ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
GENERAL PERMIT FACT SHEET - Revision 1

Permit Number: 2013DB0004

Marine Discharge of Treated Sewage, Treated Graywater, and Other Treated Wastewater from Large Commercial Passenger Vessels Operating in Alaska

DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Division of Water
Commercial Passenger Vessel Environmental Compliance Program
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General Permit to Large Commercial Passenger Vessels

The Alaska Department of Environmental Conservation (DEC), Commercial Passenger Vessel Environmental Compliance (CPVEC) Program, or Cruise Ship Program, issued a general permit pursuant to Alaska Statute (AS) 46.03 and Title 18, Chapter 69 of the Alaska Administrative Code (AAC), for marine discharge of treated sewage, treated graywater, and other treated wastewater from large commercial passenger vessels operating in Alaska on August 29, 2014.

This fact sheet explains the nature of potential discharges from large commercial passenger vessels and the development of the general permit, including:

- information on public comment, public hearing, and appeal procedures;
- a description of the industry;
- a listing of effluent limits, monitoring and other conditions;
- a description of changes from the 2010 General Permit (2009DB0026); and

- technical descriptions supporting the conditions of the 2014 General Permit.

Public Comments and Public Hearing

The draft 2014 General Permit was open to public comments for 45 days from April 8, 2014 to May 23, 2014. A Public Hearing was held in Juneau on April 30th. Materials from the public hearing were placed on the draft General Permit webpage.

Response to Comments

A Response to Comments was issued by the Department with this General Permit and is available on the General Permit webpage. There were comments received from 142 individuals or groups during the comment period.

Informal Review

The Department has both an informal review process and a formal administrative appeal process for final permit decisions. An informal review request must be delivered within 15 days after receiving the Department's decision to the Director of the Division of Water at the following address:

Director, Division of Water
Alaska Department of Environmental Conservation
410 Willoughby Avenue, Suite 303
PO Box 111800
Juneau, AK 99811-1800

Interested persons can review 18 AAC 15.185 for the procedures and substantive requirements regarding a request for an informal Department review.

See http://www.dec.state.ak.us/commish/InformalReviews.htm for information regarding informal reviews of Department decisions.

Adjudicatory Hearing

An adjudicatory hearing request must be delivered to the Commissioner of the Department within 30 days of the Permit decision or a decision issued under the informal review process. An adjudicatory hearing will be conducted by an administrative law judge in the Office of Administrative Hearings within the Department of Administration. A written request for an adjudicatory hearing shall be delivered to the Commissioner at the following address:

Commissioner
Alaska Department of Environmental Conservation
410 Willoughby Ave., Suite 303
Juneau AK, 99811-1800.

Interested persons can review 18 AAC 15.200 for the procedures and substantive requirements regarding a request for an adjudicatory hearing

See http://www.dec.state.ak.us/commish/ReviewGuidance.htm for information regarding appeals of Department decisions.

Documents are Available

The permit, fact sheet, and related documents can be obtained by visiting or contacting DEC between 8:00 a.m. and 4:30 p.m. Monday through Friday at the addresses below. The permit, fact sheet, and other information are located on the Department's Cruise Ship Program website: http://dec.alaska.gov/water/cruise_ships/index.htm.

Alaska Department of Environmental Conservation Division of Water CPVEC (Cruise Ship) Program 410 Willoughby Ave., Suite 303 Juneau, AK 99811-1800 (907) 465-5300	Alaska Department of Environmental Conservation Division of Water Wastewater Discharge Authorization Program 555 Cordova Street Anchorage, AK 99501 (907) 269-6285

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1 AUTHORITY

1.1 2013 Amendments to Article 7 of Alaska Statute 46.03

The 2014 Large Commercial Passenger Vessel General Permit (Permit) is consistent with AS 46.03.262 as amended by House Bill 80 (HB 80) which was passed by the Legislature in 2013 and signed into law on February 28, 2013. HB 80 amended AS 46.03.462(b), terms and conditions of discharge permits, which since 2008 had required water quality criteria be met at the point of discharge for large commercial passenger vessels (cruise ships) by December 31, 2015. AS 46.03.462(b) now requires discharge of untreated sewage, treated sewage, graywater, or other wastewater to meet state and federal requirements for the disposal of solid or liquid waste. AS 46.03.462(e) now allows for the authorization of a mixing zone for ships with Advanced Wastewater Treatment Systems (AWTS) or other methods of pollution prevention, control or treatment that the Department findswill be comparable effluent quality to that achieved by one or more vessels employing AWTS. Mixing zone authorizations must be issued in accordance with 18 AAC 70.240. AS 46.03.462(i) includes a provision for administratively extending the 2010 general permit. The Department administratively extended the 2010 General Permit (Permit No. 2009DB0026) on March 18, 2013. Other changes require the Department to determine the AWTS that will be approved by the Permit and allow permit terms up to five years.

1.2 Authority

AS 46.03.462 and 18 AAC 72.600 provide that the discharge of domestic wastewater from a ship is unlawful except in accordance with a state issued permit. The five year Permit is issued under the authority of AS 46.03.462, AS 46.03.100 (waste management, disposal, and discharge authorizations), and 18 AAC 72.900 (general permit).

2 OPERATION UNDER THE GENERAL PERMIT

The 2014 General Permit (Permit No. 2013DB0004) will replace the 2010 General Permit.

2.1 Changes from the 2010 General Permit

Effluent limits in the Permit for fecal coliform, 5-day biological oxygen demand (BOD), and total residual chlorine (TRC) are based on U.S. Coast Guard marine sanitation device (MSD) II requirements and they are the same as in the 2010 general permit. A monthly average limit of 30 mg/L for total suspended solids (TSS) was added in the Permit to match federal requirements as mandated by changes in legislation in 2013 (HB 80).

Limits for ammonia, dissolved copper, dissolved nickel, and dissolved zinc were changed from the 2010 general permit based on HB 80, which allows cruise ship wastewater discharge to be eligible for mixing zones under the existing provisions in 18 AAC 70.240.

The Permit includes effluent limits that are less stringent than some 2010 general permit limits because of the allowance of mixing zones for ammonia, dissolved copper, dissolved nickel, and dissolved zinc but will not result in an appreciable change in effluent quality across all ships.

List of Significant Changes:

- Mixing Zones are authorized
  - The 6 knots or greater mixing zone size is based on the class of ships with AWTS and the marine chronic aquatic life criterion for ammonia
  - The under 6 knots mixing zone size is based on an AWTS ship-specific analysis and the marine chronic aquatic life criteria for ammonia and dissolved copper
  - Sampling requirements differ for the no mixing zone and the two authorized mixing zone sizes
- Effluent limits
- Receiving water sampling and whole effluent toxicity testing is required for the under 6 knots mixing zone
- Permit covers all waters of the state of Alaska

A full list of changes can be found in Appendix A: List of Changes in the Permit.

2.2 Permit Coverage Eligibility

To be covered under the Permit, an operator of a large commercial passenger vessel must apply for coverage, have an operational AWTS or other methods of pollution prevention, control or treatment that the Department finds will be comparable effluent quality to that achieved by one or more vessels employing an AWTS, and must register the vessel with the Department under AS 46.03.461.

2.2.1 Vessel Information

Up to thirty large commercial passenger vessels operate in Alaskan waters between the months of April and October each year. Roughly half of these vessels have sought and obtained Department approval to operate under a general permit to discharge wastewater into the waters of the state. The remaining ships discharge outside of state waters. Appendix B. Description of Activities provides a description of cruise ship operations in Alaska.

2.2.2 Coverage under the General Permit

The Department will authorize discharges under the Permit after reviewing the required Notice of Intent (NOI) form and determining if the proposed discharge can meet the terms and conditions of the Permit and whether additional terms and conditions are necessary to authorize an under six knots mixing zone.

2.3 Geographic Coverage

The Permit authorizes wastewater discharges in all marine waters of the State.

2.3.1 Definition of Marine Waters of the State

Marine waters of the state of Alaska are defined as: all waters within the boundaries of the state (three nautical miles (nm) from the baseline from which territorial seas are measured); and waters of the Alexander Archipelago as defined in AS 46.03.490 (18). A map showing permit boundaries for Southeast and Southcentral Alaska is found at Figure 1.

2.3.2 Alaska Marine Water Characteristics

Alaska marine waters range from the Arctic Ocean in the North to the Canadian border in the South. The types of water ranges from open ocean to estuarine. Alaskans use state marine waters for a wide variety of activities including recreation, commercial fishing, shipping, and subsistence.

Cruise ships use Southeast waterways extensively and travel to Southcentral Alaska on a more limited basis. Only about 15 percent of the total time spent by large cruise ships in Alaska is spent in Southcentral Alaska (see Appendix B. Description of Activities). Cruise ships travel on a limited basis to other areas of the state.

The marine waters of Southeast Alaska have numerous freshwater inputs from creeks and rivers fed by rainfall, snowmelt, and continual glacial melting. Variable salinity, large tidal fluctuations, and localized sedimentation contribute to this area's complex oceanography. Overall the water and sediment quality, coastal habitat, and fish tissue condition for the coastal waters of Southeast Alaska are rated good (DEC 2004 Southeast Alaska Coastal Survey Environmental Status, May 2011).

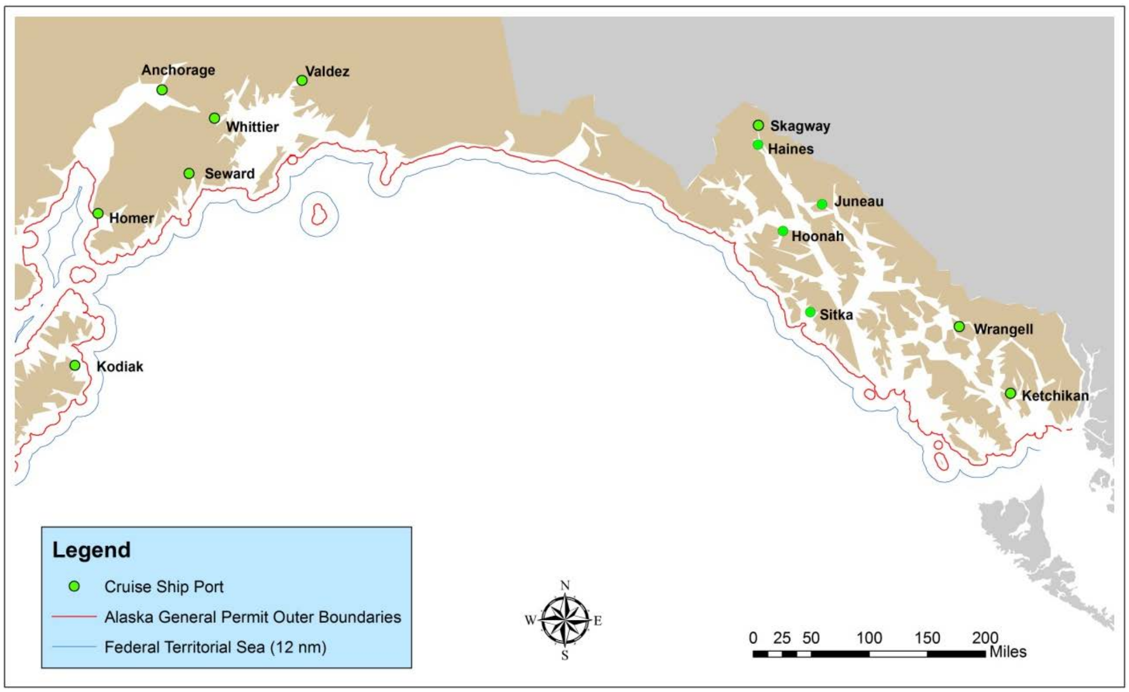

Figure 1: Permit Boundaries for Southeast and Southcentral Alaska.

2.4 Authorized Discharges

The Permit authorizes the discharge of treated sewage and treated graywater, or other treated wastewater from large commercial passenger vessels into the marine waters of the state. The Permit only authorizes discharge of waste streams specifically mentioned in the Permit. Discharge of untreated wastewater is not allowed. Other waste streams are covered in the U.S. Environmental Protection Agency (EPA) 2013 Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP), including but not limited to: ballast water, bilge water, pool water, boiler water, deck runoff, cooling water, and exhaust scrubber discharges.

2.5 Exemptions from Permit Coverage

Discharges made following the requirements of AS 46.03.463(h) for the purpose of securing the safety of the vessel or saving life at sea do not require a permit for coverage. Discharges made under 46.03.463(h) must be reported to the Department.

2.6 Individual Permit

The Department may determine an Individual Permit is appropriate after receiving a NOI for coverage under the General Permit. If this determination is made, the Department will notify the applicant.

3 ADMINISTRATIVE PROCEDURES

Signatory and submittal requirements are outlined in Section 3 of the Permit.

4 AUTHORIZATION, TRANSFERS, AND TERMINATION

4.1 Certification

The 30 day period between issuance of the permit and it going into effect in the draft was removed to facilitate issuance and coverage in the 2014 cruise ship season. There is no requirement for a 30-day delay. All forms required to be submitted under Section 4 of the Permit to the Commercial Passenger Vessel Environmental Compliance (CPVEC) program must be certified as true, accurate, and complete according to the required statement in Section 4.1.

4.2 Notice of Intent (NOI)

A NOI serves as application for coverage under the Permit.

4.3 Authorization

The Department will issue authorizations to discharge after satisfactory review of submitted NOIs. The Department may attach additional terms and conditions to authorizations for discharges to a mixing zone when moving at speeds under six knots, if necessary. Additional terms and conditions could include monitoring, reporting, and additional information submittal. Additional requirements would be in case of changes in discharge practices, new or modified AWTS, or unforeseen circumstances.

4.4 Termination

The procedures for termination of discharge authorizations are described in Section 4.6 of the Permit. The procedure for termination of the Permit by the Department is described in Section 4.7 of the Permit.

5 DISCHARGE CHARACTERIZATION

5.1 Discharge Patterns and Treatment

Large cruise ships are typically intermittent dischargers and rarely discharge at the same location for longer than one day. The volume of treated wastewater discharged from large cruise ships varies from day to day and from vessel to vessel, ranging from a minimum of 91,711 gallons per day (approximately 366 cubic meters/day) to a maximum of 330,000 gallons per day (approximately 1,250 cubic meters per day, when discharges occur).

Large cruise ships that discharge treated wastewater into marine waters of the state use several different types of AWTS. A list of AWTS types and a description of each can be found in Appendix C: Advanced

Wastewater Treatment System Information. Treated wastewater discharges can consist of either sewage, mixed sewage and graywater, or graywater only. Note that no cruise ships to date have applied to discharge other treated wastewater.

5.2 Effluent Quality

The 2010 General Permit contained effluent limits for conventional pollutants (pH, biological oxygen demand (BOD), total suspended solids (TSS), and fecal coliform), non-conventional pollutants (ammonia and total residual chlorine (TRC)), and the priority pollutants dissolved copper, dissolved nickel, and dissolved zinc. Graphs illustrating trends from 2008 to 2012 for ammonia and the three dissolved metals can be found in Appendix D: Discharge Characterization Figures. The monitoring data from 2013 was not used as permit development and modeling efforts were initiated prior to the end of the 2103 cruise ship season and prior to receipt of all monitoring reports.

Table 1 and Table 2 below provide summary statistics for large cruise ship wastewater sample results for 2011 and 2012. Additional wastewater sample results can be found on the DEC Cruise Program website at: http://www.dec.state.ak.us/water/cruise_ships/reports.htm.

Table 1: Summary of 2011 Large Cruise Ship Sampling Results (15 ships, 183 sampling events).

Parameter	Ammonia as N	Dissolved Copper	Dissolved Nickel	Dissolved Zinc	pH	5-Day BOD[c]	Total Suspended Solids	Total Residual Chlorine	Fecal coliform (daily max).
Units	mg/l	µg/L	µg/L	µg/L	S.U.	mg/L	mg/L	mg/L	MPN/ 100 mL
Alaska Chronic WQC	1.0[a]	3.1	8.2	81	6.5-8.5	N/A[d]	N/A	0.0075	40
Minimum Reported	ND[b]	ND	ND	ND	5.24	ND	ND	ND	ND
Maximum Reported	160	370	75	400	8.23	90	46	ND	110
Median	19.5	6.1	9.5	79	7.11	2.8	ND	ND	ND

Notes:

a. Ammonia standard was based on temperature, pH and salinity. The ammonia chronic water quality criterion for the Permit is 1 mg/L based on the latest and most comprehensive Southeast Alaska ambient water data, with a pH of 8.2, a salinity of 20 g/kg, and a temperature of 10-15 degrees C.
b. ND = non-detect
c. BOD = biological oxygen demand
d. N/A = not applicable

Table 2: Summary of 2012 Large Cruise Ship Sampling Results (16 ships, 168 sampling events).

Parameter	Ammonia as N	Dissolved Copper	Dissolved Nickel	Dissolved Zinc	pH	5-Day BOD	Total Suspended Solids	Total Residual Chlorine	Fecal coliform (daily max).
Units	mg/l	µg/L	µg/L	µg/L	S.U.	mg/L	mg/L	mg/L	MPN/ 100 mL
Alaska Chronic WQC	1.0[a]	3.1	8.2	81	6.5-8.5	N/A	N/A	0.0075	40
Minimum Reported	ND[b]	ND	ND	7.78	6.05	ND	ND	ND	ND
Maximum Reported	110	160	210	330	8.7	110	39	0.25	TNTC[c]
Median	23	7.3	9.1	64	7.16	2.8	ND	ND	ND

Notes:

a. Ammonia standard was based on temperature, pH and salinity. The ammonia chronic water quality criterion for the Permit is 1 mg/L based on the latest and most comprehensive Southeast Alaska ambient water data, with a pH of 8.2, a salinity of 20 g/kg, and a temperature of 10-15 °C.
b. ND = non-detect
c. TNTC = Too Numerous to Count
d. N/A = not applicable

5.3 Compliance History

Since 2008, the Department has collected data from approximately 200 sample events per year from large commercial passenger vessels. Each sample event measured 10 parameters with permit limits. Permit limit exceedances for each permitted vessel are documented in annual sampling reports, titled "20XX Large Ship Wastewater Sampling Report," which can be found on the DEC Cruise Reports website at: http://www.dec.state.ak.us/water/cruise_ships/reports.htm.

Table 3 provides a summary of compliance with effluent limitations in the 2010 Permit.

Table 3: Number of Exceedances of General Permit Limits for the years 2008-2012.

Year	# of Samples	Fecal coliform	Chlorine (free and total residual combined)	pH	BOD[a]	TSS
2008	198	3	5	3	2	0
2009	201	3	1	2	2	0
2010[b]	178	6	1	0	3	0
2011	183	5	0	8	6	0
2012	168	7	1	7	1	0

Year	# of Samples	Ammonia	Dissolved Copper	Dissolved Nickel	Dissolved Zinc
2008	198	21	8	0	7
2009	201	31	8	1	11
2010[b,c]	178	9	4	0	2
2011[c]	183	8	3	1	2
2012[c]	168	1	4	1	0

Notes:

a. BOD exceedances of the monthly average were not included if they were caused by a daily exceedance of BOD.
b. Includes sample data not included in the Permit dataset because of failure to follow approved quality assurance project plan.
c. Permit limits for ammonia and dissolved metals changed in 2010, with different limits determined for each AWTS type.

6 LIMITATIONS AND DISCHARGE PROHIBITIONS

6.1 Statutory and Regulatory Basis

Through the authority of AS 46.03.020, AS 46.03.100, and 46.03.110, the Department has the authority to ensure that applicable criteria are met by attaching terms and conditions to a permit, including operating, monitoring, inspection, sampling, and reporting requirements (18 AAC 15.090). Explicit permit terms and conditions for cruise ships are identified in AS 46.03.462. In accordance with AS 46.03.110(d), the Department may specify in a permit the terms and conditions under which waste material may be disposed.

In determining the effluent limits that are included in the Permit, DEC adopted a methodology similar to that used by the Department when issuing municipal wastewater discharge permits. The Alaska Pollutant Discharge Elimination System (APDES) program requires that the limits for a particular pollutant be the more stringent of either technology-based effluent limits (TBELs) or water quality-based effluent limits (WQBELs). TBELs are set according to the level of treatment that is achievable at the point of discharge using available technology. WQBELs are designed to ensure that Alaska WQS for a waterbody are being met. Limitations must be set to ensure that WQS are met in the applicable waterbody and must be consistent with any available wasteload allocations (WLAs). WLA are often determined for impaired waters and define a portion of a receiving waterbody's total allowable maximum daily loadings that may be assigned to a current or future discharger. The allocation of WLA is a tool to ensure applicable WQS are not exceeded in the receiving waterbody.

6.2 Technology-Based Effluent Limitations

The amendments to AS 46.03.462 in 2013 include a requirement for the Department to determine the systems that would constitute the class of AWTS to be included for coverage under the Permit. Defining the class of AWTS impacts the level of treatment and proscribes the TBELs. In addition, when a cruise ship employs an AWTS that meets the requirements in AS 46.03.462, the department finds, per the same statute, that such a cruise ship satisfies all state technology-based treatment requirements for the authorization of a mixing zone.

6.2.1 State Requirements

The Department has determined the state TBEL requirements for cruise ships include:

- Minimum treatment criteria for sewage and graywater that includes (AS 46.03.462(j)):
  - Biological treatment, solids removal, and disinfection; and
  - Higher treatment than Coast Guard certified marine sanitation devices (MSDs) Type I for fecal coliform and floating solids (33 CFR 159);
- Consistency with applicable state or federal law governing the technology requirements for disposal or discharge of solid or liquid waste material (AS 46.03.462(b));
  - Minimum and secondary treatment requirements for 5-day BOD, total suspended solids, and pH (18 AAC 72.050, 33 CFR 159.309, and 40 CFR 133.102), and
  - Fecal coliform and total residual chlorine (33 CFR 159.309 and P.L. 106-554, 33 U.S.C. 1901 Note).

6.2.2 Federal Requirements

The state requirements reference several federal requirements. Cruise ships discharging wastewater in Alaska have federal requirements for marine sanitation devices (MSDs) established by the U.S. Coast Guard and wastewater discharge requirements under the U.S. EPA's 2013 VGP. In 2001, United States Code Title XIV – Certain Alaskan Cruise Ship Operations (the "Murkowski Law") established (1) the conditional applicability of federal secondary treatment limits for biological oxygen demand (BOD) and total suspended solids (TSS) (40 CFR 133.102) to cruise ship discharges when under 6 knots and 1 nm from shore and (2) conditional requirements for fecal coliform and TRC. The U.S. Coast Guard's performance limits in 33 CFR 159.301–321 implement the requirements of the Murkowski Law, and state law requires that they are met as well.

Cruise ships operating under the Permit may also be operating under the EPA VGP and will need to comply with the terms and conditions of both permits. To aid in implementation, the Permit was developed to be as consistent as possible with the VGP; however, there are differences in permit terms and regulated conditions. The primary point of overlap is in the regulation of graywater and graywater mixed with sewage. The VGP has requirements for graywater and when it can be dicharged; sewage is still covered under marine sanitation MSD II performance limits established by the US Coast Guard. Under the VGP, mixed effluent (combined graywater and sewage) is referred to as graywater. For other federal regulations and under State regulations, mixed effluent is referred to as sewage.

The VGP requires cruise ships over 500 passengers to either hold, discharge to shore facilities, or meet the requirements of 40 CFR 133.102 and Title XIV for graywater when within 3 nm from shore. It also prohibits toxic materials from graywater, blackwater (sewage), or bilgewater. The VGP implements similar requirements for cruise ships carrying from 100 to 499 passengers.

The VGP requires permittees to submit a copy of noncompliance reports for discharges that occurred while the vessel was operating in marine waters of the state to the Department within 72 hours of submittal to EPA (VGP Section 6.1.2). The VGP also includes other waste streams not covered by the Permit (including but not limited to: ballast water, bilge water, pool water, boiler water, deck runoff, cooling water, and exhaust scrubber discharges).

6.2.3 Basis for and Definition of Advanced Wastewater Treatment Systems

In accordance with AS 46.03.462(j), the Department defines AWTS for purposes of the Permit as:

> Coast Guard certified MSD II type devices capable of complying with performance standards for discharging to Alaskan waters (Code of Federal Regulations, 33 CFR Part 159 Subparts C and E) and that:

1) have additional levels of treatment (such as filtration or biological treatment stages) and disinfection;
2) provide treatment of sewage and graywater on board commercial passenger vessels that achieves levels of biological treatment, solids removal, and disinfection higher than that achieved by traditional MSD I devices required by 33 CFR 159; and
3) produce effluent that meets all requirements under P.L. 106-554, 33 U.S.C. 1901.

Most of the systems treat both sewage and graywater. Appendix C: Advanced Wastewater Treatment System Information provides examples of treatment stages commonly included in AWTS as well as information on the AWTS that have discharged in Alaska since 2008 and that meet the above definition.

6.2.4 Summary of TBELs

Effluent limits are necessary for pollutants with TBELs to ensure ongoing compliance with statutory and regulatory requirements. Effluent limits in the Permit for fecal coliform, TRC, and BOD are the same as in the 2010 general permit. A monthly average limit for TSS was added in the Permit to match federal requirements as mandated by changes in legislation in 2013 (HB 80). The pH limit was changed to match federal secondary treatment limits (40 CFR 133.102). The pH limits now match federal limits used in the EPA VGP for large and medium sized cruise ships.

Table 4 provides a summary of the federal and State TBELs.

Table 4: Technology-Based Effluent Limits

Parameter	Units [a]	30-day Average Limit	7-day Average Limit	Maximum Daily Limit
Conventionals				
pH	S.U.	--	--	6.0 - 9.0 S.U.
5-Day Biochemical Oxygen Demand (BOD_5)	mg/L	30	45	--
Total Suspended Solids (TSS)	mg/L	30	45	150 [b]
Fecal Coliform (FC) Bacteria	FC/100 mL	20 [c]	--	40 [d], 200 [b]
Non-conventionals				
Total Residual Chlorine (TRC)	µg/L	--	--	Less than or equal to 10 µg/L

Notes:
a. L (liter), mg (milligram), µg (microgram), S.U. (standard pH units)
b. Underway and more than one nautical mile from shore
c. Geometric mean
d. Not more than 10% of samples

6.3 Water Quality-Based Effluent Limitations

6.3.1 Alaska Water Quality Standards

The water quality standards (WQS) applicable to the Permit are in 18 AAC 70, as amended through April 8, 2012. The WQS apply to State waters and specify the degree of degradation that may not be exceeded in a waterbody as a result of human actions (18 AAC 70.010(b)). WQS are composed of designated waterbody uses, numeric and/or narrative water quality criteria (WQC) to protect the designated waterbody uses, and an antidegradation policy. The WQS also include mixing zone regulations and consideration of whole effluent toxicity.

The receiving waters for discharges authorized by the Permit are marine waters that are classified in the WQS at 18 AAC 70.020(a)(2) as Classes (2)(A), (B), (C), and (D) for use in aquaculture, seafood processing, and industrial water supply; contact and secondary recreation; growth and propagation of fish, shellfish, other aquatic life, and wildlife; and harvesting for consumption of raw mollusks or other raw aquatic life, respectively.

Numeric and/or narrative WQC in 18 AAC 70.020(b) are those criteria deemed necessary by the State to support the designated waterbody use classifications. WQC often are established to protect against acute and chronic toxicity whether for human health protection or for aquatic life protection. Acute toxicity is a level of toxicity that demonstrates observable lethal or sublethal effects in aquatic organisms exposed for a short period of time, typically from 1 to 24 hours. Chronic toxicity includes levels of toxicity that effect things such as development, reproduction, growth, and survival over a longer period of time. Cook Inlet in the vicinity of the Point Woronzof has site specific criteria adopted in 18 AAC 70.236(b).

6.3.2 Reasonable Potential Analysis

WQS apply to waterbodies and include a prohibition on conduct that causes or contributes to a violation of WQS (18 AAC 70.010). The analysis to determine whether there is reasonable potential to cause or contribute to a violation of WQS in the waterbody includes consideration of applicable WQC, effluent characteristics, and available dilution for the effluent in the receiving waterbody that can be authorized through a mixing zone.

The most restrictive WQC are used to protect all applicable uses (18 AAC 70.040(1)) and are listed in Table 5. Historical effluent monitoring data (2008 –2012) was compared to the WQC in Table 5 to screen for potential pollutants of concern which exceed WQC at the point of discharge. If effluent concentrations exceed the most restrictive WQC, then a further analysis is needed to determine whether reasonable potential to cause or contribute to a violation of WQS exists after accounting for available dilution in the receiving water that can be authorized through a mixing zone. For further details on the procedure see Appendix E. Reasonable Potential Analysis.

For the class of ships with AWTS, reasonable potential to exceed WQS is determined to exist for fecal coliform. For discharges from the class of ships with AWTS and without a mixing zone, reasonable potential is determined to exist for ammonia, TRC, dissolved copper, dissolved nickel, and dissolved zinc. Since permittees that seek authorization to discharge will likely seek a mixing zone authorization in their NOI for ammonia, dissolved copper, dissolved nickel, and/or dissolved zinc, reasonable potential and the need for effluent limits will be assessed for ships requesting to discharge without a mixing zone on a ship-specific basis. When reasonable potential to exceed WQS is determined for an individual ship that is not requesting a mixing zone, then effluent limits will be required in the authorization for that ship and no mixing zone will be granted without request and further analysis.

No reasonable potential to exceed WQS for any pollutants other than fecal coliform was found for cruise ships that historically have discharged in Alaska marine waters while moving at speeds of 6 knots or greater. This is due to the large available dilution when moving at speed (see next section). However, there is reasonable potential for ammonia for discharges while moving a 6 knots or greater because there is reasonable potential for ammonia at the point of discharge and the 6 knots or greater mixing zone boundaries (i.e., the determination of whether water quality criteria are met) are a direct function of the historically discharged amount of ammonia. Note that all other pollutants were evaluated to verify they would meet water quality standards at the boundary of the 6 knots or greater mixing zone.

In addition to fecal coliform, BOD, and TSS, there is reasonable potential for ammonia, dissolved copper, and dissolved nickel when cruise ships discharge while moving at speeds of under 6 knots. Note that all other pollutants were evaluated to verify they would meet water quality standards at the boundary of the under 6 knots mixing zone. For a small number of ships, Department modeling indicates that there is reasonable potential to exceed the acute ammonia criterion outside the smaller initial mixing zone which would be a violation of 18 AAC 70.240(d)(8). For these ships, an under 6 knots mixing zone cannot be authorized without additional information demonstrating compliance per the Implementation Guidance available at http://dec.alaska.gov/water/wqsar/wqs/pdfs/MixingZoneGuidance2-3-09.pdf, and/or the Department requiring compliance with more stringent terms and conditions as part of the authorization to meet the requirements of 18 AAC 70.240(d)(8). This consideration is more prevalent for Skagway Harbor given the lower 10th percentile tidal velocity as compared to Juneau Harbor.

Table 5: Most Restrictive Applicable Marine Water Quality Criteria for Pollutants of Concern.

Parameter	Units[a]	WQC Limits		Reference
Fecal Coliform (FC) Bacteria	FC/100 mL	14[b]	40[c]	18 AAC 70.20(b)(14)
Dissolved Oxygen (DO)	mg/L	may not be less than 6 or greater than 17		18 AAC 70.20(b)(15)
pH	S.U.	may not be less than 6.5 or greater than 8.5, may not vary more than 0.2 outside of the naturally occurring range		18 AAC 70.20(b)(18)
Parameter	**Units[a]**	**Chronic WQC**	**Acute WQC**	**Reference**
Total Residual Chlorine (TRC)[d]	mg/L	0.0075	0.013	18 AAC 70.20(b)(23) [e]
Ammonia	mg/L	1.0	6.2	18 AAC 70.20(b)(23) [e,f]
Dissolved Copper	µg/L	3.1	4.8	18 AAC 70.20(b)(23) [e]
Dissolved Nickel	µg/L	8.2	74	18 AAC 70.20(b)(23) [e]
Dissolved Zinc	µg/L	81	90	18 AAC 70.20(b)(23) [e]

Notes:

a. L (liter), mg (milligram), mL (milliliter), S.U. (standard pH units)
b. Monthly geometric mean
c. In a 30-day period, not more than 10% of the samples may exceed 40 FC/100 mL
d. The TRC effluent limits are not quantifiable. DEC will use the minimum level (ML) of 0.01 mg/L as the compliance evaluation level for this parameter.
e. Which adopts by reference *Alaska Water Quality Criteria for Toxics and Other Deleterious Organic and Inorganic Substances*, dated December 12, 2008
f. Ammonia WQC are based on a pH of 8.2, a salinity of 20 g/kg, and a temperature of 10-15 °C

6.3.3 Available Dilution and Mixing Zone Analysis

6.3.3.1 Applicable statutes and regulations for cruise ship mixing zones

In addition to requiring the Department to define systems that constitute AWTS, HB 80 treats cruise ships with AWTS as a class for the purposes of authorizing mixing zones. In accordance with State regulations at 18 AAC 70.240, as amended through April 8, 2012, and AS 46.03.462(e) and (j), the Department may authorize a mixing zone under a general permit for the class of ships that use AWTS or other ships that the Department finds will be comparable effluent quality to that achieved by one or more vessels employing AWTS. Per statute AS 46.03.462(e), if a cruise ship employs an AWTS under the Permit, then the cruise ship satisfies all state technology-based treatment requirements under 18 AAC 70.240(c)(1). Upon receipt of a complete application and a determination that mixing zone requirements are met, the Department may authorize a mixing zone.

An NOI serves as the application under a general permit and includes the information and available evidence necessary to determine consistency with 18 AAC 70.240. As the Permit is a re-issuance, there was substantial information that informed the Department's analysis, including information collected during previous permit development, historical effluent monitoring results, and the work of the Cruise Ship Wastewater Science Advisory Panel.

6.3.4 Mixing Zones

A mixing zone is a regulatory defined area where treated effluent mixes with receiving water (i.e., the waterbody that receives the discharge), and WQC are met beyond the boundaries. State regulations determine whether or not a mixing zone is allowed in a waterbody and, if authorized, mixing zone size limitations based on the waterbody, technological treatment, and necessity of a mixing zone.

The mixing that occurs after discharge can also be describe based on the physical mixing processes. It can be helpful to understand the physical mixing process before adding the regulatory overlay of authorized mixing zones. Physical mixing can be generalized into two zones. A smaller "zone of initial dilution," where the speed of the discharge pushes the effluent faster than the receiving water moves, and a larger zone where the effluent has lost speed from being discharged and mixes more slowly with and becomes transported by the receiving water. The second, larger zone is the far-field zone. Dilution occurs in both zones, but the mixing is quicker and the dilution is larger in the zone of initial dilution. These two zones are sometimes described in relation to the discharge point as near-field and far-field dilution/mixing, respectively.

The mixing that occurs in the near-field zone usually determines whether acute aquatic life criteria will be met. Usually the mixing that occurs in the near-field zone determines whether chronic WQC will be met. The effluent mixes much more rapidly in the smaller initial mixing zone than in the near-field zone.

Through the evaluation of the factors in 18 AAC 70.240, the Department determines whether and how much of the available dilution will be considered, in determining the size of the authorized mixing zone, in the reasonable potential analysis, and in determining WQBELs. The evaluation factors required in 18 AAC 70.240 include the consideration of technology, existing uses of the waterbody, human consumption, spawning areas, human health, aquatic life, endangered species, and the necessity of the size of the mixing zone.

A cruise ship's effluent can exceed WQC at the point of discharge as long as it eventually meets acute and chronic WQC without causing acute or chronic impacts in the interim. Because the acute WQC are based on short exposure times, if a discharge does not meet acute WQC in the physical zone of initial dilution, then the discharge likely will not meet the acute toxicity regulatory requirements. Even if the cruise ship meets acute WQC within the smaller initial mixing zone, it must also meet the combined requirements for the waterbody and technological treatment for a chronic mixing zone. Applicable regulations also require mixing zones to be as small as practicable (18 AAC 70.240(k)). All factors must be met in order to authorize a mixing zone.

6.3.4.1 Mixing zone modeling

Modeling is a tool used to determine the mixing characteristics and available dilution that is reasonably expected to occur under a wide variety of environmental conditions (tides, temperatures, winds, etc.). Cornell Mixing Zone Expert System (CORMIX) version 8.0 is a modeling program frequently used by the state's APDES program, EPA, and other states.

CORMIX was used to analyze and predict the behavior of cruise ship wastewater discharge plumes as they mix with marine receiving waters. CORMIX determines equilibrium conditions in the near field and calculates available dilution and other regulatory endpoints such as mixing zone size for ships authorized to discharge under the Permit. Mixing zone sizes found to be as small as practicable were different for 1) ships traveling at speeds of 6 knots or greater and 2) ships traveling at speeds under 6 knots. Mixing zone shapes also differed for the two speed classifications. A detailed explanation is included in Appendix F: Available Dilution and Mixing Zone Modeling.

Available dilution is a function of ambient conditions, effluent quality, discharge characteristics, and waterbody mixing characteristics. When no mixing zone is authorized, then historical performance and effluent limitations are the primary means of ensuring WQC are met in the waterbody. When a mixing zone is authorized, the discharge characteristics can have as much or more importance in ensuring that WQC are met at the boundaries of the mixing zone. Figure 2 shows how this occurs for wastewater discharges from stationary cruise ships and provides an example of the differences in available dilution observed moving from the smaller zone of initial dilution through the near-field or chronic mixing zone. Figure 2 shows how available dilution changes from being determined by the discharge characteristics to being determined by waterbody mixing.

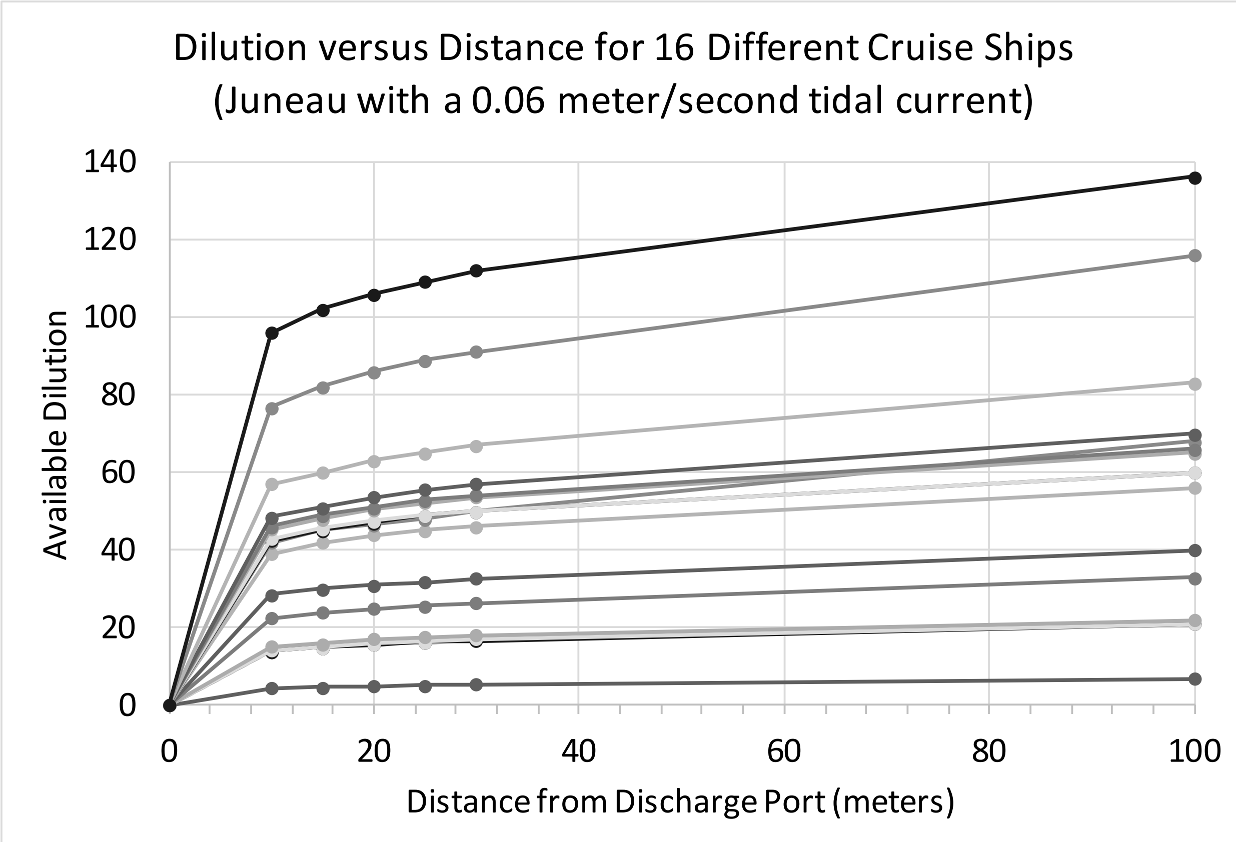

Figure 2: Available Dilution as a Function of Large Cruise Ship Characteristics and Distance from Discharge Port When Stationary

The vertical axis shows the available dilution and the horizontal axis shows the distance from the discharge port. The range of cruise ship-specific discharge characteristics results in significant differences in available dilution between the 16 cruise ships modeled by the Department within the first ten meters or within the smaller initial mixing zone. At 10 meters, the available dilution factors ranges from approximately 5 to 95, or a spread of 90 (i.e., the different curves spread apart rapidly during the initial dilution). As the distance from the discharge port increases, the differences between the cruise ships stops growing and becomes fairly constant. At 100 meters, the available dilution factors range from approximately 8 to 135, or a spread of 127. The additional 90 meters increased the spread in available dilution factors by an additional 37 compared to the spread of 90 that was achieved within the first ten meters. This shows the decreasing speed of the discharge and the greater influence of the ambient environment once outside of the smaller initial mixing zone.

6.3.4.2 <u>Initial mixing/acute zone</u>

18 AAC 70.240(d)(8) requires that acute aquatic life criteria are not exceeded at and beyond the boundaries of the smaller initial mixing zone. The Department's *Implementation Guidance: 2006 Mixing Zone Regulation Revisions* (DEC 2009) provides guidance on how to determine whether the requirements of 18 AAC 70.240(d)(8) are met. If any one of four methods to limit the size of the smaller initial mixing zone are used, compliance is assumed. Method three requires an evaluation of whether a drifting organism reaches the boundaries of the

smaller initial mixing zone in 15 minutes or less (acute aquatic life criteria are based on a one hour or greater exposure period). CORMIX is capable of modeling whether this will occur or not.

Table 5 lists the most restrictive, applicable WQC for acute and chronic endpoints. Of the pollutants of concern listed, the following acute WQC are based on aquatic life protection: TRC, ammonia, and dissolved copper, nickel, and zinc. If the pollutant that needs the greatest dilution factor can meet the requirements of method three then all acute aquatic life criteria will be met at and beyond the boundaries of the smaller initial mixing zone. Once the chronic mixing zone size is established, CORMIX is used, as necessary, to make this determination.

For discharges at speeds of 6 knots or greater, all WQC are met in less than 21 seconds after discharge. A drifting organism that was directly in the path of a moving cruise ship's discharge would have an exposure no greater than 21 seconds, and the requirements of 18 AAC 70.240(d)(8) are met. For discharges at speeds of under 6 knots, some ships may not meet acute aquatic life criteria at and beyond the boundary of the smaller initial mixing zone if not further restricted beyond the WQBELs established for the chronic mixing zone. This will be evaluated based on the information submitted with the NOI.

6.3.4.3 Chronic mixing zone driving parameter

After having determined that reasonable potential to exceed WQS exists and after ensuring that all acute aquatic life criteria are met at and beyond the boundaries of the smaller initial mixing zone (18 AAC 70.240(d)(8)), the size of the chronic mixing zone needs to be determined. When more than one pollutant would need a mixing zone to meet chronic WQC, the pollutant that needs the most dilution, which would correspond to the largest sized chronic mixing zone, is the "driving parameter." Once an allowable mixing zone size is determined, an effluent limitation must be calculated for the driving parameter since there is reasonable potential at the point of discharge and the boundaries of the mixing zone are based on driving parameter. All other pollutants were evaluated to determine whether they would meet water quality standards at the boundary of the authorized mixing zone. If any other pollutant(s) cannot meet chronic WQC before the boundaries of the authorized mixing zone, then an effluent limit must be calculated for that pollutant(s) as well. This situation occurs for ammonia and copper in wastewater discharge occurring when moving at speeds under 6 knots because ship-specific discharge characteristics needed to be considered.

For wastewater discharges that occur from vessels moving at a speed of 6 knots or greater, the chronic ammonia WQC is the driving parameter. When discharging wastewater at speeds under 6 knots, the chronic WQC for ammonia and, on occasion, dissolved copper, would not be met at the boundaries of the mixing zone without effluent limitations constraining the concentration discharged. Therefore, both ammonia and dissolved copper are the driving parameters for determining the under 6 knots mixing zone size that is as small as practicable. No effluent limitation was needed to constrain dissolved nickel concentrations in the effluent because dissolved nickel chronic WQC were met for all ships within 10 meters. This was true even at the conservative ambient concentrations used to determine dilution requirements. Details for this analysis are found in Appendix F: Available Dilution and Mixing Zone Modeling.

Appendix G: Mixing Zone Analysis Checklist provides greater detail on the factors the Department considered when analyzing whether a mixing zone can be authorized as well as the summary of findings for the mixing zones in the Permit.

6.3.4.4 Authorized mixing zone sizes

The results of the available dilution modeling were used to determine an authorized mixing zone size for cruise ships moving at speeds of 6 knots or greater and for cruise ships at speeds of under 6 knots. Mixing zone size for discharges while at speeds of 6 knots or greater was limited to a 63 meter by five meter rectangle. For discharges while at speeds under 6 knots the mixing zone size is a 83 meter radius unless discharging in Skagway at Broadway Dock or Ore Dock (See Figure 3) when the mixing zone size is a 15 meter radius.

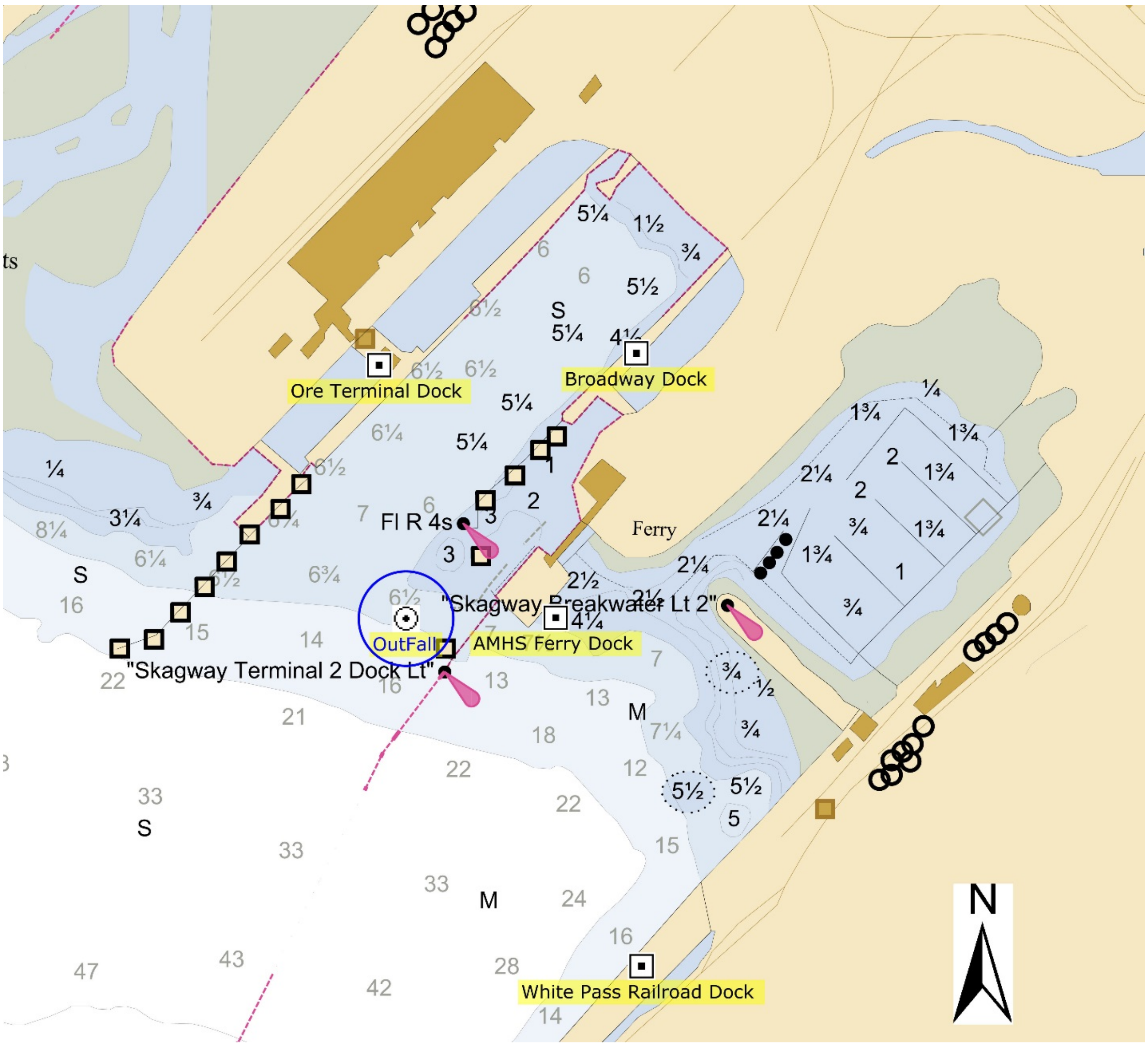

Figure 3: Schematic of Skagway Harbor Showing the Locations of Broadway and Ore Docks. Harbor Depths are in fathoms.

Authorized mixing zone for discharge while moving at 6 knots or greater

With the discharge of the maximum observed historical effluent concentrations (2008 – 2012), the most restrictive WQC (ammonia chronic criterion) will be met in less than 21 seconds or 63 meters aft (to the rear of the ship) of the discharge port. As the discharge port of a large cruise ship is typically 100 meters from the stern (midship to a typical large cruise ship), this means the chronic WQC for ammonia will be met before the discharge reaches the stern. The width of the discharge plume will be 5 meters or less, and the depth is from the surface to 1 meter below the discharge port. The rectangular mixing zone moves with the ship and the size is fixed relative to the discharge port. The mixing zone represents the maximum size (63 meters long, 5 meters wide, and depth of the discharge port plus 1 meter) and time (21 seconds) that the pollutants of concern in the waterbody that could exceed WQC due to any one cruise ship discharge at one time. This size meets the "as small as practicable" requirement in 18 AAC 70.240 by limiting the 6 knots or greater mixing zone size to be no larger than necessary to concurrently meet WQC and all other mixing zone requirements at the boundaries of the mixing zone. Additionally, once a discharged pollutant reaches the stern of the ship, the turbulent wake results in an additional 700:1 dilution factor.

Authorized mixing zone for discharge while moving at under 6 knots

As part of the Department's modeling for discharges at ship speeds under 6 knots, WQBELs for the driving parameters (chronic ammonia and dissolved copper WQC) were initially set at the maximum observed effluent concentrations for each ship (no effluent limitation was needed to constrain dissolved nickel concentrations in the effluent). However this approach did not result in mixing zones that met all the requirements in 18 AAC 70.240. For instance, mixing zone sizes of several hundred to nearly a thousand meters would have the potential to overlap with other mixing zones. In addition, such a large mixing zone size raises the possibility of adverse effects to resident species.

The 95th percentile of historical ammonia and dissolved copper effluent concentrations for each ship was a necessary limitation to calculate mixing zones that could meet chronic ammonia and dissolved copper WQC in less than 100 meters and generally avoid overlapping other mixing zones. CORMIX modeling results further showed all ships that could meet applicable WQC within 100 meters could also meet applicable WQC at or within 83 meters. Therefore, the mixing zone size suitable for most ships discharging at speeds under 6 knots was set at an 83 meter radius (relative to the discharge port) to account for the changing direction of tidal currents and depth of 1 meter below the discharge port in the Permit. The tidal current will change direction as it moves from a flood to an ebb tide and vice versa. The mixing zone size needs to be a radius of 83 meters to accommodate the shift in discharge plume to either side of the discharge port fore, aft, or any angle in between.

The mixing zone boundaries, which are based upon a docked ship discharging during the 10th percentile tidal current, were used to conservatively assess whether all existing and designated uses would be met for all wastewater discharges while moving at any speed under 6 knots. The actual mixing characteristics of discharge that occurs while moving at under 6 knots but not stationary will be intermediate between the moving mixing zone for 6 knots or greater and the stationary mixing zone for under 6 knots. The Department found that all existing marine water body uses will be maintained and protected. For example, the Douglas Island Pink and Chum fish hatchery net pens near the Thane-Sheep Creek estuary are outside the mixing zone boundaries for cruise ship discharges, even if a cruise ship was essentially stationary in the shipping channel. Cruise ship wastewater discharges would not expose the net pens to concentrations exceeding aquatic life criteria.

A finding of no overlap depends on the docking configuration, effluent concentrations, and discharge characteristics and frequency. After considering possible docking configurations, the Department determined that mixing zones no larger than 100 meters would generally prevent overlap of mixing zones in all ports except Skagway. For Skagway, there was significant potential for overlap if discharges were simultaneously permitted at Broadway Dock or Ore Dock. Simultaneous discharges from both docks can be prevented by restricting the mixing zone size further to a 15 meter radius when discharging at either Broadway Dock or Ore Dock if ships are present at the both docks. The department consulted with the Alaska Department of Fish & Game, Habitat Division in determining that the there are no salmon life history events in the harbor that would be affected by the proposed mixing zones. A determination of whether overlap is possible for an individual ship will be made based on the information submitted with the NOIs.

These sizes were determined to be as small as practicable for the ships modeled that would also not result in overlapping mixing zones for multiple docked ships. This size meets the "as small as practicable" requirement in 18 AAC 70.240 by limiting the under 6 knots mixing zone size to be no larger than the point when water quality criteria and all other mixing zone requirements can be concurrently met.

For modeling purposes, the aerial shape of the mixing zone while a ship is moored is considered to be a semicircle centered on the discharge port. However, the actual aerial shape seen depends on the ambient current velocity and direction. Unless a discharge occurs during a slack tide, the mixing zone will actually resemble a cone with the narrow end at the discharge port and a plume that widens and flattens out as it moves away from the discharge port. Therefore, the mixing zone should never fill the semicircle around the discharge port, but will constitute only a cone-shaped slice of the semicircle.

6.3.5 Mixing zone authorization process

Applicants seeking coverage under the Permit must submit a complete NOI to the Department. The NOI will indicate the type of mixing zone the applicant is applying for, if any:

- No mixing zone (vessel will meet applicable WQC at the point of discharge);
- Mixing zone for discharges at speeds of 6 knots or greater (63 meters);
- Mixing zone for discharges at speeds under 6 knots (83 meters); and/or
- Mixing zone for discharges in Skagway at Broadway Dock or Ore Dock.

The Department will review the submitted NOI and authorize a mixing zone for an applicant if:

- The acute aquatic life requirement is met in the smaller initial mixing zone; and
- The size of the mixing zone required to meet WQS for the listed pollutants of concerns (based on CORMIX modeling) meets the size restriction listed in the Permit.

Authorizations may include terms and conditions more restrictive than those outlined in the Permit when necessary to protect water quality (for example, see Section 6.3.6.1 WQBELs when no mixing zone is authorized). If a vessel can meet the acute aquatic life requirement, but the size of the mixing zone required to meet chronic WQC for the listed pollutants of concerns exceeds the size restriction listed in the Permit, then an authorization will only be granted if a more stringent effluent limitation, as part of the authorization, will ensure that WQS will be met.

6.3.6 WQBELs Calculations

WQBELs were calculated for each of the three authorized mixing zone discharge scenarios: 1) no mixing zone needed; 2) mixing zone needed for discharges at speeds of 6 knots or greater; and 3) mixing zone needed for discharges at speeds of under 6 knots. The available dilution varies with each scenario.

6.3.6.1 WQBELs when no mixing zone is authorized

Permittees requesting coverage under the Permit without a mixing zone are required to meet applicable WQC at the point of discharge. Upon review of the NOI and any historical effluent monitoring data, the Department will attach effluent limits, equal to the most restrictive applicable WQC, to the authorization under the Permit for all pollutants with reasonable potential to exceed WQS at the point of discharge.

6.3.6.2 WQBELs for speeds of 6 knots or greater

The ammonia chronic criterion for the protection of aquatic life is the parameter driving the authorized mixing zone size for speeds of 6 knots or greater. The ammonia WQBEL for discharges while moving at speeds of 6 knots or greater was calculated by dividing the maximum observed effluent concentration across all ships (160 mg/L) by the applicable chronic ammonia WQC (1.0 mg/L) and is 160 mg/L. This limitation for ammonia was developed to meet the "as small as practicable" requirement for mixing zones (18 AAC 70.240).

6.3.6.3 WQBELs for speeds of under 6 knots

The 95th percentile of ammonia and dissolved copper were used to establish the mixing zone size for speeds of under 6 knots, in order to meet WQC for ammonia and dissolved copper and to avoid overlapping other mixing zones. The 95th percentile of ammonia and dissolved copper effluent results were calculated for each ship and the maximum of these 95th percentile values were used to establish WQBELs that met all the mixing zone requirements in 18 AAC 70.240 are:

- Ammonia – 78 mg/L
- Dissolved Copper – 77 µg/L

6.3.7 Evaluation of Other Parameters Not Included in 2010 General Permit

DEC evaluated the 2008-2012 dataset of wastewater sample results for several other metals that had in the past been detected at concentrations exceeding Alaska WQC, including mercury and selenium. Sampling for these parameters was required twice per year under the 2010 General Permit. There was one exceedance of the chronic mercury WQC in 2008 and three of the chronic selenium WQC in 2009. There have been no exceedances of mercury or selenium since 2009 (Table 6). Based on these findings across multiple ships, the Department does not find that there is reasonable potential for mercury or selenium to exceed WQS. DEC will continue to monitor these and other pollutants for potential inclusion in future permits.

Table 6: Exceedances of WQC at the Point of Discharge (2010 General Permit limits for BOD and TSS) for the Years 2008-2012.

Year	# of Samples	Fecal coliform	Chlorine	pH	BOD[a]	TSS	Ammonia
2008	198	3	5	3	2	0	184
2009	201	3	1	2	2	0	168
2010[b]	178	6	1	0	3	0	141
2011	183	5	0	8	6	0	141
2012	168	7	1	7	1	0	132
Dissolved Metals[c,d] (µg/L)							

Year	# of Samples	Arsenic	Cadmium	Chromium[e]	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
2008	198	0	0	0	173	0	1	115	0	0	92
2009	201	0	0	0	168	0	0	129	3	0	109
2010[b]	178	0	0	0	126	0	0	109	0	0	81
2011	183	0	0	0	143	0	0	102	0	0	86
2012	168	0	0	0	131	0	0	92	0	0	69

Notes:

a. BOD exceedances of the monthly average were not included if they were caused by a daily exceedance of BOD.
b. Includes sample data not included in the Permit dataset because of failure to follow approved QAPP.
c. Chromium was analyzed as total dissolved chromium; WQS are for specific forms of chromium.

6.3.8 Satisfaction of the Antidegradation Policy

The Antidegradation Policy of Alaska WQS (18 AAC 70.015) states that existing water uses and the level of water quality necessary to protect existing uses must be maintained and protected. Appendix H: Antidegradation Analysis analyzes and provides the rationale for the Department's decision in the Permit issuance with respect to the Antidegradation Policy.

6.4 Determination of Effluent Limits

The TBELs from Section 6.2.4 were compared with the WQBELs in Section 6.3.6 to determine which were more stringent. The more stringent of the TBELs and the WQBELs become the effluent limits. Table 7, Table 8, and Table 9 show the results of this comparison and the corresponding effluent limits for vessels permitted to discharge without a mixing zone, with a mixing zone while at speeds of 6 knots or greater, and with a mixing zone while at speeds of under 6 knots. For vessels permitted to discharge without a mixing zone, the chronic TRC WQC of 7.5 μg/L is more stringent, when a mixing zone is not authorized, than the TBEL based on U.S. Coast Guard regulations that TRC not exceed 10 μg/L in treated effluent.

Table 7: Effluent Limitations for Vessels Permitted to Discharge Without a Mixing Zone.

Parameter	Minimum Value	Monthly Geometric Mean[a]	Daily Maximum	Sample Type
Fecal coliform	N/A	14 per 100 mL	40 per 100 mL	Water quality 18 AAC 70.20(b)
Parameter	**Minimum Value**	**Monthly Average[b]**	**Daily Maximum**	**Sample Type**
Total Flow	N/A	Not to exceed design capacity	Not to exceed design capacity	
Total Residual Chlorine (TRC)	N/A	N/A	0.01 mg/L	Technology based
pH	6.5 S.U.	N/A	8.5 S.U.	Water quality 18 AAC 70.020(b)
Biochemical Oxygen Demand (5-day)	N/A	30 mg/L	60 mg/L	Technology based

Parameter	Minimum Value	Monthly Geometric Mean [a]	Daily Maximum	Sample Type
Total Suspended Solids (TSS)	N/A	30 mg/L	150 mg/L	Technology based

Notes:

a. The "monthly geometric mean" is the geometric mean of all samples taken during the calendar month. A non-detect value may be substituted with a value of 1 for the purpose of calculating the geometric mean. If only one sample is collected, the result of that sample is the geometric mean.
b. The "monthly average" is the average of all samples taken during the calendar month. If only one sample is collected, the result of that sample is the monthly average. A non-detect value may be substituted with a value of 0 for the purpose of calculating the monthly average.

Table 8: Effluent Limitations for Vessels Permitted to Discharge at Speeds of 6 Knots or Greater with a Mixing Zone of 63 meters in length and 5 meters in width and a depth from the surface to 1 meter below the discharge port.

Parameter	Minimum Value	Monthly Geometric Mean [a]	Daily Maximum	Basis for Limit
Fecal coliform	N/A	14 per 100 mL	40 per 100 mL	Water quality 18 AAC 70.20(b)
Parameter	**Minimum Value**	**Monthly Average [b]**	**Daily Maximum**	**Basis for Limit**
Total Flow	N/A	Not to exceed design capacity	Not to exceed design capacity	
Total Residual Chlorine (TRC)	N/A	N/A	0.01 mg/L	Technology based
pH	6.5 S.U.	N/A	8.5 S.U.	Water quality 18 AAC 70.020(b)
Biochemical Oxygen Demand (5-day)	N/A	30 mg/L	60 mg/L	Technology based
Total Suspended Solids (TSS)	N/A	30 mg/L	150 mg/L	Technology based
Ammonia	N/A	N/A	160 mg/L	Water quality 18 AAC 70.020(b) and 70.240

Notes:

a. The "monthly geometric mean" is the geometric mean of all samples taken during the calendar month. A non-detect value may be substituted with a value of 1 for the purpose of calculating the geometric mean. If only one sample is collected, the result of that sample is the geometric mean.
b. The "monthly average" is the average of all samples taken during the calendar month. If only one sample is collected, the result of that sample is the monthly average. A non-detect value may be substituted with a value of 0 for the purpose of calculating the monthly average.

Table 9: Effluent Limitations for Vessels Permitted to Discharge at Speeds Under 6 Knots with a Mixing Zone of either a radius of 83 meters or 15 meters (in Skagway at Broadway Dock or Ore Dock) and 5 meters in width and a depth from the surface to 1 meter below the discharge port.

Parameter	Minimum Value	Monthly Geometric Mean [a]	Daily Maximum	Basis for Limit
Fecal coliform	N/A	14 per 100 mL	40 per 100 mL	Grab
Parameter	**Minimum Value**	**Monthly Average [b]**	**Daily Maximum**	**Basis for Limit**
Total Flow	N/A	Not to exceed design capacity	Not to exceed design capacity	Metered or estimated
Total Residual Chlorine (TRC)	N/A	N/A	0.01 mg/L	Grab/Field test
pH	6.5 S.U.	N/A	8.5 S.U.	Grab/Field test
Biochemical Oxygen Demand (5-day)	N/A	30 mg/L	60 mg/L	Grab
Total Suspended Solids (TSS)	N/A	30 mg/L	150 mg/L	Grab
Ammonia	N/A	N/A	78 mg/L	Water quality 18 AAC 70.020(b) and 70.240
Dissolved Copper	N/A	N/A	77 µg/L	

Notes:

a. The "monthly geometric mean" is the geometric mean of all samples taken during the calendar month. A non-detect value may be substituted with a value of 1 for the purpose of calculating the geometric mean. If only one sample is collected, the result of that sample is the geometric mean.

b. The "monthly average" is the average of all samples taken during the calendar month. If only one sample is collected, the result of that sample is the monthly average. A non-detect value may be substituted with a value of 0 for the purpose of calculating the monthly average.

6.5 Prohibited Discharges

6.5.1 Discharge Exclusion Areas:

The Permit prohibits wastewater discharges in any waterbody included in the DEC Clean Water Act (CWA) Section 305(b) report or effective CWA Section 303(d) list of waters which are listed as impaired or water quality-limited that are not in compliance with an approved total maximum daily load (TMDL) allocation or that exceed WQC at the point of discharge for any of the impaired pollutants.

More information on The DEC list of impaired waterbodies is available at: http://www.dec.state.ak.us/water/wqsar/waterbody/integratedreport.htm.

6.5.2 Prohibitions Other Than Effluent Limits:

The Permit includes terms and conditions limiting the release of materials that could be toxic, hazardous, or cause a nuisance. These items are not allowed to be discharged under federal or state regulations, or the Department is not allowed to include discharge of these items in a permit.

Alaska WQS (18 AAC 70) require that surface waters and adjoining shorelines designated for aquaculture water supply or the growth and propagation of fish, shellfish, aquatic life and wildlife be virtually free from floating oil, film, sheen or discoloration. Therefore, the Department has included a narrative limitation prohibiting the discharge of petroleum hydrocarbons or oils and grease that cause a sheen, film or discoloration on the surface of the water or adjoining shorelines in 18 AAC 70.020. The permittee must sample wastewater for oil and grease twice a year.

Alaska WQS (18 AAC 70) require that marine waters designated for the growth and propagation of fish, shellfish, aquatic life and wildlife not contain residues that cause a film, sheen, sludge, solid, or emulsion on the surface of the water or adjoining shorelines that would impair designated waterbody uses or cause nuisance conditions. Therefore, the Permit does not allow sludge, solids, or emulsions to be deposited. The Permit does not allow foam in other than trace amounts to be discharged.

Discharges with volumes or flow rates that exceed the maximum capacities listed in the VSSP and NOI are prohibited. The authorization to discharge is based on provided rates. Any exceedance of those rates could change effluent limitations based on provided information and the influence that has on the mixing characteristics of the discharge or may result in inadequate treatment.

7 MONITORING REQUIREMENTS

7.1 Basis for Effluent Monitoring

Monitoring in a permit is required to determine compliance with effluent limits. Monitoring may also be required to gather effluent and receiving water data to determine if additional effluent limits are required and/or to monitor for effects on the receiving water body quality. The permittee must conduct monitoring and report results on DMRs and other applicable reports.

7.1.1 Routine Monitoring

AS 46.03.465 (b) requires the collection of routine samples of effluent discharged overboard. The Department approves sampling techniques and frequencies (AS 46.03.465(d)) to ensure demonstration of compliance with AS 46.02.462 discharge requirements. Sampling shall be representative of the typical effluent being discharged.

The Permit contains two sampling scenarios; one for vessels that do not need a mixing zone and for vessels that discharge only when they are travelling at speeds of 6 knots or greater and one for vessels that may discharge at speeds under 6 knots, including stationary vessels.

The Department has determined that while a vessel is traveling at speeds of 6 knots or greater, mixing occurs rapidly, mixing zone overlap will not occur, and WQC will be met by the time the discharge reaches the stern of the ship. These factors all indicate that there is less basis for concern for these moving vessels than for vessels discharging at a speed of under 6 knots. Therefore, effluent monitoring for vessels authorized to discharge while traveling at speeds of 6 knots or greater can be more limited than monitoring for vessels authorized to discharge while traveling at speeds under 6 knots. Temperature, conductivity, hardness, and those parameters with effluent limits will generally be analyzed twice per year. The exceptions are fecal coliform and TSS which will be analyzed twice per month. These parameters provide the best overall measure of AWTS performance and assessment of the most likely threat to human health or the environment if treatment performance is inadequate. Monitoring of non-routine parameters will generally occur twice per year twice in the third year of the Permit term. Analysis of the full suite of parameters will occur for each of these sampling events.

Receiving water monitoring at the boundaries of the mixing zone is not required for vessels discharging at speeds of 6 knots or greater. This is due to the infeasibility of and safety issues associated with sample collection as well as the lack of a compelling human health or environmental concern given the large and rapid dilution that occurs.

Discharges that occur while a vessel is traveling at speeds under 6 knots are more likely to affect receiving water quality due to the slower mixing that occurs. Therefore, effluent monitoring requirements for vessels authorized to discharge while traveling at speeds under 6 knots are more extensive. For this type of discharge authorization, two parameter lists are analyzed at differing frequencies. Temperature, conductivity, hardness, and those parameters with effluent limits will be analyzed twice per month, while the full suite of pollutants will be analyzed twice in the first year of operation under the Permit and twice in the third year of the Permit term. Receiving water monitoring at the boundaries of the mixing zone is required twice a year for vessels authorized to discharge while traveling at speeds under 6 knots.

Conductivity analysis was increased from twice per year to twice per month in the Permit in order to more closely monitor the representativeness of samples collected. High conductivity (salinity) may indicate that there is an intrusion of seawater into the discharge port during sample collection. For modeling purposes, cruise ship wastewater effluent is considered to be a freshwater discharge. High salinity could have an effect on modeling and as a result, affect mixing zone size. Hardness was added as a twice per month analyte based on the need to determine the effect of hardness on the availability of dissolved metals in the effluent. Neither conductivity nor hardness has an effluent limit; rather, they are report only.

7.1.2 Basis for the Full Suite of Parameters

Parameters that are included in the full suite but not in the twice per month parameter list do not have permit limits, although some have Water Quality Standards. Parameters that measure nutrients such as nitrogen compounds, phosphorus, and carbon are an indicator of wastewater treatment equipment performance and provide information on the nutrient load released by cruise ships. Other parameters measured are toxic pollutants such as mercury and some volatile organic compounds. These parameters are monitored to check for the presence of some toxic materials and to gather information on whether an effluent limit should be established in future permits.

The full suite of parameters was modified from the 2010 general permit. Oil and Grease, which had been omitted in the 2010 general permit, was added. Nitrate-Nitrogen was changed to Nitrate-Nitrite based on input from AWTS manufacturers. Analysis of Nitrate-Nitrite is required under the Permit and current QAPP.

The Department determined that the sampling frequency of the full suite of parameters could be reduced from twice per year to twice in the third year of the Permit term plus twice in the first year of operation under the Permit for those ships that were not authorized to discharge under the 2010 General Permit. This determination was made due to the infrequent detections of those parameters during 2008-2012 as seen in Table 6.

7.1.3 Combination with Federal Sampling Requirements

The intent of the Department is to allow cruise ship operators to use samples taken for the US EPA or US Coast Guard to satisfy Permit monitoring requirements. This is to reduce the burden of duplicative sampling on the permittee.

7.2 Basis for Receiving Water Monitoring

The receiving water monitoring is informational only. Receiving water monitoring measures pollutant levels at the boundaries of the mixing zone, which allows the Department to assess decisions based on mixing zone modeling and make adjustments if necessary. Data collected will also be used in the development of future permits.

7.3 Basis for Whole Effluent Toxicity Monitoring

18 AAC 70.030 established a requirement that an effluent discharged to a water may not impart chronic toxicity to aquatic organisms either at the point of discharge or at the boundaries of an approved mixing zone. If the Department determines a reasonable potential exists to cause or contribute to an exceedance of chronic toxicity, then testing would be required as a condition of a permit or approval under this regulation. For monitoring the whole effluent toxicity (WET) test results must be reported in chronic toxic unit.

WET testing was part of the Department sampling program for cruise ships from 2002 until 2006. No acute WET toxicity was observed. Any chronic WET observed was limited, sporadic and did not indicate a persistent pattern of toxicity. Thus, no effluent limits have been established in previous cruise ship general permits. Reports for WET testing conducted from 2002-2005 are available at
http://dec.alaska.gov/water/cruise_ships/reports.htm

There is a need to collect more recent data for the ships currently discharging in State marine waters to evaluate whether permittees are currently able to meet the requirements of 18 AAC 70.030. The Department has determined that in order to comply with 18 AAC 70.030, WET testing shall be conducted by all permittees, at a monthly frequency in the third year of the Permit or the first year of operation under the Permit after the third year.

7.4 Required Plans for Monitoring

7.4.1 Quality Assurance Project Plan

Permittees are required to use a Department approved QAPP under 18 AAC 69.025 and 33 CFR 159. Most permitted vessels use the North West & Canada Cruise Association QAPP. This document is reviewed and approved by the Department annually.

7.4.2 Vessel Specific Sampling Plan

A Vessel Specific Sampling Plan (VSSP) is intended to verify that samples taken are representative of typical effluent. VSSP requirements are listed in18 AAC 69.030.

8 SPECIAL CONDITIONS

8.1 Operation and Maintenance Plan

In accordance with AS 46.03.110 (d), the Department may specify in a permit the terms and conditions under which waste material or water may be disposed of. In accordance with 18 AAC 15.090, terms and conditions may include operating, monitoring, inspection, sampling and reporting requirements as well as requirements to ensure Department access to records. The Permit requires the permittee to properly operate and maintain all facilities and systems of treatment and control. Proper operation and maintenance is essential to meeting discharge limitations, monitoring requirements, and all other permit requirements at all times including the requirements of 18 AAC 70.010 and 70.240. The permittee is required to develop, or update, and implement an operation and maintenance plan for its facility within 180 days of the effective date of an authorization granted under the Permit. The Permit contains certain conditions that must be included in the Operation and Maintenance plan. If an Operation and Maintenance Plan has already been developed and implemented, the permittee need only to review the existing plan to make sure it is up to date and all necessary revisions are made. The plan shall be retained on site and made available to the Department upon request.

9 REPORTING

9.1 Discharge Monitoring Report

A monthly Discharge Monitoring Report (DMR) is required for vessels authorized to discharge under the Permit. The DMR includes information such as effluent sample results, monthly averages for parameters with average limits, number of exceedances of permit limits, and daily flow data. DMRs are used by the Department to gather Permit-related wastewater sampling and flow rate information. The DMR is used by the permittee to report effluent limit noncompliance and any deviations from sampling plans. Vessels that do not discharge in marine waters of the state for a calendar month must submit a DMR reporting no discharge occurred for that month. The Permit includes a deadline for the signed copy submitted to the Department and a description of how to calculate monthly averages and means.

9.2 Noncompliance Notification and Reporting

Noncompliance notification is required under AS 46.03.475 and 18 AAC 72.930. Noncompliance events such as spills and inadequate treatment must be reported to the Department. Initial notification is required within 24 hours of becoming aware of the event, and a written report is due 7 days after notification, unless the Department determines the initial notification contained sufficient information.

Note that EPA, under the VGP, requires reporting of violations be submitted to the Department as stated in Section 6.1.2 of the VGP if the violation occurred in marine waters of the state.

9.3 Discharge Logs (Sewage and Graywater Discharge Record Book):

Discharge logs are used by vessels to record details of wastewater discharges. 18 AAC 69.050 lists the requirements for discharge logs. All entries shall have units and shall indicate which time zone (local, GMT, etc). was used. The Permit requires permittees to submit discharge logs monthly along with a definitions key or instructions defining all entry conventions and abbreviations.

10 RECORDKEEPING

All cruise ships are required under AS 46.03.470 to maintain records required under AS 46.03.465 for a period of three years.

The Department may request information relating to wastewater treatment, pollution avoidance, and pollution reduction measures used on cruise ships from cruise ship operators under AS 46.03.465(h).

11 ACCESS

The Department has the authority to collect wastewater samples, to inspect wastewater treatment systems, and to audit sample events and conduct inspections to verify integrity of the sampling process (18 AAC 69.085). This applies to all permitted vessels while in Alaskan waters. The Department deploys Ocean Rangers under AS 46.03.476 to observe sample events and review submitted documentation such as VSSPs.

12 OTHER LEGAL OBLIGATIONS

The Permit does not relieve the permittee from other federal, state, or local permits and requirements. This includes requirements by other divisions in the Department such as the Division of Spill Prevention and Response.

Appendix A: List of Changes in the Permit

List of Changes in the Permit Compared with the 2010 General Permit:

- Change in the outline and organization of the Permit to increase readability and match recent Department permit formats.
- Information such as geographic coverage of the Permit and authority is moved from the cover page to the Permit terms and conditions.
- Added schedule of submissions as a reference to permit required deadlines.
- Eligibility has been updated to include those vessels allowed to discharge under 2013 HB 80.
- Permit covers all waters of the state of Alaska - the 2010 General Permit did not cover Glacier Bay. Note that EPA's VGP has restrictions on the discharge of graywater in Glacier Bay.
- Discharge restrictions are now listed under Prohibited Discharges (Section 5.1).
- Notice of Intent (NOI) requirements have been removed from the text of the Permit, requirements are in the NOI form.
- NOI has a requirement to submit an updated NOI if any changes or modifications are made, or if inaccuracies are discovered.
- Authorizations may include additional terms and conditions.
- Transfer of permits as a process is no longer in the Permit. A new NOI will be used as the basis to terminate and replace the existing authorization with a new authorization.
- Mixing zones are allowed if conditions of 18 AAC 70.240 are met.
- The Department will determine the size of a mixing zone, with a maximum size of 83 meters with discharge at speeds of under 6 knots.
- Mixing zone size for discharges while in Skagway at Broadway or Ore Docks is 15 meters (if ships are present at both docks).
- Discharge of plastics are prohibited.
- Effluent limitations are no longer based on type of wastewater treatment system used.
- The discharge conditions of continuous or underway was replaced with Discharge at Speeds of 6 Knots or Greater and Discharge at Speeds under 6 Knots.
- There are three types of effluent limitations, no mixing zone, while at speeds of six knots or greater, and while under six knots.
- Effluent limits for dissolved nickel and zinc are removed.
- Effluent limits for dissolved copper are removed for discharges while at speed of six knots or greater.
- Total Suspended Solids now has a monthly average effluent limit.
- Sampling frequency has changed for some parameters.
- Samples shall be collected from each wastewater port that is used to discharge black water, graywater, or other wastewater.
- Except for chlorine, method detection limits will be less than the effluent limits.
- Temperature is now a reportable sampling parameter.
- Hardness is now a measured sample parameter.
- Oil and grease is again a measured sample parameter.

- Receiving water sampling is required for ships discharging at speeds under 6 knots.
- Whole Effluent Toxicity (WET) sampling is required for ships discharging at speeds under 6 knots.
- Discharge Monitoring Report form has been updated.
- Proper operation and maintenance of wastewater treatment equipment is required.
- An Operation and Maintenance Plan is required.
- Removal of Tributlyltin Paint Certification condition.
- Copies of CPVEC registration and waste offload plans are not required to be carried onboard. They are on file at DEC.
- Other Noncompliance reporting (such as oil spills) contact information was removed.
- Waste generation management decisions pollution prevention section was removed.
- Upset conditions section removed.
- Updated and revised NOI, Termination, and Noncompliance Reporting forms.
- Acronyms and definitions updated

List of Changes between Draft 2014 GP and Final:

- The 30 day period between issuance and when it goes into effect was removed
- The permit only supersedes the 2010 General Permit on those vessels authorized under the 2014 General Permit
- Chlorine limits apply to all vessels, not just those that use it as a disinfectant
- Sampling frequency clarified in the years sampling is required, sampling frequency added to effluent limit tables
- Underway sampling has increased frequency of field tests (temperature, pH, and chlorine) matching the fecal coliform sampling rate
- pH Limits were changed from 6.5 to 8.5 to 6.0 to 9.0 to match federal standards
- Receiving water sampling will begin in 2015, and require that sampling method used be reported
- Attachments to documents required to be mailed such as sample results may be submitted electronically.
- Certification text updated to match EPA VGP
- Notice of Intent Review and Permit Determination process (Section 4.3) added
- Vessels operating in impaired waters are required to follow requirements of approved TMDLs or else meet WQC at point of discharge
- Added website for Integrated WQ Monitoring and Assessment Report
- Removed requirement of Excel file format from sample reporting
- Vessels at the Skagway Broadway and Ore docks are allowed a full mixing zone if there are not ships at both docks
- Discharge record books only require a key in the first submittal
- Acronyms added – IMO and Non-Detect

List of Changes between Final Fact Sheet and Revised Final Fact Sheet:

- No changes made to the final permit.
- The Department reviewed whether allowing mixing zones in Gastineau Channel will limit the existing use of the Douglas Island Pink and Chum (DIPAC, a fish hatchery) net pens near the Thane-Sheep Creek estuary. The 83 meter mixing zone, authorized under the final Permit for wastewater discharges while moving at less than 6 knots, would not overlap with DIPAC net pens and would not limit the existing uses in Gastineau Channel.
    - No changes to the permitted mixing zone size were needed.
    - Changes were made to the Fact Sheet, Appendix E, and Appendix F to reflect the review and findings.
- The final Permit issued August 29, 2014 used an average of Hawk Inlet data as the basis for dissolved copper and zinc modeling in Juneau. The CPVEC program reviewed the available information and used an average of the Gastineau Channel copper and zinc data for all modeled ships.
    - No changes to the permitted mixing zone size were needed.
    - Changes were made to Appendix E and Appendix F to reflect the change in dataset for ambient dissolved copper and zinc averages.

Appendix B. Description of Activities

Cruise Industry Operations in Alaska

Cruise ships have been carrying passengers to Alaska since the late 1800's. Cruises began in Alaska to serve the nation's public interest in Alaska and to provide additional seasonal revenues for shipping companies. Competition between cruise lines and later modes of transportation such as airlines caused several companies to stop operations or merge with other lines. In the 1970's several cruise lines operated in Alaska, bringing newer ships built for an increasing worldwide demand for leisure cruises. The Alaskan market experienced rapid growth of passenger numbers and ship size in the late 1990's and early 2000's.

Cruise ships visit Alaska from late April until late September. Cruise ships repeat routes on 7 to 14 day itineraries for 10 to 22 voyages per year to Alaska. Vessel capacity ranges from 300 to 2,800 passengers. The largest ships carry around 4,000 passengers and crew.

As shown in Table 10, the composition of Department-permitted cruise ships changes from year to year. Ship size, treatment systems, and discharge volumes vary considerably as the composition changes. Even for the same ship in a different year there can be changes to wastewater operations, equipment used, and the vessel's passenger capacity.

Table 10: Large Cruise Ship Statistics

Year	Registered	Voyages	Total Passenger Capacity	With AWTS	Discharge [a] Authorized	Discharged in Alaska
2013	29	490	978,151	22	17	16
2012	28	451	922,350	21	17	16
2011	27	442	865,541	21	16	15
2010	28	449	859,512	21	16	15
2009	32	514	988,154	25	19	18
2008	31	516	1,038,590	25	25	21
2007[3]	30	509	1,002,439	23	18	17
2006[3]	29	496	909,312	24	25	23
2005[3]	29	490	918,751	21	20	20
2004	29	475	905,819	20	Unknown	20
2003	32	458	854,000	20	Unknown	16
2002	25	423	805,791	9	Unknown	15
2001	24	249	500,741	7	Unknown	10
2000	21	Unknown	Unknown	2	Unknown	Unknown

Notes:

a. DEC authorization to discharge. Prior to 2008 US Coast Guard authorization is listed; there was no DEC authorization process prior to 2008.
For a listing of which ships had Advanced Wastewater Treatment systems please see the annual Wastewater Discharge tables at:
http://www.dec.state.ak.us/water/cruise_ships/reports.htm

Location of Cruise Ship Wastewater Discharges

Large cruise ships can transit any coastal waters in Alaska, but most cruises are in Southeast and Southcentral Alaska. Nearly every cruise voyage transits Southeast Alaska. Table 11 below lists the number of cruise ship visits per port or destination in 2012. Cruise ships transit between destinations through state and federal waters, as shown in Figure 4 and Figure 5.

Table 11: 2012 Large Cruise Ship Port of Calls

Port	Port Calls	Port	Port Calls
Anchorage	7	Kodiak	11
College Fjord	37	Misty Fjords	1
Dutch Harbor	2	Pt. Sophia/Hoonah	62
Glacier Bay	210	Seward	50
Haines	21	Sitka	80
Homer	8	Skagway	353
Hubbard Glacier	123	Tracy Arm (glacier)	221
Juneau	449	Whittier	36
Ketchikan	432	Wrangell	1
Subtotals by Region			
Southeast AK Southcentral AK Southwest/Aleutians			1953 149 2
Total			**2104**
Source: CLAA 2012 Schedules			

Figure 4: Example Routes on Southeast Alaskan Voyages.

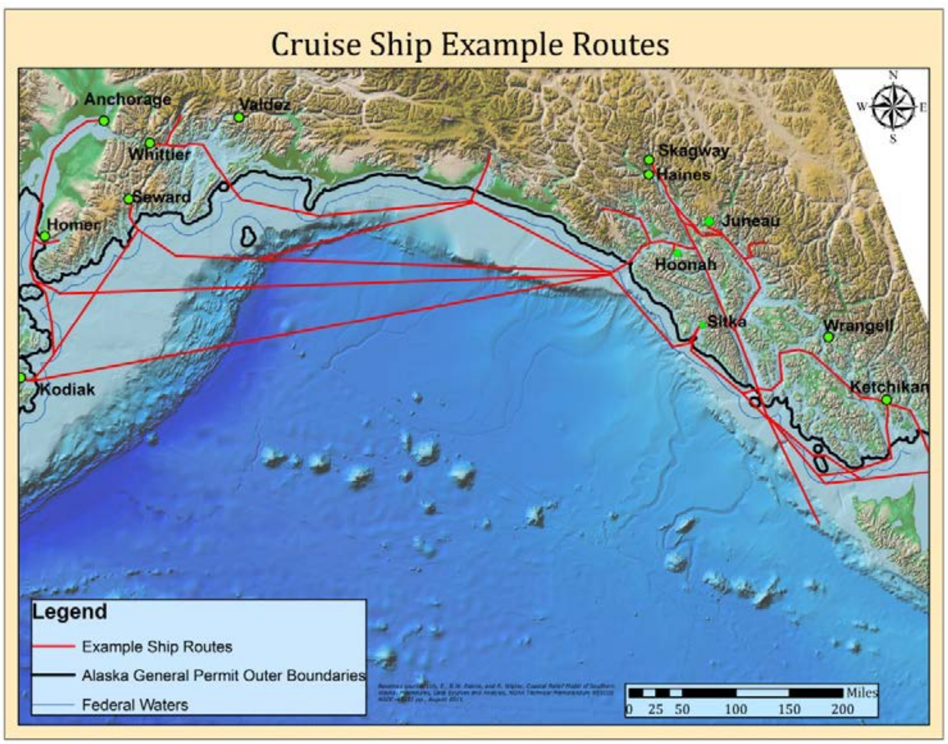

Figure 5: Example Routes on Alaskan Voyages.

Appendix C: Advanced Wastewater Treatment System Information

Sewage onboard large ships is typically treated using a Marine Sanitation Device (MSD). There are three types of MSDs regulated in the United States by the Coast Guard. Type I devices are only installed on vessels under 65 feet in length. Type II devices range from simple maceration and disinfection to those that include biological treatment and filtration. Type III devices are no-discharge systems using holding tanks to retain wastewater near shore. Marine sanitation devices must meet the effluent standards established in Section 312 of the CWA. This section set the Type II MSD effluent standards for treated sewage at 200 fecal coliform/100 ml and 150 mg/L total suspended solids (TSS). Vessels operating in Alaska must meet United States Code Title XIV – Certain Alaskan Cruise Ship Operations (the "Murkowski Law"). The U.S. Coast Guard's performance limits in 33 CFR 159.301–321 implement the requirements of the Murkowski Law. In addition to the Coast Guard requirements, cruise ships in Alaska must also adhere to state and federal wastewater effluent standards and discharge conditions.

Advanced Wastewater Treatment Systems are MSD II type devices that have additional levels of treatment such as filtration, biological treatment stages, and disinfection of effluent that also meet the minimum requirements of AS 46.02.462(j). Most of these systems treat both blackwater (sewage) and graywater.

An AWTS commonly includes the following stages:

- Collecting, equalizing and mixing;
- Pretreatment or prescreening of solids and items like grease;
- Biological treatment;
- Clarification and/or filtration (floatation, membranes, filtration);
- Disinfection and post treatment (chlorination/dechlorination, ultraviolet light, ion exchange);
- Effluent discharge or holding; and
- Sludge management.

AWTS types used since 2008 in Alaska:

Large cruise ships that discharge treated wastewater into marine waters of the state use several different types of advanced wastewater treatment systems (AWTS). Table 12 provides the number of ships using these systems in Alaska between 2008 and 2012.

Hamworthy's Membrane Bioreactor (MBR) system uses aerobic biological treatment followed by ultrafiltration and ultraviolet (UV) disinfection. Wastewater is first treated in screen presses to remove coarse solids. Bacteria digest the organic matter present in the waste in a two-stage bioreactor. Wastewater is then filtered through tubular ultrafiltration membranes to remove particulate matter and biological mass. Biomass from the membranes is returned to the bioreactor. In the final step, the treated wastewater undergoes UV disinfection to reduce pathogens.

The Hydroxyl CleanSea system consists of aerobic biological oxidation followed by dissolved air flotation and UV disinfection. The Hydroxyl system has not been used in Alaska since 2008.

The MariSan250 can be used for combined black water (sewage) and graywater. Primary treatment consists of gross screening, followed by solids separation through dissolved air flotation (DAF). Additional solids separation is accomplished through microfiltration and UV or ozone disinfection.

The ROCHEM Bio-Filt system uses vibratory screens to remove coarse solids, bioreactors to biologically oxidize the waste, ultrafiltration membranes to remove particulate matter and biological mass (which are returned to the bioreactors), and UV disinfection to reduce pathogens.

The ROCHEM LPRO (Low Pressure Reverse Osmosis) utilizes reverse osmosis membranes to remove particulates and dissolved solids, and UV disinfection to reduce pathogens.

The Scanship treatment system uses aerobic biological oxidation followed by dissolved air flotation and UV disinfection. Wastewater is pumped through a coarse drum filter and then through two separate aerated bioreactors. Free-floating plastic beads are used in the bioreactors to support biological growth. Solids separation is done using dissolved air flotation (DAF) units followed by additional solids removal through polishing screen filters. The final step is UV disinfection to reduce pathogens.

In the Triton Water Membrane Reactor process, the ultrafiltration membranes are submerged into an activated sludge reactor. Treated water is extracted through the membranes with a vacuum pump. Ion exchange resins can be added as a post treatment to remove dissolved metals. The final step is UV disinfection to reduce pathogens.

The Zenon system uses aerobic biological oxidation followed by ultrafiltration with membranes and UV disinfection. The combined wastewater flows through the proprietary ZeeWeed® hollow-fiber ultrafiltration membrane system under a vacuum. The final step is UV disinfection to reduce pathogens.

Table 12: Summary Descriptions of AWTS Types Used in Alaska during 2008-2012.

AWTS	Treatment					Ships in 2008	Ships in 2009	Ships in 2010	Ships in 2011	Ships in 2012
	Primary Solids Separation	Secondary Microbial Oxidation	Tertiary Clarification		Disinfection					
Hamworthy Bioreactor	Screen Press	Aerobic Biological Oxidation (Membrane Bioreactor)	Ultrafiltration Membranes		UV	9	9	7	7	9
Scanship	Wedge-wire Screen	Aerobic Biological Oxidation (Moving Bed Bioreactor)	Dissolved Air Flotation (DAF) / Polishing Filter		UV	3	4	3	3	3
Zenon	Coarse Screen	Aerobic Biological Oxidation (Membrane Bioreactor)	Ultrafiltration Membranes		UV	5	3	4	3	3
Rochem LPRO	Vibratory Screens	Low Pressure Reverse Osmosis (LPRO)	Reverse Osmosis Membranes		UV	1	1	1	1	1
Marisan 250	Coarse Screen	Chemical Coagulation	Dissolved Air Flotation (DAF) / Microfiltration		Ozone	1	1	*1	*1	1*
Hydroxyl Cleansea	Coarse Drum Filter	Aerobic Biological Oxidation (Moving Bed Bioreactor)	Dissolved Air Flotation (DAF) / Polishing Filter		UV	1	0	0	0	0
Rochem Bio-Filt	Vibratory Screens	Aerobic Biological Oxidation (Membrane Bioreactor)	Ultrafiltration Membranes		UV	1	0	0	0	0
Triton	Screening	Aerobic Biological Oxidation (Membrane Bioreactor)	Ultrafiltration	Ion Exchange	UV	0	0	0	1	0
* Permitted to discharge but did not discharge.										

Appendix D: Discharge Characterization Figures

Figure 6 through Figure 11 below illustrate trends in levels of BOD, TSS, TRC, fecal coliform, and the four pollutants of concerns in large cruise ship effluent from 2008-2012. Data used to generate the graphs are from the CPVEC wastewater sampling dataset.

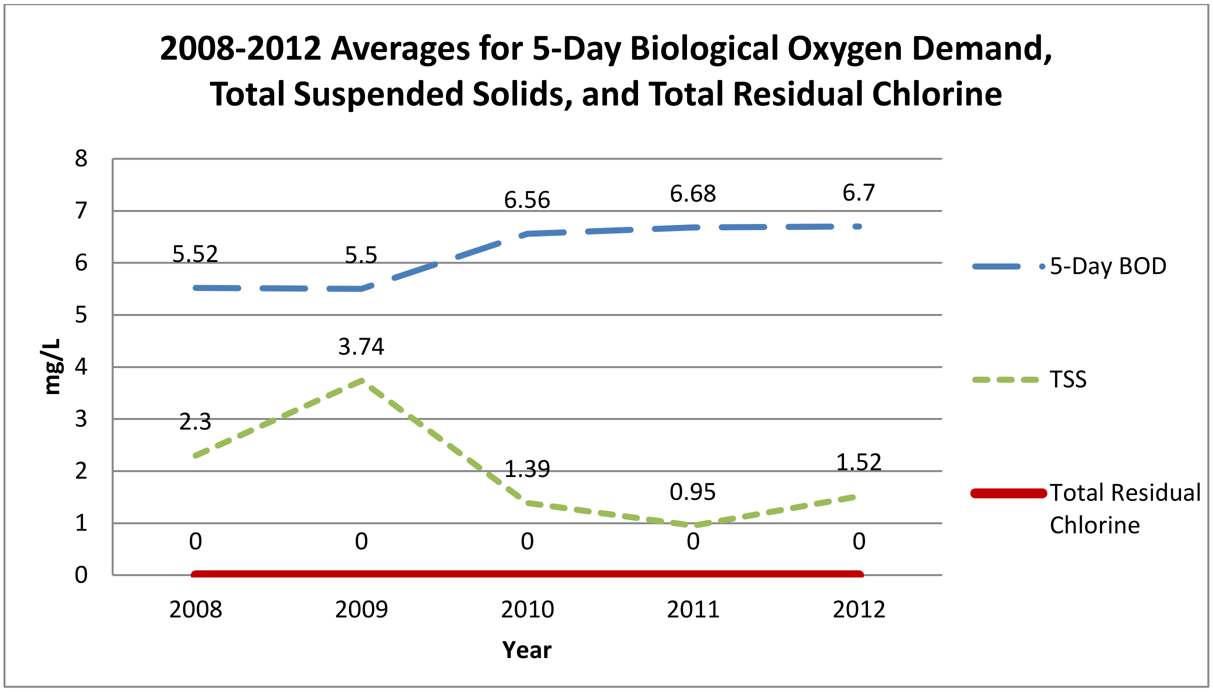

Figure 6: Large Cruise Ship Effluent Sample 5-day Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), and Total Residual Chlorine (TRC) Averages from 2008 to 2012.

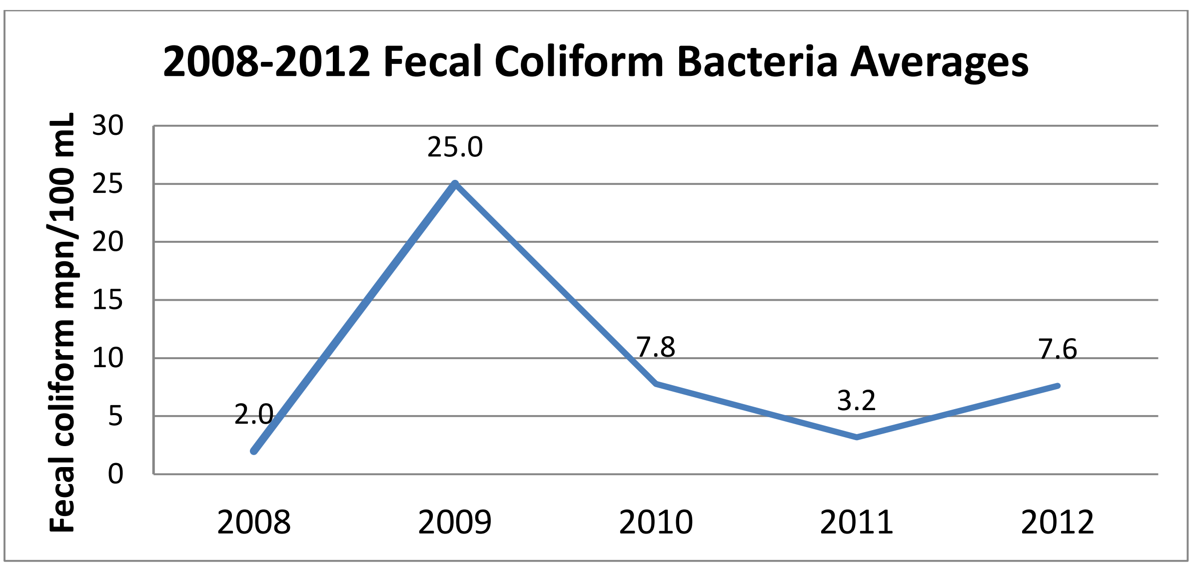

Figure 7: Large Cruise Ship Effluent Sample Fecal Coliform Averages from 2008 to 2012.

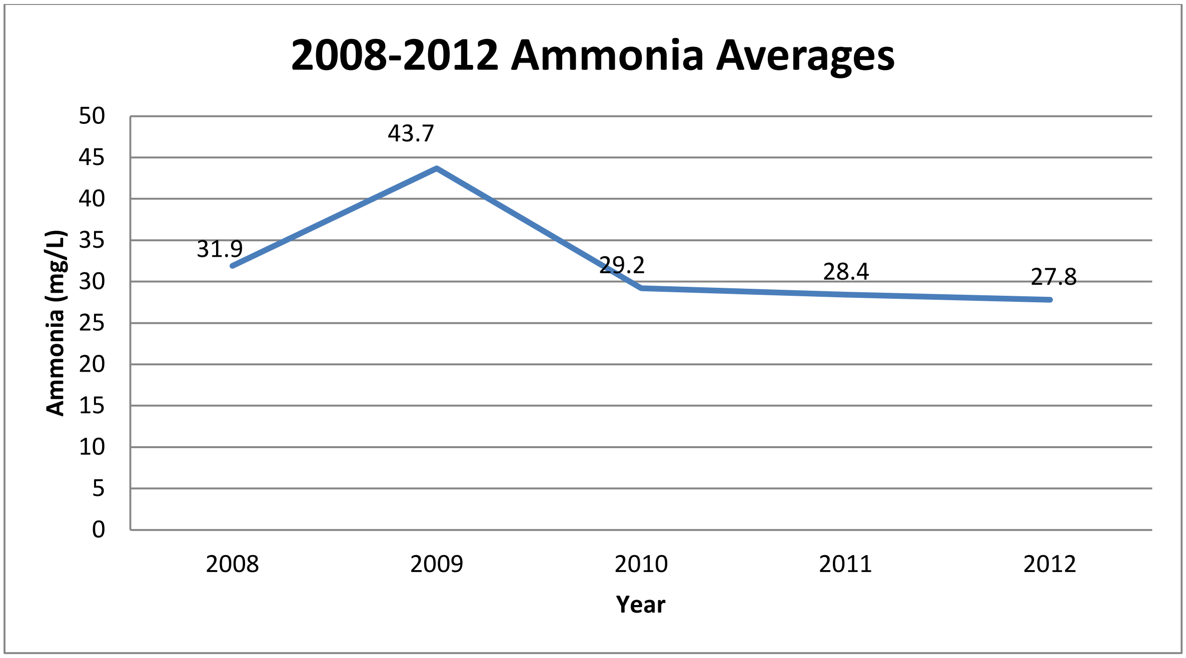

Figure 8: Large Cruise Ship Effluent Sample Ammonia Averages from 2008 to 2012.

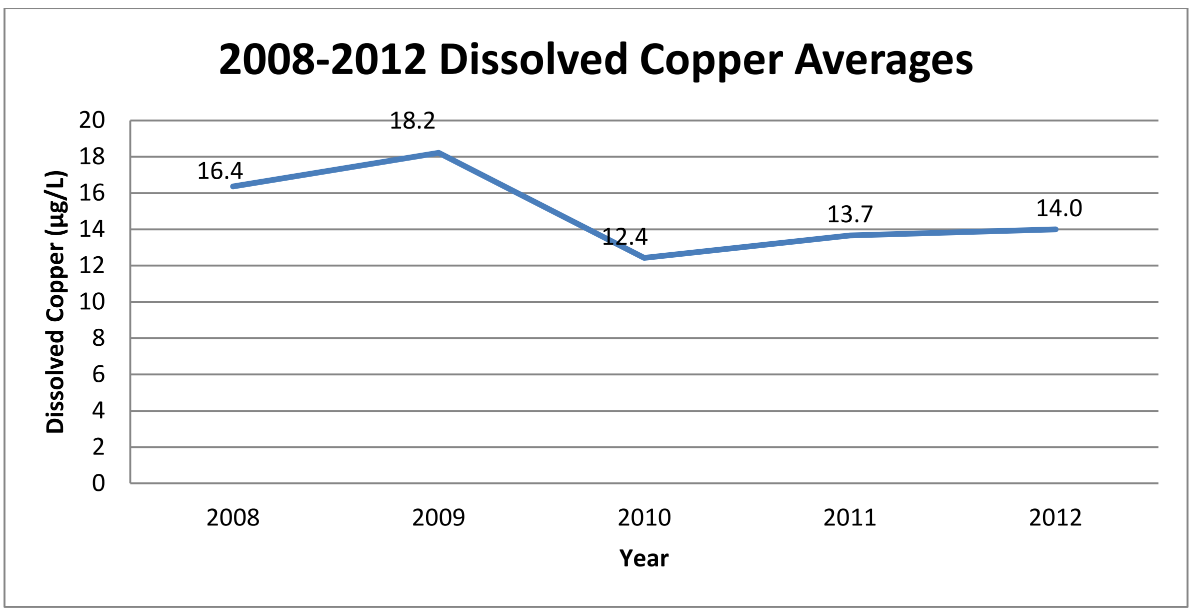

Figure 9: Large Cruise Ship Effluent Sample Dissolved Copper Averages from 2008 to 2012.

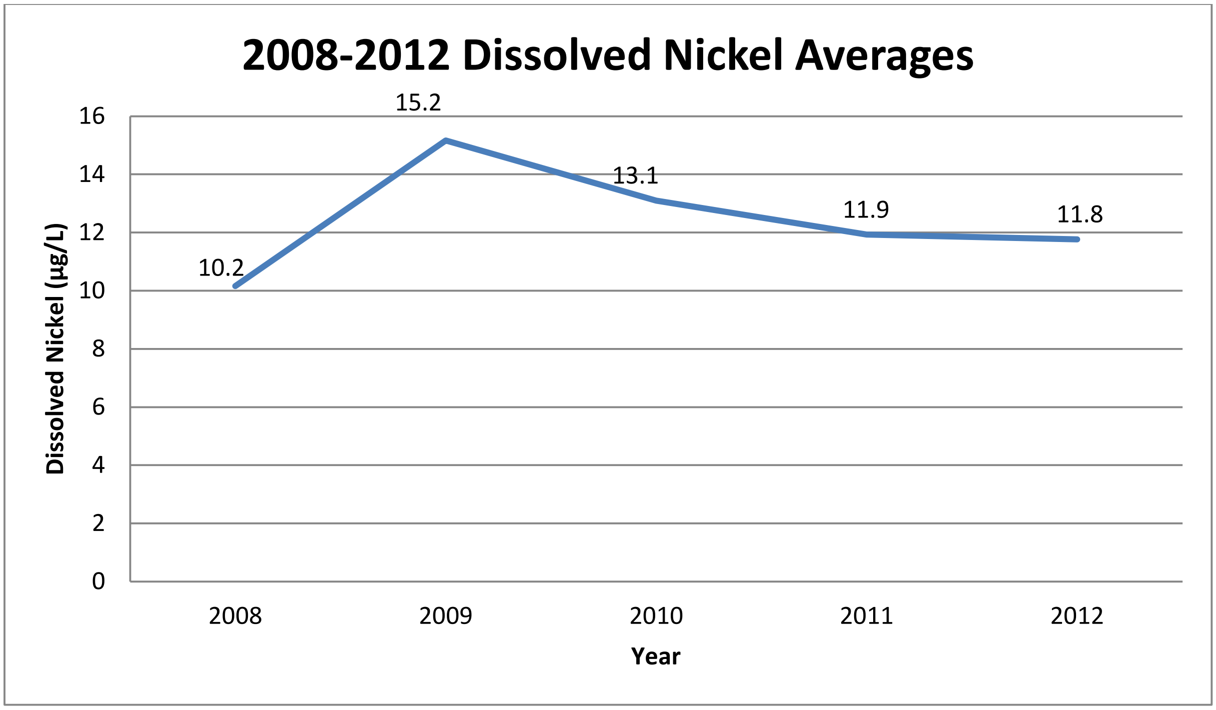

Figure 10: Large Cruise Ship Effluent Sample Dissolved Nickel Averages from 2008 to 2012.

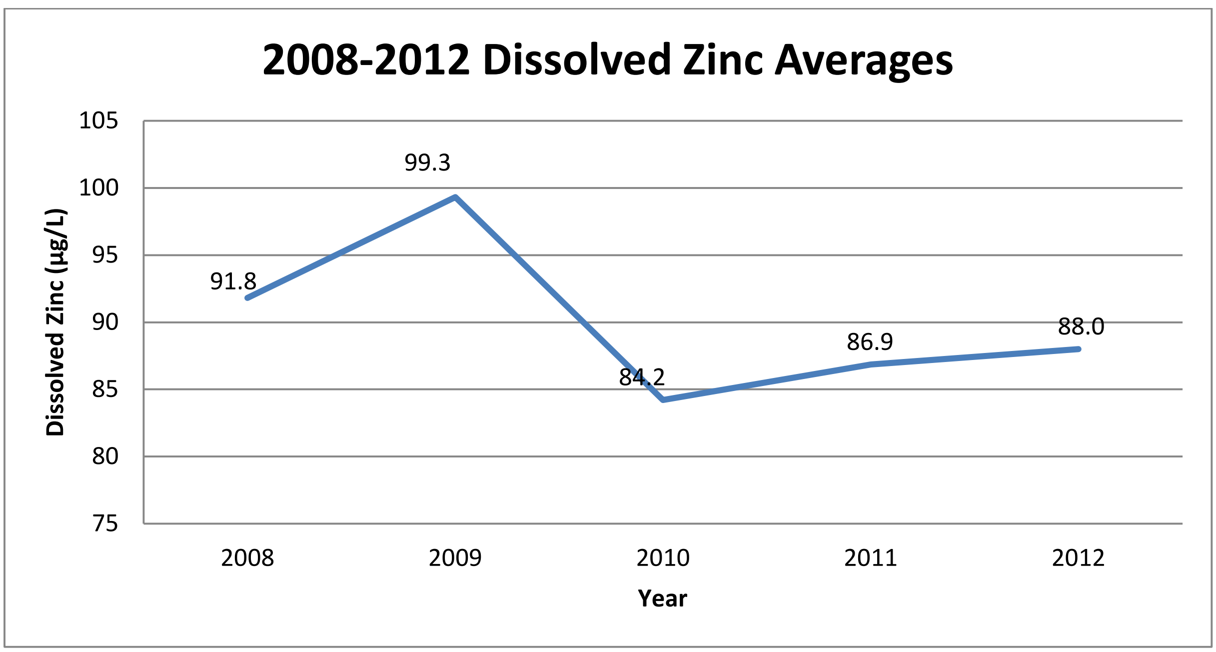

Figure 11: Large Cruise Ship Effluent Sample Dissolved Zinc Averages from 2008 to 2012.

Appendix E. Reasonable Potential Analysis

A reasonable potential analysis (RPA) calculates reasonable potential for a pollutant or parameter to cause or contribute to an exceedance of WQC. If RPA is found, WQBELs are then calculated. RPA is used to determine whether water quality-based effluent limitations (WQBELs) are required but can also be used to determine frequency of sampling for a particular parameter.

Determining Potential Pollutants of Concern from Exceedances of Applicable WQC at the Point of Discharge

Potential pollutants of concern were evaluated by comparing cruise ship effluent quality from AWTS discharges to the most restrictive, applicable WQC for State marine waters to determine if there was potential to exceed water quality criteria (WQC) before considering whether there was available dilution.

This potential was primarily evaluated by comparing the maximum values observed in the historical effluent dataset for ships with AWTS from 2008-2012 to the most restrictive, applicable WQC in Table 13. Available information was used to assess the extent to which waterbodies may be affected and to evaluate compliance with other criteria, particular narrative criteria. The monitoring data from 2013 was not used as permit development and modeling efforts were initiated prior to the end of the 2103 cruise ship season and prior to receipt of the all monitoring reports. Any pollutant that exceeds the applicable WQC from 18 AAC 70.020(b) at the point of discharge was a potential pollutant of concern. Note that ammonia criteria in marine waters are a function of pH, temperature, and salinity as described in the *Alaska Toxics Water Quality Criteria Manual* (DEC 2008), adopted by reference in 18 AAC 70.020(b). The basis for the pH, temperature, and salinity values are identified in the next section.

Table 13: Most Restrictive Applicable Marine Water Quality Criteria for Pollutants of Concern.

Parameter	Units[a]	WQC Limits		Reference
Fecal Coliform (FC) Bacteria	FC/100 mL	14[b]	40[c]	18 AAC 70.20(b)(14)
Dissolved Oxygen (DO)	mg/L	may not be less than 6 or greater than 17		18 AAC 70.20(b)(15)
pH	S.U.	may not be less than 6.5 or greater than 8.5, may not vary more than 0.2 outside of the naturally occurring range		18 AAC 70.20(b)(18)
Parameter	**Units[a]**	**Chronic WQC**	**Acute WQC**	**Reference**
Total Residual Chlorine (TRC)[d]	mg/L	0.0075	0.013	18 AAC 70.20(b)(23) [e]
Ammonia	mg/L	1.0	6.2	18 AAC 70.20(b)(23) [e, f]
Dissolved Copper	µg/L	3.1	4.8	18 AAC 70.20(b)(23) [e]
Dissolved Nickel	µg/L	8.2	74	18 AAC 70.20(b)(23) [e]
Dissolved Zinc	µg/L	81	90	18 AAC 70.20(b)(23) [e]

Notes:

a. L (liter), mg (milligram), mL (milliliter), S.U. (standard pH units)
b. Monthly Geometric Mean
c. In a 30-day period, not more than 10% of the samples may exceed 40 FC/100 mL
d. The TRC effluent limits are not quantifiable. DEC will use the minimum level (ML) of 0.01 mg/L as the compliance evaluation level for this parameter.

e. Which adopts by reference *Alaska Water Quality Criteria for Toxics and Other Deleterious Organic and Inorganic Substances*, dated December 12, 2008
f. Ammonia WQC are based on a pH of 8.2, a salinity of 20 g/kg, and a temperature of 10-15 °C

Without consideration of available dilution, there were three categories of potential pollutants of concern: conventional pollutants (fecal coliform, pH, BOD, and TSS), non-conventionals (ammonia and TRC) and priority pollutants (dissolved copper, dissolved nickel, and dissolved zinc).

Available dilution is generally not applicable, without further evaluation, for use with many conventional or non-toxic criteria when the pollutant can react in a detrimental manner after discharge (e.g., BOD loading effects on dissolved oxygen, radioactivity, etc.) or the pollutant directly affects the mixing characteristics of the discharge (e.g., temperature and dissolved solids). Thus, reasonable potential to exceed WQS is determined to exist for fecal coliform.

Consideration of available dilution for the other potential pollutants of concern (ammonia, TRC, dissolved copper, dissolved nickel, and dissolved zinc) requires knowledge of ambient receiving water conditions, discharge characteristics, and application of the mixing zone requirements in 18 AAC 70.240.

Ambient Receiving Water Conditions

TRC indicates the residual presence of chorine and chlorine disinfection byproducts and is not present to any significant extent in ambient waters; thus the baseline is assumed to be zero. For establishing numeric baselines for ammonia and dissolved metals concentrations, the data available in Alaska marine waters is variable across all marine waters and can be limited in location and frequency of measurement. In cooperation with the United States Environmental Protection Agency (EPA), the DEC Alaska Monitoring and Assessment Program (AKMAP) has been working to characterize ambient conditions for Alaska's marine waters. To date, AKMAP has produced reports for the coastal regions of Southcentral Alaska, Aleutian Islands, and Southeast Alaska (DEC 2005; DEC 2011). These reports can be found at: http://dec.alaska.gov/water/wqsar/monitoring/AKMAP.htm.

AKMAP water column data includes pH, temperature, salinity, and total suspended solids. AKMAP does not provide water column data for ammonia or dissolved metals, but there are limited sources of information for these parameters of concern. Large cruise ships can transit any coastal waters in Alaska, but most cruises are in Southeast and Southcentral Alaska (Appendix B).

pH, temperature, and salinity for ammonia criteria

The median surface water pH from AKMAP data for Southcentral AK sampling locations was equal to 7.96 S.U. at an average temperature of 11.1ºC and average salinity of 27.7 PSU (practical salinity unit). The median pH from AKMAP data for Southeast AK sampling locations was equal to 7.93 at an average temperature of 9.3 degrees C and average salinity of 28.4 practical salinity unit.

Ammonia

Ammonia was measured at nine locations within Gastineau Channel during 1989-1991 (Echo Bay Alaska, Inc., 1991). Samples were analyzed for ammonia as nitrogen (N). The average concentration of ammonia from that study was 0.021 mg/L ± 0.039 mg/L (n=91), which is well below the applicable chronic water criterion of 1.0 mg/L.

While AKMAP does not provide ammonia data, it does provide data for ammonium, the ionized form of ammonia, which is the more prevalent form at ambient pH. While unionized ammonia is the toxic form(at ambient pH and temperature) the ammonium concentration is greater than or equal to the unionized ammonia concentration, and the ammonium serves as a surrogate for ammonia The average surface water ammonium concentration from AKMAP data for Southcentral AK was equal to 0.01 mg/L, with a maximum value of 0.05 mg/L. The average ammonium concentration in samples taken from the sea bottom was equal to 0.02 mg/L, with a maximum value of 0.12 mg/L. The average ammonium concentration from AKMAP data for Southeast AK was equal to 0.01 mg/L.

Copper

There were 90 measurements of total recoverable copper obtained from nine locations in Gastineau Channel in 1989-1991 (Echo Bay Alaska, Inc., 1991). The average was 0.73 µg/L as total recoverable copper. The marine copper criteria uses a factor of 0.83 to convert total recoverable copper to dissolved copper. After applying that conversion factor to the Gastineau Channel average, an average concentration of 0.61 µg/L dissolved copper would result. Dissolved copper concentrations in Hawk Inlet and Chatham Strait were measured in 2006-2010 (Hecla Greens Creek Mining Company, 2011). The average of 60 samples was 0.41 µg/L dissolved copper. Based on these studies covering Hawk Inlet, Chatham Strait, and Gastineau Channel, it is reasonable to assign an approximate value of 0.5 µg/L dissolved copper as a background concentration for Southeast Alaska marine waters.

To meet the purpose of using stationary discharges in Juneau Harbor as a worst-case scenario for all Southeast Alaska ports, except Skagway, the department conservatively used the calculated dissolved copper value of 0.61 µg/L from Gastineau Channel as the ambient value for the RPA and the CORMIX modeling of discharges in Juneau Harbor. This value is below the applicable chronic water quality criterion of 3.1 µg/L (DEC 2008).

In a 2008 study of metals in Skagway Harbor, samples were collected from the surface (number of samples (n)=12), middle (n=12), and bottom (n=12) of the harbor and analyzed for dissolved copper (DEC and EPA Region 10, 2009). Dissolved nickel and dissolved zinc were not measured. Concentrations of dissolved copper were below the analytical detection limit of 2.6 µg/L for all samples with the exception of one of the reference sites, which had a dissolved copper concentration of 5.3 µg/L in the surface water sample.

Nickel

There were 86 measurements of total recoverable nickel obtained from nine locations in Gastineau Channel in 1989-1991 (Echo Bay Alaska, Inc., 1991). The average was 0.97 µg/L as total recoverable nickel. EPA's marine nickel criteria use a factor of 0.99 to convert total recoverable nickel to dissolved nickel, so it is reasonable to assume dissolved nickel is about the same as total recoverable nickel in this case. A background level of 0.97 µg/L for dissolved nickel in Alaska marine waters is below the applicable chronic water quality criterion of 8.2 µg/L.

Zinc

There were 90 measurements of total recoverable zinc obtained from nine locations in Gastineau Channel in 1989-1991 (Echo Bay Alaska, Inc., 1991). The average was 1.6 µg/L as total recoverable zinc. EPA's marine zinc criteria use a factor of 0.946 to convert total recoverable zinc to dissolved zinc. After applying that conversion, an average concentration of 1.5 µg/L dissolved zinc would result. Dissolved zinc concentrations in Hawk Inlet and Chatham Strait were measured in 2006-2010 (Hecla Greens Creek Mining Company 2011).

The average of 60 samples was 1.17 µg/L dissolved zinc. Based on these studies, it is be reasonable to assign an approximate value of 1.3 µg/L as a background dissolved zinc concentration in Alaska marine waters. This value is well below the applicable chronic water quality criterion of 81 µg/L.

To meet the purpose of using stationary discharges in Juneau Harbor as a worst-case scenario for all Southeast Alaska ports, except Skagway, the department conservatively used the calculated dissolved zinc value of 1.5 µg/L from Gastineau Channel as the ambient value for the RPA and the CORMIX modeling of discharges in Juneau Harbor. This value is well below the applicable chronic water quality criterion of 81 µg/L.

Available Dilution and Mixing Zone Modeling

Mixing zones

Through the evaluation of the factors in 18 AAC 70.240, the Department determines whether and how much of the available dilution will be considered in the reasonable potential analysis, in determining the authorized mixing zone, and in determining WQBELs. These evaluation factors include the treatment technology, existing uses of the water body, human consumption, spawning areas, human health, aquatic life, endangered species, and size of the mixing zone. All factors must be met in order to authorize a mixing zone. For further information see Appendix G: Mixing Zone Analysis Checklist.

Modeling

Since there is a marked difference in the mixing and available dilution for a cruise ship that is underway versus docked, the mixing zone analysis considered two different modeling scenarios for large cruise ships: 1) speeds of 6 knots or greater and 2) speeds of under 6 knots. Cornell Mixing Zone Expert System models near-field plumes as they come into contact with marine receiving waters. A detailed explanation is included in Appendix F: Available Dilution and Mixing Zone Modeling

Determining Reasonable Potential to Exceed WQS at the Boundaries of the Mixing Zone

Historical effluent monitoring results from 2008 through 2012 were used in the RPA. In the 2010 General Permit, sample data was grouped for each treatment system. This method was not used for the Permit because all ships with AWTS are now defined as a class as per statutory changes.

Speeds of 6 knots or greater

The available dilution for the RPA while at speeds of 6 knots or greater was 700:1. Ships with AWTS are a class per statute, but AWTS were designed to treat only conventional parameters. There is substantial variability in effluent concentrations of ammonia, TRC, dissolved copper, dissolved nickel, and dissolved zinc from ships with AWTS. However, given the large available dilution of 700:1 that occurs within a minute after discharge at the stern in the wake of the ship, the variability in effluent concentrations is small relative to the available dilution and the performance for all ships can be judged by using the maximum observed concentrations.

Speeds of under 6 knots

Because of the much smaller available dilution when docked or at speeds of under 6 knots, both the vessel-specific discharge characteristics and effluent characteristics become important. CORMIX modeling conducted by the Department indicated that the available dilution factors in Juneau Harbor with the low flow ambient tidal velocity of 0.06 meters/second range from 8:1 to 150:1 at 100 meters from the discharge port.

These ship-specific dilution factors were used for the RPA at speeds of less than 6 knots. Reasonable potential to exceed WQS was determined on a ship-by-ship basis using the maximum effluent concentrations for that ship. As this is a general permit, if any ship showed reasonable potential for a pollutant, then the Department considers that reasonable potential exists for that pollutant for all ships.

Summary of Results

As stated earlier, available dilution is generally not applicable for use with conventional or non-toxic criteria for dissolved oxygen, pH, radioactivity, residues, sediment, temperature, and marine water dissolved solids. Thus, reasonable potential to exceed WQS is determined to exist for fecal coliform, BOD, and TSS from the class of ships with AWTS.

No mixing zone authorized

Since permittees that seek authorization to discharge will likely seek a mixing zone authorization in their NOI for ammonia, dissolved copper, dissolved nickel, and/or dissolved zinc, reasonable potential and the need for effluent limits will be assessed for ships requesting to discharge without a mixing zone on a ship-specific basis. When reasonable potential to exceed WQS is determined then effluent limits will be required in the authorization and no mixing zone will be granted without request and further analysis.

Speeds of 6 knots or greater

No reasonable potential to exceed WQS for any pollutants other than fecal coliform, pH, BOD, and TSS was found for cruise ships that historically have discharged in Alaska marine waters while moving at speeds of 6 knots or greater. This is due to the large available dilution when moving at speed (700:1). However, since ammonia is the driving parameter in determining the 6 knots or greater mixing zone size, there is reasonable potential to exceed ammonia at the boundaries of the mixing zone. Note that all other pollutants were evaluated to verify they would meet water quality standards at the boundary of the 6 knots or greater mixing zone.

Speeds of under 6 knots

Using the minimum available dilution (8:1) across all ships and the maximum observed effluent concentrations, reasonable potential to exceed WQS exists for ammonia and dissolved copper and nickel (in addition to fecal coliform, BOD, and TSS) when cruise ships discharge wastewater while moving at speeds under 6 knots. There is no reasonable potential to exceed WQS for zinc with an under 6 knots mixing zone. Note that all other pollutants were evaluated to verify they would meet water quality standards at the boundary of the 6 knots or greater mixing zone.

Because of the ship-specific differences in available dilution when moving at speeds under 6 knots, an additional reasonable potential analysis was done for each ship. For a small number of ships, there is reasonable potential to exceed the acute ammonia criterion outside the smaller initial mixing zone, which would be a violation of 18 AAC 70.240(d)(8). For these ships, an under 6 knots mixing zone cannot be authorized without additional information demonstrating compliance per the Implementation Guidance available here http://dec.alaska.gov/water/wqsar/wqs/pdfs/MixingZoneGuidance2-3-09.pdf.

Results of the ship-specific RPA for discharges while moving at under 6 knots are presented below. These values are based upon the results of the mixing zone modeling described in Appendix F: Available Dilution and Mixing Zone Modeling. Chronic water quality criteria were used and combined with each ship's CORMIX dilution to determine reasonable potential to exceed WQS at the boundaries of a hypothetical 100 meter mixing zone in Juneau Harbor. While the low flow ambient tidal velocity for Skagway Harbor is lower at 0.05 meters/second, density stratification for the discharge plume is also less. Thus, if ships exhibit reasonable potential to exceed WQS in Juneau Harbor they are expected to exhibit reasonable potential in Skagway Harbor. A "Yes" in Table 14 below represents a reasonable potential to exceed WQS for speeds under 6 knots including stationary discharges.

Table 14: Ship-specific RPA Results for Juneau at 0.06 Ambient Tidal Velocity and a Default 100 Meters

Vessel	Ammonia	Copper	Nickel	Zinc
Coral Princess	NO	NO	NO	NO
Diamond Princess	YES	NO	NO	NO
Disney Wonder	YES	NO	NO	NO
Golden mixed wastewater	YES	NO	NO	NO
Golden graywater only	NO	NO	NO	NO
Island Princess	YES	NO	NO	NO
Norwegian Jewel	NO	NO	NO	NO
Norwegian Pearl	NO	NO	NO	NO
Norwegian Sun	YES	NO	NO	NO
Ocean Regatta	YES	NO	NO	NO
Sapphire mixed wastewater	YES	YES	YES	NO
Sapphire graywater only	NO	YES	NO	NO
Seven Seas Navigator	YES	YES	NO	NO
Silver Shadow	NO	NO	NO	NO
Star Princess	YES	YES	YES	NO
Statendam	YES	NO	NO	NO
Volendam	NO	NO	NO	NO
Zaandam	NO	NO	NO	NO

Limitations of the RPAs

- Total daily load data could not be included in the analyses. DEC has maximum flow rates and daily volumes but not totals for in-port discharges. This is not significant since there is not a localized concern for loading of pollutants or bioaccumulation.
- Sample data on some ships is limited and can be highly variable compared with combined sample data from multiple ships. All ships had at least 10 sample results.

Appendix F: Available Dilution and Mixing Zone Modeling

Appendix F Table of Contents

F.1. Overview of CORMIX Modeling

Cornell Mixing Zone Expert System (CORMIX) version 8.0 was used to analyze and predict the behavior of cruise ship wastewater discharge plumes as they come into contact with marine receiving waters. CORMIX determines equilibrium conditions in the near field when the available dilution is primary determined by the discharge characteristics. CORMIX is a mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones. This program is used by the EPA, the State of Alaska, and other states as a tool to simulate mixing behavior of wastewater discharges into receiving waters. The results of the mixing zone modeling conducted by the Department on cruise ships serves as the basis for determining authorized mixing zone sizes and effluent limits for ammonia, and dissolved copper, nickel, and zinc in the Permit. More information on the CORMIX modeling system can be found at: http://www.cormix.info/.

F.2. Available Dilution While Moving at 6 Knots or Greater

A 2001 Science Advisory Panel and DEC report concluded that for a typical large cruise ship moving at a minimum speed of 6 knots and discharging wastewater at 200 meters^3/hour the dilution factor for wastewater effluent ranges from 700:1 just at the stern of the ship to 50,000:1 within 15 minutes of discharge and including turbulent mixing in the wake behind the ship. The 700:1 dilution is a conservative estimation for near-field mixing, but does not consider vigorous mixing in the boundary layer, at the stern of a cruise ship moving at 6 knots ("Cruise Ship Wastewater Discharge into Alaskan Coastal Waters. Technical Report 2000-01" and the "March 8, 2001 Addendum" prepared for the Alaska SeaLife Center). The 2001 Science Advisory Panel's assessment of the Alaska SeaLife Center's Technical Report 2000-01 and why it may underestimate available dilution is included in its "Near-Field Dispersion of Wastewater Behind a Moving Large Cruise Ship," June 26, 2001 and available at: http://dec.alaska.gov/water/cruise_ships/pdfs/dispersion_of_ww_report.pdf. The 50,000:1 dilution is based on "The Impact of Cruise Ship Wastewater Discharge on Alaska Waters," November 2002, available at: http://www.dec.state.ak.us/water/cruise_ships/pdfs/impactofcruiseship.pdf).

The dilution factor of 700:1 was used to conservatively assess reasonable potential to exceed WQS as this dilution is achieved in less than a minute and could be authorized in a mixing zone.

To determine the authorized mixing zone size for discharges from cruise ships moving at 6 knots or greater, CORMIX was used to model the mixing that occurs after and before the plume reaches the stern of the ship. Rather than modeling the ship as moving and the receiving water as stationary, the ship was modeled as stationary with the receiving water moving at 6 knots. This approach preserves the relative difference in velocities of 6 knots.

F.3. Inputs for Mixing Zone When Moving at 6 Knots or Greater

F.3.1 Default Values Used in the CORMIX Program

CORMIX allows wind speed to be used in prediction calculations. The default value used by CORMIX is 2 m/s (a breeze). The range of wind speeds used in the CORMIX program is from 0 m/s (no breeze) to 15 m/s (strong wind). DEC used a wind speed of 2 m/s in the interest of modeling a worst case scenario when there is minimal wind-driven surface mixing of the water.

Another default parameter used in the CORMIX modeling is a Manning's n coefficient, which specifies any bottom friction. Because none of the plumes evaluated made contact with the bottom, a low Manning's n of 0.01 was used.

F.3.2 Ambient Conditions

The ambient temperature, salinity, and density profiles, as well as ambient concentrations, for Juneau harbor were used as surrogates for all marine waters (see description in the "Inputs" section below under "Inputs for Mixing Zone While Moving at Under 6 Knots").

F.3.3 Vessel Characteristics

Ship specific information was obtained from documents submitted by permittees (e.g., 2013 VSSPs, 2010-2013 NOIs) as well as from Ocean Ranger observations during the 2013 cruise season for the vessels identified in Table 15. Information included maximum estimated effluent discharge rate and discharge port diameter, orientation (angle) to waterline, and depth below waterline. Ranges for reported vessel characteristics are presented in Table 16 below. Discharge port characteristics (diameter, shape, angle, and depth) were verified by Ocean Rangers onboard the ships during the 2013 cruise season.

Discharge rates and port diameters were used by modelers to calculate a discharge exit velocity for each ship. The variations in individual ship characteristics resulted in a unique available dilution factor for each ship under each evaluated scenario. However, the predicted dilution available for each pollutant of concern for each ship remained the same because each ship's characteristics remained constant.

Table 15: Vessels Evaluated

Coral Princess Diamond Princess Disney Wonder Golden Princess – Mixed sewage and graywater Golden Princess – Graywater only Island Princess	Norwegian Jewel Norwegian Pearl Norwegian Sun Oceania Regatta Sapphire Princess – Mixed sewage and graywater Sapphire Princess – Graywater only	Seven Seas Navigator Silver Shadow Star Princess Statendam Volendam Zaandam

Table 16: Vessel Discharge Characteristics

Vessel Discharge Characteristic	Range of Values
Discharge rate (maximum for each ship estimated)	0.0022 – 0.0139 cubic meters per second (m^3/s)
Discharge port diameter (internal)	0.06 – 0.2 meters
Discharge exit velocity	0.22 – 2.936 meters per second (m/s)
Discharge port depth below waterline	0.4 – 6.3 meters

F.3.4 Discharge Scenarios Considered

Modeling of cruise ship wastewater discharges was conducted on effluent discharges for the 16 ships that were permitted to discharge in Alaskan waters in 2013 and had effluent sampling data during the time period of 2008–2012. For two of the ships both mixed (sewage and graywater) discharges and graywater only discharges were modeled since those two ships had a split system in which they were able to discharge different types of effluent at different times. As a result, a total of 18 ship scenarios were modeled.

F.3.5 Pollutants of Concern and Effluent Data

The potential pollutants of concerns evaluated for the available dilution were: TRC, ammonia, dissolved copper, dissolved nickel, and dissolved zinc. The dataset used for CORMIX modeling consisted of effluent sampling data submitted by permittees on Discharge Monitoring Reports (DMRs) within the 5 year timeframe of 2008-2012. Data from 2010 that was rejected due to QA/QC issues were not included in the dataset.

F.4. Inputs for Mixing Zone While Moving at Under 6 Knots

The default values for CORMIX, vessel characteristics, and pollutants of concern from the 6 knots or greater mixing zone size analysis were used for the under 6 knots mixing zone.

F.4.1 Discharge Scenarios Considered

For each ship scenario, the two pollutants of concerns that were most likely to dictate mixing zone size, ammonia and dissolved copper, were modeled for the worst case under 6 knots scenario of discharging when docked (i.e., speed of zero knots). All 18 ship scenarios were modeled for discharges at two harbors under unbounded conditions (i.e., discharges away from shore and at two ambient velocities. The two harbor (Juneau and Skagway) were deemed to be representative of the range of discharge scenarios for ships moving at speeds under 6 knots. All ships were also modeled for discharges at a speed of 6 knots.

F.4.2 Harbors Evaluated

Juneau and Skagway harbors were the focus of this project's CORMIX modeling. Juneau and Skagway are two of the top three cruise ship ports in Alaska and have been identified by the Department as having the potential for limited mixing; therefore, they can be considered worst case scenarios for in port discharges. In addition, these two ports have multiple docks that are close together. Ketchikan harbor, the second most visited port, has multiple docks located close together as well, but is open-ended and has higher current velocities.

Ambient data for the harbors are from a variety of sources. Temperature and salinity data for determining density were collected by DEC staff, tidal data were obtained from National Oceanic and Atmospheric Administration (NOAA) web sites, and ambient concentrations of pollutants of concerns were based on data compiled by CPVEC staff (DEC 2012, Ambient Dissolved Metals and Ammonia Data for Alaska Marine Waters).

F.4.3 Ambient Temperature, Salinity, and Density Profiles

Available temperature and conductivity data for the receiving waters in the Juneau and Skagway harbors were used to determine density. Temperature and conductivity readings were taken in Juneau in July 2013 at low tide and high tide and at two locations close to where cruise ships dock. Values typically vary because moving water is dynamic and eddies and currents not obvious from surface observation exist. To determine a density profile for the Juneau harbor, the four sets of readings were graphed and best professional judgment was used to choose one profile. It was determined that a linear density stratification where the water becomes denser with depth could be used to represent Juneau harbor (CORMIX Profile type A). Surface density was the same for all ships and bottom densities for each ship were actual data that corresponded with each schematized bottom.

For Skagway, temperature and salinity readings were used from the DEC and EPA study of cruise ship discharges in July 2008. The calculated densities were graphed and best professional judgment was used to choose a profile to represent the Skagway harbor. The data showed that the Skagway harbor receiving water had a uniform density down to at least 6.5 meters in depth. Of the ships evaluated in this project, the maximum depth of a ship's discharge pipe was 6.3 meters from the surface; therefore, a uniform density was chosen as the CORMIX Profile. An average of the calculated densities from the surface to 6.5 meters was used for all ships.

F.4.4 Ambient Water Depths

Water depths at high tide were estimated using tidal information and reported low tide depths. Data characterizing the temperature and salinity in each harbor was only available to a depth of 10 meters except at one dock during low tide when data only goes to 8 meters because that was the measured depth at low tide. Preliminary modeling indicated that there was no difference between results obtained for low and high tide conditions because the effluent discharges occur near the surface and the plumes do not come in contact with either the true bottom or the schematized bottom. A depth change based on low or high tide conditions would not be a factor. The depth of water used for dilution would always be the top 4 –8 meters depending on the depth of the discharge pipe. Low tide conditions were used in all modeling runs.

In order to run the CORMIX model the discharge port must be located within the top (slightly submerged discharge) or bottom (deeply submerged discharge) 1/3 of the water column. The model does not allow it to be located within the middle 1/3 of the water column. About half of the ship scenarios modeled had discharge ports located in the middle 1/3 of the water column. To account for this, an artificial "bottom" depth was entered for the model runs for those ships. This did not affect the output from the model because the "schematized" bottom depth was always below the discharge port depth, and since the plume was buoyant it always rose within the water column. The modeled plumes stayed above the depth of the discharge port and did not interact with the bottom.

F.4.5 Ambient Tidal Currents

EPA has a Technical Support Document (TSD) in which there is a recommendation for the tidal current to be used to model discharges to tidally influenced waters. At Section 4.4.2 Critical Design periods for Waterbodies, 4) Oceans, it states: The 10th percentile value from the cumulative frequency of each parameter should be used to define the period of minimal dilution. For the purposes of modeling DEC uses the upper and lower 10th percentiles for the current based upon the cumulative velocities in a tidal cycle.

For the CORMIX modeling runs using Juneau harbor as the receiving water, predicted daily maximum currents at a depth of 3.99 meters (13.1 feet) for the months of May through September of 2013 from NOAA were used. As a result of tidal harmonics, the following results are also obtained using May through September data in 2014, 2012, 2011, and 2010. Data was available for two locations in Gastineau Channel. Only data from one location was used because the second location was located at a point where the channel narrowed and the current velocities were higher than what would be expected in the harbor. Due to the sinusoidal nature of tidal currents, the current velocity is close to the maximum velocity the majority of the time. Since the cumulative frequency distribution was not available for tidal current, the 90th percentile and 10th percentile of the maximum tidal current was used. The maximum predicted tidal current velocity was determined to be 0.566 meter per second (m/s), the 90th percentile was determined to be 0.50 m/s, and the 10th percentile was 0.06 m/s.

For Skagway harbor CORMIX modeling runs, predicted daily maximum currents for the months of May through September in 2013 from the NOAA were used. Data from the location closest to the cruise ship dock was used (Taiya Inlet). The maximum predicted tidal current velocity was determined to be 0.154 m/s and the 90th percentile was determined to be 0.15 m/s and the 10th percentile was 0.05 m/s.

F.4.6 Ambient Concentrations of the Pollutants of Concern

The following background ambient concentrations in Table 17 were used in CORMIX modeling:

Table 17: Ambient Concentrations for Pollutants of Concern

Location	Ammonia (mg/L)	Dissolved Copper (μg/L)	Dissolved Nickel (μg/L)	Dissolved Zinc (μg/L)
Juneau Harbor	0.021	0.61	0.97	1.6
Skagway Harbor	0.021	2.6	1.14	37

Site specific data were not available for ammonia for Skagway Harbor. Therefore, the ammonia value obtained for Juneau Harbor was used for Skagway. This value was based on data collected in Gastineau Channel from 1989-1991 (Echo Bay Alaska, Inc., 1991).

Total recoverable data for copper, nickel and zinc from data collected in 1989-1991 were used in modeling. (Echo Bay Alaska, Inc., 1991) Dissolved sample data for the metals that are parameters of concern were not available for Gastineau Channel. The total recoverable metals data was converted using the values of 0.83 for copper, 0.99 for nickel, and 0.946 for zinc. The conversion factors were obtained from the Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances which is adopted by reference in 18 AAC 70.020(b). An average was obtained based on each dataset. (See Appendix E. Reasonable Potential Analysis).

An exact value for dissolved copper was not available for Skagway Harbor. Samples analyzed in 2008 were below the detection limit of 2.6 μg/L, with the exception of a reference site sample which was below a detection limit of 5.3 μg/L (DEC and EPA Region 10, 2009). A value of 2.6 μg/L was used in CORMIX modeling. It should be noted that this was a very conservative use of the available data for ambient dissolved copper.

While using a copper value of 2.6 μg/L for Skagway Harbor may appear excessively conservative as compared to the value of 0.61 μg/L for Juneau Harbor, this did not result in unreasonable findings. In 12 of the 18 Skagway modeling scenarios, ammonia was the parameter that needed the largest dilution to meet water quality criteria. In three scenarios, copper needed more dilution than ammonia to meet water quality criteria, but the dilution was achievable in less than 10 meters which is a smaller distance than that required for ammonia in the first 12 scenarios. In the final three scenarios, both ammonia and copper needed even more dilution that would equate to a chronic mixing zone size of hundreds of meters; however, exceedance of acute WQC requirements prohibits mixing zones of that size for the conditions in Skagway.

A dissolved zinc value of 37 μg/L was used in CORMIX modeling for Skagway Harbor. This value was based on 2007 sampling (DEC and EPA Region 10, 2008). It should be noted that samples collected in 2007 were not filtered in the field. Therefore, the value may represent total recoverable zinc rather than dissolved. Dissolved nickel samples collected in Skagway in 2007 were not filtered in the field, and were rejected by project researchers due to levels higher than total recoverable levels (DEC and EPA Region 10, 2008). The total recoverable nickel value from the study was used because it was the only data available.

F.4.7 Vessel Characteristics and Effluent Characteristics

Vessel characteristics are as described above in Section F.3.3.

F.5. CORMIX Results

F.5.1 Dilution Required to Meet Water Quality Criteria

The amount of dilution required to meet WQC depends not only on the effluent concentration and the applicable WQC, but also on the amount of that parameter that naturally exists in the receiving water. If ambient levels are high, the dilution needed to meet WQC is higher than if there were no pollutant present in the receiving water.

Although the dilution required depends on the effluent concentration, the WQC for the pollutant, and the concentration of the parameter in the receiving water, these factors do not influence the way a discharge plume physically interacts with the receiving water. Once it has been determined that a ship can obtain a dilution at a particular distance from the point of discharge this holds true no matter the pollutant reviewed.

DEC determined that dissolved nickel and dissolved zinc did not need to be modeled. For each ship, the dilution required to meet chronic WQC for dissolved nickel was compared with the dilution available at different distances from the point of discharge to determine whether that pollutant would drive the mixing zone size. In all scenarios it was determined that dissolved nickel and dissolved zinc would reach chronic WQC within a 10 meter mixing zone.

F.6. Compliance with Acute Aquatic Life Criteria

As per 18 AAC 70.240(d)(8), the size of the zone in which acute aquatic life criteria are exceeded (smaller initial mixing zone) was evaluated for all 18 scenarios for the 16 ships modeled. The Department's *Implementation Guidance: 2006 Mixing Zone Regulation Revisions* (DEC 2009), available at http://dec.alaska.gov/water/wqsar/wqs/mixingzones.html, was used to select a method for determining whether the requirement was being. Method 3 (a drifting organism reaches the acute mixing zone boundary in 15 minutes or less) was chosen. CORMIX was used to determine which ships would require longer than 15 minutes to reach the acute aquatic life WQC and what length of time is required to meet acute aquatic life. Most ships meet the acute aquatic life within 15 minutes. Mixing zones will not be authorized for ships that cannot meet the acute aquatic life criteria.

F.7. Analysis and Findings for 6 Knots of Greater Mixing Zone

F.7.1 Driving Parameter

An analysis of available dilution was performed for all ships when discharging at knots or greater. The analysis determined that ammonia required the most dilution to meet chronic WQC in the receiving water, and therefore ammonia was the driving parameter that determined the mixing zone size in all cases. The maximum observed effluent ammonia value was used along with the minimum available dilution across all ships to determine the mixing zone size. This approach was sufficient to set a mixing zone size in the Permit for the class of ships with AWTS.

F.7.2 Findings

The most restrictive WQC (ammonia chronic criterion) will be met in less than 21 seconds or 63 meters aft (to the rear of the ship) of the discharge port. As the discharge port of a large cruise ship is typically 100 meters from the stern (midship to a typical large cruise ship), this means the chronic WQC for ammonia will be met before the discharge reaches the stern. The width of the discharge plume will be 5 meters or less, and the depth extends from the surface to 1 meter below the discharge port. Modeling indicated that a rectangular mixing zone shape appropriately characterizes discharges at these speeds, with one end of the rectangle located at the discharge port and the rectangle extending along the side of the ship towards the stern. This rectangular mixing zone moves with the ship and represent the maximum size (63 meters long, 5 meters wide, and depth of the discharge port plus 1 meter) and time (21 seconds) that the waterbody that could exceed WQC due to any one cruise ship discharge at one time. Overlap of mixing zones for ships discharging at speed of 6 knots or greater are considered by the Department as not reasonably likely, to impossible, to occur as ships are never in this close proximity to each other while moving at 6 knots or greater. Therefore a greater than 6 knots mixing zone size of 63 meters by 5 meters is authorized. Additionally, once a discharged pollutant reaches the stern of the ship, the turbulent wake results in an additional 700:1 dilution factor.

F.8. Analysis and Findings for Under 6 Knots Mixing Zone

F.8.1 Driving Parameter

Because of the much smaller available dilution when docked, both the vessel-specific discharge characteristics and effluent characteristics become important. Ammonia and occasionally copper were the driving parameters in determining the mixing zone size for a particular ship. Initially the maximum effluent concentrations for each ship were used to determine the available dilution and the mixing zone size. However, the mixing zone sizes required to meet chronic WQC with maximum effluent concentrations could not be authorized because they were so large that several ships 1) could overlap with other mixing zones and potentially cause or contribute to an exceedance of WQC and 2) there was the potential for direct effects on aquatic life within the mixing zone.

The 95th percentile of ammonia and dissolved copper were used to establish the mixing zone size for speeds of under 6 knots, in order to meet WQC for ammonia and dissolved copper and to avoid overlapping other mixing zones. No outliers were identified. The ranges of the ships' 95th percentiles are identified in Table 18.

Table 18: 95th percentiles for Pollutants of Concern in Cruise Ships Effluent

Pollutant	Range of Values	WQC (chronic/acute)
Ammonia [a]	1.42 mg/L – 126.5 mg/L[b]	1 mg/L / 6.2 mg/L
Dissolved Copper	3.22 µg/L – 143.5 µg/L [c]	3.1 µg/L / 4.8 µg/L
Dissolved Nickel	8.70 µg/L – 72.8 µg/L	8.2 µg/L / 74 µg/L
Dissolved Zinc	42 µg/L –321 µg/L	81 µg/L / 90 µg/L

Notes:

a. Ammonia standard was based on a pH of 8.2, a salinity of 20 g/kg, and a temperature of 10-15 °C.
b. mg/L = milligram per liter
c. µg/L = microgram per liter

F.8.2 Mixing Zone Size

The 95th percentile of ammonia and dissolved copper were used to establish the mixing zone size for speeds of under 6 knots, in order to meet WQC for ammonia and dissolved copper and to avoid overlapping other mixing zones. CORMIX modeling results showed all ships that could meet applicable WQC within 100 meters could also meet applicable WQC at or within 83 meters. Therefore, mixing zone for most ships discharging at speeds under 6 knots was set at an 83 meter radius (relative to the discharge port) to account for the changing direction of tidal currents and depth extending from the surface to 1 meter below the discharge port in the Permit. The tidal current will change direction as it moves from a flood to an ebb tide and vice versa. The mixing zone size needs to be a radius of 83 meters to accommodate the shift in discharge plume to either side of the discharge port fore, aft, or any angle in between.

The under 6 knots mixing zone boundaries, which are based upon a docked ship discharging during the 10th percentile tidal current, were used to conservatively assess whether all existing and designated uses would be met for all wastewater discharges while moving at any speed under 6 knots. The actual mixing characteristics of discharge that occurs while moving at under 6 knots but not stationary will be intermediate between the moving mixing zone for 6 knots or greater and the stationary mixing zone for under 6 knots. The Department found that all existing marine water body uses will be maintained and protected. For example, the Douglas Island Pink and Chum fish hatchery net pens near the Thane-Sheep Creek estuary are outside the mixing zone boundaries for cruise ship discharges, even if a cruise ship was essentially stationary in the shipping channel. Cruise ship wastewater discharges would not expose the net pens to concentrations exceeding aquatic life criteria.

After considering possible docking configurations between cruise ships, including stern to stern and side to side, the Department determined that mixing zones no larger than 100 meters would prevent overlap of mixing zones in all ports except Skagway. For Skagway, there was significant potential for overlap if discharges were simultaneous permitted at Broadway Dock and Ore Dock. Thus, the Permit restricts the mixing zone size further to a 15 meter radius when discharging at either Broadway Dock or Ore Dock. Dissolved nickel chronic and acute WQC were met for all ships within a 10 meters. This was true even at the conservative ambient concentrations used to determine dilution requirements. These sizes were determined to be as small as practicable for the ships modeled that would also not result in overlapping mixing zones for multiple docked ships.

For modeling purposes, the aerial shape of the chronic mixing zone while a ship is moored is considered to be a semicircle centered on the discharge port. However, the actual aerial shape seen depends on the ambient current velocity and direction. Unless a discharge occurs during a slack tide, the mixing zone will actually resemble a cone with the narrow end at the discharge port and a plume that widens and flattens out as it moves away from the discharge port. Therefore, the chronic mixing zone will almost never fill the semicircle around the discharge port, but will constitute only a cone-shaped slice of the semicircle.

F.8.3 Effect of Discharge Exit Velocity

Discharge velocity greatly affects the interaction of the discharge plume with the receiving water. While the hydrodynamic mixing process between the discharge plume and the receiving water occurs within the near-field and far field, the near-field is the region of receiving water where the initial characteristics of the momentum flux, buoyancy flux, and outfall geometry influence the jet trajectory and mixing of an effluent discharge. In the near-field region the outfall conditions are most likely to have an effect on plume's behavior. As the plume travels further away from the source, the source characteristics become less important and conditions existing in the ambient environment will control the trajectory and dilution of the plume through buoyant spreading motions and passive diffusion due to ambient turbulence. This region is referred to as the far-field.

As shown in Figure 12, the range of source characteristics (see Table 16) result in significant differences in available dilution, for discharges while stationary, among large cruise ships (i.e., the spread between the different lines) within the first ten meters or the smaller initial mixing zone. As the distance from the discharge port increases, the differences between the cruise ships remains fairly constant showing the greater influence of the ambient environment as the discharge moves from the near-field to the far-field.

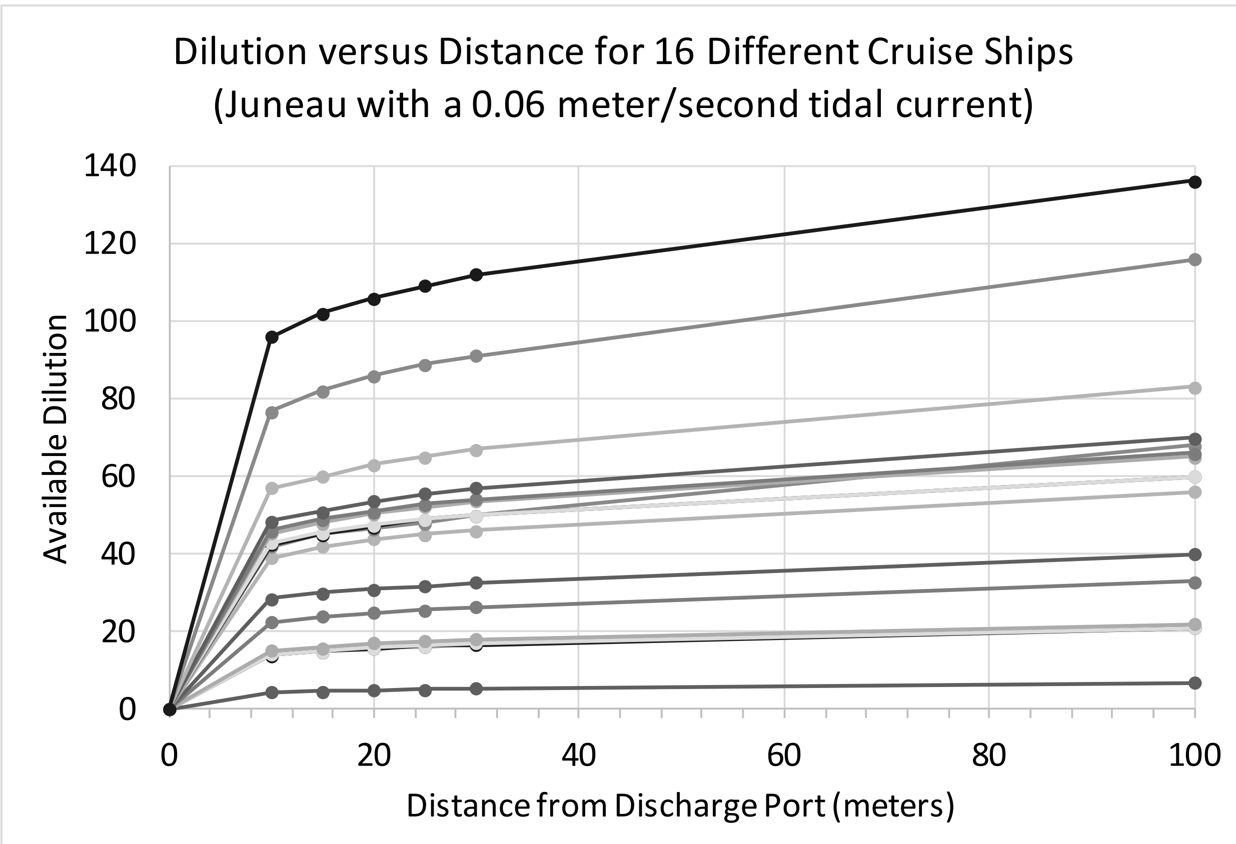

Figure 12: Available Dilution as a Function of Large Cruise Ship Characteristics and Distance from Discharge Port When Stationary

Due to varying discharge characteristics, the ship that has the highest dilution requirement may not be the one that requires the largest mixing zone. If the discharge has a high initial discharge velocity it is able to entrain water by jet turbulence, whereas a vessel with a low exit velocity may still have a relatively high concentration of pollutants at the termination of jet turbulence when it entrains ambient water by diffusion and ambient eddies, which occurs far more slowly than the jet turbulence entrainment.

Due to the effluent's density and temperature, the discharges from all ships reviewed in this project were positively buoyant with respect to the ambient seawater. The plume possesses initial momentum by virtue its discharge velocity. This combination of properties creates a buoyant jet, instead of either a "pure" jet (no buoyancy) or a "pure" plume (no initial momentum). As the buoyant jet rises, its momentum is dissipated in turbulence and its density increases, as it mixes with the surrounding water.

Ships with a higher discharge velocity have a plume that is initially carried out and away from the side of the ship and water is entrained by jet turbulence from both sides of the plume, resulting in a mixing zone size less than that which occurs with a slow exit velocity. With low exit velocities the plume hugs the side of the ship, there is minimal jet turbulence entrainment, and the plume can only entrain ambient water from one side of the plume. This occurs at a slow rate in the "far field" from diffusion and ambient water eddies.

F.9. Discharges towards Shore

While a cruise ship is docked, wastewater discharges towards shore are intermittently constrained by both the ship and the shoreline rather than only by the ship. As a result of this additional boundary, the rate of mixing can be restricted for certain discharges. In CORMIX, a bounded channel is defined as "an ambient environment in which the plume is likely to interact with both lateral banks within the region of interest." This scenario is often referred to as a bounded discharge when the receiving waterbody is constrained to the point that the discharge plume has the potential to completely traverse across the waterbody.

However, this scenario does not apply to cruise ship discharges when docked and discharging towards shore since the volume of water between the ship and shore represent only a portion of the waterbody. The constrained volume between the ship and shore is still capable of mixing at either end of the ship. In order to avoid potential overlap of discharge plumes from ships docked and simultaneously discharging towards shore, the maximum authorized mixing zone size is less than 100 meters and was determined to be 83 meters in practice.

F.9.1 Unsteady State Modeling

Unsteady state flows are those which occur during a tidal reversal, when the plume reverses upon itself. In order to model this, current velocities at the time of the desired analysis are needed (e.g. 30 minutes after slack tide). The modeler did not have this data for either Juneau or Skagway. It should be noted that whenever the time to reach WQS during a low ambient velocity scenario is greater than approximately 60 minutes the modeling results are not accurate because the amount of time spent at one velocity is not generally that long.

To represent a low ambient velocity, the 10th percentile value from the cumulative frequency curve was used; 0.06 m/s was used in Juneau models and 0.05 m/s was used in Skagway models. However, the tidal velocity would not remain at this low velocity for longer than about 60 minutes. That would include a time period prior to a slack tide, slack tide, and time period after slack tide. As the tidal current increases, mixing also increases and the time to meet WQS would decrease.

DEC did not have the data needed to modify CORMIX to run as an unsteady state model. However, worst case modeling results indicated that discharges that did not reach WQS within 60 minutes were already larger than 83 meters at 30 minute; thus such discharges would not be authorized even if tidal velocity, and mixing, increases rapidly after 60 minutes.

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Appendix G: Mixing Zone Analysis Checklist

The table below outlines those items in State of Alaska regulations (18 AAC 70.240) that must be considered in order for the Department to authorize mixing zones for cruise ship wastewater discharges. The majority of the items are considered on a large scale, for the mixing zones described in the Permit. However, whether the acute WQC are met within the smaller initial mixing zone and whether chronic mixing zone size restrictions are met is specific to individual applicants and will be considered once NOIs (applications) are received by the Department.

18 AAC 70.240. Mixing Zones (only sections that apply to marine waters and require analysis are included here).

(b) In determining whether to authorize a mixing zone under this section, the Department will **consider**:

Criterion	Considered?	Resources used to consider
Characteristics of the receiving water	Yes	Ambient data collected directly for Juneau and Skagway harbors and past studies conducted in AK marine waters (e.g., Skagway, Gastineau Channel, Hawk Inlet).
Characteristics of the effluent	Yes	Sampling results, VSSPs, NOIs, CORMIX modeling
Cumulative effects of multiple discharges	Yes	Regulate behavior (e.g., WQC are met at boundaries of mixing zones(MZs)) to avoid cumulative effects. Overlapping mixing zones prohibited when under 6 knots and will not occur in any meaningful way when moving at 6 knots or greater (i.e., don't overlap in time). Later criteria address bioaccumulation, etc.
Additional measures that would mitigate potential adverse effects to the aquatic resources present	Yes	Whole effluent toxicity testing and receiving water monitoring required for discharges to approved mixing zones will at speeds under 6 knots.
Any other factors the Department finds must be considered to determine whether a mixing zone will comply with this section	Yes	No other factors required.

(c) The Department will approve a mixing zone, as proposed or with conditions, **only if** the Department finds that available evidence reasonably demonstrates that:

Criterion	Sub criterion	Available Evidence Demonstrates?	Evidence
Treatment methods are the most effective, technologically and economically feasible.	---	Yes	Science Advisory Panel, HB80
Treatment methods are at a minimum consistent with statutory and regulatory treatment requirements including:	(A) any federal technology-based effluent limitation	Yes	40 CFR 133.102 33 CFR Part 159 Subpart E (Title XIV—Certain Alaskan Cruise Ship Operations" contained in section 1(a)(4) of Pub. L. 106-554) 2013 EPA Vessel General Permit Coast Guard certifies. If approved by federal agency, consider this requirement met.
	(B) minimum treatment standards in 18 AAC 72.050	N/A	18 AAC 72.050 does not apply to the Permit.
	(C) any other more stringent state statute or regulatory treatment requirements	Yes	More stringent state treatment requirements for commercial passenger vessels do not exist.
Designated and existing uses of the waterbody as a whole will be maintained and protected	---	Yes	Achieved through size and location of approved MZ plus the requirement that acute WQC are met at boundaries of smaller initial MZ and chronic WQC are met at boundaries of the larger, chronic MZ. Antidegradation analysis
The overall biological integrity of the waterbody will not be impaired	---	Yes	Achieved through size and location of approved MZ plus the requirement that acute WQC are met at boundaries of smaller initial MZ and chronic WQC are met at boundaries of the larger, chronic MZ.

Criterion	Sub criterion	Available Evidence Demonstrates?	Evidence
The mixing zone will **not**:	(A) result in an acute or chronic toxic effect in the water column, sediments, or biota outside the boundaries of the mixing zone	Yes	The established mixing zone size is expected to adequately protect the integrity of the water column, sediments, and biota outside the mixing zone boundaries.
	(B) create a public health hazard	Yes	The mixing zone will not occur in water supply or contact recreation areas. The most restrictive ammonia and dissolved metal WQC that require a MZ are aquatic life based. Bacteria and total suspended solids requirements are human health related and met at end of pipe.
	(C) preclude or limit established processing activities or established fish and shellfish harvesting	Yes	The established mixing zone size is expected to adequately prevent effects on established processing activities or established fish and shellfish harvesting in the area.
	(D) result in a reduction in fish or shellfish population levels	Yes	Due to the transient nature of vessel discharges, population level effects are not expected.
	(E) result in permanent or irreparable displacement of indigenous organisms	Yes	Due to the transient nature of vessel discharges, permanent or irreparable displacement of indigenous organisms is not expected. Discharge plumes are buoyant, rise to surface, and are not expected to affect benthic organisms.

Criterion	Sub criterion	Available Evidence Demonstrates?	Evidence
	(F) adversely affect threatened or endangered species	Yes	Threatened or endangered species are not expected to be adversely affected. MZ size and location ensures no toxicity to these species. http://www.fws.gov/alaska/fisheries/endangered/listing.htm http://www.adfg.alaska.gov/index.cfm?adfg=specialstatus.akendangered
	(G) form a barrier to migratory species or fish passage	Yes	Overlapping mixing zones prohibited; areas can be avoided by fish and migratory species, if necessary.

(d) The Department will approve a mixing zone, as proposed or with conditions, **only if** the Department finds that available evidence reasonably demonstrates that within the mixing zone the pollutants discharged **will not**:

Criterion	Available Evidence Demonstrates?	Evidence
Bioaccumulate, bioconcentrate, or persist above natural levels in sediments, water, or biota to significantly adverse levels, based on consideration of bioaccumulation and bioconcentration factors, toxicity, and exposure	Yes	While metals bioaccumulate, the discharges contain low level of metals that are not expected to bioaccumulate to adverse levels. Data from other discharge has not demonstrated evident that metals are bioaccumulating.
Present an unacceptable risk to human health from carcinogenic, mutagenic, teratogenic, or other effects as determined using risk assessment methods approved by the Department and consistent with 18 AAC 70.025	Yes	Past effluent sampling results (arsenic, mercury, chromium, benzene, thallium, vinyl chlorine, etc). Cancer threshold for chronic human health WQC has been developed to make sure it is protective.
Settle to form objectionable deposits, except as authorized under 18 AAC 70.210	Yes	Past effluent sampling results (settleable solids) indicate objectionable deposits will not form under current limits.
Produce floating debris, oil, scum, and other material in concentrations that form nuisances	Yes	Past effluent sampling results (TSS, SS, oil and grease) indicate objectionable deposits will not form under current limits. No past visual reports recorded.
Result in undesirable or nuisance aquatic life	Yes	No complaints recorded.
Produce objectionable color, taste, or odor in aquatic resources harvested from the area for human consumption	Yes	No complaints recorded.
Cause lethality to passing organisms	Yes	Based on the analysis and the modeling effort to determine whether the MZ is appropriate per the factors in implementation guide for 2006 MZ regs. WET testing results can be used to monitor and check expectations.
Exceed acute aquatic life criteria at and beyond the boundaries of a smaller initial mixing zone surrounding the outfall, the size of which shall be determined using methods approved by the Department	Yes	To be determined for each ship using Method 3 on page 9 of DEC's Implementation Guidance: 2006 Mixing Zone Regulation Revisions (2009).

(k) The Department will approve a mixing zone, as proposed or with conditions, **only if** it finds the mixing zone is as small as practicable and will comply with the following size restrictions, unless the Department finds that evidence is sufficient to reasonably demonstrate that these size restrictions can be safely increased:

Criterion	Sub criterion	Criterion Met?	Resources
Mixing zone is as small as practicable.	---	Yes	The MZ sizes in the Permit meet the "as small as practicable" requirement in 18 AAC 70.240 by limiting the MZ sizes to be no larger than necessary to concurrently meet WQC and all other mixing zone requirements at the boundaries of the MZs.
For estuarine and marine waters, measured at mean lower low water: These requirements could trigger a limitation on the number of ships allowed to discharge simultaneously in port, based on the size of their mixing zones. Limitations would be port specific. "unless the department finds that evidence is sufficient to reasonably demonstrate that these size restrictions can be safely increased"	(A) the cumulative linear length of all mixing zones intersected on any given cross section of an estuary, inlet, cove, channel, or other marine water may not exceed 10 percent of the total length of that cross section	Yes	Discharges constitute a small portion of each harbor where discharges routinely occur. The limitation on size to prevent overlapping discharges prevents these criteria from being exceeded.
	(B) the total horizontal area allocated to all mixing zones at any depth may not exceed 10 percent for the surface area		

Appendix H: Antidegradation Analysis

The Antidegradation Policy of Alaska Water Quality Standards (18 AAC 70.015) states that existing water uses and the level of water quality necessary to protect existing uses must be maintained and protected. This section analyzes and provides the rationale for the Department's decision in the Permit issuance with respect to the Antidegradation Policy.

The State Antidegradation Policy (18 AAC 70.015) addresses three categories of waters.

There are three levels of protection in the antidegradation policy. These are commonly referred to as "tiers," even though the regulation itself does not use that term. The level of protection afforded to a particular waterbody, or portion of a waterbody, depends upon which tier applies to it. The higher numbered tier indicates a greater level of water quality protection.

- Tier 1 (18 AAC 70.015(a)(1)) states that existing water uses and the level of water quality necessary to protect existing uses must be maintained and protected. This is the minimum level of protection under the antidegradation policy.
- Tier 2 (18 AAC 70.015(a)(2)), for high quality waters, authorizes the lowering of water quality towards applicable criteria, where necessary for social or economic importance. The Tier 2 provision states that if the quality of water exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water that quality must be maintained and protected unless the Department, after receiving from the applicant all information reasonably necessary to make a decision, allows the reduction of water quality for a zone of deposit under 18 AAC 70.210, a mixing zone under 18 AAC 70.240, or another purpose as authorized in a Department permit, certification, or other approval. The Department may authorize a reduction of water quality only after the applicant submits information in support of the application, and the Department must make five findings. This is the next highest level of protection under the antidegradation policy
- Tier 3 (18 AAC 70.015(a)(3)) provides additional protection for water of exceptional ecological or recreational significance. This is the highest level of protection under the antidegradation policy.

There is insufficient information to make a reasonable determination of water quality on a parameter-by-parameter basis for all marine waters under the Permit. However, given the available information and for purposes of applying the antidegradation policy, the Department has conservatively assumed that all marine waters are high quality or Tier 2 for all parameters regulated under the Permit. Thus, all marine waters are treated as Tier 2 rather than Tier 1.

Need for Antidegradation Analysis

An antidegradation analysis was conducted during the development of the 2010 general permit. The need for an antidegradation analysis for the re-issued 2014 general permit is based on whether there will be new or additional lowering of water quality as compared to the 2010 general permit. Additional lowering of water quality may occur if there is a greater number or volume of discharges under the Permit or if the terms and conditions of the Permit result in a lower effluent quality being discharged.

In the Permit, the mixing zone regulations (18 AAC 70.240) have been formally applied to pollutants of concern resulting in more stringent limitations and conditions on discharges to mixing zones when moving at speeds under 6 knots (the limitations are similar for discharges at greater than or equal to 6 knots while the monitoring requirements are less stringent). While no lowering of water quality is anticipated given the conditions placed on authorized mixing zones, there is the potential for additional lowering of water quality as ships that previously did not discharge may now to choose to make use of the authorized mixing zones.

The other significant change in the Permit is that ships with AWTS are treated as a class. This results in setting single, class-based effluent limitations in the general permit for all ships with AWTS. The differences in effluent limitations are based on parameter (e.g., ammonia versus copper) and discharge scenario (e.g., no mixing zone versus an under 6 knots mixing zone) but not on treatment system manufacturer. While many ships will now operate under a class-based limitation that is less stringent than the system-based one in the 2010 general permit, good operation and maintenance as required by the Permit, should result in effluent quality similar to historical performance regardless of the class-based limitation. Therefore, no additional lowering of water quality is anticipated.

Overall, given the significant change of including mixing zones in the Permit, and the potential for additional lowering of water quality as ships that previously did not discharge may now to choose to make use of the authorized mixing zones, the Department chose to review and update the antidegradation analysis from the 2010 general permit.

Tier 2 Findings

The five required findings and the Department's determination are as follows:

18 AAC 70.015 (a)(2)(A). Allowing lower water quality is necessary to accommodate important economic or social development in the area where the water is located.

Necessity of Lowering Water Quality

Evaluating the necessity of lowering water quality has been a focal point for the Department since Ballot Measure 2 amended cruise ship wastewater statutes in 2006. As a result of the amended statute, the Department established a diverse eleven-member science advisory panel on cruise ship wastewater treatment (SAP) in 2009, and one of the panel's three mandates directly addresses the necessity question of lowering water quality. The Panel was tasked with determining whether there were additional economically feasible methods of pollution prevention, control, and treatment that could be employed to provide the most technologically effective measures to control all wastes and other substances in the discharge.

The panel included representatives from multiple countries and with expertise in wastewater plant design and operation; wastewater engineering and science; ship engineering, design and construction; environmental science; shipping economy; fisheries; and environmental policy. The panel met fifteen times and held one public technology workshop on September 20, 2012. Handouts and summaries from the panel meetings may be found at: http://dec.alaska.gov/water/cruise_ships/SciencePanel/index.htm.

At the meetings, panel members listened to presentations delivered by state and federal government officials, ship builders, academic scientists, economists, and wastewater engineers, and engaged them in discussions. The Department and panel members went onboard a cruise ship and looked at wastewater systems. They talked directly with vessel managers and crew about installing, maintaining and operating AWTSs. They also inquired about retrofitting vessels with new or add-on systems. They learned about and discussed the complexity of managing onboard wastewater treatment methods; state water quality criteria and how they apply to the cruise ship industry; detailed explanations about wastewater dilution studies; and the many varied sources of pollutants that can become a part of a vessel's waste stream. During the statutorily required public technical workshop, Department staff, panel members, and the general public had the opportunity for one-on-one interaction with visiting vendors and manufacturers of AWTSs.

The presentations and meetings helped panel members develop a solid foundation of the regulatory requirements; the challenges of wastewater treatment onboard ships; capabilities of existing and emerging treatment systems; economic issues associated with retrofitting existing ships; the quality of current discharges; and the relationship of wastewater discharges to the marine environment. Panel members also contributed to the design and data analysis of the 2012 DEC Data Collection Survey for Pollution Prevention, Control, and Treatment for Large Cruise Ships Operating in Alaska Waters (Appendix A of SAP 2012). Panel members also benefitted from public statements and from the one-on-one discussions. Public input has been constructive and prompted further work by the panel and Department that has been incorporated into the panel's and Department's reports.

This panel addressed the necessity of lowering water quality in its report (SAP 2012) as did the Department's in its Preliminary Report on Cruise Ship Wastewater (DEC 2013. The collective findings are summarized below:

Additional economically feasible methods of pollution prevention, control, and treatment that could be employed to provide the most technologically effective measures to control all wastes and other substances in the discharge

<u>Prevention</u>: Neither the Department nor the panel identified additional prevention methods above those identified in the source reduction evaluations, though both bodies are confident that dedication to source reduction can reduce pollutants that enter the water. Source reduction efforts varied in the level of implementation between vessels. Results of source reduction efforts were not clearly identifiable since the efforts were implemented in conjunction with other methods, resulting in an inability to attribute effluent improvement or degradation to source reduction efforts. In those cases where source reduction was undertaken, then later abandoned, there was no identifiable improvement or degradation in effluent results.

<u>Control</u>: Pollution control includes all actions taken or avoided in order to reduce pollution released into the environment. In the context of the panel'sreport, pollution control includes all other aspects of control not included in the prevention and treatment sections. These methods broadly include vessels discharging outside of state waters, discharge to shore-based facilities, and actions vessels' crews and passengers could take or avoid to prevent the release of pollutants into the water. In the pollution control category, none of the methods discussed are actually "new." The discussions below are in the context of refining methods, or introducing the methods for more widespread use.

Discharge outside of state waters: One alternative method for eliminating the necessity of direct lowering water quality in the State of Alaska is a "no-discharge in state waters" alternative. Many vessels that operate in Alaskan wasters often opt for this pollution control alternative. Those vessels that have built-in holding capacity that allows them to hold wastewater while transiting their current routes opt to refrain from discharging. When a vessel refrains from discharging in Alaskan water, they hold wastewater in onboard storage tanks and then later discharge in waters adjacent to Alaskan waters. While this alternative works for some vessels because of combinations of holding capacity and timing in relation to servicing profitable routes, it is not a practical alternative for all vessels. Nor is this alternative the best environmental practice since that wastewater that may be treated to lesser levels is then discharged, often very near Alaskan waters.

Several permitted and non-permitted vessels currently hold wastewater in tanks for discharge outside of State waters. The VSSP information provided by permitted vessels also indicates that most if not all vessels currently have the capacity to hold their wastewater until leaving State waters, though this would leave little margin for schedule delays or unanticipated increases in wastewater production. If cruise line companies want their vessels to hold more wastewater than they currently do, they will have to add or modify tanks and address vessel stability. This is further complicated by concurrent weight changes such as ballast water redistribution and fuel usage. Because of the more stringent ballast water requirements in the EPA VGP wastewater storage may compete with ballast water storage, affecting some vessels' ability to store wastewater even if they have been able to in the past.

Discharge to shore-based facilities: Another alternative is the discharge of wastewater to shore-based treatment facilities. The Department does not believe that discharge to a shore-based domestic wastewater treatment facility is a promising alternative. The premise of this method appears to rest on the assumptions that treatment at shore facilities is better (produces higher quality effluent) and that dilution of wastewater discharged to the marine environment from shore facilities is in some way superior to dilution from cruise ship discharges. There are a number of considerations that must be addressed before this could be a viable, widely used alternative.

- The discharged wastewater eventually enters the marine waters of the State.
- The cruise ship discharges would likely be classified by the Department as wastewater from “significant industrial users” since they are not exclusively sanitary waste and potentially include waste from galleys, pools, engine room shop sinks/drains, other shop sinks/drains, desalination brine, laundries and medical facilities. This would require the shore facility to address pretreatment.
- Shore facilities are designed to treat a specified influent concentration range of conventional parameters (for example, total suspended solids and biological oxygen demand). If cruise ships “pretreated’ using AWTS, the treated cruise ship discharges would be adding very clean water that would dilute the influent with low concentrations of conventional parameters. With dilute influent, biological treatment processes are less efficient, and shore facilities would likely have problems with BOD and TSS percent-removal requirements resulting in poorer effluent quality.
- The seasonal nature of the cruise industry and its discharges will likely cause problems for the on shore treatment plant at least twice per year; at the start and at the end of cruise season. Sewage treatment plants can be very sensitive to the quality of water entering the facility, which affects treatment performance. The balance of treatment (bacteria that degrade wastes versus waste) would require adjustments at least twice, and maybe more often during the cruise season and after.
- Untreated wastewater from cruise ships is very concentrated. When mixed with municipal wastewater, it will affect the treatment system significantly.

Good Operational Practices, Train, Maintain and Operate: The Permit requires permittees to develop and have available Operation and Maintenance Plans in order to prevent the unnecessary lowering of water quality in Alaska marine waters.

<u>Treatment</u>: The panel sought technical and cost information from vendors for potential treatment technologies. The panel looked at supplementing or replacing existing AWTS with other known treatment technologies that could be expected to further reduce ammonia and dissolved metal concentrations, such as

nitrification, ion exchange (IX), and reverse osmosis (RO). The panel was unable to identify technologically effective and economically feasible treatment methods capable of consistently meeting all numeric water quality criteria at the point of discharge and that have been proven effective on ships.

There are no readily available new technologies or methods that will result in cruise ship's consistently meeting water quality criteria at the point of discharge for ammonia, copper, nickel, and zinc. The Department concurs with this preliminary finding. The Department also recognizes that adapting emerging technologies from other industries to cruise ships presents significant feasibility challenges, and therefore additional methods will not be readily available to consistently use on cruise ships in the near future. The Department has substantial doubt whether any new system that could meet all water quality criteria at the point of discharge could become commercially available, much less installed on large commercial passenger vessels operating in Alaska, within the life of this permit. The Department concludes that it is necessary to allow cruise ships a means to discharge effluent that does not meet all WQC at the point of discharge and has the potentially lower existing high quality water to a small but discernible extent.

Economic Importance

According to the Alaska Department of Labor and Workforce Development's *Alaska Economic Trends, July 2012*, the Leisure and Hospitality industry employs nearly 34,000 Alaskans.

According to the report, *Economic Impact of Alaska's Visitor Industry, March 2010*, prepared for the Alaska Department of Commerce, Community & Economic Development (DCCED), the cruise industry created 1,800 year-round jobs in 2009 with a total payroll of $62 million. However, the number of Alaskans earning income from cruise-related employment is significantly higher because passengers buy products and services at local businesses that employ Alaskans.

The 2010 DCCED report indicates that nearly 1.6 million people visited Alaska in 2009. More than one million, or 65% visited Alaska by cruise ship. Based on the 2010 DCCED report, and the *Alaska Visitor Statistics Program VI: Summer 2011*, the total estimated annual spending of outside dollars in Alaska is $857 million, including visitor spending, vessel crew spending, Alaskan employee payroll, non-passenger cruise line spending on goods and services, and municipal fees. This total does not include taxes and fees paid by the cruise industry to the State of Alaska.

DEC finds that the importance of the cruise industry to local economic development is well documented, and that this criterion is satisfied.

18 AAC 70.015 (a)(2)(B). Except as allowed under this subsection, reducing water quality will not violate the applicable criteria.

The Permit limits preclude violating WQC in receiving waters, except within the boundaries of the approved mixing zones as provided in 18 AAC 70.015(a)(2). Methods used to derive effluent limits, including how the limits assure that WQC are met at and beyond the boundaries of the mixing zones, are described in the Effluent Limitations section. DEC finds that this criterion is satisfied.

18 AAC 70.015(a)(2)(C). The resulting water quality will be adequate to fully protect existing uses of the water.

"Existing uses" are defined in 18 AAC 70.990(24) as, "those uses actually attained in a waterbody on or after November 28, 1975." The Department concludes that all uses that existed before 1975 are present today and are protected by the designated uses applied to marine waters and the applicable water quality criteria.

Marine water quality is protected for aquaculture, seafood processing and industrial uses, for contact and secondary recreation; for growth and propagation of fish, shellfish, other aquatic life, and wildlife; and for harvesting for consumption of raw mollusks or other raw aquatic life. No waters in the Permit area have been reclassified to exclude certain uses from water quality protection. All designated uses are present today generally throughout the marine waters of the state covered by the permit, as they were prior to 1975.

The Department is not aware of any existing uses beyond the designated uses for marine waters or that would not be protected by the applicable criteria in place to protect the designated uses. Within these limited areas where water quality criteria might be exceeded for certain parameters, no impacts on uses are anticipated when discharging vessels are not present. Even when discharging vessels are present, there will be no impacts on recreational use that close to the cruise ships. Similarly, given the small size of the mixing zones and their seasonal and intermittent nature, there will be no population or community level impacts on growth and propagation of fish, shellfish, other aquatic life and wildlife. The Department finds that this criterion is satisfied.

18 AAC 70.015(a)(2)(D). The methods of pollution prevention, control, and treatment found by the Department to be most effective and reasonable will be applied to all wastes and other substances to be discharged.

The Department finds the most effective methods of prevention, control, and treatments are practices and requirements set out in the Permit and currently in use onboard these permitted vessels.

AWTS replaced or supplemented the long used Type 1 Marine Sanitation Devices (MSD I) as the predominant systems treating wastewater discharged by commercial passenger vessels. AWTS were designed to meet required criteria for conventional pollutants (i.e., biochemical oxygen demand, fecal coliform, and total suspended solids) and are the most advanced, effective, and proven treatment systems available. AWTS have been proven effective in meeting applicable WQC at the point of discharge for all parameters except ammonia and dissolved metals. The effluent quality of all of the AWTS is superior to wastewater treated through MSD I alone.

The Department and the cruise ship wastewater Science Advisory Panel researched additional methods of pollution prevention, control, and treatment and, as explained in the response above to the "necessary" requirement of 18 AAC 70.015(a)(2)(A), did not find additional methods that were technologically effective and economically feasible. One of the Science Advisory Panel's mandates was to identify "additional economically feasible methods of pollution prevention, control, and treatment the Department finds to be the most technologically effective." This requirement is functionally equivalent to the antidegradation policy requirement for "methods of pollution prevention, control, and treatment found by the Department to be the most effective and reasonable."

The Department has determined that AWTS satisfy this antidegradation policy criterion. Because the Permit requires the use of AWTS or other methods of pollution prevention, control or treatment that the

Department finds that will be comparable effluent quality to that achieved by one or more vessels employing AWTS, the Department finds that this criterion is satisfied.

18 AAC 70.015(a)(2)(E) (i). All wastes and other substances discharged will be treated and controlled to achieve, for new and existing point sources, the highest statutory and regulatory requirements.

The highest statutory requirements applicable to the Permit are state statutes found at AS 46.03.462(b), (e), ((h) and (j). The highest regulatory requirements are found within the various provisions of Alaska's Water Quality Standard regulations at 18 AAC 70. The Department created the Permit terms and conditions dealing with wastewater treatment and control to satisfy the combined requirements of the above provisions, with one exception discussed below.

Other applicable statutory and regulatory requirements are found in the Alaska wastewater disposal regulations at 18 AAC 72 and in U.S. Coast Guard regulations at 33 CFR Part 159 Subpart E. The permit's treatment and control requirements surpass the minimum treatment and other requirements of the Alaska wastewater disposal regulations.

The Permit's treatment and control requirements surpass those of the U.S. Coast Guard regulations with one exception, where it adopts the more stringent USCG requirement. U.S. Coast Guard regulations require that TRC in the treated effluent not exceed 10 μg/L. This requirement is more stringent than a TRC limit based on state chronic WQC after consideration of the authorized mixing zone sizes. The Permit therefore reflects the more stringent U.S. Coast Guard effluent limit for TRC as required to satisfy this provision of the antidegradation policy. With this limit, DEC concludes that this criterion is satisfied.

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Alaska Monitoring and Assessment Program: http://dec.alaska.gov/water/wqsar/monitoring/AKMAP.htm

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http://www.dec.state.ak.us/water/wqsar/waterbody/integratedreport.htm

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NOAA Tide and Current data: http://tidesandcurrents.noaa.gov/currents13/tab2pc3.html#37

EPA Marine Sanitation Devices: http://water.epa.gov/polwaste/vwd/vsdmsd.cfm

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