.165	1.6	0.16	0.18	1.9	140	0.16	0.095
Sun Princess	DB	Galley	22-Aug-01	0.095	0.165	1.3	0.16	0.18	0.085	37	0.16	0.095

Dawn Princess	DB	Galley	23-Jul-01	0.095	0.165	0.115	31	0.18	0.085	16	1.2	0.51
Ocean Princess	DB	Acc/galley	26-Jul-01	0.095	0.165	3.4	0.16	0.18	0.085	95	0.16	58
Ocean Princess	DB	Laundry	26-Jul-01	0.095	0.165	1.4	0.16	0.18	0.085	31	0.16	1.8
Dawn Princess	DB	Accomo	23-Jul-01	0.095	0.165	1.6	3	0.18	0.085	58	0.16	0.095
Regal Princess	DB	Accomo	2-Aug-01	0.095	0.165	0.115	0.16	16	3.5	0.125	0.16	0.095
			Minimum	**0.095**	**0.165**	**0.115**	**0.16**	**0.18**	**0.085**	**0.125**	**0.16**	**0.095**
			Maximum	**1.3**	**4**	**6**	**31**	**16**	**3.5**	**170**	**3.5**	**58**
			Geometric Mean	**0.113**	**0.204**	**1.088**	**0.522**	**0.312**	**0.134**	**7.769**	**0.392**	**0.248**
			Median	**0.095**	**0.165**	**1.6**	**0.16**	**0.18**	**0.085**	**19**	**0.16**	**0.095**

Table 42. 2001 Large Ship Graywater Volatile Organic Compounds (m-t) (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Tank Type	Water type	Sample Date	methyl chloride	methylene chloride	Toluene	Tetrachloroethene	Trichloroethene
			MDL	1.0	1.0	0.50	0.5	0.5
Crystal Harmony	CT	Accomo	19-Sep-01	8.4	0.6	0.125	0.06	0.13
Crystal Harmony	CT	Galley	19-Sep-01	0.6	0.6	0.125	0.06	0.13
Norwegian Wind	CT	Mixed Gray	17-Aug-01	0.6	0.6	0.125	35	5.1
Norwegian Wind	CT	Mixed Gray	17-Aug-01	0.6	0.6	0.125	40	9
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.6	1.8	1.1	0.7	0.13
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.6	1.9	0.125	0.78	0.13
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.6	0.6	0.125	0.06	0.13
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.6	0.6	0.125	0.06	0.13
Regal Princess	DB	Galley	2-Aug-01	5	8.2	2.2	0.06	0.13
Sun Princess	DB	Galley	22-Aug-01	0.6	0.6	0.125	0.06	0.13
Dawn	DB	Galley	23-Jul-01	0.6	0.6	1.7	0.06	0.13

Vessel Name	Tank Type	Water type	Sample Date	methyl chloride	methylene chloride	Toluene	Tetrachloroethene	Trichloroethene
			MDL	**1.0**	**1.0**	**0.50**	**0.5**	**0.5**
Princess								
Ocean Princess	DB	Acc/galley	26-Jul-01	0.6	0.6	0.125	0.06	0.13
Ocean Princess	DB	Laundry	26-Jul-01	0.6	0.6	0.125	0.96	0.13
Dawn Princess	DB	Accomo	23-Jul-01	0.6	0.6	0.83	0.06	0.13
Regal Princess	DB	Accomo	2-Aug-01	81	12	0.125	0.06	0.13
			Minimum	**0.6**	**0.6**	**0.125**	**0.06**	**0.13**
			Maximum	**81**	**12**	**2.2**	**40**	**9**
			Geometric Mean	**1.143**	**1.013**	**0.236**	**0.238**	**0.22**
			Median	**0.6**	**0.6**	**0.125**	**0.06**	**0.13**

Table 43. 2001 Large Ship Graywater Bases-Neutrals & Acids

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Water type	Sample Date	Bis(2-Ethylhexyl)Phthalate	Butylbenzylphthalate	2,4-dichlorophenol	Diethylphthalate	2,4,6-trichlorophenol
		MDL	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Crystal Harmony	Accomo	19-Sep-01	8.2	0.19	2.2	9.4	0.195
Crystal Harmony	Galley	19-Sep-01	9.1	1.4	42	6.9	40
Norwegian Wind	Mixed Gray	17-Aug-01	55	0.19	0.275	7.9	0.195
Norwegian Wind	Mixed Gray	17-Aug-01	15	0.19	0.275	7.4	0.195
Norwegian Sky	Mixed Gray	29-Aug-01	15	0.19	0.275	17	0.195
Norwegian Sky	Mixed Gray	29-Aug-01	21	0.19	0.275	20	0.195
Norwegian Sky	Mixed Gray	29-Aug-01	0.35	0.19	0.275	0.275	0.195
Norwegian Sky	Mixed Gray	29-Aug-01	0.35	0.19	0.275	0.275	0.195
Regal Princess	Galley	2-Aug-01	3.4	0.19	0.275	7.6	0.195
Sun Princess	Galley	22-Aug-01	3.1	2.7	0.275	3.6	0.195
Dawn Princess	Galley	23-Jul-01	5.8	1.9	0.275	6.3	0.195
Ocean Princess	Acc/galley	26-Jul-01	14	0.19	0.275	12	0.195
Ocean Princess	Laundry	26-Jul-01	17	0.19	0.275	15	0.195
Dawn Princess	Accomo	23-Jul-01	8.9	2.3	0.275	9.6	0.195
Regal Princess	Accomo	2-Aug-01	5.2	0.19	3.2	13	5.6
		Minimum	**0.35**	**0.19**	**0.275**	**0.275**	**0.195**
		Maximum	**55**	**2.7**	**42**	**20**	**40**
		Geometric Mean	**6.51**	**0.357**	**0.52**	**5.913**	**0.348**

Vessel Name	Water type	Sample Date	Bis(2-Ethylhexyl)Phthalate	Butylbenzylphthalate	2,4-dichlorophenol	Diethylphthalate	2,4,6-trichlorophenol
		MDL	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
		Median	**8.9**	**0.19**	**0.275**	**7.9**	**0.195**

Table 44. 2001 Large Ship Graywater Bases-Neutrals & Acids (continued) (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Tank Type	Water Type	Sample Date	Diethylphthalate	Di-N-Butylphthalate	Di-N-Octylphthalate	Phenol	2,4,6-trichlorophenol
			MDL	1.0	1.0	1.0	1.0	1.0
Crystal Harmony	CT	Accomo	19-Sep-01	9.4	0.7	0.125	0.44	0.195
Crystal Harmony	CT	Galley	19-Sep-01	6.9	1.7	0.125	0.44	40
Norwegian Wind	CT	Mixed Gray	17-Aug-01	7.9	2.9	3.5	0.44	0.195
Norwegian Wind	CT	Mixed Gray	17-Aug-01	7.4	3.8	0.125	0.44	0.195
Norwegian Sky	DB	Mixed Gray	29-Aug-01	17	0.7	0.125	4	0.195
Norwegian Sky	DB	Mixed Gray	29-Aug-01	20	0.7	0.125	0.44	0.195
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.275	0.7	0.125	0.44	0.195
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.275	0.7	0.125	0.44	0.195
Regal Princess	DB	Galley	2-Aug-01	7.6	2.2	0.125	0.44	0.195
Sun Princess	DB	Galley	22-Aug-01	3.6	2.7	0.125	0.44	0.195

Vessel Name	Tank Type	Water Type	Sample Date	Diethylphthalate	Di-N-Butylphthalate	Di-N-Octylphthalate	Phenol	2,4,6-trichlorophenol
			MDL	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Dawn Princess	DB	Galley	23-Jul-01	6.3	2.9	0.125	1.8	0.195
Ocean Princess	DB	Acc/galley	26-Jul-01	12	14	0.125	0.44	0.195
Ocean Princess	DB	Laundry	26-Jul-01	15	4	0.125	0.44	0.195
Dawn Princess	DB	Accomo	23-Jul-01	9.6	1.9	0.125	0.44	0.195
Regal Princess	DB	Accomo	2-Aug-01	13	3.7	0.125	0.44	5.6
			Minimum	**0.275**	**0.7**	**0.125**	**0.44**	**0.195**
			Maximum	**20**	**14**	**3.5**	**4**	**40**
			Geometric Mean	**5.913**	**1.944**	**0.156**	**0.56**	**0.348**
			Median	**7.9**	**2.2**	**0.125**	**0.44**	**0.195**

Table 45. 2001 Large Ship Graywater Metals (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel Name	Tank Type	Water type	Sample Date	antimony	arsenic III	beryllium	cadmium (TR)	chromium (TR)	copper (TR)	lead (TR)	nickel (TR)	selenium (TR)	silver (TR)	zinc (TR)
			MDL	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Crystal Harmony	CT	Accomo	19-Sep-01	0.75	1.44	0.1	0.0724	2.72	255	4.47	27.9	0.965	0.367	458
Crystal Harmony	CT	Galley	19-Sep-01	0.75	0.434	0.1	0.4	10.6	74.9	2.51	15.4	0.862	1.43	173
Norwegian Wind	CT	Mixed Gray	17-Aug-01	2.74	3.52	0.0867	0.789	4.11	275	78.6	51.9	9.14	0.43	10300
Norwegian Wind	CT	Mixed Gray	17-Aug-01	0.417	2.55	0.0167	0.4	4.88	272	12.6	56	6.63	0.167	1390
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.75	0.18	0.1	0.4	1.15	0.6	0.7	0.55	2.4	0.45	1.4
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.75	0.18	0.1	0.4	1.15	0.6	0.7	0.55	2.4	0.45	1.4
Norwegian Sky	DB	Mixed Gray	29-Aug-01	1.01	0.419	0.0157	0.317	1.82	338	1.7	15	0.566	0.231	289
Norwegian Sky	DB	Mixed Gray	29-Aug-01	0.893	0.447	0.0274	0.26	3.1	267	2.25	13.7	0.771	0.138	228
Regal Princess	DB	Galley	2-Aug-01	0.125	0.846	0.0289	0.177	10.7	652	1.06	17.1	1.16	0.294	106
Sun Princess	DB	Galley	22-Aug-01	0.365	2.38	0.0206	0.108	8.76	69.3	2.73	13.2	1.25	1.18	206
Dawn	DB	Galley	23-Jul-01	0.748	8.27	0.1	0.4	13.6	1710	94.7	32.3	31.5	1.68	400

Vessel Name	Tank Type	Water type	Sample Date	antimony	arsenic III	beryllium	cadmium (TR)	chromium (TR)	copper (TR)	lead (TR)	nickel (TR)	selenium (TR)	silver (TR)	zinc (TR)
			MDL	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Princess														
Ocean Princess	DB	Acc/galley	26-Jul-01	0.364	0.454	0.0273	0.111	3.87	170	5.7	16.9	1.28	0.15	411
Ocean Princess	DB	Laundry	26-Jul-01	0.635	0.192	0.1	0.308	2.05	44.1	3.27	5.25	0.396	0.384	163
Dawn Princess	DB	Accomo	23-Jul-01	0.434	2.43	0.1	0.4	4.96	174	4.25	10.7	8.99	0.901	270
Regal Princess	DB	Accomo	2-Aug-01	0.338	0.559	0.1	0.281	2.62	355	2.75	8.71	1.76	0.431	276
			Minimum	**0.125**	**0.18**	**0.0157**	**0.0724**	**1.15**	**0.6**	**0.7**	**0.55**	**0.396**	**0.138**	**1.4**
			Maximum	**2.74**	**8.27**	**0.1**	**0.789**	**13.6**	**1710**	**94.7**	**56**	**31.5**	**1.68**	**10300**
			Geometric Mean	**0.591**	**0.835**	**0.054**	**0.273**	**3.833**	**103.439**	**4.039**	**11.084**	**2.047**	**0.43**	**179.346**
			Median	**0.748**	**0.559**	**0.1**	**0.317**	**3.87**	**255**	**2.75**	**15**	**1.28**	**0.43**	**270**

Table 46. 2001 Large Ship Blackwater Conventional Pollutants(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

	Treatment Type	Sample Date	Waste Type	Fecal Coliform (MPN/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
			MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
N/A	Advanced	5/14/2001	Black/Gray	2	0.7	1.18	4.0	63	99.7	ND	ND	16.1
Mercury	Advanced	7/31/2001	Black/Gray	1	0.7	0.73	7.4	1	1.7	ND	ND	61.9
Mercury	Advanced	8/8/2001	Black/Gray	1	0.7	0.62	7.1	2	1.7	ND	ND	36.2
Mercury	Advanced	8/8/2001	Black/Gray	1	0.7	0.95	7.0	5	10.4	ND	ND	69.3
Mercury	Advanced	8/9/2001	Black/Gray	1	0.7	0.46	6.8	3	1.7	ND	ND	45.8
Mercury	Advanced	8/10/2001	Black/Gray	1	0.7	0.54	7.2	1	1.7	ND	ND	46.1
Mercury	Advanced	8/10/2001	Black/Gray	1	0.7	0.49	7.0	11	23.2	ND	ND	65
Mercury	Advanced	8/11/2001	Black/Gray	1	0.7	0.27	7.4	2	1.7	ND	ND	85
Mercury	Advanced	8/11/2001	Black/Gray	1	0.7	0.17	7.3	1	12.6	ND	ND	86.8
Mercury	Advanced	9/9/2001	Black/Gray	1	0.7	0.45	7.1	1	14.7	ND	ND	13.2
N/A	Advanced	6/28/2001	Black/Gray	1	0.7	0.64	7.2	ND	ND	ND	ND	ND
Statendam	Advanced	8/1/2001	Black/Gray	1	0.7	17.90	7.6	1	1.7	ND	ND	570
Universe Explorer	Macerator/Chlorinator	7/13/2001	Black/Gray	60	189.0	0.34	7.0	134	1,100.0	5.00	1.40	40,400.00
Universe Explorer	Macerator/Chlorinator	7/13/2001	Black/Gray	5	128.0	3.49	7.1	190	973.0	2.50	0.40	34,400.00
Universe Explorer	Macerator/Chlorinator	8/8/2001	Black/Gray	Invalidated	326.0	11.20	ND	313	ND	ND	ND	ND
Universe Explorer	Macerator/Chlorinator	8/8/2001	Black/Gray	Invalidated	173.0	16.70	7.2	180	1,100.0	ND	ND	28,500.00

	Treatment Type	Sample Date	Waste Type	Fecal Coliform (MPN/100 ml)	TSS (mg/l)	Ammonia (mg/l)	pH	BOD (mg/l)	COD (mg/l)	Cl, Residual (mg/l)	Cl, Free (mg/l)	Conductivity (umhos/cm)
			MDL	**2**	**1.3**	**0.03**	**0.1**	**2**	**3.0**	**0.10**	**0.10**	**1**
			Minimum	**1**	**0.7**	**0.17**	**4.0**	**1**	**1.7**	ND	ND	**13.2**
			Median	**1**	**0.7**	**0.63**	**7.1**	**3**	**11.5**	ND	ND	**67.2**
			Maximum	**60**	**326.0**	**17.90**	**7.6**	**313**	**1,100.0**	**5.00**	**1.40**	**40,400.00**
			Geometric Mean	**2**	**2.7**	**1.08**	**6.9**	**7**	**16.7**	**0.09**	**0.07**	**223**

Table 47. 2001 Large Ship Blackwater Conventional Pollutants taken with Priority Pollutants(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Vessel/Type	Water type	Sample Date / Units / MDL	Ammonia mg/l 0.1	pH 1	BOD5 mg/l 2	COD mg/l 3.0	TSS mg/l 1.3	Total CL Mg/l 0.1	Fecal Coliform MPU/ 100ml 2	Conductivity Umhos/cm 1	Free CL mg/l 0.1	Oil & Grease mg/l 1.5	TOC mg/l 1.0	Alkalinity mg/l as CaCO3 0.5	Total N mg/l 1.0	Phosphorus mg/l 0.01	TKN mg/l 1.0	Settable Solids mg/l 0.1
Statendam/ Advanced	Mixed BW&GW	20-Sep-01	17.9	7.55	1.7	0.65	0.05	0.05	1	570	0.05	n/a	12.0	99.7	1.9	14.30	19.4	0.1
Mercury/ Advanced	Mixed BW&GW	9-Sep-01	0.454	7.05	1.7	14.7	n/a	n/a	n/a	13.2	n/a	0.1	1.0	6.3	0.1	0.05	11.1	0.1
Universe Explorer/ Macerator	Mixed BW&GW	8-Aug-01	11.2	7.1	313	1180	326	0.05	n/a	26,400	0.05	n/a	229.0	n/a	0.6	n/a	29.6	10.0
Universe Explorer/Macerator	Mixed BW&GW	8-Aug-01	16.7	7.2	180	1100	173	0.05	n/a	28,500	0.05	35.0	100.0	151.0	0.5	3.79	27.8	4.5
Crystal Harmony /Biological*	BW	19-Aug-01	292	7.85	258	1630	692	0.05	1700000	3,590	0.05	0.2	373.0	743.0	41.2	102.00	363.0	32.0
		Minimum	**0.454**	**7.05**	**1.7**	**0.65**	**0.05**	**0.05**	**1**	**13.2**	**0.05**	**0.1**	**1.0**	**6.3**	**0.1**	**0.05**	**11.1**	**0.1**
		Maximum	**292**	**7.85**	**313**	**1,630**	**692**	**0.05**	**1,700,000**	**28,500**	**0.05**	**35.0**	**373.0**	**743.0**	**41.2**	**102.00**	**363.0**	**32.0**
		Geometric Mean	**13.472**	**7.34**	**33.471**	**115.12**	**37.375**	**0.05**	**1,303.84**	**1,826**	**0.05**	**0.6**	**40.0**	**91.4**	**1.2**	**4.08**	**36.5**	**1.3**
		Median	**16.7**	**7.2**	**180**	**1,100**	**249.5**	**0.05**	**850,000.5**	**3,590**	**0.05**	**0.2**	**100.0**	**125.4**	**0.6**	**9.05**	**27.8**	**4.5**

***** This ship continued to sample but was not discharging in Alaska waters.

Table 48. 2001 Large Ship Blackwater Volatile Organic Compounds (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Type	Water type	Sample Date	Bromodichloromethane	Bromoform	Chloroform	Dibromo Chloro methane	Ethylbenzene	Tetrachloroethene	Trichloroethene
			0.50	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
Statendam/ Advanced	Mixed BW&GW	20-Sep-01	0.68	0.16	4.2	0.115	0.125	11.00	0.51
Mercury/ Advanced	Mixed BW&GW	9-Sep-01	0.6	0.16	11	0.115	0.125	0.13	0.25
Universe Explorer/ Macerator	Mixed BW&GW	8-Aug-01	4.8	26	22	9.6	0.125	0.13	0.25
Universe Explorer/Macerator	Mixed BW&GW	8-Aug-01	0.6	13	27	3.3	0.53	0.13	0.25
Crystal Harmony DB	Mixed BW&GW	19-Aug-01	0.6	0.16	1.7	0.115	0.125	0.13	0.25
Crystal Harmony /Biological	BW	19-Aug-01	0.6	0.16	0.87	0.115	0.125	0.13	0.25
		Minimum	**0.6**	**0.16**	**0.87**	**0.115**	**0.125**	**0.13**	**0.25**
		Maximum	**4.8**	**26**	**27**	**9.6**	**0.53**	**11.00**	**0.51**
		Geometric Mean	**0.866**	**0.778**	**5.862**	**0.421**	**0.159**	**0.27**	**0.28**
		Median	**0.60**	**0.16**	**7.6**	**0.115**	**0.125**	**0.13**	**0.25**

Table 49. 2001 Large Ship Blackwater Base-Neutrals and Acids (Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Type	Water Type	Sample Date	1,4 di Chlorobenzene	Bis(2-Ethylhexyl)Phthalate	Butylbenzyl phthalate	Diethylphthalate	Di-N-Butylphthalate	Phenol
		MDL	**1.00**	**1.0**	**1.00**	**1.0**	**1.0**	**1.0**
Statendam/ Advanced	Mixed BW&GW	20-Sep-01	0.18	0.19	0.275	0.7	3.2	0.35
Mercury/ Advanced	Mixed BW&GW	9-Sep-01	0.18	4.2	0.275	0.7	0.165	0.35
Universe Explorer/ Macerator	Mixed BW&GW	8-Aug-01	3.9	0.19	0.275	0.7	0.165	0.35
Universe Explorer/Macerator	Mixed BW&GW	8-Aug-01	0.18	3.1	0.275	2.3	2.9	2.3
Crystal Harmony DB	Mixed BW&GW	19-Aug-01	0.18	7	1.2	0.7	3.7	0.35
Crystal Harmony /Biological	BW	19-Aug-01	0.18	0.19	0.275	0.7	1.8	0.35
		Minimum	**0.18**	**0.19**	**0.275**	**0.7**	**0.165**	**0.35**
		Maximum	**3.9**	**7**	**1.2**	**2.3**	**3.7**	**2.3**

		Geometric Mean	**0.301**	**0.925**	**0.352**	**0.853**	**1.091**	**0.479**
		Median	**0.18**	**1.65**	**0.275**	**0.70**	**2.35**	**0.35**

Table 50. 2001 Large Ship Blackwater Metals

(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Type	Water type	Sample Date	Arsenic III	Antimony(Tr)	Beryllium	Cadmium (TR)	Chromium (TR)	Copper (TR)	Lead (TR)	Nickel (TR)	Selenium (TR)	Silver (TR)	Zinc (TR)
		MDL	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Statendam/ Advanced	Mixed BW&GW	20-Sep-01	1.09	1.8	0.4	1.15	0.685	2.66	0.0628	18.3	1.05	1.4	32.4
Mercury/ Advanced	Mixed BW&GW	9-Sep-01	0.1	0.104	0.4	1.15	0.196	0.501	0.195	0.688	0.213	1.4	3.02
Universe Explorer/ Macerator	Mixed BW&GW	8-Aug-01	32.8	1.8	0.465	1.15	8.12	203	3.67	25.4	105	1.4	228
Universe Explorer/Macerator	Mixed BW&GW	8-Aug-01	36	1.8	0.4	1.15	6.92	98.7	0.55	22.7	155	1.4	111
Crystal Harmony DB	Mixed BW&GW	19-Aug-01	53.4	22.7	0.381	1.15	0.6	169	3.43	16.2	152	1.66	268
Crystal Harmony /Biological	BW	19-Aug-01	9.03	1.99	0.4	2.52	2.61	1670	80.3	38.1	8.31	0.983	3020
		Minimum	**0.1**	**0.104**	**0.381**	**1.15**	**0.196**	**0.501**	**0.0628**	**0.688**	**0.213**	**0.983**	**3.02**
		Maximum	**53.4**	**22.7**	**0.465**	**2.52**	**8.12**	**1670**	**80.3**	**38.1**	**155**	**1.66**	**3020**
		Geometric Mean	**6.292**	**1.736**	**0.407**	**1.311**	**1.509**	**44.278**	**1.377**	**12.84**	**12.895**	**1.358**	**112.286**
		Median	**20.915**	**1.8**	**0.4**	**1.15**	**1.6475**	**133.85**	**1.99**	**20.5**	**56.655**	**1.4**	**169.5**

2000 Large ship data
(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).

Table 51. 2000 Large Ship Accommodations & Laundry Graywater – Conventional Pollutants

Sample Date	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
	mg/L		mg/L	mg/L	mg/L	Mg/L	MPN/100ml	mg/L
MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
20-Sep-00	0.61	7.3	69	240.0	30.0	ND	1	ND
13-Sep-00	ND	ND	ND	ND	ND	2.80	230	0.10
25-Aug-00	45.00	6.7	58	ND	200.0	ND	1	0.40
Minimum	**0.61**	**6.7**	**58**	**240.0**	**30.0**	**ND**	**1**	**ND**
Maximum	**45.00**	**7.3**	**69**	**240.0**	**200.0**	**2.80**	**230**	**0.40**
Geometric Mean	**5.24**	**7.0**	**63**	**240.0**	**77.5**	**0.37**	**6**	**0.13**
Median	**25.12**	**6.8**	**61**	**240.0**	**138.7**	**0.37**	**4**	**0.26**

Table 52. 2000 Large Ship Accommodations Graywater Conventional Pollutants

Sample Date	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
	mg/l		mg/l	mg/l	mg/l	mg/l	MPN/100ml	mg/l
MDL	**0.03**	**0.1**	**2**	**3.0**	**1.3**	**0.10**	**2**	**0.10**
6-Sep-00	0.88	9.0	500	ND	110.0	ND	ND	ND
18-Sep-00	ND	ND	ND	ND	ND	0.05	1,200	ND
18-Sep-00	49.00	7.8	210	1,340.0	800.0	1.50	9	ND
Minimum	**0.88**	**7.8**	**210**	**1,340.0**	**110.0**	**0.05**	**9**	**ND**
Maximum	**49.00**	**9.0**	**500**	**1,340.0**	**800.0**	**1.50**	**1,200**	**ND**
Geometric Mean	**6.57**	**8.4**	**324**	**1,340.0**	**297.0**	**0.27**	**104**	**ND**
Median	**24.94**	**8.4**	**355**	**1,340.0**	**455.0**	**0.78**	**605**	**ND**

Table 53. 2000 Large Ship Laundry Graywater Conventional Results

Sample Date	Sample Name	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100ml	mg/L
	MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
29-Aug-00	Gry laundry	0.17	7.6	120	400.0	39.0	not taken	8,000	ND
7-Aug-00	Gry laundry	0.39	10.5	70	230.0	4.0	0.85	1	0.40
22-Aug-00	Gry stbrd laundry	0.10	9.6	7	180.0	54.0	not taken	1	ND
29-Sep-00	Gry laundry	not taken	not taken	not taken	not taken	not taken	0.50	not taken	not taken
20-Sep-00	Gry laundry coll. Tank	not taken	not taken	not taken	not taken	not taken	1.00	1	0.80
3-Aug-00	Gry laundry	3.00	9.2	85	300.0	19.0	ND	700	ND
12-Aug-00	Gry laundry room	10.00	3.0	290	1,310.0	420.0	ND	1	ND
6-Sep-00	Gry laundry	0.01	7.6	86	270.0	46.0	ND	1	ND
2-Sep-00	Gry laundry	0.75	10.2	98	300.0	38.0	1.00	1	0.40
18-Sep-00	Gry laundry tank	not taken	not taken	not taken	not taken	not taken	ND	30	0.05
Minimum		**0.01**	**3.0**	**7**	**180.0**	**4.0**	**0.05**	**1**	**0.05**
Maximum		**10.00**	**10.5**	**290**	**1,310.0**	**420.0**	**1.00**	**8,000**	**0.80**
Geometric Mean		**0.38**	**7.7**	**74**	**340.0**	**38.0**	**0.20**	**8**	**0.11**

Sample Date	Sample Name	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100ml	mg/L
	MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
Median		**0.39**	**9.2**	**86**	**300.0**	**39.0**	**0.28**	**1**	**0.05**

Table 54. 2000 Large Ship Galley Graywater Conventional Pollutants

Sample Date	Waste Type	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
		mg/L		mg/L	mg/L	Mg/L	mg/L	MPN/100ml	mg/L
	MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
6-Sep-00	Gray (Galley)	2.00	7.3	11	25.0	21.0	ND	ND	ND
13-Sep-00	Gray (Galley)	0.63	9.5	1,210	1,730.0	320.0	ND	ND	ND
13-Sep-00	Gray (Galley)	ND	ND	ND	ND	ND	2.50	3,000	0.20
29-Sep-00	Gray (Galley)	ND	ND	ND	ND	ND	4.00	ND	4.00
3-Aug-00	Gray (Galley)	1.60	6.1	1,720	1,090.0	257.0	ND	ND	ND
5-Aug-00	Gray (Galley)	11.00	7.1	180	430.0	140.0	ND	ND	ND
29-Aug-00	Gray (Galley)	9.50	6.9	490	790.0	160.0	0.05	28,000	ND
2-Sep-00	Gray (Galley)	0.01	5.6	330	785.0	190.0	0.05	9,000,000	ND
18-Sep-00	Gray (Galley)	ND	ND	ND	ND	ND	0.05	130,000	ND
9-Sep-00	Gray (Galley)	2.37	6.8	3,190	10,420.0	4,500.0	0.05	5	1.20
18-Sep-00	Gray (Galley)	8.20	3.7	37,030	69,080.0	29,400.0	0.05	ND	ND
Minimum		**0.01**	**3.7**	**11**	**25.0**	**21.0**	**0.05**	**5**	**ND**
Maximum		**11.00**	**9.5**	**37,030**	**69,080.0**	**29,400.0**	**4.00**	**9,000,000**	**4.00**
Geometric Mean		**1.55**	**6.4**	**728**	**1,317.0**	**420.0**	**0.16**	**13,750**	**0.18**

Sample Date	Waste Type	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
		mg/L		mg/L	mg/L	Mg/L	mg/L	MPN/100ml	mg/L
	MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
Median		**2.19**	**6.9**	**850**	**940.0**	**223.5**	**0.05**	**28,000**	**ND**

Table 55. Ship Mixed Graywater held in Collecting Tanks - Conventional Pollutants

Sample Date	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
	mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100ml	mg/L
MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
7-Aug-00	3.40	7.2	81	190.0	67.0	ND	50,000	ND
13-Sep-00	not taken	not taken	not taken	not taken	not taken	not taken	30	not taken
2-Aug-00	1.40	6.1	1,120	2,060.0	497.0	ND	350,000	ND
29-Sep-00	0.12	7.5	730	440.0	190.0	ND	invalid	ND
29-Sep-00	5.30	6.7	190	286.0	86.0	ND	170,000	ND
3-Aug-00	1.70	4.7	86	1,250.0	171.0	ND	1,300,000	ND
21-Sep-00	2.10	6.6	180	370.0	110.0	ND	280,000	ND
25-Aug-00	3.80	3.8	Invalidated	15,700.0	3,000.0	ND	7,000	ND
22-Sep-00	1.20	7	150	410.0	69.0	ND	70,000	ND
5-Aug-00	0.45	10.3	440	850.0	98.0	ND	490,000	ND
5-Aug-00	0.99	6.8	89	410.0	37.0	0.20	22,000	ND
5-Aug-00	0.26	4.7	780	1,160.0	294.0	ND	9,200,000	ND
5-Aug-00	0.50	6.4	170	350.0	57.0	0.10	16,000,000	ND
12-Aug-00	2.00	9.1	150	170.0	67.0	ND	220,000	ND
15-Aug-00	1.30	4.8	1,030	1,530.0	500.0	ND	invalid	ND
12-Aug-00	1.10	5.7	810	1,190.0	150.0	ND	1,600	ND
12-Aug-00	0.52	7.7	130	380.0	54.0	ND	800,000	ND
29-Aug-00	2.10	7.2	130	250.0	51.0	ND	8,000	ND
18-Sep-00	1.40	8	230	400.0	230.0	ND	invalid	ND
9-Sep-00	26.90	6.8	170	470.0	110.0	ND	110,000	ND
20-Sep-00	2.90	7.6	150	290.0	51.0	1.20	invalid	0.60

Sample Date	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
	mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100ml	mg/L
MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
9-Aug-00	not taken	7.9	40	400.0	62.0	ND	invalid	3.50
14-Sep-00	not taken	6.6	270	360.0	73.0	ND	2,200,000	ND
Minimum	**0.12**	**3.8**	**40**	**170.0**	**37.0**	**ND**	**30**	**ND**
Maximum	**26.90**	**10.3**	**1,120**	**15,700.0**	**3,000.0**	**1.20**	**16,000,000**	**3.50**
Geometric Mean	**1.41**	**6.62**	**223**	**573.0**	**124.0**	**0.06**	**118,052**	**0.07**
Median	**1.40**	**6.8**	**170**	**405.0**	**92.0**	**ND**	**170,000**	**ND**

Table 56. Ship Mixed Graywater held in Ballast Tanks - Conventional Pollutants

Date	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
	mg/L		mg/L	mg/L	mg/L	mg/L		mg/L
MDL	0.03	0.1	2.0	3.0	1.3	0.10	2	0.10
22-Aug-00	1.20	6.00	1040.0	1,140.0	480	0.00	32,000,000	0.00
22-Aug-00	1.70	5.50	420.0	860.0	250	0.00	27,000	0.00
01-Aug-00	24.00	5.80	1100.0	3,860.0	623	0.10	3,500,000	0.10
02-Aug-00	15.00	4.80	1270.0	3,460.0	612	0.00	490,000	0.00
13-Sep-00	0.76	6.20	480.0	720.0	120	0.00	16,000,000	0.00
29-Sep-00	0.00	7.80	4.8	320.0	18	0.00	invalid	0.00
20-Sep-00	missing	missing	missing	missing	missing	0.00	170,000	0.00
20-Sep-00	missing	missing	missing	missing	missing	0.00	50,000	0.00
20-Sep-00	30.00	5.90	420.0	1,020.0	250	0.00	invalid	0.00
21-Sep-00	48.00	7.20	1190.0	2,760.0	2060	0.00	5,000,000	0.00
22-Sep-00	0.18	6.40	110.0	280.0	55	0.00	900,000	0.00
06-Aug-00	0.76	5.50	360.0	780.0	120	0.00	invalid	0.00
15-Aug-00	missing	missing	missing	missing	missing	missing	5,000,000	missing
Minimum	**0.00**	**4.80**	**4.8**	**280.0**	**18**	**0.00**	**27,000**	**0.00**
Maximum	**48.00**	**7.80**	**1270.0**	**3,860.0**	**2060**	**0.10**	**32,000,000**	**0.10**
Median	**1.45**	**5.95**	**450.0**	**940.0**	**250**	**0.00**	**2,200,000**	**0.00**

Date	**Ammonia**	**pH**	**BOD**	**COD**	**TSS**	**T Cl**	**FECAL**	**FREE CL**
	mg/L		**mg/L**	**mg/L**	**mg/L**	**mg/L**		**mg/L**
Geometric Mean							**1,163,188**	

Table 57. 2000 Large Ship Graywater Priority Pollutants (Table 1 of 3)

Sample Name	Ethylbenzene	Naphthalene	Toluene	Phenol	Heptachlor	Bis(2-Ethylhexyl) Phthalate	Butylbenzyl Phthalate	Diethyl Phthalate	Dimethyl Phthalate	Di-N-Butyl Phthalate	Acena Phthene	Fluoran Thene	Fluorene	Phenan Threne
MDL	**0.500**	**2.000**	**0.500**	**1.00**	**0.150**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.440**	**1.000**
Ballast tank 5S	0.180	0.100	0.770	0.425	0.075	17.000	0.180	3.700	0.250	2.500	0.240	0.260	0.220	0.260
Composite graywater	0.180	0.100	0.260	0.425	0.075	10.000	0.180	3.000	0.250	1.100	0.240	0.260	0.220	0.260
Composite# 4,6,11	0.180	0.100	0.260	0.425	0.075	11.000	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gray water accommodation tank 4	0.180	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gray water composite mixed	0.180	0.100	0.260	0.425	0.075	0.340	0.180	1.100	0.250	6.500	0.240	0.260	0.220	0.260
Gray water galley tank 4	0.180	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gray water overboard	0.180	0.100	0.260	0.425	0.075	32.000	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Graywater composite	0.180	0.100	0.260	2.900	0.075	15.000	1.600	5.800	0.250	8.400	0.240	0.260	0.220	0.260
Graywater port	1.600	0.100	1.400	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Graywater starboard	2.600	0.100	1.700	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry 78 port	0.530	0.100	0.470	0.425	0.075	20.000	1.100	4.500	0.250	2.200	0.240	0.260	0.220	1.400
Gry accom	0.180	0.100	11.410	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry ballast #6	1.500	0.100	1.300	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry comp	0.180	0.100	0.260	0.425	0.082	183.000	1.200	13.000	0.250	8.100	0.240	0.260	0.220	0.260

Sample Name	Ethylbenzene	Naphthalene	Toluene	Phenol	Heptachlor	Bis(2-Ethylhexyl) Phthalate	Butylbenzyl Phthalate	Diethyl Phthalate	Dimethyl Phthalate	Di-N-Butyl Phthalate	Acena Phthene	Fluoran Thene	Fluorene	Phenan Threne
MDL	**0.500**	**2.000**	**0.500**	**1.00**	**0.150**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.440**	**1.000**
Gry composite	0.180	0.100	0.260	1.200	0.075	112.000	9.600	12.800	0.250	10.300	0.240	0.260	0.220	0.260
Gry DHTS composite	0.180	3.000	0.260	0.425	0.075	35.000	0.180	6.000	0.250	5.300	7.700	1.200	4.100	3.100
Gry gal/acco	0.180	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry galley	0.180	0.100	1.300	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry galley #11	1.100	0.100	0.260	0.425	0.075	0.340	0.180	5.800	0.250	0.700	0.240	0.260	0.220	0.260
Gry galley tank #11	0.180	0.100	0.260	0.425	0.075	3.700	0.180	6.300	0.250	3.300	0.240	0.260	0.220	0.260
Gry galley tank H	0.180	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry HTS composite	0.180	0.100	0.260	0.425	0.075	51.000	1.100	8.500	0.250	6.800	0.240	0.260	0.220	0.260
Gry laundry	0.180	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry pump accom.	2.800	0.100	1.700	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry tank #2		0.100	0.260	0.425	0.075	20.000	0.180	5.800	0.250	2.100	0.240	0.260	0.220	0.260
Gry tank 3C	0.680	0.100	0.260	0.425	0.075	7.600	0.180	3.600	0.250	3.300	0.240	0.260	0.220	0.260
Gry tank 7 port and starboard	0.680	0.100	0.260	3.100	0.075	14.000	0.180	11.000	0.250	3.000	0.240	0.260	0.220	0.260
Gry tank C	0.590	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Gry Tank F	0.180	0.100	0.260	0.425	0.075	13.000	0.180	15.000	1.100	1.600	0.240	0.260	0.220	0.260

Sample Name	Ethylbenzene	Naphthalene	Toluene	Phenol	Heptachlor	Bis(2-Ethylhexyl) Phthalate	Butylbenzyl Phthalate	Diethyl Phthalate	Dimethyl Phthalate	Di-N-Butyl Phthalate	Acena Phthene	Fluoran Thene	Fluorene	Phenan Threne
MDL	**0.500**	**2.000**	**0.500**	**1.00**	**0.150**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.440**	**1.000**
Grywtr 5 tank (composite)	0.180	0.100	0.260	2.200	0.075	19.000	0.610	9.700	0.250	0.700	0.240	0.260	0.220	0.260
Grywtr laundry room	24.000	0.100	1.700	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Grywtr shaft tank	1.000	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Grywtr stabilizer port tank	0.180	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Main graywater	0.180	0.100	0.260	0.425	0.075	0.340	0.180	0.260	0.250	0.700	0.240	0.260	0.220	0.260
Minimum	**0.180**	**0.100**	**0.260**	**0.425**	**0.075**	**0.340**	**0.180**	**0.260**	**0.250**	**0.700**	**0.240**	**0.260**	**0.220**	**0.260**
Maximum	**24.000**	**3.000**	**11.410**	**3.100**	**0.082**	**183.000**	**9.600**	**15.000**	**1.100**	**10.300**	**7.700**	**1.200**	**4.100**	**3.100**
Geometric Mean	**0.362**	**0.111**	**0.416**	**0.516**	**0.075**	**2.359**	**0.263**	**1.144**	**0.261**	**1.397**	**0.266**	**0.272**	**0.240**	**0.294**
Median	**0.180**	**0.100**	**0.260**	**0.425**	**0.075**	**0.340**	**0.180**	**0.260**	**0.250**	**0.700**	**0.240**	**0.260**	**0.220**	**0.260**

Table 58. 2000 Large Ship Graywater Priority Pollutants (Table 2 of 3)

Sample Name	1,4 Dichloro benzene	Chloro ethane	1,2-Dichloro ethane	1,1,2,2,-Tetra chloroethane	Bis(2-Chloro ethoxy) Methane	Carbon tetra chloride	Chloroform	Tetrachloro ethene	Trichloro ethene	2,4,6-Trichlorophenol	Bromoform	Dibromo chloro methane	Bromodichloromethane	Methyl chloride
MDL	**1.000**	**0.500**	**0.500**	**0.500**	**1.000**	**0.500**	**0.500**	**0.500**	**0.500**	**1.000**	**0.500**	**0.500**	**0.500**	**1.000**
Ballast tank 5S	0.140	0.180	0.750	0.110	0.200	0.090	15.000	230.000	71.000	0.250	0.160	0.160	1.100	0.600
Composite graywater	0.140	0.180	0.190	0.110	0.200	0.090	0.130	0.060	0.130	2.300	0.160	0.160	0.120	0.600
Composite# 4,6,11	0.140	0.180	0.190	0.110	0.200	0.090	0.130	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Gray water accumulation tank 4	0.140	0.180	0.190	0.110	0.200	0.090	4.000	0.060	0.130	0.250	2.100	2.800	2.000	0.600
Gray water composite (galley,accumulation,laundry)	0.140	0.180	0.190	0.110	14.000	0.090	0.130	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Gray water galley tank 4	0.140	0.180	0.190	0.110	0.200	0.090	2.000	0.060	0.130	0.250	1.200	1.300	0.980	0.600
Gray water overboard	0.140	0.180	0.520	0.110	0.200	0.090	1.800	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Graywater composite	0.140	0.180	0.190	0.110	0.200	0.090	0.130	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Graywater port	0.140	0.180	0.190	0.110	0.200	0.090	15.000	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Graywater starboard	0.140	0.180	0.190	0.110	0.200	0.090	19.000	0.060	0.130	0.250	1.100	0.160	0.120	0.600
Gry 78 port	0.140	0.180	0.190	0.110	0.200	0.090	44.000	0.060	0.130	0.250	0.160	0.160	1.300	0.600
Gry accom	0.140	0.180	0.700	0.910	0.200	1.800	313.000	11.650	0.670	0.250	41.200	27.100	29.520	28.300
Gry ballast #6	0.140	0.180	0.190	0.110	0.200	0.090	4.100	0.740	0.130	0.250	0.160	1.400	1.500	0.600
Gry comp	11.000	0.180	0.190	0.110	0.200	0.090	0.130	0.060	0.130	0.250	0.160	0.160	0.120	0.600

Sample Name	1,4 Dichloro benzene	Chloro ethane	1,2-Dichloro ethane	1,1,2,2,-Tetra chloroethane	Bis(2-Chloro ethoxy) Methane	Carbon tetra chloride	Chloroform	Tetrachloro ethene	Trichloro ethene	2,4,6-Trichlorophenol	Bromoform	Dibromo chloro methane	Bromodichloromethane	Methyl chloride
MDL	**1.000**	**0.500**	**0.500**	**0.500**	**1.000**	**0.500**	**0.500**	**0.500**	**0.500**	**1.000**	**0.500**	**0.500**	**0.500**	**1.000**
Gry composite	2.200	0.180	0.190	0.110	0.200	0.090	0.130	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Gry gal/acco	0.140	0.180	0.190	0.110	0.200	0.090	19.000	0.060	0.130	0.250	0.160	0.160	1.000	0.600
Gry galley	0.140	0.180	0.190	1.000	0.200	0.090	292.800	2.200	0.130	0.250	0.160	0.160	2.580	0.600
Gry galley #11	0.140	0.180	0.190	0.110	0.200	0.090	1.400	0.060	0.130	0.250	1.900	0.160	0.120	0.600
Gry galley tank #11	0.140	1.500	0.190	0.110	0.200	0.090	48.000	0.060	0.130	0.250	9.800	14.000	16.000	3.000
Gry galley tank H	0.140	0.180	0.760	0.110	0.200	0.090	14.000	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Gry HTS composite	0.140	0.180	0.190	0.110	0.200	0.090	0.130	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Gry laundry	0.140	0.180	0.190	0.110	0.200	0.090	207.000	954.000	8.200	0.250	0.160	0.160	0.570	0.600
Gry pump accom.	0.140	0.180	0.190	0.110	0.200	0.090	2.300	0.060	0.130	0.250	0.160	0.160	0.120	0.600
Gry tank #2	0.140	0.180	0.650	0.110	0.200	0.090	1.800	7.700	1.600	0.250	0.160	0.160	0.120	0.600
Gry tank 3C	0.140	0.180	0.190	0.110	0.200	0.090	26.000	0.060	0.130	0.250	0.160	0.160	0.510	0.600
Gry tank 7 port and starboard	0.140	0.180	0.190	0.110	0.200	0.090	16.000	0.060	0.130	0.250	1.200	1.100	2.000	0.600
Gry tank C	0.140	0.180	0.190	0.110	0.200	0.090	15.000	0.060	0.130	0.250	0.160	0.860	2.100	0.600
Gry Tank F	0.140	0.180	0.190	0.110	0.200	0.090	6.500	4.200	0.130	0.250	0.540	4.200	1.100	0.600
Grywtr 5 tank (composite)	0.140	0.180	0.190	0.110	0.200	0.090	0.130	0.060	0.130	0.610	0.160	0.160	0.120	0.600
Grywtr laundry room	0.140	0.180	0.190	0.110	0.200	0.090	13.000	2.300	0.760	0.250	0.160	0.160	0.120	0.600
Grywtr shaft tank	0.140	0.180	0.190	0.110	0.200	0.090	34.000	0.060	0.130	0.250	0.160	0.160	0.120	23.000

Sample Name	1,4 Dichloro benzene	Chloro ethane	1,2-Dichloro ethane	1,1,2,2,-Tetra chloroethane	Bis(2-Chloro ethoxy) Methane	Carbon tetra chloride	Chloroform	Tetrachloro ethene	Trichloro ethene	2,4,6-Trichlorophenol	Bromoform	Dibromo chloro methane	Bromodichloromethane	Methyl chloride
MDL	**1.000**	**0.500**	**0.500**	**0.500**	**1.000**	**0.500**	**0.500**	**0.500**	**0.500**	**1.000**	**0.500**	**0.500**	**0.500**	**1.000**
Grywtr stabilizer port tank	0.140	0.180	0.190	0.110	0.200	0.090	25.000	0.060	0.130	0.250	0.160	0.160	0.690	0.600
Main graywater	0.140	0.180	0.910	0.110	0.200	0.090	15.000	0.060	0.130	0.250	1.300	0.650	0.700	0.600
Starboard graywater	0.140	0.180	0.190	0.110	0.200	0.090	96.000	0.460	0.130	0.250	32.000	64.000	89.000	0.600
Minimum	**0.140**	**0.180**	**0.190**	**0.110**	**0.200**	**0.090**	**0.130**	**0.060**	**0.130**	**0.250**	**0.160**	**0.160**	**0.120**	**0.600**
Maximum	**11.000**	**1.500**	**0.910**	**1.000**	**14.000**	**1.800**	**313.000**	**954.000**	**71.000**	**2.300**	**41.200**	**64.000**	**89.000**	**28.300**
Geometric Mean	**0.177**	**0.196**	**0.235**	**0.128**	**0.232**	**0.100**	**4.081**	**0.219**	**0.218**	**0.281**	**0.317**	**0.334**	**0.415**	**0.808**
Median	**0.140**	**0.180**	**0.190**	**0.110**	**0.200**	**0.090**	**13.500**	**0.060**	**0.130**	**0.250**	**0.160**	**0.160**	**0.315**	**0.600**

Table 59. 2000 Large Ship Graywater Priority Pollutants (Table 3 of 3)

Sample Name	Methylene chloride	Cadmiuim (TR)	Chromium (TR)	Copper (TR)	Cyanide (total) mg/L	Lead (TR)	Mercury (TR)	Nickel (TR)	Silver (TR)	Zinc(TR)
MDL	**1.000**	**0.150**	**0.150**	**0.150**	**1.500**	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**
Ballast tank 5S	0.600	0.014	0.038	150.000	0.001	0.023	0.025	46.000	0.016	460.000
Composite graywater	0.600	0.014	0.038	260.000	22.000	7.500	0.025	0.090	0.016	560.000
Composite# 4,6,11	0.600	0.014	0.038	2,200.000	0.001	0.023	0.025	0.090	1.500	860.000
Gray water accumulation tank 4	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gray water composite (galley,accumulation,laundry)	0.600	0.014	0.038	230.000	0.001	21.000	0.025	0.090	0.016	480.000
Gray water galley tank 4	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gray water overboard	0.600	0.290	4.000	62.000	0.001	2.500	0.330	0.090	0.300	350.000
Graywater composite	0.600	0.480	30.000	1,203.400	0.001	21.400	0.025	99.000	7.500	770.000
Graywater starboard	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry 78 port	0.600	0.014	0.038	180.000	22.000	0.023	0.025	0.090	2.300	750.000
Gry accom	4.800	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry ballast #6	3.200	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry comp	0.600	0.014	14.000	4,320.000	0.001	387.000	0.330	184.000	4.900	2,860.000
Gry composite	0.600	0.014	57.000	710.000	0.001	28.000	0.025	676.000	4.000	1,460.000

Sample Name	Methylene chloride	Cadmiuim (TR)	Chromium (TR)	Copper (TR)	Cyanide (total) mg/L	Lead (TR)	Mercury (TR)	Nickel (TR)	Silver (TR)	Zinc(TR)
MDL	**1.000**	**0.150**	**0.150**	**0.150**	**1.500**	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**
Gry DHTS composite	0.600	0.014	0.038	720.000	0.001	0.023	0.025	46.000	0.016	600.000
Gry gal/acco	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry galley	41.000	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry galley #11	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry galley tank #11	0.600	0.014	53.000	650.000	0.001	62.000	0.025	0.090	0.016	530.000
Gry galley tank H	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry HTS composite	0.600	0.014	0.038	830.000	0.001	0.023	0.025	44.000	0.016	400.000
Gry laundry	67.000	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry pump accom.	0.690	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry tank #2	0.600	0.014	0.038	130.000	0.001	0.023	0.025	85.000	0.016	340.000
Gry tank 3C	0.600	12.000	0.038	1,500.000	0.001	0.023	0.025	140.000	0.016	540.000
Gry tank 7 port and starboard	0.600	0.014	0.038	150.000	0.001	0.023	0.025	0.090	0.016	740.000
Gry tank C	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Gry Tank F	1.100	0.014	0.038	210.000	0.001	0.023	0.025	0.090	0.016	330.000
Grywtr 5 tank (composite)	0.600	0.350	0.038	480.000	0.001	14.000	0.025	0.090	3.500	0.050
Grywtr laundry room	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Grywtr shaft tank	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050

Sample Name	Methylene chloride	Cadmiuim (TR)	Chromium (TR)	Copper (TR)	Cyanide (total) mg/L	Lead (TR)	Mercury (TR)	Nickel (TR)	Silver (TR)	Zinc(TR)
MDL	**1.000**	**0.150**	**0.150**	**0.150**	**1.500**	**0.150**	**0.150**	**0.150**	**0.150**	**0.150**
Grywtr stabilizer port tank	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Main graywater	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Starboard graywater	0.600	0.014	0.038	0.020	0.001	0.023	0.025	0.090	0.016	0.050
Minimum	**0.600**	**0.014**	**0.038**	**0.020**	**0.001**	**0.023**	**0.025**	**0.090**	**0.016**	**0.050**
Maximum	**67.000**	**12.000**	**57.000**	**4,320.000**	**22.000**	**387.000**	**0.330**	**676.000**	**7.500**	**2,860.000**
Geometric Mean	**0.891**	**0.023**	**0.097**	**2.973**	**0.001**	**0.117**	**0.029**	**0.473**	**0.044**	**4.229**
Median	**0.600**	**0.014**	**0.038**	**31.010**	**0.001**	**0.023**	**0.025**	**0.090**	**0.016**	**0.050**

Table 60. 2000 Large Ship Mixed Black and Graywater held in Double Bottom Tanks - Conventional results

Sample Date	Waste Type	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100ml	mg/L
	MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
25-Aug-00	Blk/Gry DB	0.19	5.0	650	230.0	380.0	ND	50,000	ND
30-Jul-00	Blk/Gry DB	57.00	5.9	220	395.0	40.0	ND	35,000	ND
10-Sep-00	Blk/Gry RO treated	1.22	5.9	80	130.0	not taken	ND	1	ND
10-Sep-00	Blk/Gry RO treated,	1.24	6.1	75	130.0	not taken	ND	1	ND
19-Aug-00	Gry/Blk aft	8.10	7.5	110	670.0	130.0	1.00	4,000	0.20
19-Aug-00	Gry/blk forward	13.00	7.4	130	710.0	92.0	1.30	510	0.75
29-Aug-00	Gry/Blk aft	3.70	7.8	72	135.0	89.0	1.10	30,000	0.70
29-Aug-00	Gry/Blk forward	8.50	7.6	150	135.0	150.0	1.10	60,000	0.75
5-Aug-00	Gry/Blk DB tank	17.00	7.0	110	710.0	55.0	ND	16,000,000	ND
12-Aug-00	Gry/Blk DB tank	13.00	6.3	180	680.0	110.0	ND	3,000,000	ND
6-Aug-00	Gry/Blk	200.00	8.3	250	1,030.0	320.0	ND	5,000,000	ND
	DB								
	Minimum	**0.19**	**5.0**	**72**	**130.0**	**40.0**	**ND**	**1**	**ND**
	Maximum	**200.00**	**8.3**	**650**	**1,030.0**	**380.0**	**1.30**	**16,000,000**	**0.75**
	Geometric Mean	**7.12**	**6.7**	**146**	**338.0**	**119.0**	**0.16**	**12,824**	**0.12**
	Median	**8.50**	**7.0**	**130**	**395.0**	**110.0**	**ND**	**35,000**	**ND**

Table 61. 2000 Large Ship Blackwater Conventional Pollutants

Sample Date	Sample Name	Waste Type	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
		Units	mg/L		Mg/L	mg/L	Mg/L	mg/L	mg/L	mg/L
		MDL	0.03	0.1	2	3.0	1.30	0.10	2	0.10
2-Aug-00	Composite	Blackwater	100.00	5.3	75	not taken	236.00	composite	composite	Composite
13-Sep-00	Composite	Blackwater	64.10	6.9	130	not taken	650.00	1.50	4,410	1.13
29-Sep-00	Composite	Blackwater	66.00	7.6	150	1,400.00	1,430.00	0.11	182,436	0.08
29-Sep-00	Composite	Blackwater	52.00	7.3	250	not taken	1,480.00	1.50	3,504	0.50
20-Sep-00	Composite	Blackwater	74.00	7.7	49	not taken	300.00	0.24	18,027	0.09
3-Aug-00	One Unit	Blackwater	520.00	8.4	140	not taken	589.00	ND	1,400,000	ND
21-Sep-00	One Unit	Blackwater	730.00	8.7	320	not taken	950.00	ND	700,000	ND
22-Sep-00	Composite	Blackwater	44.00	4.6	58	510.00	250.00	0.92	2	ND
25-Aug-00	Composite	Blackwater	not taken	missing	not taken	not taken	not taken	ND	300	ND
5-Aug-00	Composite	Blackwater	90.25	7.9	109	not taken	231.76	0.07	387,493	ND
12-Aug-00	2 of 4 units	Blackwater	65.89	7.7	65	not taken	407.00	ND	1,100,000	ND
29-Aug-00	Composite	Blackwater	109.00	7.8	65	not taken	330.00	0.42	4,650	ND
6-Sep-00	Composite	Blackwater	96.00	7.6	80	not taken	335.50	0.56	invalidated	ND
9-Aug-00	Composite	Blackwater	100.00	6.9	130	not taken	1,260.00	0.46	5,349	0.18
20-Sep-00	Composite	Blackwater	50.00	7.4	140	not taken	860.00	not taken	7	3.33
9-Aug-00	Composite	Blackwater	110.00	7.5	170	not taken	1,230.00	not taken	100	0.96
14-Sep-00	Composite	Blackwater	140.00	8.2	82	not taken	280.00	ND	6,300	ND

Sample Date	Sample Name	Waste Type	Ammonia	pH	BOD	COD	TSS	T Cl	FECAL	FREE CL
		Units	mg/L		Mg/L	mg/L	Mg/L	mg/L	mg/L	mg/L
		MDL	0.03	0.1	2	3.0	1.30	0.10	2	0.10
2-Sep-00	Unit	Blackwater	180.00	7.6	150	1,210.00	200.00	ND	80	ND
18-Sep-00	Unit	Blackwater	130.00	6.7	110	not taken	300.00	3.00	1	2.00
9-Sep-00	Composite	Blackwater	155.00	7.5	250	not taken	980.00	not taken	540	0.54
18-Sep-00	Unit	Blackwater	17.60	7.6	146	not taken	580.00	0.87	24	0.13
6-Aug-00	Unit	Blackwater	160.00	8.5	120	not taken	280.00	9.00	23	ND
		Minimum	17.60	4.6	49	510.00	200.00	ND	1	ND
		Maximum	730.00	8.7	320	1,400.00	1,480.00	9.00	1,400,000	3.33
		Geometric Mean	104.48	7.2	105	845.00	478.00	0.21	18,213	0.09
		Median	100.00	7.6	130	1,210.00	407.00	0.33	3,957	ND

Table 62. 2000 Large Ship Blackwater Priority Pollutants in Alphabetical Order (Table 1 of 3)

Type	Sample Date	1,1,2,2-Tetrachloroethane	1,2-Dichlorobenzene	1,2-Dichloroethane	1,3-Dichlorobenzene	1,4-Dichlorobenzene	2,4,6-Trichlorophenol	2-Nitrophenol	4-Nitrophenol	Alpha-Bhc	Bis(2-Ethylhexyl)Phthalate	Bromodichloromethane	Bromoform	Butylbenzylphthalate
		0.500	**1.000**	**0.500**	**1.000**	**1.000**	**1.000**	**1.000**	**25.000**	**0.011**	**1.000**	**0.500**	**0.500**	**1.000**
DB	8-Sep-00	0.220	0.210	0.370	0.220	1.100	0.190	0.280	0.080	0.002	1.500	0.230	0.315	1.100
DB	14-Sep-00	0.220	0.210	0.750	0.220	0.230	0.190	0.280	0.080	0.002	17.000	1.100	0.315	0.550
DB	20-Sep-00	0.220	0.210	0.370	0.220	0.230	0.190	0.280	0.080	0.002	6.500	6.300	16.000	0.550
DB	21-Sep-00	0.220	0.210	0.370	0.220	2.800	2.000	0.280	0.080	0.002	3.700	0.230	0.315	0.550
HT	21-Sep-00	0.220	0.210	0.370	0.220	0.230	0.190	0.280	0.080	0.002	8.800	1.700	1.100	0.550
MSD	11-Aug-00	0.220	0.210	0.370	0.220	0.230	0.190	0.280	0.080	0.002	1.900	0.230	0.315	0.550
MSD	15-Aug-00	0.220	0.210	0.370	0.220	0.230	0.190	0.280	0.080	0.002	2.000	0.230	3.300	0.550
MSD	18-Aug-00	0.220	0.210	0.370	0.220	1.200	0.190	0.280	0.080	0.002	1.900	1.900	1.200	0.550
MSD	22-Aug-00	0.220	0.210	1.500	0.220	0.230	0.190	0.280	0.080	0.002	0.340	18.000	95.000	0.550
MSD	25-Aug-00	0.220	0.210	0.370	0.220	0.230	0.190	5.400	0.080	0.002	0.340	1.100	0.315	0.550
MSD	6-Sep-00	0.220	0.210	0.970	0.220	0.230	0.190	0.280	0.080	0.140	0.340	18.000	28.000	0.550
MSD	13-Sep-00	0.220	0.210	0.370	0.220	0.230	0.190	0.280	0.080	0.002	0.340	77.000	170.000	0.550
MSD	14-Sep-00	0.220	0.210	0.890	0.220	0.230	0.190	0.280	0.080	0.002	1.400	110.000	14.000	0.550
MSD	15-Sep-00	0.220	0.210	0.970	0.220	0.230	0.190	0.280	0.080	0.002	2.300	43.000	6.100	0.550
MSD	18-Sep-00	5.900	390.000	0.370	380.000	350.000	3.200	0.280	0.080	0.002	6.200	180.000	440.000	0.550
MSD	20-Sep-00	0.220	0.210	0.660	0.220	0.230	0.190	0.280	0.080	0.002	5.100	53.000	80.000	0.550
MSD	22-Sep-00	0.220	0.210	0.370	0.220	0.230	0.190	0.280	0.080	0.002	0.340	190.000	25.000	0.550
MSD	26-Sep-00	0.220	0.210	0.370	0.220	0.230	0.190	0.280	7.700	0.002	1.800	0.230	0.315	0.550
MSD	29-Aug-00	0.220	0.210	1.200	0.220	0.230	0.190	0.280	0.080	0.002	3.600	3.600	30.000	0.550
RO	2-Sep-00	0.220	0.210	1.900	0.220	0.230	0.190	0.280	0.080	0.002	4.100	0.230	0.315	0.550
RO	10-Sep-00	0.220	0.210	0.370	1.200	0.230	0.190	0.280	0.080	0.002	1.300	0.230	0.315	0.550
	Minimum	**0.220**	**0.210**	**0.370**	**0.220**	**0.230**	**0.190**	**0.280**	**0.080**	**0.002**	**0.340**	**0.230**	**0.315**	**0.550**
	Maximum	**5.900**	**390.000**	**1.900**	**380.000**	**350.000**	**3.200**	**5.400**	**7.700**	**0.140**	**17.000**	**190.000**	**440.000**	**1.100**
	Geometric Mean	**0.257**	**0.301**	**0.549**	**0.340**	**0.428**	**0.243**	**0.322**	**0.099**	**0.002**	**1.888**	**3.651**	**4.086**	**0.568**
	Median	**0.220**	**0.210**	**0.370**	**0.220**	**0.230**	**0.190**	**0.280**	**0.080**	**0.002**	**1.90**	**1.900**	**3.300**	**0.550**

Table 63. 2000 Large Ship Blackwater Priority Pollutants in Alphabetical Order (Table 2 of 3)

Type	Sample Date	Cadmium (TR)	Carbon tetra chloride	Chloro Form	Chromium (TR)	Copper (TR)	cyanide (total)mg/l	delta-bhc	Dibromo Chloro methane	Diethyl phthalate	di-n-butyl phthalate	di-n-octyl phthalate	Endosulphan sulfate	Ethyl benzene	Lead (TR)
	MDL	**0.15**	**0.500**	**0.500**	**0.150**	**0.150**	**1.500**	**0.009**	**0.500**	**1.000**	**1.000**	**1.000**	**0.009**	**0.500**	**0.15**
DB	15-Aug-00	0.013	0.170	0.700	3.100	0.020	0.001	0.002	0.100	0.250	0.700	0.160	0.002	0.180	0.020
DB	8-Sep-00	0.013	0.170	0.790	0.038	510.000	0.001	0.068	0.100	0.250	0.700	0.160	0.002	0.180	30.000
DB	14-Sep-00	0.013	0.170	15.000	0.038	150.000	0.001	0.002	0.100	3.700	2.500	0.160	0.002	0.180	0.020
DB	20-Sep-00	0.013	0.170	6.700	0.038	530.000	0.001	0.002	0.100	2.700	3.900	0.160	0.002	0.870	0.020
DB	21-Sep-00	0.013	0.170	0.700	10.000	3,900.000	0.001	0.002	0.990	0.250	8.200	0.160	0.002	0.180	0.020
HT	21-Sep-00	0.013	0.170	13.000	0.038	6,400.000	0.001	0.002	0.100	3.300	2.100	0.160	0.002	0.920	16.000
MSD	11-Aug-00	0.013	0.170	0.700	0.038	360.000	0.001	0.002	0.100	0.250	0.700	0.160	0.002	0.180	0.020
MSD	15-Aug-00	0.430	0.170	2.900	0.038	210.000	0.001	0.002	0.100	2.700	0.700	0.160	0.002	0.930	0.020
MSD	18-Aug-00	0.013	0.170	1.600	0.038	50.000	0.001	0.002	1.400	0.250	4.800	0.160	0.002	0.180	0.020
MSD	22-Aug-00	0.013	0.170	21.000	18.000	560.000	25.000	0.002	40.000	0.250	0.700	0.160	0.002	0.180	23.000
MSD	25-Aug-00	0.260	0.170	18.000	1.500	150.000	51.000	0.002	0.100	0.250	0.700	0.160	0.002	0.180	1.800
MSD	6-Sep-00	0.013	0.170	20.000	0.038	530.000	19.000	0.073	18.000	0.250	0.700	0.160	0.035	0.180	27.000
MSD	13-Sep-00	0.013	4.200	210.000	0.038	240.000	73.000	0.002	88.000	0.250	0.700	0.160	0.002	0.180	0.020
MSD	14-Sep-00	0.013	2.000	140.000	0.038	170.000	0.001	0.002	63.000	0.250	3.200	0.160	0.002	0.180	18.000
MSD	15-Sep-00	0.013	0.170	200.000	0.038	760.000	0.001	0.002	16.000	0.250	2.000	0.160	0.002	0.180	0.020
MSD	18-Sep-00	0.013	5.800	380.000	14.000	7,100.000	28.000	0.002	270.000	0.250	2.700	1.200	0.002	4.700	0.020
MSD	20-Sep-00	0.013	1.600	93.000	19.000	360.000	26.000	0.002	56.000	0.250	3.100	0.160	0.002	0.180	0.020
MSD	21-Sep-00	0.013	0.170	1.600	25.000	130.000	0.001	0.002	0.100	0.250	2.600	0.160	0.002	0.180	0.020
MSD	22-Sep-00	0.013	27.000	1,500.000	0.038	0.020	0.001	0.002	88.000	0.250	0.700	0.160	0.002	0.180	0.020
MSD	26-Sep-00	0.240	0.170	3.700	0.038	54.000	0.001	0.002	0.100	0.250	2.100	0.160	0.002	0.180	0.020
OB	11-Aug-00	0.013	0.170	1.200	0.038	0.020	0.001	0.002	0.100	0.250	0.700	0.160	0.002	0.180	0.020
OB	29-Aug-00	0.013	0.170	15.000	52.000	740.000	0.001	0.002	13.000	1.600	9.800	0.160	0.002	0.530	50.000
RO	2-Sep-00	0.013	0.170	4.800	0.038	0.020	0.001	0.002	0.100	0.250	0.700	0.160	0.002	0.180	0.020
RO	10-Sep-00	0.013	0.170	4.100	0.038	0.020	0.001	0.002	0.100	0.250	1.100	0.160	0.002	0.180	0.020
	Minimum	**0.01**	**0.170**	**0.70**	**0.038**	**0.020**	**0.001**	**0.002**	**0.100**	**0.250**	**0.70**	**0.160**	**0.002**	**0.180**	**0.020**
	Maximum	**0.43**	**27.000**	**1,500.00**	**52.000**	**7,100.000**	**73.000**	**0.073**	**270.000**	**3.700**	**9.80**	**1.200**	**0.035**	**4.700**	**50.000**

Type	Sample Date	Cadmium (TR)	Carbon tetra chloride	Chloro Form	Chromium (TR)	Copper (TR)	cyanide (total)mg/l	delta-bhc	Dibromo Chloro methane	Diethyl phthalate	di-n-butyl phthalate	di-n-octyl phthalate	Endosulphan sulfate	Ethyl benzene	Lead (TR)
	MDL	**0.15**	**0.500**	**0.500**	**0.150**	**0.150**	**1.500**	**0.009**	**0.500**	**1.000**	**1.000**	**1.000**	**0.009**	**0.500**	**0.15**
	Geometric Mean	**0.02**	**0.338**	**10.91**	**0.255**	**52.839**	**0.011**	**0.003**	**1.233**	**0.410**	**1.57**	**0.174**	**0.002**	**0.264**	**0.144**
	Median	**0.01**	**0.170**	**9.85**	**0.038**	**225.000**	**0.001**	**0.002**	**0.100**	**0.250**	**1.55**	**0.160**	**0.002**	**0.180**	**0.020**

Table 64. 2000 Large Ship Blackwater in Alphabetical Order (Table 3 of 3)

Type	Sample Date	Mercury (TR)	Methyl bromide	Methyl chloride	Methylene chloride	Nickel (TR)	Phenan Threne	Phenol	Silver (TR)	Tetrachloro ethene	Toluene	Trichloro ethene	Zinc (TR)
		0.150	**1.000**	**1.000**	**1.000**	**0.150**	**1.000**	**1.000**	**0.150**	**0.500**	**0.500**	**0.500**	**0.150**
DB	8-Sep-00	0.930	0.600	0.600	0.115	0.018	0.270	250.000	0.015	0.115	0.255	0.255	1,200.000
DB	14-Sep-00	0.025	0.600	0.600	0.115	46.000	0.270	0.430	0.015	230.000	0.770	71.000	460.000
DB	20-Sep-00	0.025	0.600	0.600	1.000	42.000	0.270	0.430	0.015	33.000	0.690	1.300	530.000
DB	21-Sep-00	0.300	0.600	0.600	0.115	0.018	0.270	160.000	0.015	0.115	0.255	0.255	390.000
HT	21-Sep-00	0.840	0.600	0.600	0.115	0.018	0.270	17.000	2.100	0.115	0.255	0.255	1,800.000
MSD	11-Aug-00	0.025	0.600	0.600	0.115	0.018	0.270	13.000	0.760	0.115	0.255	0.255	170.000
MSD	15-Aug-00	0.025	0.600	0.600	0.115	0.018	1.800	29.000	0.590	0.115	0.255	0.255	390.000
MSD	18-Aug-00	0.025	0.600	0.600	0.115	0.018	0.270	0.430	0.270	0.115	0.255	0.255	210.000
MSD	22-Aug-00	0.025	0.600	25.000	0.115	0.018	0.270	0.430	0.015	0.115	0.255	0.255	1,100.000
MSD	25-Aug-00	0.025	0.600	0.600	0.115	130.000	0.270	0.430	0.180	0.115	0.255	0.255	350.000
MSD	6-Sep-00	0.025	0.600	0.600	0.115	41.000	0.270	0.430	1.900	0.115	0.255	0.255	1,000.000
MSD	13-Sep-00	0.670	0.600	0.600	0.115	0.018	0.270	0.430	0.015	0.115	0.255	0.255	580.000
MSD	14-Sep-00	0.025	0.600	9.400	0.115	0.018	0.270	0.430	1.500	0.115	0.255	0.255	800.000
MSD	15-Sep-00	0.240	0.600	0.600	0.115	0.018	0.270	0.430	0.015	0.115	0.730	0.255	0.500
MSD	18-Sep-00	0.260	7.000	160.000	42.000	0.018	0.270	0.430	2.000	7.600	2.200	0.255	610.000
MSD	20-Sep-00	0.230	0.600	0.600	1.800	89.000	0.270	0.430	0.015	0.115	0.255	0.255	620.000
MSD	21-Sep-00	0.370	0.600	0.600	0.115	0.018	0.270	100.000	0.015	0.115	0.255	0.255	700.000
MSD	22-Sep-00	0.025	0.600	81.000	0.115	0.018	0.270	0.430	0.015	0.115	0.255	0.255	0.500
MSD	26-Sep-00	0.025	0.600	240.000	0.115	0.018	0.270	0.430	0.015	0.115	0.255	0.255	250.000
OB	29-Aug-00	0.025	0.600	0.600	0.115	0.018	0.270	0.430	1.900	0.115	0.255	0.255	140.000
RO	2-Sep-00	0.025	0.600	0.600	0.115	0.018	0.270	0.430	0.015	0.115	0.580	0.255	7.000
RO	10-Sep-00	0.025	0.600	0.600	0.115	0.018	0.270	2.100	0.015	0.115	0.255	0.255	0.500
	Minimum	**0.025**	**0.600**	**0.600**	**0.115**	**0.018**	**0.270**	**0.430**	**0.015**	**0.115**	**0.26**	**0.255**	**0.500**
	Maximum	**0.930**	**7.000**	**240.000**	**42.000**	**130.000**	**1.800**	**250.000**	**2.100**	**230.000**	**2.20**	**71.000**	**1,800.000**
	Geometric Mean	**0.069**	**0.671**	**1.704**	**0.188**	**0.115**	**0.294**	**1.729**	**0.081**	**0.254**	**0.34**	**0.355**	**162.133**
	Median	**0.025**	**0.600**	**0.600**	**0.115**	**0.018**	**0.270**	**0.430**	**0.015**	**0.115**	**0.26**	**0.255**	**425.000**

Appendix C. Summary of Large Ship Sampling for Priority Pollutants

The method detection limit (MDL) is the lowest value that a method can reliably detect. ADEC only evaluated priority pollutants that had a median that was equal to or greater than the MDL. This approach eliminated pollutants with a majority of non-detects.

All data is given in ug/l (ppb).

Table 1. Priority Pollutants in Large Ship Blackwater – Medians At Least MDL (Numbers in bold exceed AWQS.)

ANALYTE	AK Water Quality Standard[1]	MDL	BW 2003 (Table 7 A - C in Large Ship Appendix)	BW 2002 (Table 9 – 10 in Large Ship Appendix)	BW 2001 (Table 40 - 42 in Large Ship Appendix)[2]	BW 2000 Table 53 – 55 in Large Ship Appendix.) [3]
Number of Samples			35	9	6	24
Acetone	n/a	2.5	6.7	6.15	<MDL	<MDL
Bis(2-Ethylhexyl)Phthalate	18.0	0.50	<MDL	<MDL	1.65	1.90

[1] ADEC, Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic & Inorganic Substances, May 15, 2003, Table IV or V available at http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/wqs/pdf/70wqsmanual.pdf Fecal coliform standards for consumption of raw aquatic life and pH for aquaculture from ADEC Water Quality Standards, 18 AAC 70, http://www.state.ak.us/dec/title18/wpfiles/70mas.pdf For carcinogens, the values are from the "Compilation of the USEPA Water Quality Criteria for the Priority Toxic Pollutants" By K. McKerney. September 1997. The most conservative standard is listed.

[2] The dissolved metals were not reported. The DEC took the total recoverable metals values as dissolved. This is the most conservative approach.

[3] The dissolved metals were not reported. The DEC took the total recoverable metals values as dissolved. This is the most conservative approach.

ANALYTE	AK Water Quality Standard[1]	MDL	BW 2003 (Table 7 A - C in Large Ship Appendix)	BW 2002 (Table 9 – 10 in Large Ship Appendix)	BW 2001 (Table 40 - 42 in Large Ship Appendix)[2]	BW 2000 Table 53 – 55 in Large Ship Appendix.) [3]
Bromodichloromethane	n/a	0.50	<MDL	<MDL	0.60	1.90
Bromoform	3,600.0	0.50	<MDL	<MDL	<MDL	3.30
Diethylphthalate	23,000.0	0.50	<MDL	<MDL	0.70	<MDL
Chloroform	5,700.0	0.50	1.3	1.20	7.60	9.85
di-n-butyl phthalate	2,700.0	1.0	<MDL	1.80	2.35	1.55
Toluene	n/a	0.50	<MDL	0.55	<MDL	0.26
Arsenic, dissolved	36.0	0.15	1.22	0.78	20.92	Not Tested
Chromium, dissolved	50.0	0.15	1.43	5.59	1.65	<MDL
Copper, dissolved	3.1	0.15	**10.70**	**7.72**	**133.85**	**225.00**
Lead, dissolved	8.1	0.15	0.33	1.10	1.99	<MDL
Nickel, dissolved	8.2	0.15	**12.60**	**16.70**	**20.50**	<MDL
Selenium, dissolved	71.0	0.15	1.05	0.94	**56.66**	Not tested
Zinc, dissolved	81.0	0.15	**109.5**	**195.50**	**169.50**	**425.00**

n/a = There is no water quality standard for this pollutant. The pollutant is neither toxic nor carcinogenic.

Table 2. Priority Pollutants in Large Ship Graywater – Medians At Least MDL (Numbers in bold exceed AWQS.)

ANALYTE	AK Water Quality Standard	MDL	GW 2003 (Table 6 in Large Ship Appendix)	GW 2002 (Tables 20 - 24 in Large Ship Appendix)	GW 2001 (Tables 34-37)	GW 2000 Tables 48-50)
Number of samples			2	17	15	34
1,2,4-trimethylbenzene	n/a	0.50	0.85	<MDL	Not tested	Not tested
Acetone	n/a	3.20[40]	34.00	54.50	Not tested	Not tested
Bis (2ethylhexyl) phthalate	18	1.00	<MDL	13.00	8.90	<MDL
Bromoform	3,600	0.50	<MDL	0.43	<MDL	<MDL
2 – Butanone	n/a	1.50	<MDL	4.75	Not tested	Not tested
Chloroform	5,700	0.50	<MDL	60.50	19.0	13.5
Benzoic Acid	n/a	25.00	<MDL	205.00	<MDL	<MDL
Benzyl Alcohol	n/a	0.65	186.50	19.50	<MDL	<MDL
Butylbenzyl phthalate	3,000	1.00	<MDL	0.18	<MDL	<MDL
Diethylphthalate	23,000	1.00	<MDL	5.35	7.9	<MDL
Bromodichloromethane	n/a	0.50	<MDL	4.05	1.6	<MDL
Dibromochloromethane	n/a	0.50	<MDL	<MDL	<MDL	<MDL

ANALYTE	AK Water Quality Standard	MDL	GW 2003 (Table 6 in Large Ship Appendix)	GW 2002 (Tables 20 - 24 in Large Ship Appendix)	GW 2001 (Tables 34-37)	GW 2000 Tables 48-50)
di-n-butyl phthalate	2,700	1.00	<MDL	1.55	2.2	<MDL
M&p Xylenes	n/a	0.28	7.35	1.08	Not tested	Not tested
O-xylene	n/a	0.50	1.69	<MDL	Not tested	Not tested
Antimony, dissolved	4,300	0.15	<MDL	0.22	0.748	<MDL
Arsenic, dissolved	36.0	0.15	0.89	2.03	0.559	<MDL
Chromium, dissolved	50.0	0.15	0.36	4.37	3.87	<MDL
Copper, dissolved	3.1	0.15	1.95	**31.65**	**255**	**31.01**
Lead, dissolved	8.1	0.15	<MDL	2.13	2.75	<MDL
Nickel, dissolved	8.2	0.15	2.21	**12.70**	**15.00**	<MDL
Selenium, dissolved	71.0	0.15	<MDL	4.20	1.28	<MDL
Zinc, dissolved	81.0	0.15	41.35	**264.50**	**270.00**	<MDL[4]

*10X MDL

[4] The maximum sample result is 2860, the average of all samples is 353.85 but the median is below the minimum detection limit (MDL) because of many non detects.

APPENDIX D. CRUISE SHIP STATIONARY DISCHARGE MODELING

The Science Advisory Panel concluded in *The Impact of Cruise Ship Wastewater Discharge on Alaska Waters*, November 2002 report that wastewater discharges from vessels moving at a minimum of 6 knots, 1 mile from shore, met water quality standards.[1] The Panel also concluded that wastewater treated by an advanced treatment system and discharged from a stationary vessel, within limits specified by the federal law for continuous discharge certification, limits the impact on Alaska water. The Panel made a dilution assumption for stationary vessels using the EPA approved CORMIX model which calculates the dilution a waste water discharge can be expected to experience under certain conditions. This model showed that a discharge rate of 50 m^3/hr yields a dilution factor of 36 at a distance about 4.5 m from the ship and a dilution factor of 50 at 7 m from the ship after 43 seconds.[2]

ADEC subsequently modeled the dilution of wastewater that is discharged from stationary cruise ships using the EPA approved Visual Plumes model and vessel specific information in order to verify the assumptions made by the Panel in the November 2002 report.[3] The ADEC routinely uses Visual Plumes instead of CORMIX to model discharges into the marine environment. The resulting dilution factor was used to determine whether a pollutant's effluent concentration would meet Alaska water quality standards.

Neither the Visual Plumes nor CORMIX model is designed for cruise ships. A boundary layer is formed by the hull of a ship. Neither model takes into account the momentum needed to break through this boundary layer. Some of the pump pressure, producing jet like propulsion, is needed to break through this boundary layer. Ports and harbors have minimum wave action by design, which reduces far field dilution effects. Docks can also trap wastewater effluent and prevent it from mixing with ambient sea water. The effluent's temperature and salinity affects its density, which in turn affects the water's ability to disperse.

ADEC used information provided by the cruise ship companies in their Vessel Specific Sampling Plans (VSSP) to input into the Visual Plumes model. This information is found in Table 1 and Table 2. The Visual Plumes model calculates a dilution factor of 1 for above the water line discharges even in areas of large currents even though some dilution must exist because of the currents. This is because the model uses the elevation above the sea floor in its calculations. In cases where discharges occur above the water, the elevation exceeds the maximum. The ADEC consulted with a physical oceanographer on the Science Panel who suggested assuming the discharge occurred just under the waterline. In order to use the Visual Plumes model which is designed for discharges below the water surface, ADEC treated ships that discharge above the waterline as if they were discharging 5 centimeters below the waterline.

ADEC modeled stationary discharges from large ships that visit Juneau, Ketchikan, and Skagway during a neap tide.[4] These towns are located in Southeast Alaska's Inside Passage and were chosen based upon the high number of vessel visits per year. The lowest dilution factor generally occurred

[1] Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters", November 2002 located at http://www.state.ak.us/dec/press/cruise/documents/impact/executivesummary.htm Section I.
[2] Science Advisory Panel "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters," November 2002, Appendix 8 located at http://www.state.ak.us/dec/press/cruise/documents/impact/appendix8.htm footnote 1.
[3] ADEC used the PLUMES mode UM3 with the Brooks far field solution. For more information on this model go to http://www.epa.gov/ceampubl/swater/vplume/
[4] A tide of minimum range occurring at the first and the third quarters of the moon.

in Skagway whereas Juneau and Ketchikan have higher ambient currents even during NEAP tide. Juneau harbor experiences a large eddy in their harbor, created by currents in Gastineau channel.

Skagway is located at the end of Lynn Canal and is not affected by open ocean effects. Large storms in the winter cause upper Lynn Canal to mix.[5] Skagway sits on the Taiya Inlet at the outfall of the Skagway River. During the neap tides of July 2003, the overall current was small and direction variable. There was slight ebb flow moving water away from Skagway that was inputted as far field dilution. The data on the salinity and water temperature stations was taken from the town's ambient monitoring stations submitted in their Federal National Pollution Discharge Elimination System (NPDES) permit application. The data shows the water in the central dock area is brackish with low salinity. The town has docking space for four large cruise ships, the AMHS ferry, and a small cruise ship.[6] A fifth large ship could dock at the ferry dock, if needed. The water at the western most cruise ship dock has higher salinity and temperatures than at the ferry/cruise ship dock in the center.

Ambient data was also inputted into the model. This information came from various sources including software program *Chart Navigator* and ambient data used on other ADEC water modeling projects. ADEC modeled the wastewater discharged under worst case scenario, during the neap tides that occurred on July 7 and July 21, 2003. The flow was the same on both days. The ambient data used for the model is included in Table 3.

[5] Douglas, Robert McLain. Heat and Water Balance of Lynn Canal. Historical section State Library, 1969.
[6] Town of Skagway at http://www.romancingalaska.com/southeast/SE_skagway_map.htm

Table 1. Large Ship Information used in Visual Plumes Model

Ship Name	Port diameter (cm)	Port depth from Water line [7] (meters)	Effluent Flow		
			Flow Rate gal/min (MGD)	Temperature C	Salinity Psu
Coral Princess	60.0	-2.5	133 (0.191)	32.4	0
Dawn Princess	8.0	-2.8	133 (0.191)	31	0
Island Princess	60.0	-2.5	133 (0.191)	35.45	0
Pacific Princess	16.0	-3.6	133 (0.191)	30.35	0
Star Princess	10.0	-2.5	133 (0.191)	34	0
Sun Princess	10.0	-1.3	133 (0.191)	31.9	0
Carnival Spirit	10.0	+0.5	220 (0.317)	25.35	0
Mercury	10.0	-1.0	613 (0.883)	19.8	0
Norwegian Sky	10.0	-5.0	154 (0.222)	28.5	0
Norwegian Sun	10.0	-2.0	660 (0.950)	27	0
Norwegian Wind	10.0	-3.0	265 (0.382)	32.8	0
Seven Seas Mariner	5.0	-4.0	33 (0.0475)	79.34	0
Maasdam	7.6	-2.0	618 (0.1728)	25.9	0
Ryndam	7.6	-2.0	618 (0.1728)	26.35	0
Statendam	10.0	-2.0	618 (0.1728)	23.1	
Veendam	7.6	-2.0	618 (0.1728)	28.85	0
Volendam	7.6	-2.0	618 (0.1728)	28.15	0
Zaandam	7.6	-2.0	618 (0.1728)	27.25	0

Table 2. Small Ship Information used in Visual Plumes Model

Ship Name	Port Diameter (cm)	Port Depth from Water line [8] (meters)	Effluent Flow		
			Flow Rate Gal/min (MGD)	Temperature C	Salinity Psu
Clipper Odyssey BW	6.50	-1.200	150.0 (0.2160)	15.8	14
Clipper Odyssey GW	6.50	-1.000	150.0 (0.2160)	20.7	0
Columbia BW&GW	Unknown	Unknown	10.0 (0.0140)	16.7	10
Empress of the North BW&GW	1.27	0.000	15.0 (0.0210)	17.7	5
Kennicott BW&GW	10.16	0.152	10.0 (0.0140)	17.3	10
Malaspina BW&GW	Unknown	Unknown	10.0 (0.0140)	16.7	10
Matanuska BW&GW	10.02	-0.610	10.0 (0.0140)	21.7	10
Sea Bird GW	5.10	0.152	45.0 (0.0650)	19.6	0
Sea Bird BW	7.60	0.152	2.5 (0.0040)	14.9	14
Sea Lion GW	5.10	0.152	45.0 (0.0650)	19.6	0
Sea Lion BW	7.60	0.152	2.5 (0.0040)	14.9	14
Spirit of 98 BW	5.10	-0.305	3.0 (0.0040)	19.6	
Spirit of 98 GW	10.20	-0.152	5.0 (0.0070)	29.9	0
Spirit of Alaska BW	5.10	0.152	0.2 (0.0003)	35.5	14

[7] The negative numbers are inputted as positives in the model.
[8] The negative numbers are inputted as positives in the model.

Ship Name	Port Diameter (cm)	Port Depth from Water line [8] (meters)	Effluent Flow		
			Flow Rate Gal/min (MGD)	Temperature C	Salinity Psu
Spirit of Alaska GW	5.10	0.152	0.2 (0.0003)	30.4	0
Spirit of Columbia BW	3.80	0.152	5.0 (0.0070)	14.6	14
Spirit of Columbia GW	5.10	0.152	10.0 (0.0140)	17.3	0
Spirit of Discovery BW	6.40	0.152	5.0 (0.0070)	19.4	14
Spirit of Discovery GW	7.60	0.152	5.0 (0.0070)	38.0	0
Spirit of Endeavour BW	7.60	0.152	5.2 (0.0080)	19.7	14
Spirit of Endeavour GW	7.60	0.152	16.0 (0.0230)	20.3	0
Spirit of Oceanus BW&GW	12.70	-1.00	90.0 (0.1300)	24.6	2
Taku BW&GW	15.20	0.610	75.0 (0.1080)	16.7	10
Wilderness Adventurer BW&GW	5.10	-0.051	2.60 (0.0040)	18.0	0
Wilderness Discoverer BW&GW	5.10	-0.051	2.60 (0.0040)	18.5	0
Yorktown Clipper BW	10.20	0.000	5.2 (0.0080)	17.0	14
Yorktown Clipper GW	7.60	0.000	25.0 (0.0360)	23.5	0

Table 3. Ambient Water Assumptions in Skagway during NEAP tide July 7, 2003 and July 21, 2003

Depth (feet)	Near Field		Ambient[9]		Far Field	
	Speed (knots)	Direction (degrees)	Salinity (psu)	Temp (C)	Speed (knots)	Direction (degrees)
0	0	90	5	12	.45	90
5	0	90	5	12	.45	90
10	0	90	7	12	.45	90
15	0	90	14	9	.45	90
20	0	90	19	7	.45	90
25	0	90	19	7	.45	90
30	0	90	19	7	.45	90
35	0	90	19.5	7	.45	90
40	0	90	20	6.5	.45	90
45	0	90	20	6	.45	90
50 (floor)	0	90	20	6	.45	90

MODELING RESULTS

The dilution factor for stationary large ships in Skagway during a neap tide ranged from 5 – 60. The dilution factor for small ships ranged from 1 – 60. These Skagway dilution factors are used throughout the report.

[9] ADEC George, Kenwyn. Skagway ENSR Modeling 7/30/03 WQ Station1 located at the Cruise Ship/Ferry Dock

Table 4. Dilution of Stationary Discharge from Large Ships during Neap Tides

Ship Name	Skagway	
	Max Dilution Factor	Reached @
Coral Princess	10	1.0 m
Dawn Princess	24	4.0 m
Island Princess	8	<1.0 m
Pacific Princess	10	1.5 m
Star Princess	20	4.0 m
Sun Princess	15	2.5 m
Carnival Spirit	5	<1.0m
Mercury	18	4.0 m
Norwegian Sky	14	2.0 m
Norwegian Sun	30	7.0 m
Norwegian Wind	24	5.0 m
Seven Seas Mariner	18	2.0 m
Maasdam	60	5.0 m
Ryndam	60	5.0 m
Statendam	45	4.0 m
Veendam	60	5.0 m
Volendam	60	5.0 m
Zaandam	60	5.0 m

Table 5: Dilution of Stationary Discharge from Small Ships during Neap Tides

Ship Name	Skagway	
	Max Dilution Factor	Reached @
Clipper Odyssey BW	38	5.8 m
Clipper Odyssey GW	30	4.5 m
Columbia BW&GW mixed	Unable to Model	Unable to Model
Empress of the North BW&GW mixed	30	1 m
Kennecott BW&GW mixed	23	< 1 m
Malaspina	Unable to Model	Unable to Model
Matanuska BW&GW mixed	1.5	2 m
Sea Bird GW	2.5	20 m
Sea Bird BW	60	20 m
Sea Lion GW	2.5	20 m
Sea Lion BW	60	20 m
Spirit of 98 BW	44	1 m
Spirit of 98 GW	2.5	1 m
Spirit of AK-BW	60	< 1m
Spirit of AK - GW	60	< 1m
Spirit of Columbia BW	50	< 1m
Spirit of Columbia GW	2.5	< 1 m
Spirit of Discovery GW	5	< 1 m
Spirit of Discovery BW	40	< 1 m
Spirit of Oceanus BW&GW mixed	8	1.5 m

Ship Name	Skagway	
	Max Dilution Factor	**Reached @**
Taku BW&GW mixed	1	< 1 m
Wilderness Adventurer BW&GW mixed	20	< 1m
Wilderness Discoverer BW&GW mixed	20	< 1m
Yorktown Clipper BW	40	< 1 m
Yorktown Clipper GW	1.5	< 1 m

Appendix E. Small Ship Sampling Data

MDL = Method Detection Limit MPN= Most Probable Number

Table 1. 2003 Small Ship Graywater Conventional Pollutants

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
VESSEL_ID	Sample Date								
Clipper Odyssey	7/2/2003	0.56	9.0	310	675.0	67.9	2.50	1	
Clipper Odyssey	7/30/2003	0.51	7.1	235	662.0	45.8	8.50	13	0.50
Clipper Odyssey	7/30/2003	1.10	7.2	270	692.0	51.0	6.00	1	1.50
Clipper Odyssey	8/8/2003	0.91	7.0	343	360.0	54.2	6.50	1	2.00
Sea Bird	7/20/03	0.10	7.7	144	298.0	33.1	20.00	1	10.00
Sea Bird	8/17/03	0.12	7.3	157	280.0	28.8	5.50	1	4.00
Sea Lion	7/19/03	0.39	7.1	705	1,220.0	197.0	25.00	1	20.00
Sea Lion	8/16/03	0.46	10.0	1,810	110.0	71.4	0.00	30	ND
Spirit of 98	6/14/03	0.00	7.8	0	14.0	0.0	0.00	160,000	ND
Spirit of 98	7/26/03	0.00	7.8	0	0.0	0.0	0.00	5	ND
Spirit of Alaska	6/28/03	19.00	6.9	294	330.0	135.0	0.00	1,600	ND
Spirit of Alaska	8/2/03	0.96	7.3	157	210.0	86.8	0.00	1,600	ND
Spirit of Alaska	8/30/03	5.70	6.7	203	830.0	55.6	0.00	50,000	ND
Spirit of Columbia	6/6/03	1.40	10.6	196	232.0	56.7	0.50	4	ND

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	**0.03**	**0.1**	**2**	**3.0**	**1.3**	**0.10**	**2**	**0.10**
VESSEL_ID	**Sample Date**								
Spirit of Columbia	6/9/03	0.86	7.5	134	126.0	48.5	0.00	16,000	ND
Spirit of Columbia	7/25/03	5.53	6.3	423	664.0	160.0	0.70	1,600	ND
Spirit of Discovery	6/5/03	0.00	5.5	315	198.0	148.0	0.00	60	ND
Spirit of Discovery	7/17/03	0.13	7.2	946	1,360.0	249.0	0.00	1,700	ND
Spirit of Discovery	7/31/03	0.00	10.9	147	650.0	24.8	1.00	1	0.70
Spirit of Endeavor	6/12/03	0.00	8.0	180	505.0	139.0	200.00	1	150.00
Spirit of Endeavor	7/24/03	2.57	8.9	199	394.0	83.4	0.00	500	ND
Yorktown Clipper	6/21/03	0.44	7.2	98	178.0	22.9	2.80	2,300	0.12
Yorktown Clipper	7/26/03	0.00	7.9	99	206.0	19.6	11.00	1	8.50
	Minimum	**0.00**	**5.5**	**0**	**0.0**	**0.0**	**0.00**	**1**	**ND**
	Median	**0.46**	**7.3**	**199**	**330.0**	**55.6**	**0.70**	**13**	**ND**
	Maximim	**19.00**	**10.9**	**1,810**	**1,360.0**	**249.0**	**200.00**	**160,000**	**150.00**
	Geometric Mean							**48**	

Table 2. 2003 Small Ship Graywater Conventional Pollutants (continued)

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	Mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.0	0.5	1.0	0.01	1.00	1.3
VESSEL_ID	Sample Date								
Clipper Odyssey	7/2/2003	863	11.0	131.0	76.3	0.0	5.00	6.30	0.0
Clipper Odyssey	7/30/2003	457	25.0	90.8	31.8	0.6	2.04	6.00	0.0
Clipper Odyssey	7/30/2003	475	15.0	83.7	44.9	0.6	2.22	10.00	0.0
Clipper Odyssey	8/8/2003	555	0.0	107.0	45.9	0.9	3.40	12.00	0.0
Sea Bird	7/20/03	587	46.0	74.4	130.0	0.0	1.05	8.60	0.0
Sea Bird	8/17/03	429	17.0	72.9	69.0	0.0	1.30	8.80	0.0
Sea Lion	7/19/03	1,490	110.0	278.0	172.0	0.0	3.55	22.00	0.9
Sea Lion	8/16/03	941	130.0	1070.0	333.0	0.0	54.00	21.00	0.0
Spirit of 98	6/14/03	150	0.0	1.0	41.7	0.0	0.09	0.00	0.0
Spirit of 98	7/26/03	110	12.0	0.0	39.5	0.0	0.00	0.00	1.0
Spirit of Alaska	6/28/03	363	68.0	63.5	132.0	0.0	1.60	22.00	0.7
Spirit of Alaska	8/2/03	264	65.0	38.8	109.0	0.0	1.40	8.40	0.0
Spirit of Alaska	8/30/03	356	90.0	68.9	141.0	0.0	2.70	23.00	0.0
Spirit of Columbia	6/6/03	220	13.3	52.5	70.0	0.0	1.60	5.00	1.6

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	Mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	**1**	**1.5**	**1.0**	**0.5**	**1.0**	**0.01**	**1.00**	**1.3**
VESSEL_ID	**Sample Date**								
Spirit of Columbia	6/9/03	111	0.0	7.9	25.0	0.0	1.20	3.50	0.0
Spirit of Columbia	7/25/03	335	0.0	12.0	119.0	0.0	3.90	31.00	1.6
Spirit of Discovery	6/5/03	217	320.0	19.6	26.6	0.0	0.34	1.40	0.0
Spirit of Discovery	7/17/03	241	5.9	248.0	0.0	0.0	3.30	6.10	0.3
Spirit of Discovery	7/31/03	1,580	110.0	205.0	454.0	0.0	69.00	3.00	0.0
Spirit of Endeavor	6/12/03	1,050	0.0	124.0	174.0	0.0	3.75	4.70	1.5
Spirit of Endeavor	7/24/03	1,210	57.0	60.8	255.0	0.0	1.55	11.00	6.6
Yorktown Clipper	6/21/03	291	0.0	23.4	26.3	0.0	0.60	4.00	0.0
Yorktown Clipper	7/26/03	435	0.0	38.3	149.0	0.0	0.52	2.20	0.0
	Minimum	**110**	**0.0**	**0.0**	**0.0**	**0.0**	**0.00**	**0.00**	**0.0**
	Median	**429**	**15.0**	**68.9**	**76.3**	**0.0**	**1.60**	**6.30**	**0.0**
	Maximum	**1,580**	**320.0**	**1070.0**	**454.0**	**0.9**	**69.00**	**31.00**	**6.6**

Table 3. 2003 Small Ship Blackwater & Graywater Mixed Conventional Pollutants

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	**0.03**	**0.1**	**2**	**3.0**	**1.3**	**0.10**	**2**	**0.10**
VESSEL_ID	**Sample Date**								
Columbia	8/11/03	33.00	7.3	229	370.0	105.0	ND	9,000,000	ND
Columbia	9/1/03	38.00	7.0	185	8,700.0	53.6	ND	160,000	ND
Empress of the North	9/10/03	0.02	8.2	22	120.0	53.3	70.00	23	70.00
Empress of the North	9/11/03	40.00	6.8	412	270.0	146.0	ND	1,600	ND
Empress of the North	9/16/03	20.10	Not run	363	596.7	266.0	1.31	1	1.16
Kennecott	9/1/03	11.00	6.5	366	500.0	314.0	ND	16,000,000	ND
Malaspina	8/16/03	72.00	7.2	344	280.0	119.0	ND	3,000,000	ND
Malaspina	10/13/03	8.60	6.9	80	230.0	72.4	20.00	1	2.40
Matanuska	8/11/03	25.00	7.2	249	590.0	154.0	ND	90,000	ND
Spirit of Oceanus	6/7/03	2.40	5.8	293	456.0	86.8	ND	16,000,000	ND
Spirit of Oceanus	6/12/03	75.90	7.0	420	828.0	91.8	ND	16,000,000	ND
Spirit of Oceanus	8/15/03	7.80	6.3	569	1,200.0	138.0	ND	160,000	ND
Taku	8/14/03	6.50	7.2	128	300.0	1.5	11.00	1	6.50
Taku	9/11/03	2.40	7.7	61	230.0	79.0	1.80	300	0.80
Wilderness Adventurer	8/16/03	150.00	7.9	419	750.0	198.0	ND	16,000,000	ND
Wilderness Adventurer	9/14/03	110.00	7.7	459	1,100.0	316.0	ND	16,000,000	ND
Wilderness Discoverer	8/3/03	54.10	7.0	347	984.0	164.0	ND	3,000,000	ND
Wilderness Discoverer	9/14/03	70.00	6.4	638	800.0	308.0	ND	16,000,000	ND
	Minimum	**0.02**	**5.8**	**22**	**120.0**	**1.5**	**ND**	**1**	**ND**
	Median	**29.00**	**7.0**	**346**	**545.0**	**128.5**	**ND**	**1,580,000**	**ND**
	Maximum	**150.00**	**8.2**	**638**	**8,700.0**	**316.0**	**70.00**	**16,000,000**	**70.00**
	Geometric Means							**56,513**	

Table 4. 2003 Small Ship Blackwater & Graywater Mixed Conventional Pollutants (continued)

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.00	0.5	1.0	0.01	1.00	1.30
VESSEL_ID	Sample Date								
Columbia	8/11/03	26,400	43.0	116.0	256.0	1.9	0.53	32.0	2.2
Columbia	9/1/03	25,000	25.0	313.0	211.0	0.0	6.70	35.0	0.0
Empress of the North	9/10/03	29	Not run	Not run	87.1	1.0	0.00	Not run	53.3
Empress of the North	9/11/03	14,200	62.0	91.6	275.0	0.0	2.70	60.0	2.6
Empress of the North	9/16/03	2,660	78.0	96.1	198.0	0.0	8.80	34.0	13.0
Kennecott	9/1/03	29,000	240.0	306.0	133.0	0.0	3.80	25.0	15.0
Malaspina	8/16/03	17,200	63.0	183.0	344.0	0.0	9.20	84.0	0.0
Malaspina	10/13/03	32,100	16.0	95.2	107.0	0.0	1.80	21.0	0.0
Matanuska	8/11/03	19,900	72.0	83.0	138.0	1.8	4.20	31.0	0.4
Spirit of Oceanus	6/7/03	610	53.0	87.3	58.3	0.0	2.50	5.7	0.0
Spirit of Oceanus	6/12/03	2,010	0.0	385.0	312.0	0.0	6.60	79.0	0.0
Spirit of Oceanus	8/15/03	1,540	140.0	182.0	96.9	0.0	7.90	23.0	0.0
Taku	8/14/03	27,600	37.0	79.3	112.0	0.0	3.50	36.0	3.5
Taku	9/11/03	30,700	21.0	356.0	80.8	0.9	1.30	13.0	1.5
Wilderness Adventurer	8/16/03	25,900	56.0	Not run	779.0	Not run	Not run	190.0	7.0
Wilderness Adventurer	9/14/03	2,170	84.0	135.0	603.0	0.0	2.90	110.0	14.0
Wilderness Discoverer	8/3/03	18,600	69.0	198.0	261.0	0.0	8.50	64.0	3.5
Wilderness Discoverer	9/14/03	2,320	100.0	388.0	368.0	0.0	3.30	60.0	6.0
	Minimum	**29**	**0.0**	**79.3**	**58.3**	**0.0**	**0.00**	**5.7**	**0.00**
	Median	**17,900**	**62.0**	**158.5**	**204.5**	**0.0**	**3.50**	**35.0**	**2.40**
	Maximum	**32,100**	**240.0**	**388.0**	**779.0**	**1.9**	**9.20**	**190.0**	**53.30**

Table 5. 2003 Small Ship Small Ship Blackwater Conventional Pollutants

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.1	2	3	1.3	0.10	2	0.10
VESSEL_ID	Sample Date								
Clipper Odyssey	7/2/03	11.50	8.1	28	465.0	66.0	0.40	80	Not Taken
Clipper Odyssey	7/9/03	1.00	7.9	2	140.0	21.4	ND	1	ND
Clipper Odyssey	8/8/03	0.67	8.1	0	230.0	15.9	ND	30	ND
Sea Bird	7/20/03	0.25	7.4	20	454.0	44.9	20.00	500	7.50
Sea Bird	8/17/03	8.10	8.0	34	0.0	52.6	8.00	1	8.00
Sea Lion	7/19/03	8.35	7.6	22	468.0	87.1	ND	220	ND
Sea Lion	8/16/03	0.00	7.9	0	200.0	22.1	5.50	8	2.50
Spirit of 98	6/14/03	120.00	8.0	125	625.0	92.6	ND	160,000	ND
Spirit of 98	7/26/03	73.30	8.1	68	646.0	84.8	26.00	1	3.70
Spirit of Alaska	6/14/03	29.00	8.4	200	880.0	421.0	ND	11,000	ND
Spirit of Alaska	8/2/03	180.00	8.6	284	730.0	578.0	ND	16,000,000	ND
Spirit of Columbia	6/6/03	2.30	8.1	8	1,310.0	9.6	ND	50,000	ND
Spirit of Columbia	6/9/03	0.93	8.1	0	836.0	28.9	50.00	1,400	50.00
Spirit of Columbia	7/25/03	5.29	6.7	66	494.0	163.0	12.00	500	3.00
Spirit of Discovery	6/5/03	68.10	7.1	355	1,220.0	753.0	ND	3,000,000	ND
Spirit of Discovery	7/17/03	70.30	7.4	120	730.0	239.0	ND	2,400,000	ND

		Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
		mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100	mg/L
	MDL	0.03	0.1	2	3	1.3	0.10	2	0.10
VESSEL_ID	Sample Date								
Spirit of Discovery	7/31/03	56.90	7.9	104	498.0	167.0	18.00	1	18.00
Spirit of Endeavor	6/12/03	5.70	7.3	126	920.0	256.0	7.00	13	7.00
Spirit of Endeavor	7/24/03	32.50	7.8	287	924.0	385.0	ND	5,000,000	ND
Yorktown Clipper	6/21/03	84.70	7.7	39	1,370.0	129.0	ND	230,000	ND
Yorktown Clipper	7/26/03	16.20	6.4	9	306.0	48.2	ND	3,000	ND
	Minimum	**0.00**	**6.4**	**0**	**0.0**	**9.6**	**ND**	**1**	**ND**
	Median	**11.50**	**7.9**	**39**	**625.0**	**87.1**	**ND**	**1,363**	**ND**
	Maximum	**180.00**	**8.6**	**355**	**1,370.0**	**753.0**	**50.00**	**16,000,000**	**50.00**
	Geometric Mean							**500**	

Table 6. 2003 Small Ship Blackwater Conventional Pollutants (continued)

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.00	0.5	1.000	0.01	1	0.1
VESSEL_ID	Sample Date								
Clipper Odyssey	7/2/03	36,700	0.0	15.8	125.0	0.0	1.56	12.0	0.0
Clipper Odyssey	7/9/03	24,800	0.0	2.1	72.3	2.9	0.05	1.6	0.0
Clipper Odyssey	8/8/03	27,700	0.0	1.4	71.9	0.8	0.05	1.9	0.0
Sea Bird	7/20/03	22,900	12.0	15.0	70.3	0.0	1.18	14.0	0.0
Sea Bird	8/17/03	28,800	7.3	33.6	99.6	0.8	0.44	28.0	3.0
Sea Lion	7/19/03	27,000	6.8	29.7	79.9	0.0	1.43	23.0	4.9
Sea Lion	8/16/03	30,000	0.0	1.8	72.5	0.0	0.00	1.4	0.0
Spirit of 98	6/14/03	37,800	14.0	69.5	464.0	1.5	10.60	100.0	0.0
Spirit of 98	7/26/03	29,400	9.3	62.7	444.0	0.0	10.00	97.0	0.0
Spirit of Alaska	6/14/03	32,200	31.0	56.4	246.0	0.0	9.60	39.0	52.0
Spirit of Alaska	8/2/03	23,400	74.0	96.6	457.0	0.7	14.00	120.0	55.0
Spirit of Columbia	6/6/03	40,800	6.6	7.1	91.0	0.0	0.66	5.6	0.0
Spirit of Columbia	6/9/03	35,000	0.0	3.7	85.1	0.0	0.42	2.3	0.0
Spirit of Columbia	7/25/03	26,000	0.0	32.0	83.9	0.0	3.30	39.0	6.0
Spirit of Discovery	6/5/03	34,300	63.0	27.1	399.0	0.0	13.40	82.0	90.0

		Conductivity	Oil & Grease	Total Organic Carbon	Alkalinity	Total Nitrate and Nitrite as N	Total Phosphorus	Total Kjeldahl Nitrogen	Total Settleable Solids
		umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L
	MDL	1	1.5	1.00	0.5	1.000	0.01	1	0.1
VESSEL_ID	Sample Date								
Spirit of Discovery	7/17/03	23,800	21.0	248.0	385.0	0.0	13.40	99.0	17.0
Spirit of Discovery	7/31/03	17,800	25.0	0.0	372.0	0.7	12.00	86.0	6.1
Spirit of Endeavor	6/12/03	30,900	54.0	103.0	187.0	0.0	10.80	46.0	9.0
Spirit of Endeavor	7/24/03	22,000	64.0	79.5	425.0	0.0	12.60	94.0	3.3
Yorktown Clipper	6/21/03	38,000	0.0	43.8	232.0	0.0	7.45	84.0	2.0
Yorktown Clipper	7/26/03	20,300	0.0	9.7	53.9	0.0	2.26	9.6	1.0
	Minimum	**17,800**	**0.0**	**0.0**	**53.9**	**0.0**	**0.00**	**1.4**	**0.0**
	Median	**28,800**	**7.3**	**29.7**	**125.0**	**0.0**	**3.30**	**39.0**	**2.0**
	Maximum	**40,800**	**74.0**	**248.0**	**464.0**	**2.9**	**14.00**	**120.0**	**90.0**

Table 7. 2003 Small Ship Graywater Metals (A – C)

Median = > MDL or at Least One Sample 10X MDL

		Antimony (TR)	Antimony, dissolved	Arsenic (TR)	Arsenic, dissolved	Cadmium (TR)	Chromium (TR)	Chromium, dissolved	Copper (TR)	Copper, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
VESSEL_ID	Sample Date									
Clipper Odyssey	02-Jul-03	0.320	0.180	0.870	0.779	0.328	4.520	3.300	185.000	160.000
Sea Bird	17-Aug-03	0.050	0.000	1.38	1.290	0.130	1.310	1.150	110.000	86.400
Spirit of Alaska	30-Aug-03	0.200	0.000	0.990	0.381	0.610	1.430	0.572	181.000	9.590
Spirit of Columbia	09-Jun-03	1.390	1.760	1.130	1.320	0.303	2.100	2.730	118.000	148.000
Spirit of Columbia	25-Jul-03	2.500	1.930	1.210	0.453	0.836	5.610	0.690	376.000	15.300
Spirit of Discovery	31-Jul-03	0.220	0.160	0.240	0.234	0.097	6.220	6.050	96.700	87.100
Spirit of Endeavor	24-Jul-03	2.150	0.780	0.570	0.390	0.000	3.720	1.590	174.000	63.200
Yorktown Clipper	26-Jul-03	0.000	0.150	0.810	0.435	0.097	0.999	1.090	115.000	39.100
	Minimum	**0.000**	**0.000**	**0.240**	**0.234**	**0.000**	**0.999**	**0.572**	**96.700**	**9.590**
	Median	**0.270**	**0.170**	**0.930**	**0.444**	**0.217**	**2.910**	**1.370**	**146.000**	**74.800**
	Maximum	**2.500**	**1.930**	**1.380**	**1.320**	**0.836**	**6.220**	**6.050**	**376.000**	**160.000**
	10X MDL	**1.500**	**1.500**	**1.500**	**1.500**	**1.500**	**1.500**	**1.500**	**1.500**	**1.500**

Table 8. 2003 Small Ship Graywater Metals (L – Z)

Median = > MDL or at Least One Sample 10X MDL (Continued)

		Lead (TR)	Lead, dissolved	Nckel (TR)	Nickel, dissolved	Selenium (TR)	Selenium, dissolved	Zinc (TR)	Zinc, dissolved
	MDL	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
		0.150	0.150	0.150	0.150	0.15	0.15	0.150	0.150
VESSEL_ID	Sample_Date								
Clipper Odyssey	02-Jul-03	3.100	1.930	5.930	5.160	2.00	1.92	195.000	220.000
Sea Bird	17-Aug-03	1.280	0.480	5.810	5.110	0.48	0.55	101.000	94.500
Spirit of Alaska	30-Aug-03	7.020	0.349	8.690	5.730	0.29	0.00	1,430.000	80.100
Spirit of Columbia	09-Jun-03	5.730	6.530	9.510	11.000	3.66	4.12	617.000	715.000
Spirit of Columbia	25-Jul-03	12.800	0.880	14.200	9.750	0.51	0.00	1,890.000	106.000
Spirit of Discovery	31-Jul-03	4.070	2.640	8.090	2.300	0.62	0.00	288.000	370.000
Spirit of Endeavor	24-Jul-03	3.340	0.926	7.470	4.970	0.67	0.00	596.000	194.000
Yorktown Clipper	26-Jul-03	0.726	0.284	2.320	1.530	2.27	1.57	103.000	69.800
	Minimum	**0.726**	**0.284**	**2.320**	**1.530**	**0.29**	**0.00**	**101.000**	**69.800**
	Median	**3.705**	**0.903**	**7.780**	**5.135**	**0.65**	**0.28**	**442.000**	**150.000**
	Maximum	**12.800**	**6.530**	**14.200**	**11.000**	**3.66**	**4.12**	**1,890.000**	**715.000**
	10X MDL	**1.500**	**1.500**	**1.500**	**1.500**	**1.50**	**1.50**	**1.500**	**1.500**

Table 9. 2003 Small Ship Graywater Priorities, excluding Metals (A – D)

Medians => MDL or at Least One Sample 10X MDL

		Acetone	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Bromodichloromethane	Chloroform	Diethylphthalate
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	3.2	23	0.500	0.500	0.500	0.500
VESSEL ID	**Sample Date**						
Clipper Odyssey	02-Jul-03	16.0	0	120.000	0.000	1.200	9.000
Sea Bird	17-Aug-03	0.0	0	3.000	2.200	100.000	4.900
Spirit of Alaska	30-Aug-03	0.0	740	13.000	3.700	25.000	33.000
Spirit of Columbia	09-Jun-03	6.1	0	0.000	1.300	7.900	0.000
Spirit of Columbia	25-Jul-03	0.0	0	1.600	1.800	14.000	2.700
Spirit of Discovery	31-Jul-03	0.0	340	0.000	0.000	24.000	0.000
Spirit of Endeavor	24-Jul-03	0.0	0	16.000	0.000	7.300	7.900
Yorktown Clipper	26-Jul-03	400.0	0	8.200	3.900	31.000	27.000
	Minimum	**0.0**	**0**	**0.000**	**0.000**	**1.200**	**0.000**
	Median	**0.0**	**0**	**5.600**	**1.550**	**19.000**	**6.400**
	Maximum	**400.0**	**740**	**120.000**	**3.900**	**100.000**	**33.000**
	10X MDL	**32.0**	**230**	**5.000**	**5.000**	**5.000**	**5.000**

Table 10. 2003 Small Ship Graywater Priorities, excluding Metals

Medians => MDL or at Least One Sample 10X MDL (E - T)

		Ethylbenzene	m&p Xylenes	3&4-Methylphenol	O-Xylene	Phenol	Toluene
	MDL	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
		0.500	0.500	0.500	0.500	0.500	0.500
VESSEL ID	Sample Date						
Clipper Odyssey	02-Jul-03	0.000	0.000	0.000	0.000	0.000	0.000
Sea Bird	17-Aug-03	1.100	4.400	0.000	0.000	0.000	1.300
Spirit of Alaska	30-Aug-03	0.000	0.000	97.000	0.000	13.000	73.000
Spirit of Columbia	09-Jun-03	0.000	0.000	0.000	0.000	0.000	0.000
Spirit of Columbia	25-Jul-03	0.000	0.000	5.800	0.000	0.000	0.000
Spirit of Discovery	31-Jul-03	0.000	0.000	0.000	0.000	0.000	0.000
Spirit of Endeavor	24-Jul-03	9.600	37.000	0.000	15.000	0.000	1.200
Yorktown Clipper	26-Jul-03	0.000	0.000	0.000	0.000	0.000	1.600
	Minimum	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	Median	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.600**
	Maximum	**9.600**	**37.000**	**97.000**	**15.000**	**13.000**	**73.000**
	10X MDL	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**

Table 11. 2003 Small Ship Priorities Mixed Blackwater & Graywater Metals

	MDL	Arsenic, dissolved	Chromium, dissolved	Copper, dissolved	Lead, dissolved	Nickel, dissolved	Selenium, dissolved	Silver, dissolved	Zinc, dissolved
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
		0.150	0.150	0.150	0.150	0.150	0.15	0.150	0.150
VESSEL ID	Sample Date								
Columbia	01-Sep-03	29.300	2.430	6.990	5.330	9.100	88.50	0.000	46.400
Empress of the North	10-Sep-03	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
Empress of the North	11-Sep-03	15.600	2.090	23.700	3.970	6.460	50.50	0.000	191.000
Kennecott	30-Jul-03	32.500	2.480	11.000	0.000	46.400	136.00	0.111	31.400
Kennecott	01-Sep-03	33.900	3.530	16.200	5.640	19.800	109.00	0.000	102.000
Malaspina	13-Oct-03	55.800	9.490	57.100	0.000	18.900	166.00	0.000	97.000
Spirit of Oceanus	12-Jun-03	4.180	1.290	20.200	1.690	6.170	5.08	1.250	278.000
Spirit of Oceanus	15-Aug-03	2.450	2.870	53.400	0.965	4.630	6.94	1.400	100.000
Taku	11-Sep-03	50.300	279.000	60.900	22.000	13.000	164.00	2.810	164.000
Wilderness Adventurer	14-Sep-03	5.140	20.700	55.900	3.880	15.700	106.00	0.000	51.200
Wilderness Discoverer	14-Sep-03	3.740	9.800	0.000	0.000	11.300	90.40	0.000	32.500
	Minimum	**2.450**	**1.290**	**0.000**	**0.000**	**4.630**	**5.08**	**0.000**	**31.400**
	Median	**22.450**	**3.200**	**21.950**	**2.785**	**12.150**	**98.20**	**0.000**	**98.500**
	Maximum	**55.800**	**279.000**	**60.900**	**22.000**	**46.400**	**166.00**	**2.810**	**278.000**
	10X MDL	**1.500**	**1.500**	**1.500**	**1.500**	**1.500**	**1.50**	**1.500**	**1.500**

Table 12. 2003 Small Ship Priorities Mixed Blackwater & Graywater Priority Pollutants (A-C)

		Acetone	Benzoic Acid	Benzyl Alcohol	Bis(2-ethylhexyl)phthalate	Bromodichloromethane	Bromoform	Carbon Disulfide	Chloroform
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	**3.2**	**23**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**
VESSEL ID	**Sample Date**								
Columbia	01-Sep-03	14.0	410	0.000	1.700	0.920	2.900	2.300	3.800
Empress of the North	10-Sep-03	12.0	0	0.000	0.000	0.000	41.000	0.000	0.000
Empress of the North	11-Sep-03	0.0	Not Tested	Not Tested	Not Tested	0.000	1.800	0.000	12.000
Kennecott	30-Jul-03	0.0	110	0.000	1.900	0.000	51.000	0.000	0.000
Kennecott	01-Sep-03	0.0	170	0.000	5.400	1.300	11.000	0.000	1.700
Malaspina	13-Oct-03	0.0	370	0.000	0.000	8.800	75.000	0.000	5.100
Spirit of Oceanus	12-Jun-03	70.0	950	14.000	8.200	5.400	2.700	1.100	17.000
Spirit of Oceanus	15-Aug-03	0.0	0	0.000	6.700	10.000	2.900	0.000	84.000
Taku	11-Sep-03	0.0	0	0.000	0.000	0.000	99.000	0.000	0.000
Wilderness Adventurer	14-Sep-03	0.0	1,700	0.000	2.200	0.000	0.000	9.100	8.900
Wilderness Discoverer	14-Sep-03	0.0	1,200	0.000	3.700	1.900	0.000	4.000	19.000
	Minimum	**0.0**	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	Median	**0.0**	**270**	**0.000**	**2.050**	**0.920**	**2.900**	**0.000**	**5.100**
	Maximum	**70.0**	**1,700**	**14.000**	**8.200**	**10.000**	**99.000**	**9.100**	**84.000**
	10X MDL	**32.0**	**230**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**

Table 13. 2003 Small Ship Priorities Mixed Blackwater & Graywater Priority Pollutants (D-Z)

		Dibromo-Chloro-methane	**Diethyl phthalate**	**4-Isopropyl toluene**	**3&4-Methylphenol**	**Phenol**	**Sec-butylbenzene**	Styrene	Trichloroethene
		ug/L	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	ug/L	ug/L
	MDL	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	0.500	0.500
VESSEL ID	**Sample Date**								
Columbia	01-Sep-03	1.600	3.300	22.000	82.000	5.700	0.000	0.000	0.000
Empress of the North	10-Sep-03	1.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Empress of the North	11-Sep-03	0.000	Not Tested	0.000	Not Tested	Not Tested	0.000	0.000	0.000
Kennecott	30-Jul-03	2.300	2.600	0.000	41.000	3.900	0.000	0.000	0.000
Kennecott	01-Sep-03	3.700	1.300	0.000	89.000	2.300	0.000	0.000	0.000
Malaspina	13-Oct-03	32.000	2.000	0.000	0.000	0.000	0.000	0.000	0.000
Spirit of Oceanus	12-Jun-03	5.200	7.800	2.200	0.000	29.000	0.000	0.000	8.500
Spirit of Oceanus	15-Aug-03	8.500	4.700	19.000	0.000	3.700	34.000	0.000	0.000
Taku	11-Sep-03	2.100	2.000	0.000	0.000	0.000	0.000	0.000	0.000
Wilderness Adventurer	14-Sep-03	0.000	12.000	0.000	190.000	110.000	0.000	0.000	0.000
Wilderness Discoverer	14-Sep-03	0.000	0.000	0.000	180.000	65.000	0.000	0.000	0.000
	Minimum	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	Median	**2.100**	**2.300**	**0.000**	**20.500**	**3.800**	**0.000**	**0.000**	**0.000**
	Maximum	**32.000**	**12.000**	**22.000**	**190.000**	**110.000**	**34.000**	**0.000**	**8.500**
	10X MDL	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**

Table 14. 2003 Small Ship Blackwater Metals

		Arsenic, dissolved	Beryllium, dissolved	Chromium, dissolved	Copper, dissolved	Nickel, dissolved	Selenium, dissolved	Silver, dissolved	Zinc, dissolved
	MDL	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
		0.150	0.150	0.150	0.150	0.150	0.15	0.150	0.150
VESSEL ID	**Sample Date**								
Clipper Odyssey	02-Jul-03	55.200	0.000	2.040	21.700	18.400	235.00	0.532	18.800
Clipper Odyssey	08-Aug-03	42.800	0.000	5.020	6.390	10.400	168.00	1.790	13.000
Sea Lion	16-Aug-03	37.200	0.000	3.450	5.530	13.000	179.00	2.150	14.000
Spirit of 98	26-Jul-03	52.000	0.000	6.410	49.700	19.500	201.00	2.020	38.100
Spirit of Alaska	02-Aug-03	33.400	0.000	2.990	5.510	12.600	114.00	0.000	74.200
Spirit of Columbia	09-Jun-03	56.100	0.000	3.560	25.100	24.300	171.00	1.150	74.400
Spirit of Discovery	17-Jul-03	38.200	0.000	8.560	6.150	10.900	116.00	2.940	25.700
	Minimum	**33.400**	**0.000**	**2.040**	**5.510**	**10.400**	**114.00**	**0.000**	**13.000**
	Median	**42.800**	**0.000**	**3.560**	**6.390**	**13.000**	**171.00**	**1.790**	**25.700**
	Maximum	**56.100**	**0.000**	**8.560**	**49.700**	**24.300**	**235.00**	**2.940**	**74.400**
	10X MDL	**1.500**	**1.500**	**1.500**	**1.500**	**1.500**	**1.50**	**1.500**	**1.500**

Median >= MDL or at least 1 sample 10X MDL

Table 15. 2003 Small Ship Blackwater Priority Pollutants

		Acetone	Benzoic Acid	Benzyl Alcohol	Bromo Dichloro methane	Bromoform	2-Butanone	Chloroform	Iodo methane	3&4-Methyl phenol	Phenol
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	MDL	**3.2**	**23**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**	**0.500**
VESSEL ID	**Sample Date**										
Clipper Odyssey	02-Jul-03	21.0	250	0.000	21.000	0.000	6.700	570.000	0.000	16.000	5.100
Clipper Odyssey	08-Aug-03	2.5	0	0.000	0.000	3.300	0.000	0.000	0.000	0.000	0.000
Sea Lion	16-Aug-03	0.0	0	0.000	0.000	18.000	0.000	0.000	0.000	0.000	0.000
Spirit of 98	26-Jul-03	0.0	0	0.000	0.000	0.000	0.000	2.900	0.000	0.000	9.500
Spirit of Alaska	02-Aug-03	0.0	0	0.000	0.000	0.000	0.000	0.000	0.000	100.000	21.000
Spirit of Columbia	09-Jun-03	3.9	0	0.000	0.660	3.000	0.000	0.000	9.200	0.000	0.000
Spirit of Discovery	17-Jul-03	Not Tested	0	300.000	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	8.900	0.000
	Minimum	**0.0**	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	Median	**1.3**	**0**	**0.000**	**0.000**	**1.500**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	Maximum	**21.0**	**250**	**300.000**	**21.000**	**18.000**	**6.700**	**570.000**	**9.200**	**100.000**	**21.000**
	10X MDL	**32.0**	**230**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**	**5.000**

Median >= MDL or at least 1 sample 10X MDL

2002

Table 16. 2002 Small Ship Graywater Conventional Pollutants

Sample Name		Ammonia as N	BOD 5-Day	COD	Fecal coliform	Free chlorine	pH	Total chlorine	TSS
		mg/L	mg/L	mg/L	MPN/100 ml	mg/L		mg/L	mg/L
MDL	**Sample Date**	**0.03**	**2**	**3.0**	**2**	**0.10**	**0.1**	**0.10**	**1.3**
Clipper Odyssey GW-AFT	6/25/2002	0.31	290	496.0	1,600	ND	6.0	ND	49.40
Clipper Odyssey GW-FWD	6/25/2002	1.49	126	400.0	1,600	1.50	9.0	3.00	30.00
Sea Bird GW 0817	8/17/2002	0.30	499	767.0	13,000	ND	5.2	0.20	65.60
Sea Bird GW 6/28	6/28/2002	0.97	263	621.0	1	1.80	7.1	2.70	123.00
Sea Lion-GW 0721	7/21/2002	0.02	364	678.0	1	ND	7.0	ND	56.00
Spirit of 98 Graywater	7/6/2002	0.80	47	149.0	500,000	ND	7.2	ND	129.00
Spirit of Endeavour GW	8/22/2002	2.05	175	365.0	240	1.20	9.9	1.40	54.10
Spirit of Endeavour GW 0711	7/11/2002	0.69	450	927.0	16,000,000	ND	10.1	not taken	212.00
Taku GW Stbd 77	8/15/2002	0.02	3	1.5	1	ND	7.2	ND	0.65
York Clipper GW Discharge Line	7/13/2002	0.01	138	228.0	1	9.00	8.2	12.00	17.10
Yorktown Clipper GW	7/27/2002	0.10	77	154.0	1	0.40	8.0	1.10	8.80
	Minimum	**0.01**	**3**	**1.5**	**1**	**ND**	**5.2**	**ND**	**0.7**
	Median	**0.31**	**175**	**400.0**	**240**	**ND**	**7.2**	**0.65**	**54.1**
	Maximum	**2.05**	**499**	**927.0**	**16,000,000**	**9.00**	**10.1**	**12.00**	**212.0**
	Geometric Mean				**222**				

Table 17. 2002 Small Ship Graywater Conventional Pollutants

Sample Name	Sample Date	Alkalinity, Total as CaCO3	Conductivity	Oil&Grease	Nitrate as N	TKN	Phosphorous, Total	TOC	Total settleable solids
		mg/L	umHos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MDL	**Sample Date**	**0.5**	**1**	**1.50**	**1.0**	**1.0**	**0.01**	**1**	**0.1**
Clipper Odyssey GW-AFT	6/25/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Clipper Odyssey GW-FWD	6/25/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Sea Bird GW 0817	8/17/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Sea Bird GW 6/28	6/28/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Sea Lion-GW 0721	7/21/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of 98 Graywater	7/6/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Endeavour GW	8/22/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Endeavour GW 0711	7/11/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Taku GW Stbd 77	8/15/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
York Clipper GW Discharge Line	7/13/2002	61.0	369	52.00	0.5	0.4	0.86	352	0.05
Yorktown Clipper GW	7/27/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
	Minimum	**61.0**	**369**	**52.0**	**0.5**	**0.4**	**0.86**	**352.0**	**0.1**
	Median	**61.0**	**369**	**52.0**	**0.5**	**0.4**	**0.86**	**352.0**	**0.1**
	Maximum	**61.0**	**369**	**52.0**	**0.5**	**0.4**	**0.86**	**352.0**	**0.1**

Table 18. 2002 Small Ship Blackwater & Graywater Mixed Conventional Results

Sample Name	Date	Ammonia as N	BOD 5-Day	COD	Fecal coliform	Free chlorine	pH	Total chlorine	TSS
		mg/L	mg/L	mg/L	MPN/100 ml	mg/L		mg/L	mg/L
	MDL	**0.03**	**2**	**3.0**	**2**	**0.10**	**0.1**	**0.10**	**1.3**
ADEC Matanuska WW-1	7/20/2002	1.27	134	451.0	1	10.00	6.9	25.00	75.2
Columbia TWW-2	8/12/2002	48.20	283	726.0	2,400,000	0.00	7.4	0.05	77.0
Columbia TWW-3	9/3/2002	35.00	110	260.0	5,000,000	0.00	7.3	0.05	40.8
Columbia WW-1 Mixed	7/22/2002	29.40	117	495.0	22	12.00	7.7	20.00	73.9
Kennicott MSD 3 Mixed Wastewater	7/10/2002	0.02	1	870.0	1	25.00	8.1	40.00	22.5
Kennicott TWW	6/25/2002	0.02	1	1,200.0	14	2.00	8.0	not taken	32.0
Kennicott WW1	4/1/2002	12.00	246	1,180.0	9,000,000	0.00	7.0	not taken	179.0
Malaspina 0626	6/26/2002	10.10	89	876.0	5	4.00	7.0	not taken	100.0
Malaspina MSD-1	7/9/2002	0.12	1	514.0	1	2.50	7.9	3.50	22.9
Malaspina TWW-2	9/6/2002	8.90	94	220.0	1	0.00	7.2	0.05	55.6
Matanuska #1 Overboard	7/27/2002	11.00	225	600.0	3,000	0.10	7.6	0.05	140.0
Matanuska WW	2/25/2002	16.80	154	1,240.0	50,000	5.00	7.5	0.05	73.7
Spirit of Oceanus Mixed BW & GW 0717	7/17/2002	58.40	1,060	1,810.0	5,000,000	0.20	6.9	not taken	232.0
Spirit of Oceanus Mixed TBW and GW	8/6/2002	21.10	870	1,610.0	3,000,000	0.00	5.3	0.25	295.0
Wilderness Adventurer WW #1	8/19/2002	39.20	174	931.0	2,200,000	1.10	8.2	2.10	155.0
Wilderness Adventurer WW #2	8/19/2002	42.40	163	800.0	500,000	1.10	8.2	2.10	114.0
Wilderness Discoverer Mixed GW & TBW	8/21/2002	43.40	354	not taken	9,000,000	0.00	7.5	0.05	192.0
	Minimum	**0.02**	**1**	**220.0**	**1**	**0.00**	**5.3**	**0.05**	**22.5**
	Median	**16.80**	**154**	**835.0**	**50,000**	**1.10**	**7.5**	**0.25**	**77.0**
	Maximum	**58.40**	**1,060**	**1,810.0**	**9,000,000**	**25.00**	**8.2**	**40.00**	**295.0**
	Geometric Mean				**5,487**				**85.4**

Table 19. 2002 Small Ship Mixed Blackwater and Graywater Conventional Pollutants

Sample Name		Alkalinity, Total as CaCO3	Conductivity	Oil & Grease	Total Nitrate and Nitrite as N	TKN	Phosphorous, Total	TOC	Total Settleable Solids
		mg/L	umHos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MDL	**Date**	**0.5**	**1**	**1.5**	**1.0**	**1.0**	**0.01**	**1.0**	**0.1**
ADEC Matanuska WW-1	7/20/2002	79.5	23,000	27.0	0.5	17.6	2.38	336.0	0.1
Columbia TWW-2	8/12/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Columbia TWW-3	9/3/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Columbia WW-1 Mixed	7/22/2002	166.0	22,800	30.0	0.5	42.4	5.65	419.0	0.2
Kennicott MSD 3 Mixed Wastewater	7/10/2002	76.3	31,200	0.8	0.5	28.7	0.01	274.0	0.1
Kennicott TWW	6/25/2002	not taken	37,000	not taken	not taken	not taken	not taken	not taken	not taken
Kennicott WW1	4/1/2002	not taken	36,400	not taken	not taken	not taken	not taken	not taken	not taken
Malaspina 0626	6/26/2002	not taken	28,300	not taken	not taken	not taken	not taken	not taken	not taken
Malaspina MSD-1	7/9/2002	62.3	23,800	13.0	0.5	0.8	0.35	6.0	0.1
Malaspina TWW-2	9/6/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Matanuska #1 Overboard	7/27/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Matanuska WW	2/25/2002	not taken	35,500	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Oceanus Mixed BW & GW 0717	7/17/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Oceanus Mixed TBW and GW	8/6/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Wilderness Adventurer WW #1	8/19/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Wilderness Adventurer WW #2	8/19/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Wilderness Discoverer Mixed GW & TBW	8/21/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
	Minimum	**62.3**	**22,800**	**0.8**	**0.5**	**0.8**	**0.01**	**6.0**	**0.1**
	Median	**77.9**	**29,750**	**20.0**	**0.5**	**23.2**	**1.36**	**305.0**	**0.1**
	Maximum	**166.0**	**37,000**	**30.0**	**0.5**	**42.4**	**5.65**	**419.0**	**0.2**

Table 20. 2002 Small Ship Blackwater Conventional Pollutants

Sample Name		Ammonia as N	BOD 5-Day	COD	Fecal coliform	Total chlorine	pH	Free chlorine	TSS
		mg/L	mg/L	mg/L	MPN/100 ml	mg/L		mg/L	mg/L
MDL	**Date**	**0.03**	**2.0**	**3**	**2**	**0.10**	**0.1**	**0.10**	**1.3**
Clipper Odyssey TBW	6/25/2002	4.39	4.4	1830	90,000	ND	8.0	0.05	32.8
Sea Bird TBW 0628	6/28/2002	23.50	105.0	461	4,000	2.20	7.8	Not taken	329.0
Sea Bird TBW 0817	8/17/2002	3.35	45.3	844	11	0.80	7.5	1.60	101.0
Sea Lion TBW 0804	8/4/2002	26.70	293.0	996	220,000	ND	6.2	0.10	486.0
Sea Lion-TBW 0721	7/21/2002	10.90	335.0	767	30,000,000	0.50	8.0	Not taken	801.0
Spirit of 98 Treated Blackwater	7/6/2002	102.00	127.0	897	220	1.20	8.0	Not taken	96.8
Spirit of Columbia TBW	8/22/2002	21.40	146.0	700	200	ND	7.3	0.10	133.0
Spirit of Columbia TBW 0805	8/5/2002	21.40	146.0	700	200	ND	7.3	0.10	133.0
Spirit of Endeavour TBW	8/22/2002	0.93	291.0	1370	3,000,000	ND	7.7	ND	276.0
Spirit of Endeavour TBW 0711	7/11/2002	83.30	478.0	1400	16,000,000	ND	7.5	ND	657.0
York Clipper BW from MSD	7/13/2002	6.32	5.5	512	2,400	ND	7.0	ND	66.6
Yorktown Clipper TBW	7/27/2002	6.44	1.0	634	220	ND	7.0	ND	25.4
	Minimum	**0.93**	**1.0**	**461.0**	**11**	**ND**	**6.2**	**ND**	**25.4**
	Median	**16.15**	**137**	**805.5**	**3,200**	**ND**	**7.5**	**ND**	**133.0**
	Maximum	**102.00**	**478**	**1830.0**	**30,000,000**	**2.20**	**8.0**	**1.60**	**801.0**
	Geometric Mean				**11,582**				

Table 21. 2002 Small Ship Blackwater Conventional Pollutants (continued)

Sample Name	Date	Alkalinity, Total as CaCO3	Conductivity	Oil & Grease	Phosphorus	Total Nitrate and Nitrite as N	TKN	TOC	Total settleable solids
		mg/L	umHos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MDL		**0.5**	**1**	**1.50**	**0.01**	**1.0**	**1.0**	**1.0**	**0.1**
Clipper Odyssey TBW	6/25/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Sea Bird TBW 0628	6/28/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Sea Bird TBW 0817	8/17/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Sea Lion TBW 0804	8/4/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Sea Lion-TBW 0721	7/21/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of 98 Treated Blackwater	7/6/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Columbia TBW	8/22/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Columbia TBW 0805	8/5/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Endeavour TBW	8/22/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Spirit of Endeavour TBW 0711	7/11/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
York Clipper BW from MSD	7/13/2002	116.0	34500	8.50	2.33	0.5	5.7	299	0.05
Yorktown Clipper TBW	7/27/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
	Minimum	**116.0**	**34,500**	**8.5**	**2.33**	**0.5**	**5.7**	**299.0**	**0.1**
	Median	**116.0**	**34,500**	**8.5**	**2.33**	**0.5**	**5.7**	**299.0**	**0.1**
	Maximum	**116.0**	**34,500**	**8.5**	**2.33**	**0.5**	**5.7**	**299.0**	**0.1**

Table 22. 2002 Small Ship Graywater Dissolved Metals

Sample Name	Sample Date	Antimony-dissolved	Arsenic-dissolved	Chromium-dissolved	Copper-dissolved	Lead-dissolved	Nickel-dissolved	Selenium-dissolved	Zinc-dissolved
MDL		**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Sea Bird GW	8/17/02	1.11	4.44	4.27	37.70	0.91	7.50	5.65	35.10
Sea Lion GW-1	9/1/02	0.33	1.20	5.10	27.40	2.00	8.60	1.70	418.00
Spirit of Endeavour GW	8/22/02	missing	missing	missing	missing	missing	missing	missing	missing
York Clipper GW Discharge Line	7/13/02	0.12	0.30	0.64	84.70	0.29	1.77	0.60	86.90
Yorktown Clipper GW	7/27/02	0.37	45.10	3.93	15.10	0.12	13.70	232.00	31.60
Minimum		**0.12**	**0.02**	**0.60**	**2.33**	**0.12**	**0.89**	**0.07**	**31.60**
Median		**0.33**	**1.20**	**3.93**	**27.40**	**0.29**	**7.50**	**1.70**	**86.90**
Maximum		**1.11**	**45.10**	**5.10**	**84.70**	**2.00**	**13.70**	**232.00**	**418.00**

All Spirit of Columbia graywater samples deleted because of QAQC Concerns

Table 23. 2002 Small Ship Blackwater Metals

Sample Name	Date	Antimony-dissolved	Arsenic-dissolved	Chromium-dissolved	Copper-dissolved	Lead-dissolved	Nickel-dissolved	Selenium-dissolved	Zinc-dissolved
MDL		**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
Sea Bird TBW	8/17/2002	0.16	45.70	3.50	17.30	0.25	21.10	177.00	1350.00
Sea Lion TBW	8/4/2003	0.02	44.00	10.90	13.40	14.60	14.70	201.00	69.30
Spirit of Endeavour TBW	8/22/2002	missing	missing	missing	missing	missing	missing	missing	Missing
Taku TBW	9/6/2002	0.02	49.40	17.40	50.70	2.75	22.00	128.00	65.80
Spirit of Columbia TBW	8/5/2002	0.43	35.70	4.39	8.81	0.21	12.20	163.00	28.00
York Clipper BW from MSD	7/13/2002	0.02	53.20	7.56	8.48	0.02	15.10	233.00	26.20
Minimum		**0.02**	**0.15**	**0.15**	**0.15**	**0.02**	**0.15**	**0.15**	**0.15**
Median		**0.02**	**44.85**	**5.98**	**11.11**	**0.23**	**14.90**	**170.00**	**46.90**
Maximum		**0.43**	**53.20**	**17.40**	**50.70**	**14.60**	**22.00**	**233.00**	**1350.00**

Table 24. 2002 Small Ship Mixed Blackwater & Graywater Dissolved Metals

Sample Name	Date	Antimony-dissolved	Arsenic-dissolved	Chromium-dissolved	Copper-dissolved	Lead-dissolved	Nickel-dissolved	Selenium-dissolved	Zinc-dissolved
MDL		**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
ADEC Matanuska WW-1	7/20/2002	0.02	35.00	4.18	163.00	0.02	21.20	164.00	74.90
Columbia TWW	9/3/2002	not taken	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Columbia WW-1 Mixed	7/22/2002	0.02	31.90	13.00	76.30	0.02	12.60	155.00	1050.00
Kennicott MSD 3 Mixed Wastewater	7/10/2002	0.02	50.00	4.32	119.00	1.21	16.60	171.00	71.30
Kennicott TWW	6/25/2002	1.37	48.60	7.55	103.00	10.70	23.40	148.00	111.00
Malaspina MSD-1	7/9/2002	0.02	39.40	10.30	18.70	0.02	16.60	101.00	67.30
Matanuska TWW	9/30/2002	0.02	37.70	5.94	319.00	8.69	36.10	101.00	165.00
Spirit of Oceanus Mixed TBW and GW	8/6/2002	0.02	33.00	8.52	6.85	16.60	10.40	145.00	34.60
Wilderness Adventurer WW #1	8/19/2002	1.30	30.20	5.08	16.80	4.67	24.10	134.00	556.00
Wilderness Adventurer WW #2	8/19/2002	1.25	30.70	5.69	13.90	0.74	11.90	126.00	225.00
Wilderness Discoverer Mixed GW & TBW	8/21/2002	0.54	30.30	6.62	241.00	5.95	16.60	132.00	317.00
Minimum		**0.02**	**30.20**	**4.32**	**6.85**	**0.02**	**10.40**	**101.00**	**34.60**
Median		**0.02**	**33.00**	**6.62**	**76.30**	**4.67**	**16.60**	**134.00**	**165.00**
Maximum		**1.37**	**50.00**	**13.00**	**319.00**	**16.60**	**36.10**	**171.00**	**1050.00**

Table 25. 2002 Small Ship Graywater Priority Pollutants, Excluding Metals (A-B)

Sample Name	Sample Date	Acetone	Benzoic Acid	Benzyl Alcohol	Bis(2-Ethylhexyl)Phthalate	Bromodichloromethane	Bromoform
MDL		**3.20**	**25.00**	**0.65**	**1.00**	**0.50**	**0.50**
Sea Bird GW	8/17/02	n/a	n/a	n/a	64.00	13.00	38.00
Sea Lion GW-1	9/1/02	n/a	n/a	n/a	15.00	1.80	0.32
Spirit of Columbia GW	8/5/02	n/a	n/a	n/a	7.90	2.10	0.55
Spirit of Endeavour GW	8/22/02	n/a	n/a	n/a	17.00	1.90	0.32
York Clipper GW Discharge Line	7/13/02	52.00	60.00	9.00	2.80	7.20	0.32
Yorktown Clipper GW	7/27/02	n/a	n/a	n/a	4.00	7.90	1.40
Minimum		**52.00**	**60.00**	**9.00**	**2.80**	**1.80**	**0.32**
Median		**52.00**	**60.00**	**9.00**	**11.45**	**4.65**	**0.43**
Maximum		**52.00**	**60.00**	**9.00**	**64.00**	**13.00**	**38.00**

Table 26. 2002 Small Ship Graywater Priority Pollutants, Excluding Metals (C-T)

Sample Name	Sample Date	Chloroform	Chloromethane	Dibromochloromethane	Diethylphthalate	Phenol	Toluene
MDL		**0.50**	**0.29**	**0.50**	**1.00**	**1.00**	**0.500**
Sea Bird GW	8/17/02	66.00	0.15	21.00	25.00	16.00	0.125
Sea Lion GW-1	9/1/02	120.00	0.15	0.16	17.00	7.00	0.125
Spirit of Columbia GW	8/5/02	7.50	0.15	1.60	0.27	0.42	0.125
Spirit of Endeavour GW	8/22/02	18.00	0.15	0.16	11.00	3.40	0.540
York Clipper GW Discharge Line	7/13/02	140.00	2.70	1.70	14.00	0.42	1.200
Yorktown Clipper GW	7/27/02	140.00	21.00	2.40	17.00	0.42	2.700
Minimum		**7.50**	**0.15**	**0.16**	**0.27**	**0.42**	**0.125**
Median		**93.00**	**0.15**	**1.65**	**15.50**	**1.91**	**0.333**
Maximum		**140.00**	**21.00**	**21.00**	**25.00**	**16.00**	**2.700**

Table 27. 2002 Small Ship Blackwater Priority Pollutants, Excluding Metals

Sample Name	Sample Date	1,4-Difluoro benzene	Acetone	Benzoic Acid	Benzyl Alcohol	Bis(2-Ethyl hexyl) Phthalate	Bromoform	Dibromo Chloro methane	Di-n-Butyl phthalate	Phenol
MDL		**1.00**	**3.20**	**25.00**	**0.65**	**1.00**	**0.50**	**0.50**	**1.00**	**1.00**
Sea Bird TBW	8/17/02	n/a	n/a	n/a	n/a	25.00	20.00	6.70	0.70	0.42
Sea Lion TBW	8/4/02	n/a	n/a	n/a	n/a	0.34	1.20	0.16	0.70	3.80
Spirit of Columbia TBW	8/5/02	n/a	n/a	n/a	n/a	0.34	1.80	1.90	0.70	7.80
Spirit of Endeavour TBW	8/22/02	n/a	n/a	n/a	n/a	0.34	0.32	0.16	0.70	20.00
Taku TBW	9/06/02	250.00	n/a	260.00	7.30	1.70	1000.00	28.00	11.00	0.42
York Clipper BW from MSD	7/13/02	n/a	9.10	23.50	0.03	0.34	0.32	0.16	2.60	0.42
Yorktown Clipper TBW	7/27/02	n/a	n/a	n/a	n/a	0.34	18.00	1.80	3.20	0.42
Minimum		**250.00**	**9.10**	**23.50**	**0.03**	**0.34**	**0.32**	**0.16**	**0.70**	**0.42**
Median		**250.00**	**9.10**	**141.75**	**3.66**	**0.34**	**1.80**	**1.80**	**0.70**	**0.42**
Maximum		**250.00**	**9.10**	**260.00**	**7.30**	**25.00**	**1,000.00**	**28.00**	**11.00**	**20.00**

Table 28. 2002 Small Ship Mixed Blackwater and Graywater Priority Pollutants (A-B) except Metals

Sample Name	Sample	1,4-Difluorobenzene	Acetone	Benzoic Acid	Benzyl Alcohol	Bis(2-Ethyl hexyl) Phthalate	Bromo Dichloro methane	Bromoform
MDL	**Date**	**1.0**	**3.20**	**25.0**	**0.65**	**1.000**	**0.50**	**0.500**
ADEC Matanuska WW-1	7/20/2002	n/a	45.00	220.0	8.00	2.100	31.00	130.000
Columbia TWW	9/3/2002	50.0	n/a	2800.0	0.28	2.300	0.59	5.400
Columbia WW-1 Mixed	7/22/2002	n/a	47.00	600.0	5.60	2.800	8.90	89.000
Kennecott MSD 3 Mixed	7/10/2002	n/a	4.00	23.5	0.28	5.100	0.23	36.000
Kennecott TWW	6/25/2002	50.0	n/a	92.0	0.28	0.335	0.23	18.000
Malaspina MSD-1	7/9/2002	n/a	1.25	62.0	0.28	8.000	1.60	57.000
Malaspina TWW-2	9/6/2002	50.0	n/a	740.0	0.28	0.335	6.50	130.000
Matanuska TWW	7/27/2002	50.0	n/a	630.0	0.28	2.200	17.00	51.000
Spirit of Oceanus TBW&GW	8/6/2002	n/a	n/a	n/a	n/a	3.900	6.50	1.700
Wilderness Adventurer WW #1	8/19/2002	n/a	n/a	n/a	n/a	4.200	13.00	18.000
Wilderness Adventurer WW #2	8/19/2002	n/a	n/a	n/a	n/a	5.300	13.00	18.000
Wilderness Discoverer GW&TBW	8/21/2002	n/a	n/a	n/a	n/a	9.600	0.23	0.315
	Minimum	**50.0**	**1.25**	**23.5**	**0.28**	**0.335**	**0.23**	**0.315**
	Median	**50.0**	**24.50**	**410.0**	**0.28**	**3.350**	**6.50**	**27.000**
	Maximum	**50.0**	**47.00**	**2800.0**	**8.00**	**9.600**	**31.00**	**130.000**

Table 29. 2002 Small Ship Mixed Blackwater and Graywater Priority Pollutants (C-Z) except Metals

Sample Name	Sample	Chloroform	Chloromethane	Dibromo chloromethane	Diethylphthalate	Di-n-Butylphthalate	m&p Xylenes	Phenol	Toluene
MDL	**Date**	**0.5**	**1**	**0.5**	**1**	**1**	**0.28**	**1**	**0.5**
ADEC Matanuska WW-1	7/20/2002	19	2.9	73	3.7	0.7	8	0.415	0.5
Columbia TWW	9/3/2002	3.8	0.15	1.3	2.7	0.7	n/a	22	0.125
Columbia WW-1 Mixed	7/22/2002	5.8	4.5	30	2.2	0.7	0.55	0.415	0.125
Kennecott MSD 3 Mixed	7/10/2002	0.65	0.15	1.1	0.265	0.7	0.075	0.415	0.125
Kennecott TWW	6/25/2002	0.65	0.15	0.58	0.265	17	n/a	0.415	0.125
Malaspina MSD-1	7/9/2002	0.65	1.9	8.8	0.265	0.7	0.075	1.1	0.125
Malaspina TWW-2	9/6/2002	6.7	0.15	30	0.265	0.7	n/a	0.415	0.125
Matanuska TWW	7/27/2002	7.4	23	39	2.6	2.6	n/a	2.8	0.125
Spirit of Oceanus TBW&GW	8/6/2002	25	34	5.1	3.8	1.8	n/a	14	6.8
Wilderness Adventurer WW #1	8/19/2002	23	0.15	21	10	0.7	n/a	27	0.125
Wilderness Adventurer WW #2	8/19/2002	23	0.15	21	10	0.7	n/a	27	0.125
Wilderness Discoverer GW&TBW	8/21/2002	100	0.15	0.16	7.4	0.7	n/a	40	0.125
	Minimum	**0.65**	**0.15**	**0.16**	**0.265**	**0.7**	**0.075**	**0.415**	**0.125**
	Median	**7.05**	**0.15**	**14.9**	**2.65**	**0.7**	**0.3125**	**1.95**	**0.125**
	Maximum	**100**	**34**	**73**	**10**	**17**	**8**	**40**	**6.8**

2001 **(Samples Taken before July 1, 2001 are part of the voluntary program and the ship name withheld).**

Table 30. 2001 Small Ship Graywater Conventional Pollutant Results

Sample Name	Sample Date	VESSEL_ID	Ammonia, Total (As N) mg/L	pH	BOD5 mg/L	COD mg/L	TSS mg/L	Total Chlorine Residual mg/L	Fecal Coliform MPN/100 ml	Free Chlorine Residual mg/L
		MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
Aft Graywater	04-Aug-01	Clipper Odyssey	not taken	not taken	not taken	not taken	106.0	ND	not taken	not taken
GW1 (Graywater)	04-Aug-01	Sea Bird	0.38	7.8	1	901.0	316.0	180.00	1	180.00
Sea Bird GW	18-Aug-01	Sea Bird	0.47	8.2	430	1370.0	372.0	270.00	50	150.00
GW1 (Graywater)	05-Aug-01	Sea Lion	1.06	8.0	395	674.0	78.6	ND	30,000	ND
Sea Lion GW HT	19-Aug-01	Sea Lion	0.26	7.6	330	722.0	132.0	10.00	1	7.50
Spirit of AK GW HT	23-Aug-01	Spirit of Alaska	1.49	7.0	372	578.0	143.0	ND	11,000	ND 5
Spirit of End GW OB Discharge	25-Aug-01	Spirit of Endeavor	4.87	8.0	205	472.0	83.6	ND	300,000	ND
Spirit of Oceanus GW HT	13-Aug-01	Spirit of Oceanus	1.80	5.9	519	846.0	49.6	ND	16,000,000	ND
Spirit of Oceanus GW HT	27-Aug-01	Spirit of Oceanus	1.00	5.4	1010	860.0	269.0	ND	16,000,000	ND
102 STBD (Galley Pots and Pans)	06-Jun-01	Name withheld	71.70	not taken	223	not taken	81.5	6.00	100	not taken
103 STBD (Galley Saladmaker Sink)	06-Jun-01	Name withheld	28.90	not taken	275	not taken	22.3	0.81	1	not taken
107 PORT (Boat Deck Aft Men & Women's Washroom, Bar)	06-Jun-01	Name withheld	59.00	not taken	224	not taken	805.0	1.56	1,400	not taken
107 PORT (Boat Deck Aft Men & Women's Washroom, Bar)	20-Jun-01	Name withheld	0.02	not taken	205	not taken	2.5	0.05	20	not taken

Sample Name	Sample Date	VESSEL_ID	Ammonia, Total (As N) mg/L	pH	BOD5 mg/L	COD mg/L	TSS mg/L	Total Chlorine Residual mg/L	Fecal Coliform MPN/100 ml	Free Chlorine Residual mg/L
		MDL	**0.03**	**0.1**	**2**	**3.0**	**1.3**	**0.10**	**2**	**0.10**
131 PORT (Aft cabin Deck Women's Washroom)	06-Jun-01	Name withheld	42.40	not taken	209	not taken	112.5	0.36	1	not taken
131 STBD (Aft Cabin Deck Men's Washroom)	06-Jun-01	Name withheld	58.80	not taken	223	not taken	17.3	0.11	1	not taken
24 STBD (Focs'l Crew Quarters Shower and Sinks)	06-Jun-01	Name withheld	30.80	not taken	309	not taken	2.7	ND	1	not taken
45 PORT (Aft Cabin Deck Men's Washroom)	06-Jun-01	Name withheld	63.60	not taken	216	not taken	59.5	0.28	1	not taken
49 STBD (Bridge SR's, Boat Deck Men's Shower, Fwd Cabin Deck Staterooms)	06-Jun-01	Name withheld	56.70	not taken	113	not taken	19.5	0.13	1,000	not taken
49 STBD (Bridge SR's, Boat Deck Men's Shower, Fwd Cabin Deck Staterooms)	20-Jun-01	Name withheld	0.02	not taken	1	not taken	6.5	0.02	1	not taken
GW-1 (77 Aft Strbd)	28-Dec-01	Taku	0.02	7.3	3	25.3	5.7	ND	1	not taken
GW-2 (102 strbd)	28-Dec-01	Taku	0.02	7.3	115	225.0	44.4	ND	1,300,000	not taken
York Clip GW HT (accom)	08-Sep-01	Yorktown Clipper	0.02	6.6	50	1.5	41.4	ND	1	ND
York Clip GW HT (laundry)	08-Sep-01	Yorktown Clipper	0.25	10.7	138	374.0	22.9	0.30	2	ND
York Clipper GW Accom	05-Sep-01	Yorktown Clipper	0.56	6.9	109	174.0	22.0	ND	200	ND
York Clipper GW Laundry	05-Sep-01	Yorktown Clipper	0.02	7.8	110	272.0	20.1	0.40	1	0.30
		Minimum	**0.02**	**5.4**	**1**	**1.50**	**2.50**	**ND**	**1**	**ND**
		Median	**1.03**	**7.5**	**212**	**525.0**	**49.6**	**ND**	**11**	**ND**
		Maximum	**71.70**	**10.7**	**1010**	**1370.0**	**805.0**	**270.00**	**16,000,000**	**180.00**
		Geometric Mean							**103**	

Table 31. 2001 Small Ship Blackwater & Graywater Mixed Conventional Pollutant Results

Sample Name	Sample Date	VESSEL_ID	Ammonia, total (as N) mg/L	pH	BOD5 mg/L	COD mg/L	TSS mg/L	Total chlorine Residual mg/L	Fecal Coliform MPN/100 ml	Free Chlorine Residual mg/L	Conductivity umhos/CM
		MDL	**0.03**	**0.1**	**2**	**3.0**	**1.3**	**0.10**	**2**	**0.10**	**1**
Columbia BW-2	13-Aug-01	Columbia	7.50	not taken	84	765.0	111.0	1.50	1,100	0.70	34400
Columbia BW-3	13-Aug-01	Columbia	7.40	7.5	89	744.0	118.0	1.00	1,300	ND	34700
Columbia BW-4	13-Aug-01	Columbia	7.72	7.5	81	863.0	105.0	1.20	500	0.60	34700
Malaspina WW-01 (BW/GW)	02-Jul-01	Malaspina	1.40	7.9	20	470.0	40.0	ND	70,000	0.00	34800
M/V Matanuska Wastewater	19-Jul-03	Matanuska	not taken	6.7	213	not taken	78.0	3.15	1	not taken	not taken
M/V Matanuska Wastewater	18-Dec-01	Matanuska	1.01	7.4	110	608.0	69.7	3.10	2	not taken	35900
WW-01	09-Apr-01	Matanuska	22.00	7.3	150	not taken	73.0	not taken	2,200	not taken	not taken
GW/BW Holding tank	09-Aug-01	Wilderness Adventurer	12.80	7.2	580	1,340.0	1,030.0	0.80	9,000	0.10	not taken
BW/GW	17-Sep-01	Wilderness Discoverer	53.50	5.5	1,310	1,850.0	146.0	ND	16,000,000	ND	not taken
WW	23-Aug-01	Wilderness Discoverer	9.16	6.3	2,080	2,850.0	1,200.0	ND	16,000,000	ND	not taken
		Minimum	**1.01**	**5.5**	**20**	**470.0**	**40.0**	**ND**	**1**	**ND**	**34400**
		Median	**7.72**	**7.3**	**130**	**814.0**	**108.0**	**1.00**	**1,750**	**0.10**	**34700**
		Maximum	**53.50**	**7.9**	**2,080**	**2,850.0**	**1,200.0**	**3.15**	**16,000,000**	**0.70**	**35900**
		Geometric Mean							**3,720**		

Table 32. 2001 Small Ship Blackwater Conventional Pollutant Results

Sample Name	Sample Date	VESSEL_ID	Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
			mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100 ml	mg/L
		MDL	0.03	0.1	2	3.0	1.3	0.10	2	0.10
Sewage Effluent	04-Aug-01	Clipper Odyssey	not taken	not taken	1	not taken	7.0	ND	17	not taken
Sea Bird BW	18-Aug-01	Sea Bird	0.61	7.9	6	644.0	25.8	1.50	1	0.90
Sea Bird GW	18-Aug-01	Sea Bird	0.47	8.2	430	1,370.0	372.0	270.00	50	150.00
TBW1 (Treated Blackwater)	04-Aug-01	Sea Bird	0.73	8.1	19	697.0	48.8	3.50	130	0.40
TBW1 (Treated Blackwater)	05-Aug-01	Sea Lion	42.60	6.4	318	1,470.0	638.0	0.30	2,400,000	0.10
BW	01-Sep-01	Spirit of 98	95.80	7.8	178	1,170.0	162.0	ND	9,000,000	ND
Spirit of Discovery	16-Aug-03	Spirit of Discovery	118.00	7.8	182	778.0	247.0	ND	16,000,000	ND
Spirit of Discovery	30-Aug-01	Spirit of Discovery	55.00	7.7	88	697.0	142.0	ND	9,000,000	ND
S of 98 BW	18-Aug-01	Spirit of 98	100.00	7.5	585	1,240.0	880.0	0.05	16,000,000	ND
BW-1	09-Aug-01	Spirit of Alaska	1.37	7.9	5	982.0	72.2	2.10	300	0.80
Spirit of AK BW HT	23-Aug-01	Spirit of Alaska	3.30	8.0	24	863.0	89.6	ND	500,000	ND
Treated Blackwater	05-Sep-01	Spirit of Columbia	0.01	7.2	32	569.0	51.8	14.00	1	3.50
Spirit of End BW	25-Aug-01	Spirit of Endeavor	27.10	8.0	264	1,160.0	421.0	ND	500,000	ND
Spirit of Oceanus	13-Aug-01	Spirit of Oceanus	310.00	8.0	599	1,650.0	216.0	ND	16,000,000	ND

Sample Name	Sample Date	VESSEL_ID	Ammonia, total (as N)	pH	BOD5	COD	TSS	Total Chlorine Residual	Fecal Coliform	Free Chlorine Residual
			mg/L		mg/L	mg/L	mg/L	mg/L	MPN/100 ml	mg/L
		MDL	**0.03**	**0.1**	**2**	**3.0**	**1.3**	**0.10**	**2**	**0.10**
York Clip BW (discharge pipe)	08-Sep-01	Yorktown Clipper	0.23	7.8	1	778.0	28.2	ND	110	ND
York Clipper BW Sample Port	05-Sep-01	Yorktown Clipper	0.02	7.6	1	509.0	32.0	3.50	33	ND
		Minimum	**0.01**	**6.4**	**1**	**509.0**	**7.0**	**ND**	**1**	**ND**
		Median	**3.30**	**7.8**	**60**	**863.0**	**115.8**	**0.03**	**250,150**	**ND**
		Maximum	**310.00**	**8.2**	**599**	**1,650.0**	**880.0**	**270.00**	**16,000,000**	**150.00**
		Geometric Mean							**10,561**	

Table 33. 2001 Small Ship Laundry Graywater

Vessel Name	Sample Date	Ammonia as N	BOD 5-Day	COD	FECAL	FREE CL	pH	T Cl	CONDUCT	TSS
		Mg/L	mg/L	mg/L	MPU/100ml	mg/L		mg/L	umhos/cm	mg/L
MDL		**0.030**	**2.0**	**3.00**	**2.00**	**0.10**	**0.10**	**0.10**	**1**	**1.30**
Laundry										
Yorktown Clipper	9/8/2001	0.245	138.0	374	2.00	0.05	10.70	0.30	not analyzed	22.90
Yorktown Clipper	9/5/2001	0.015	110.0	272	1.00	0.30	7.79	0.40	not analyzed	20.10
	Minimum	**0.015**	**110.0**	**272**	**1.00**	**0.05**	**7.79**	**0.30**	**not analyzed**	**20.10**
	Median	**0.130**	**124.0**	**323**	**1.50**	**0.18**	**9.25**	**0.35**	**None**	**21.50**
	Maximum	**0.245**	**138.0**	**374**	**2.00**	**0.30**	**10.70**	**0.40**	**0**	**22.90**
	Geometric Mean				**1.41**					

Table 34. 2001 Small Ship Accommodations Graywater Conventional Pollutants

Vessel Name	Sample Date	Ammonia as N	BOD 5-Day	COD	Fecal	Free Cl	pH	T Cl	Conduct	TSS
		mg/L	mg/L	mg/L	MPU/100ml	mg/L		mg/L	umhos/cm	mg/L
MDL		**0.030**	**2.0**	**3.00**	**2.00**	**0.10**	**0.10**	**0.10**	**1**	**1.30**
Accommodations										
Yorktown Clipper	9/8/2001	0.0150	49.70	1.50	1.00	0.05	6.63	0.05	not analyzed	41.40
Taku	6/6/2001	not analyzed	224.37	not analyzed	1400.00	not analyzed	not analyzed	1.56	not analyzed	805.00
Taku	6/6/2001	not analyzed	208.60	not analyzed	1.00	not analyzed	not analyzed	0.36	not analyzed	112.50
Taku	6/6/2001	not analyzed	223.17	not analyzed	1.00	not analyzed	not analyzed	0.11	not analyzed	17.30
Taku	6/6/2001	not analyzed	309.10	not analyzed	1.00	not analyzed	not analyzed	0.05	not analyzed	2.70
Taku	6/6/2001	not analyzed	215.57	not analyzed	1.00	not analyzed	not analyzed	0.28	not analyzed	59.50
Taku	6/6/2001	not analyzed	112.67	not analyzed	1000.00	not analyzed	not analyzed	0.13	not analyzed	19.50
Taku	6/20/2001	not analyzed	205.13	not analyzed	20.00	not analyzed	not analyzed	ND	not analyzed	2.50
Taku	6/20/2001	not analyzed	1.00	not analyzed	1.00	not analyzed	not analyzed	0.02	not analyzed	6.50
Yorktown Clipper	9/5/2001	not analyzed	109.00	174.00	200.00	0.05	6.86	ND	not analyzed	22.00
	Minimum,	**0.0150**	**1.00**	**1.50**	**1.00**	**0.05**	**6.63**	**0.02**	**not analyzed**	**2.50**
	Median	**0.0150**	**206.87**	**87.75**	**1.00**	**0.05**	**6.75**	**0.12**	**not analyzed**	**20.75**
	Maximum	**0.0150**	**309.10**	**174.00**	**1400.00**	**0.05**	**6.86**	**1.56**	**not analyzed**	**805.00**
	Geometric Mean				**9.44**					

Table 35. 2001 Small Ship Galley Graywater

Vessel Name	Sample Date	Ammonia as N mg/L	BOD 5-Day Mg/L	COD mg/L	Fecal MPU/100ml	Free Cl mg/L	pH	T Cl mg/L	Conduct umhos/cm	TSS mg/L
MDL		**0.030**	**2.0**	**3.00**	**2.00**	**0.10**	**0.10**	**0.10**	**1**	**1.30**
Galley										
Taku	06-Jun-01	not analyzed	222.70	not analyzed	100.00	not analyzed	not analyzed	6.00	not analyzed	81.50
Taku	06-Jun-01	not analyzed	274.83	not analyzed	1.00	not analyzed	not analyzed	0.81	not analyzed	22.30
	Minimum	not analyzed	**222.70**	not analyzed	**1.00**	not analyzed	not analyzed	**0.81**	not analyzed	**22.30**
	Median	not analyzed	**248.77**	not analyzed	**50.50**	not analyzed	not analyzed	**3.41**	not analyzed	**51.90**
	Maximum	not analyzed	**274.83**	not analyzed	**100.00**	not analyzed	not analyzed	**6.00**	not analyzed	**81.50**
	Geometric Mean	not analyzed	**247.40**	not analyzed	**10.00**	not analyzed	not analyzed	**2.20**	not analyzed	**42.63**

Table 36. Alaska Marine Highway System

AMHS Data from 2003

Sample Name	Date	Ammonia as N	BOD 5-Day	COD	Fecal coliform	Free chlorine	pH	Total chlorine	TSS
		mg/L	mg/L	mg/L	MPN/100 ml	mg/L		mg/L	mg/L
MDL		**0.030**	**2.0**	**3.0**	**2**	**0.10**	**0.10**	**0.10**	**1.3**
VESSEL_ID	**Sample_Date**								
Columbia	8/11/03	33.000	229.0	370.0	9,000,000	0.00	7.31	0.00	105.0
Columbia	9/1/03	38.000	185.0	8,700.0	160,000	0.00	6.97	0.00	53.6
Kennecott	7/30/03	0.270	55.4	365.0	11,000	0.75	7.20	2.60	99.2
Kennecott	9/1/03	11.000	366.0	500.0	16,000,000	0.00	6.50	0.00	314.0
Malaspina	8/16/03	72.000	344.0	280.0	3,000,000	0.00	7.17	0.00	119.0
Malaspina	10/13/03	8.600	80.4	230.0	1	2.40	6.87	20.00	72.4
Matanuska	8/11/03	25.000	249.0	590.0	90,000	0.00	7.16	0.00	154.0
Taku	8/14/03	6.500	128.0	300.0	1	6.50	7.23	11.00	1.5
Taku	9/11/03	2.400	60.9	230.0	300	0.80	7.71	1.80	79.0
	Minimum	**0.270**	**55.4**	**230.0**	**1**	**0.00**	**6.50**	**0.00**	**1.5**
	Median	**11.000**	**185.0**	**365.0**	**90,000**	**0.00**	**7.17**	**0.00**	**99.2**
	Maximum	**72.000**	**366.0**	**8,700.0**	**16,000,000**	**6.50**	**7.71**	**20.00**	**314.0**
	Geometric Mean				**13,990**				

Table 37. AMHS Data from Samples Taken at the Correct Sampling Time

Sample Name	Date	Ammonia as N	BOD 5-Day	COD	Fecal coliform	Free chlorine	pH	Total chlorine	TSS
		mg/L	mg/L	mg/L	MPN/100 ml	mg/L		mg/L	mg/L
MDL		**0.030**	**2.0**	**3.0**	**2**	**0.10**	**0.10**	**0.10**	**1.3**
ADEC Matanuska WW-1	7/20/2002	1.270	134.0	451.0	1	10.00	6.88	25.00	75.20
Columbia TWW-2	8/12/2002	48.200	283.0	726.0	2,400,000	0.00	7.43	0.05	77.00
Columbia TWW-3	9/3/2002	35.000	110.0	260.0	5,000,000	0.00	7.27	0.05	40.80
Columbia WW-1 Mixed	7/22/2002	29.400	117.0	495.0	22	12.00	7.67	20.00	73.90
Kennicott MSD 3 Mixed Wastewater	7/10/2002	0.015	1.0	870.0	1	25.00	8.10	40.00	22.50
Kennicott TWW	6/25/2002	0.015	1.0	1200.0	14	2.00	8.02	not taken	32.00
Malaspina 0626	6/26/2002	10.100	88.8	876.0	5	4.00	6.99	not taken	100.00
Malaspina MSD-1	7/9/2002	0.121	1.0	514.0	1	2.50	7.91	3.50	22.90
Malaspina TWW-2	9/6/2002	8.900	93.9	220.0	1	0.00	7.16	0.05	55.60
Matanuska #1 Overboard	7/27/2002	11.000	225.0	600.0	3,000	0.10	7.61	0.05	140.00
	Minimum	**0.015**	**1.0**	**220.0**	**1**	**0.00**	**6.88**	**0.05**	**22.50**
	Median	**9.500**	**102.0**	**557.0**	**10**	**2.25**	**7.52**	**1.78**	**64.75**
	Maximum	**48.200**	**283.0**	**1200.0**	**5,000,000**	**25.00**	**8.10**	**40.00**	**140.00**
	Geometric mean				**94**				

Table 38. AMHS Data from Samples Taken at the Wrong Sampling Time

Sample Name	Date	Ammonia as N	BOD 5-Day	COD	Fecal coliform	Free chlorine	pH	Total chlorine	TSS
		mg/L	mg/L	mg/L	MPN/100 ml	mg/L		mg/L	mg/L
MDL		**0.030**	**2.0**	**3.0**	**2**	**0.10**	**0.10**	**0.10**	**1.3**
Kennecott WW1	4/1/2002	12.000	246.0	1180.0	9,000,000	0.00	7.04	not taken	179.0
Matanuska WW	2/25/2002	16.800	154.0	1240.0	50,000	5.00	7.50	0.05	73.7
Columbia BW-2	8/13/2001	7.500	84.2	765.0	1,100	0.70	not taken	1.50	111.0
Columbia BW-3	8/13/2001	7.400	89.3	744.0	1,300	0.50	7.50	1.00	118.0
Columbia BW-4	8/13/2001	7.720	80.6	863.0	500	0.60	7.50	1.20	105.0
Malaspina WW-01 (BW/GW)	7/2/2001	1.400	20.0	470.0	70,000	0.00	7.90	0.05	40.0
M/V Matanuska Wastewater	12/18/2001	1.010	110.0	608.0	2	not taken	7.38	3.10	69.7
Matanuska	4/9/2001	22.000	150.0	not taken	2,200	not taken	7.30	not taken	73.0
	Minimum	**1.010**	**20.0**	**470.0**	**2**	**0.00**	**7.04**	**0.05**	**40.0**
	Median	**7.610**	**99.7**	**765.0**	**1750**	**0.55**	**7.50**	**1.10**	**89.4**
	Maximum	**22.000**	**246.0**	**1240.0**	**9,000,000**	**5.00**	**7.90**	**3.10**	**179.0**
	Geometric Mean				**4,212**				

Appendix F. Summary of Small Ship Sampling for Priority Pollutants

All priority pollutant data is given in ug/l (ppb).

Table 1. Priority Pollutants in Small Ship Graywater – Medians At Least MDL (Numbers in bold exceed AWQS.)

All pollutant data is in parts per billion (ppb)

Analyte	AK Water Quality Standard[1]	MDL	GW 2003 (Tables 7-10 in Small Ship Appendix)	GW 2002 (Tables 22&25 in Small Ship Appendix)
Number of samples			**8**	**5**
Bis (2ethylhexyl) phthalate	18.0	0.50	5.60	11.45
Benzoic Acid	n/a	25.00	<MDL	**60.00**
Benzyl Alcohol	n/a	0.65	<MDL	**9.00**
Bromodichloromethane	n/a	0.50	**1.55**	**4.65**
Chloroform	5,700.0	0.50	19.00	93.00
Diethylphthalate	23,000.00	1.00	6.40	15.50
Dibromochloromethane	n/a	0.50	<MDL	1.65
Phenol	n/a	1.00	<MDL	1.91
Antimony, dissolved	n/a	0.15	0.17	0.33
Arsenic, dissolved	36.0	0.15	0.44	1.20

[1] ADEC, Alaska Water Quality Criteria Manual for Toxic and other Deleterious Organic & Inorganic Substances, May 15, 2003, Table IV or V available at http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/wqs/pdf/70wqsmanual.pdf Fecal coliform standards for consumption of raw aquatic life and pH for aquaculture from ADEC Water Quality Standards, 18 AAC 70, http://www.state.ak.us/dec/title18/wpfiles/70mas.pdf For carcinogens, the values are from the "Compilation of the USEPA Water Quality Criteria for the Priority Toxic Pollutants" By K. McKerney. September 1997. The most conservative standard is listed.

Analyte	AK Water Quality Standard[1]	MDL	GW 2003 (Tables 7-10 in Small Ship Appendix)	GW 2002 (Tables 22&25 in Small Ship Appendix)
Number of samples			**8**	**5**
Chromium, dissolved	50.0	0.15	1.37	3.93
Copper, dissolved	3.1	0.15	**74.80**	**27.40**
Lead, dissolved	8.1	0.15	0.90	0.29
Nickel, dissolved	8.2	0.15	5.14	7.50
Selenium, dissolved	71.0	0.15	0.28	1.70
Zinc, dissolved	81.0	0.15	**150.00**	**86.90**

Table 2. Priority Pollutants in Small Ship Blackwater – Medians At Least MDL (Numbers in bold exceed AWQS.) All pollutant data is in parts per billion (ppb)

Analyte	AK Water Quality Standard	MDL	BW 2003 (Tables 14&15 in Small Ship Appendix)	BW 2002 (Tables 23&26 in Small Ship Appendix)
Number of samples			7	7
Acetone	n/a	3.20	1.30	**9.10**
Bis (2ethylhexyl) phthalate	18.00	1.00	<MDL	0.34
Bromoform	3,600.00	0.50	1.50	1.80
Benzoic Acid	n/a	25.00	<MDL	**141.75**
Benzyl Alcohol	n/a	0.65	<MDL	**3.66**
Dibromochloromethane	n/a	0.50	<MDL	1.80
Phenol	n/a	1.00	<MDL	0.42
Arsenic, dissolved	36.00	0.15	**42.80**	**44.85**
Chromium, dissolved	50.00	0.15	3.56	5.98
Copper, dissolved	3.10	0.15	**6.39**	**11.11**
Lead, dissolved	8.10	0.15	<MDL	0.23
Nickel, dissolved	8.20	0.15	**13.00**	**14.90**
Selenium, dissolved	71.00	0.15	**171.00**	**170.00**
Silver, dissolved	1.90	0.15	1.79	<MDL
Zinc, dissolved	81.00	0.15	25.70	46.90

Table 3. Priority Pollutants in BW & GW Mix – Medians At Least MDL (Numbers in bold exceed AWQS.)

All pollutant data is in parts per billion (ppb)

Analyte	AK Water Quality Standard	MDL	BW&GW 2003 (Tables 11-13 in Small Ship Appendix)	BW&GW 2002 (Tables 24, 27, 28 in Small Ship Appendix)
Number of samples			11	10
3&4 Methylphenol	n/a	0.50	20.50	<MDL
Acetone	n/a	3.20	<MDL	24.50
Bis (2ethylhexyl) phthalate	18.0	1.00	2.05	3.35
Bromoform	3,600.0	0.50	2.90	27.00
Chloroform	5,700.0	0.50	5.10	7.05
Benzoic Acid	n/a	25.00	270.00	410.00
Benzyl Alcohol	n/a	0.65	<MDL	0.28
Diethylphthalate	23,000	1.00	2.30	2.65
Bromodichloromethane	n/a	0.50	0.92	6.50
Dibromochloromethane	n/a	0.50	2.10	14.90
M&p Xylenes	n/a	0.28	5.80	0.31
Phenol	n/a	1.00	3.80	1.95
Arsenic, dissolved	36.0	0.15	32.45	33.00
Chromium, dissolved	50.0	0.15	3.20	6.62
Copper, dissolved	3.1	0.15	**21.95**	**76.30**
Lead, dissolved	8.1	0.15	2.79	4.67

Analyte	AK Water Quality Standard	MDL	BW&GW 2003 (Tables 11-13 in Small Ship Appendix)	BW&GW 2002 (Tables 24, 27, 28 in Small Ship Appendix)
Nickel, dissolved	8.2	0.15	**12.15**	**16.60**
Selenium, dissolved	71.0	0.15	**98.20**	**134.00**
Zinc, dissolved	81.0	0.15	**98.50**	**165.00**

Table 4. Small Ship Metals Where At Least One Sample Exceeded 10X MDL

(Numbers in bold exceed AWQS.) All pollutant data is in parts per billion (ppb)

Waste Type (Number of Samples) *Table in Small Appendix*	Antimony, Dissolved (# samples 10X MDL)	Arsenic, dissolved (# samples 10X MDL)	Chromium, dissolved (# samples 10X MDL)	Copper, dissolved (# samples 10X MDL)	Lead, dissolved (# samples 10X MDL)	Nickel, dissolved (# samples 10X MDL)	Selenium, dissolved (# samples 10X MDL)	Silver, dissolved (# samples 10X MDL)	Zinc, dissolved (# samples 10X MDL)
MDL	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
AKWQ	4,300.00	36.00	50.00	3.10	8.10	8.20	71.00	1.90	81.00
10XMDL	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
2003 GW (8) *Table 7&8*	1.93 (2)	<10XMDL	6.05 (4)	**160.00** (8)	6.53 (3)	**11.00** (8)	4.12 (3)	<10XMDL	**715.00** (8)
2003 BW (7) *Table 14*	<10XMDL	**56.10** (7)	8.56 (7)	**49.70** (7)	<10XMDL	**24.30** (7)	**235.00** (7)	**2.940** (4)	74.40 (7)
2003 BW&GW (11) *Table 11*	<10XMDL	**55.80** (10)	**279.00** (9)	**60.90** (9)	**22.00** (5)	**46.40** (10)	**166.00** (10)	**2.810** (1)	**278.00** (10)
2002 GW (4) *Table 22*	<10XMDL	**45.10** (2)	5.10 (3)	**84.70** (4)	2.00 (1)	**13.70** (4)	**232.00** (3)	<10XMDL	**418.00** (4)
2002 BW (5) *Table 23*	<10XMDL	**53.20** (5)	14.40 (5)	**50.70** (5)	**14.60** (2)	**22.00** (5)	**233.00** (5)	<10XMDL	**1,350.00** (5)
2002 BW&GW (10) *Table 24*	<10XMDL	**50.00** (10)	13.00 (10)	**319.00**(10)	**16.60** (5)	**36.10** (10)	**171.00**(10)	<10XMDL	**1,050.00**(10)

Table 5. Small Ship Priority Pollutants Where At Least One Sample Exceeded 10X MDL (a-b) (Numbers in bold exceed AWQS.) pollutant data is in parts per billion (ppb)

Waste Type (Number of Samples) ***Table in Small Ship Appendix***	**1,4-difluoro benzene**	**4-isopropyl toluene**	**3&4-Methylphenol**	**Acetone**	**Benzoic Acid**	**Benzyl Alcohol**	**Bis (2 ethyl hexyl phthalate**	**Bromo Dichloro methane**	**Bromo form**
MDL[2]	**1.0**	**0.55**	**0.61**	**3.2**	**25**	**0.65**	**1.0**	**0.50**	**0.50**
AKWQ	**None**	**None**	**None**	**None**	**None**	**None**	**18**	**none**	**3,600***
10XMDL	10.0	5.50	6.1	32.0	255	5.50	10.0	5.00	5.00
2003 GW (8) ***Table 9***	<10XMDL	<10XMDL	97.00 (2)	400.0 (3)	740 (2)	<10XMDL	**120.0** (5)	<10XMDL	<10XMDL
2003 BW (7) ***Table 15***	<10XMDL	<10XMDL	<10XMDL	<10XMDL	250 (1)	300.00 (1)	<MDL	21.00 (1)	18.00 (1)
2003 BW&GW (11) ***Tables 11&12***	<10XMDL	22.00 (2)	190.00 (5)	70.0 (1)	1700 (7)	14.00 (1)	8.2 (2)	10.00 (3)	99.00 (5)
2002 GW (6) ***Tables 25&26***	<10XMDL	<10XMDL	<10XMDL	52.0 (1)	60 (1)	9.00 (1)	**64.0** (3)	13.00 (3)	38.00 (1)
2002 BW (7) ***Table 26***	250.0 (1)	<10XMDL	<10XMDL	9.1 (1)	260 (1)	7.30 (1)	**25.0** (1)	28.00 (2)	1,000.00 (3)
2002 BW&GW (10) ***Table 27&28***	50.0 (4)	<10XMDL	<10XMDL	47.0 (2)	2800 (7)	8.00 (2)	<10XMDL	31.00 (7)	130.00 (10)

* Standard for fish consumption only.

[2] MDL are listed in the 2003 QAQC Plan. Used MDL listed in the Veendam's July 2, 2003 report.

Table 6. Small Ship Priority Pollutants Where At Least One Sample Exceeded 10X MDL (c-d)

(Numbers in bold exceed AWQS.) All pollutant data is in parts per billion (ppb)

Waste Type (Number of Samples) *Table in Small Ship Appendix*	Carbon disulfide	Chloro form	Chloro methane	Dibromo Chloro methane	Diethyl Phthalate	Di-n-Butyl Phthalate
MDL[3]	**0.46**	**0.50**	**1.0**	**0.50**	**1.00**	**1.00**
AKWQ	**None**	**4,700***	**None**	**None**	**23,000.00**	**2700.00**
10XMDL	4.60	5.00	10.0	5.00	10.00	10.00
2003 GW (8) ***Table 9***	<10XMDL	100.00 (7)	<10XMDL	<10XMDL	33.00 (4)	<10XMDL
2003 BW (7) ***Table 15***	<10XMDL	570.00 (1)	<10XMDL	<10XMDL	<10XMDL	<10XMDL
2003 BW&GW (11) ***Tables 11&12***	9.1 (1)	84.00 (6)	<10XMDL	32.00 (3)	12.00 (2)	<10XMDL
2002 GW (6) ***Table 25***	<10XMDL	140.00 (6)	21.00 (1)	21.00 (1)	25.00 (5)	<10XMDL
2002 BW (7) ***Table 26***	<10XMDL	<10XMDL	<10XMDL	28.00 (2)	<10XMDL	11.00 (1)
2002 BW&GW (12) ***Table 27***	<10XMDL	100.00 (8)	34.0 (2)	73 (8)	<10XMDL	17 (1)

***** Standard for fish consumption only.

[3] MDL are listed in the 2003 QAQC Plan. When pollutants were not in the QAQC plan, ADEC used the MDL listed in the July 2, 2003 Veendam unannounced sampling lab report.

Table 7. Small Ship Priority Pollutants Where At Least One Sample Exceeded 10X MDL (d-z)

(Numbers in bold exceed AWQS.) All pollutant data is in parts per billion (ppb)

Waste Type (Number of Samples) *Table in Small Ship Appendix*	Ethyl benzene	Iodo Methane	m&p Xylenes	O-xylene	Phenol	Sec-butyl Benzene	Toluene	Trichloro ethene
MDL	**0.5**	**0.5**	**0.28**	**0.46**	**1.00**	**0.52**	**0.5**	**0.50**
AKWQ	**3,100.0**	**None**	**None**	**None**	**21,000.00**	**None**	**6,800.0**	**None**
10XMDL	5.0	5.0	2.80	4.60	10.00	5.20	5.0	5.00
2003 GW (8) *Table 9&10*	9.6 (1)	<10XMDL	37.00 (1)	15.00 (1)	13.00 (1)	<10XMDL	73 (1)	<10XMDL
2003 BW (7) *Table 15*	<10XMDL	**9.2** (1)	<10XMDL	<10XMDL	21.00 (3)	<10XMDL	<10XMDL	<10XMDL
2003 BW&GW (11) *Table 12&13*	<10XMDL	<10XMDL	<10XMDL	<10XMDL	110.00 (4)	34.00 (1)	<10XMDL	8.50 (1)
2002 GW (6) *Table 25*	<10XMDL	<10XMDL	<10XMDL	<10XMDL	16.00 (1)	<10XMDL	<10XMDL	<10XMDL
2002 BW (7) *Table 26*	<10XMDL	<10XMDL	<10XMDL	<10XMDL	20.00 (1)	<10XMDL	<10XMDL	<10XMDL
2002 BW&GW (12) *Table 27,28*	<10XMDL	<10XMDL	8.00 (1)	<10XMDL	40.00 (5)	<10XMDL	6.8 (1)	<10XMDL