LYNNHAVEN RIVER BOAT WASTEWATER SAMPLING PROGRAM

LYNNHAVEN RIVER
VIRGINIA BEACH, VA
February 29, 2008

Prepared for: Department of Public Works
City of Virginia Beach

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VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

LYNNHAVEN BOAT WASTEWATER SAMPLING PROGRAM

February 29, 2008

INTRODUCTION

The Lynnhaven River including the Eastern Branch, the Western Branch, Broad Bay and Linkhorn Bay are listed as impaired waters by the Virginia Department of Environmental Quality. Among other impairments, the water quality standard for shellfish and for dissolved oxygen has not been met. Prior to 2007, boats were allowed to discharge wastewater directly to the water body provided the wastes were treated with a Coast Guard approved "Marine Sanitation Device" (MSD). MSDs macerate the sewage and then treat it with chemicals to reduce the bacteria count before it is discharged overboard. The bacteria count cannot exceed 1,000 per 100 milliliters for a Type I device and 200 per 100 milliliter for a Type II device. MSDs are not required reduce the nutrient level or the oxygen demand in the wastewater. The introduction of these boat wastes into an estuary such as the Lynnhaven River system not only increases the bacteria count, but also places an oxygen demand on the water body at a time of the year when the natural oxygen level is at its minimum due to water temperature and salinity.

As a part of the effort to improve the quality of the waters in the Lynnhaven Watershed, the City of Virginia Beach petitioned the Environmental Protection Agency through the Virginia Department of Environmental Quality to have waters of the Lynnhaven Watershed designated as a "No Discharge Zone". In the spring of 2007, the "No Discharge Zone" went into effect.

As a part of the "Boater Education and Pump Out Program", a boat waste pump out team was assigned specifically to the Lynnhaven Basin. The team was available on Fridays, Saturdays and Sundays for the period from Memorial Day to Labor Day, 2007. Pump outs could be scheduled at the home or boat slip of the boat owner. Over 1,000 gallons of wastewater was collected from boats in the Lynnhaven River and transported to a Hampton Roads Sanitation District (HRSD) wastewater plant for treatment. The pump out service is in addition to the pump out facilities provided by a number of marinas in the Lynnhaven River.

In order to evaluate the impact of previously permitted boat wastewater discharges and the discharges from an improperly functioning MSD or an illegal direct discharge, samples of the wastewater pumped from boats in the Lynnhaven were collected and sent to the HRSD laboratories for analysis. The laboratory testing included fecal indicator bacteria, oxygen demand, nitrogen and phosphorus. Fecal coliform is the bacteria used to evaluate the water quality standard for shellfish and enterococcus is use to evaluate the water quality for recreational use. Oxygen demand, nitrogen and phosphorus affect the level of dissolved oxygen in the waters.

BOAT WASTEWATER PUMP OUT PROGRAM

During the period from May 26 through September 3, 2007, fifty-four (54) boats had their wastewater holding tanks pumped out by the pump out team. The volume of wastewater collected was one thousand sixty-three (1,063) gallons and transported to the HRSD treatment plant. On average, twenty (20) gallons per boat was collected. Samples of the wastewater were collected on twelve occasions and delivered to the HRSD laboratory for analysis.

Copies of the Analytical Reports showing the results of testing for bacteria, oxygen demand, nitrogen, nitrites, nitrates and phosphorus are included in Appendix A. Table 1 on the following page lists the bacteria and pollutant levels by date for the summer of 2007. Appendix B shows the calculations to determine the volume of bacteria-free or pollutant-free water to necessary dilute the pollutant level to the required standard. .

Pump out facilities are available for all vessels including those that are not docked at the marinas in the Lynnhaven River. The marinas with pump out facilities are delineated in the "Lynnhaven River Watershed, Virginia Beach, Virginia, Applications for Federal No Discharge Zone Designation, Submitted to US Environmental Agency Region III by the Commonwealth of Virginia". This document is on file at the City of Virginia Beach Department of Public Works.

The Cavalier Golf and Yacht Club reported that there were 154 pump outs for a total of approximately 10,800 gallons in FY2006 and 299 pump outs for a total of approximately 21,000 gallons in FY2007. Note that the number of pump outs and the pump out volume nearly doubled from 2006 to 2007. A large portion of this increase is attributed to the No Discharge Zone designation and the associated publicity.

Table 1
LYNNHAVEN MARINAS BOAT WASTEWATER SAMPLING RESULTS

DATE	BOD Mg/l	COD mg/l	NO2,3 mg/l	TKN mg/l	TP mg/l	FECAL COLIFORM # / 100ml	ENTERO COCCUS # / 100ml	GAL PUMPED Gallons	Calls	REMARKS
6/8/07								75	1	
6/9/07								13	3	
6/10/07	2,890	5,000	0.20	2,290	113	29,000,000	>24,200	5	1	See note 1
6/29/07								0	0	
6/30/07								20	1	
7/1/07*	1,360	2,910	0.20	623	46	37,000	>24,200	60	3	See notes 1,2
7/6/07								0	0	
7/7/07								3	1	
7/8/07	3,740	8,660	0.44	1,670	141	46,000	>24,200	37	2	
7/13/07								75	1	
7/14/07	2,320	5,690	0.20	1,140	115	350,000	>24,200	68	1	See notes 1
7/15/07								15	1	
7/20/07	5,590	15,800	1.00	2,700	313	2,800,000	2,420,000	34	2	See note 3,4
7/21/07								8	2	
7/22/07	3,120	7,030	1.00	1,490	56	42,000,000	2,420,000	70	2	See note 3,5
7/27/07	1,850	4,590	1.00	1,230	118	42,000	1,200,000	25	2	See note 3
7/28/07	1,070	3,160	1700.00	2,860	56	10,800	166,000	25	2	
7/29/07								0	0	
8/3/07	2,880	6,260	1.00	1,320	84	1,310,000	308,000	90	3	See note 3
8/4/07	5,240	53,200	3.79	721	98	1,000	78,400	25	2	See notes 6,7
8/5/07								15	1	
8/10/07								0	0	
8/11/07								20	2	
08/12/07	2,940	6,410	40.00	1,360	50	230,000	687,000	50	3	See note 8
08/17/07								0	0	
08/18/07								0	0	
08/19/07	3,250	6,700	40.00	1,500	146	100,000	2,420,000	25	1	See note 9
Avg	3,172	11,136	163	1,662	117	7,578,980	1,212,425			
Total								758	37	
								20.5		Avg Gals/boat

NOTE 1 The reported number for NO2,3 was <0.20, the "<" was not included to allow averaging

NOTE 2 Improper preservation - sample not received on ice.
Values for all tests on this date are not included in the average

NOTE 3 The reported number for NO2,3 was <1.00, the "<" was not included to allow averaging

NOTE 4 The reported number for Entero was >2,420,000, the ">" not included to allow averaging

NOTE 5 The reported number for Entero was >2,420,000, the ">" not included to allow averaging

NOTE 6 The reported number for BOD was >5,240, the ">" was not included to allow averaging

NOTE 7 The reported number for Fecal Coliform was <1,000, the "<" not included to allow averaging

NOTE 8 The reported number for NO2,3 was <40, the "<" was not included to allow averaging
The high report limit for NO2,3 due to matrix interference

NOTE 9 The reported number for Fecal Coliform was <100,000, the "<"not included
Invalid result due to sample matrix interference. The result for FC not included in average

Table 2 below shows the comparison of the concentration of pollutants in boat wastewater to raw sewage entering and the treated sewage discharged from the Hampton Road Sanitation District Chesapeake-Elizabeth Wastewater Treatment Plant.

Table 2
BOAT WASTE POLLUTANT CONCENTRATIONS COMPARED TO RAW AND TREATED SEWAGE AT THE CHESAPEAKE ELIZABETH WASTE WATER TREATMENT PLANT

	POLLUTANT LEVEL				
	BOD mg/l	COD mg/l	Total Nitrogen mg/l	Total Phosphorus mg/l	Fecal Coliform #/100ml
Boat Wastewater Average	3,172	11,136	1,662	117	7,500,000
Raw Sewage to Chesapeake-Elizabeth Treatment Plant	242	463	38	5.7	ND
Treated Effluent from Chesapeake-Elizabeth Treatment Plant	1.5	ND	3.1	1.4	4
Ratio Boat Waste to Raw Sewage	13.11	24.05	43.74	20.53	ND

ND – Data not available

The concentrations of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are 13 to 24 times the concentrations in domestic wastewater. These concentrations are similar to those published by the Florida Department of Environmental Protection website which lists BOD levels in raw sewage to be 100 to 400 mg/l compared to boat sewage of 1700 to 3500 mg/l. The nitrogen and phosphorus concentrations in boat waste are 44 times higher and 20 times higher respectively than domestic wastewater. The marine sanitation devices used to treat boat wastes are not designed to reduce BOD, COD, nitrogen or phosphorus.

FECAL INDICATOR BACTERIA

Fecal Coliform - The water quality standard for shellfish waters is 14 fecal coliform bacteria per 100 milliliters (ml). The fecal coliform bacteria levels in the wastewater pumped from boats varied from as little as 1,000 per 100ml to a high of 42,000,000. The average fecal coliform count and the weighted average count were both approximately 7.5 million per 100ml. The median was 230,000 per 100 ml.

To illustrate the impact of one boat discharging its wastewater tank without any treatment directly into the Lynnhaven River, the average fecal coliform of 7.5 million per 100 ml multiplied by the average pump out volume of twenty gallons to determine the total fecal coliform discharged by one boat. Then the volume of clean, bacteria free water needed to dilute the total fecal coliform to the 14 per 100 ml required by the shellfish standards is calculated. The total fecal coliform bacteria count from a discharge of twenty gallons is 5.7 billion. The volume of bacteria-free water needed to dilute the fecal coliform bacteria to the shellfish standard is 33 acre feet or the equivalent of nearly 30 football fields at a depth of one foot.

If the wastewater were treated with a type I MSD, the total fecal coliform bacteria count from a discharge of twenty gallons would be 757,000. The volume of bacteria-free water needed to dilute the fecal coliform bacteria to the shellfish standard would be about 200 cubic feet.

Enterococcus – The standard for primary recreational waters for enterococcus is 104 per 100 ml. The enterococcus levels in the wastewater pump from boats varied from as little as 24,200 per 100ml to a high of 2,420,000. The average enterococcus count was approximately 1,212,000 per 100ml. The median was 1,200,000 per 100 ml. The total enterococcus count from a discharge of twenty gallons is 917 million. The volume of bacteria free water needed to dilute the enterococcus to the primary recreation standard is approximately 31,000 cubic feet or about two thirds of a football field at one foot of depth.

If the wastewater were treated with a type I MSD, the total enterococcus count from a discharge of twenty gallons would be 757,000. The volume of bacteria-free water needed to dilute the enterococci to the recreation standard would be about 20 cubic feet.

OXYGEN DEMAND

Biochemical Oxygen Demand (BOD) – The biochemical oxygen demand is the measure of oxygen required to stabilize the decomposable matter present in water by aerobic biochemical action. BOD used in this report is the five (5) day BOD. The BOD levels for the boat waste collected in the Lynnhaven River varied from 1,070 mg per liter to 5,490 mg per liter. The average for the period of testing was approximately 3,200 mg per liter. If a twenty gallon wastewater holding tank were discharged into the Lynnhaven River the total BOD loading would be about 0.53 pounds. The amount of water required to stabilize the BOD loading of 0.53 pounds such that the oxygen level in the water was only reduced by one part per million is 8,500 cubic feet or an area of about 85 feet by 100 feet at a depth of one foot.

Chemical Oxygen Demand (COD) – Chemical oxygen demand is the measure of the oxygen demand from biological process and other compounds which can be oxidized through chemical processes. The COD includes the BOD and therefore is always higher than the BOD. The COD levels for the boat waste collected in the Lynnhaven River varied from 2,900 mg per liter to 53,200 mg per liter. The average for the period of testing was approximately 11,100 mg per liter. If a twenty gallon wastewater holding tank were discharged into the Lynnhaven River to total COD loading would be about 1.83 pounds. The amount of water required to stabilized the COD loading of 1.83 pounds such that the oxygen level in the water was only reduced by one part per million is 30,000 cubic feet or an area of about 62 percent the size of a football field at a depth of one foot.

Marine sanitation devices are not designed to reduce the level of oxygen demand in the wastewater. MSD could increase the COD level in the discharge. Spills or discharges of poorly treated or untreated wastewater into confined or poorly flushed areas such as marinas or fingers can become oxygen depleted which is referred to as anoxic.

PHOSPHORUS AND NITROGEN

Phosphorus, nitrogen, nitrites and nitrates are nutrients which will lead to the growth of algae which will lower the content of the oxygen in the water way. The testing results for these chemical in the wastewater of the boat holding tanks are included in the table titled Lynnhaven River Boat Wastes Sampling Results located at the rear of this report. Oxygen reduction as a result of these nutrients is not easily calculated.

CONCLUSION

Based on the example described above, it is evident that the discharge of untreated or poorly treated boat wastewater from just one boat directly into the Lynnhaven River has a major impact to the surrounding waters. With MSD type I treatment, the bacteria and oxygen demand place a stress on the existing waters. The designation of the Lynnhaven River as a "No Discharge Zone" has and will lead to an improvement in water quality of the Lynnhaven watershed. In addition to the direct improvement in water quality, the public awareness has been raised significantly by the "No Discharge Zone "designation and the Boater Education and Pump Out Program. The pump out results from the Cavalier Golf and Yacht Club indicate an increase of about 100% since the "No Discharge Zone Designation" and the expansion of the Boater Education and Pump Out Program.

Within the Lynnhaven River system, there are approximately 400 vessels with wastewater holding tanks and 2700 vessels with portable toilets. Pump out stations are available for those boats docked at various marinas. These pump out facilities are also available to vessels not docked at the marinas including those boats docked at private riparian properties. The pollutant concentrations in boat wastes are 12 to 40 times that of domestic waste water. Given the impact of a direct discharge of boat waste, either untreated or treated through an approved marine sanitation device, the continuation of the Boater Education and Pump Out Program is essential to maintaining the water quality of the navigable waters of Lynnhaven Watershed.

ACKNOWLEDGEMENTS

The Boater Education and Pump Out Program was operated by the Hampton Roads Sanitation District under contract with the City of Virginia Beach Department of Public Works.

Funding for the Boater Education and Pump Out Program was provided by a Sportfish Restoration Grant by the United States Fish and Wildlife Service (USFWS) through the Federal Clean Vessel Act, administered by the Virginia Department of Health (VDH).

This program received funding from the Virginia Water Quality Improvement Fund provided by the Virginia Department of Conservation and Recreation (DCR) via grant number WQIA-2006-11.

Funding was also provided by the City of Virginia Beach, VA.

The views expressed herein do not necessarily reflect the views of USFWS, VDH, and/or DCR.

APPENDIX A – ANALYTICAL REPORTS

HRSD
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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 06/10/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	2,890	2	KWILLI	06/11/07	09:37
COD	HM 8000	mg/L	5,000	25	JGETTI	06/13/07	07:25
NO2,3	EPA 353.2	mg/L	<0.20	0.20	VJOHNS	06/12/07	12:57
TKN	EPA 351.2	mg/L	2,290	0.50	VJOHNS	06/13/07	12:11
TN	calculation	mg/L	2,290	0.50			
TP	EPA 365.1	mg/L	113	0.20	LREED	06/12/07	14:58
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	29,000,000	10	RMAUNZ	06/10/07	12:22
Enterococcus	ASTM#D6503	Entero/100ml	>24,200	10	RMAUNZ	06/10/07	12:05

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.

Authorization: Robin Parnell Date: 7/13/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: LBP
Sample Date: 07/01/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD*	SM5210B	mg/L	1,360	2	TSCHUL	07/02/07	10:02
COD*	HM 8000	mg/L	2,910	25	JGETTI	07/03/07	07:26
NO2,3*	EPA 353.2	mg/L	<0.20	0.20	AMOORE	07/05/07	12:38
TKN*	EPA 351.2	mg/L	623	0.50	VJOHNS	07/04/07	12:36
TN*	calculation	mg/L	623	0.50			
TP*	EPA 365.1	mg/L	45.6	0.20	LREED	07/03/07	13:45
Microbiological							
Fecal coliform - MF*	SM 9222D	FC/100 mL	37,000	10	RMAUNZ	07/01/07	11:18
Enterococcus*	ASTM#D6503	Entero/100 mL	>24,200	10	RMAUNZ	07/01/07	11:01

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.
*Improper preservation - sample not received on ice.

Authorization: Robin Parnell

Date: 7/9/07

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ANALYTICAL REPORT

Project: City of Virginia Beach – Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: Long Bay
Sample Date: 07/08/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	3,740	2	TSCHUL	07/09/07	09:07
COD	HM 8000	mg/L	8,660	25	JGETTI	07/13/07	07:43
NO2,3	EPA 353.2	mg/L	0.44	0.20	VJOHNS	07/10/07	15:55
TKN	EPA 351.2	mg/L	1,670	0.50	AMOORE	07/11/07	11:22
TN	calculation	mg/L	1,670	0.50			
TP	EPA 365.1	mg/L	141	0.20	LREED	07/10/07	15:49
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	46,000	100	CDUNCA	07/08/07	10:54
Enterococcus	ASTM#D6503	Entero/100 mL	>24,200	10	CDUNCA	07/08/07	11:12

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.

Authorization: Robin Parnell Date: 7/23/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 07/14/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	2,320	2	HSTEPH	07/14/07	13:55
COD	HM 8000	mg/L	5,690	25	JGETTI	07/19/07	07:52
NO2,3	EPA 353.2	mg/L	<0.20	0.20	VJOHNS	07/19/07	12:47
TKN	EPA 351.2	mg/L	1,140	0.50	AMOORE	07/20/07	14:19
TN	calculation	mg/L	1,140	0.50			
TP	EPA 365.1	mg/L	115	0.20	LREED	07/17/07	14:04
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	350,000	100	CDUNCA	07/14/07	14:01
Enterococcus	ASTM#D6503	Entero/100 mL	>24,200	10	CDUNCA	07/14/07	13:52

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.

Authorization: Robin Parnell **Date:** 7/23/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 07/20/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	5,590	2	MALCOR	07/21/07	10:28
COD	HM 8000	mg/L	15,800	25	JGETTI	07/26/07	07:14
NO2,3	EPA 353.2	mg/L	<1.00	1.00 *	GMCCAR	07/26/07	15:11
TKN	EPA 351.2	mg/L	2,700	0.50	GMCCAR	07/25/07	14:20
TN	calculation	mg/L	2,700	0.50			
TP	EPA 365.1	mg/L	313	0.20	GMCCAR	07/24/07	14:24
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	2,800,000	100	TSCHUL	07/20/07	11:39
Enterococcus	ASTM#D6503	Entero/100 mL	>2,420,000	100	CBOLLI	07/20/07	11:22

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.
*Higher Report Limit due to sample matrix.

Authorization: _____ Date: 073107

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: Long Bay
Sample Date: 07/22/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	3,120	2	KWILLI	07/23/07	09:27
COD	HM 8000	mg/L	7,030	25	JGETTI	07/26/07	07:14
NO2,3	EPA 353.2	mg/L	<1.00	1.00*	GMCCAR	07/26/07	15:12
TKN	EPA 351.2	mg/L	1,490	0.50	GMCCAR	07/25/07	14:21
TN	calculation	mg/L	1,490	0.50			
TP	EPA 365.1	mg/L	55.5	0.20	GMCCAR	07/24/07	14:06
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	42,000,000	100	RMAUNZ	07/22/07	12:54
Enterococcus	ASTM#D6503	Entero/100 mL	≥2,420,00	100	RMAUNZ	07/22/07	12:40

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.
*Higher Report Limit due to sample matrix.

Authorization: PR Lee

Date: 073107

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 07/27/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	1,850	2	HSTEPH	07/28/07	09:32
COD	HM 8000	mg/L	4,590	25	JGETTI	08/03/07	06:54
NO2,3	EPA 353.2	mg/L	<1.00	1.00*	VJOHNS	07/31/07	14:26
TKN	EPA 351.2	mg/L	1,230	0.50	GMCCAR	08/01/07	12:53
TN	calculation	mg/L	1,230	0.50			
TP	EPA 365.1	mg/L	118	0.20	LREED	07/31/07	13:57
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	42,000	100	RMAUNZ	07/27/07	12:45
Enterococcus	ASTM#D6503	Entero/100 mL	1,200,000	10	RMAUNZ	07/27/07	12:12

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.
*Higher Report Limit due to sample matrix.

Authorization: Robin Parnell Date: 8/13/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 07/28/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	1,070	2	HSTEPH	07/28/07	12:35
COD	HM 8000	mg/L	3,160	25	JGETTI	08/03/07	06:54
NO2,3	EPA 353.2	mg/L	1700	0.20	VJOHNS	07/31/07	14:59
TKN	EPA 351.2	mg/L	2860	0.50	GMCCAR	08/01/07	12:54
TN	calculation	mg/L	4560	0.50			
TP	EPA 365.1	mg/L	55.6	0.20	LREED	07/31/07	13:58
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	10,800	100	RMAUNZ	07/28/07	13:06
Enterococcus	ASTM#D6503	Entero/100 mL	166,000	10	RMAUNZ	07/28/07	12:48

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.

Authorization: Robin Parnell **Date:** 8/13/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 08/03/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	2,880	2	MALCOR	08/04/07	10:02
COD	HM 8000	mg/L	6,260	25	JGETTI	08/15/07	06:32
NO2,3	EPA 353.2	mg/L	<1.00	1.00*	GMCCAR	08/07/07	14:18
TKN	EPA 351.2	mg/L	1,320	0.50	VJOHNS	08/08/07	12:53
TN	calculation	mg/L	1,320	0.50			
TP	EPA 365.1	mg/L	84.1	0.20	LREED	08/07/07	12:36
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	1,310,000	100	RMAUNZ	08/03/07	13:58
Enterococcus	ASTM#D6503	Entero/100 mL	308,000	10	RMAUNZ	08/03/07	13:52

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.
*Higher Report Limit due to sample matrix.

Authorization: Robin Parnell Date: 8/21/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 08/04/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	>5,240	2	MALCOR	08/04/07	10:02
COD	HM 8000	mg/L	53,200	25	JGETTI	08/15/07	06:32
NO2,3	EPA 353.2	mg/L	3.79	0.20	GMCCAR	08/07/07	14:19
TKN	EPA 351.2	mg/L	721	0.50	VJOHNS	08/0807	12:54
TN	calculation	mg/L	725	0.50			
TP	EPA 365.1	mg/L	98.3	0.20	LREED	08/07/07	12:37
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	<1,000	100	RMAUNZ	08/04/07	12:34
Enterococcus	ASTM#D6503	Entero/100 mL	78,400	10	RMAUNZ	08/04/07	12:13

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.

Authorization: Robin Parnell **Date:** 8/21/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 08/12/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	2,940	2	KWILLI	08/13/07	09:24
COD	HM 8000	mg/L	6,410	25	JGETTI	08/15/07	06:32
NO2,3	EPA 353.2	mg/L	<40	40*	VJOHNS	08/21/07	12:55
TKN	EPA 351.2	mg/L	1,360	0.50	GMCCAR	08/15/07	13:22
TN	calculation	mg/L	1360	0.50			
TP	EPA 365.1	mg/L	50.1	0.20	LREED	08/14/07	12:36
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	230,000	100	RMAUNZ	08/12/07	12:22
Enterococcus	ASTM#D6503	Entero/100 mL	687,000	10	RMAUNZ	08/12/07	12:11

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.
*High report limit due to matrix interference.

Authorization: Robin Parnell **Date:** 8/28/07

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ANALYTICAL REPORT

Project: City of Virginia Beach -- Lynnhaven Marinas Special Sample
Customer Sample ID: Lynnhaven Marinas
Project Code: VB_LM
Sample Point: 1
Sample Date: 08/19/07

Analyte	Method	Unit	Result	Report Limit	Analyst	Analysis Date	Analysis Time
AutoChemistry							
BOD	SM5210B	mg/L	3,250	2	HSTEPH	08/20/07	09:26
COD	HM 8000	mg/L	6,700	25	JGETTI	08/23/07	06:46
NO2,3	EPA 353.2	mg/L	<40	40**	VJOHNS	08/21/07	12:56
TKN	EPA 351.2	mg/L	1,500	0.50	VJOHNS	08/22/07	12:10
TN	calculation	mg/L	1,500	0.50			
TP	EPA 365.1	mg/L	146	0.20	GMCCAR	08/21/07	12:09
Microbiological							
Fecal coliform - MF	SM 9222D	FC/100 mL	<100,000*	100	RMAUNZ	08/19/07	13:10
Enterococcus	ASTM#D6503	Entero/100 mL	>2,420,000	10	RMAUNZ	08/19/07	13:00

Notes
Report Limit is lowest concentration at which quantitation is demonstrated.
*Invalid result due to sample matrix interference.
**High report limit due to matrix interference

Authorization: Robin Parnell Date: 8/30/07

APPENDIX B – POLLUTANT CALCULATIONS

LYNNHAVEN MARINA PUMPOUT PROGRAM
BOAT WASTEWATER CALCULATIONS

FECAL COLIFORM
With No Treatment

AVG COUNT PER BOAT	7,500,000 per 100ml
AVG PUMPOUT VOLUME	20 Gallons

Total bacteria count for average count and volume

(7,500,000/ 100ml) x(1000ml/liter) x (3.785 liters/gal) x (20gal) =

Total bacteria count = 5,677,500,000

Vol of Bacteria-Free water to dilute the total bacteria count to the Shellfish Standard of 14 per 100ml

Vol = (5,677,500,000 / 14/100 ml) x liter/1000ml x cu ft/ 28.32 liters) =

Vol = 1,431,976 cu ft
32.87 Acft
29.83 Football fields at a depth of 1 foot

With MSD Type I Treatment

AVG COUNT PER BOAT	1,000 per 100ml
AVG PUMPOUT VOLUME	20 Gallons

Total bacteria count for average count and volume

(1,000/ 100ml) x(1000ml/liter) x (3.785 liters/gal) x (20gal) =

Total bacteria count = 757,000

Vol of Bacteria-Free water to dilute the total bacteria count to the Shellfish Standard of 14 per 100ml

Vol = (757,000 / 14/100 ml) x liter/1000ml x cu ft/ 28.32 liters) =

Vol = 191 cu ft
0.00 Acft
0.00 Football fields at a depth of 1 foot

LYNNHAVEN MARINA PUMPOUT PROGRAM
BOAT WASTEWATER CALCULATIONS

ENTEROCOCCUS
With No Treatment

AVG COUNT PER BOAT 1,212,000 per 100ml
AVG PUMPOUT VOLUME 20 Gallons

Total bacteria count for average count and volume

(1,212,000/ 100ml) x(1000ml/liter) x (3.785 liters/gal) x (20gal) =

Total bacteria count = 917,484,000

Vol of Bacteria-Free water to dilute the total bacteria count to Recreation Std of 104 per 100ml

Vol = (917,484,000 / 104/100 ml) x liter/1000ml x cu ft/ 28.32 liters) =

Vol = 31,151 cu ft
0.72 Acft
0.65 Football fields at a depth of 1 foot

With MSD Type I Treatment

AVG COUNT PER BOAT 1,000 per 100ml
AVG PUMPOUT VOLUME 20 Gallons

Total bacteria count for average count and volume

(1,000/ 100ml) x(1000ml/liter) x (3.785 liters/gal) x (20gal) =

Total bacteria count = 757,000

Vol of Bacteria-Free water to dilute the total bacteria count to Recreation Std of 104 per 100ml

Vol = (757,000 / 104/100 ml) x liter/1000ml x cu ft/ 28.32 liters) =

Vol = 26 cu ft
0.00 Acft
0.00 Football fields at a depth of 1 foot

LYNNHAVEN MARINA PUMPOUT PROGRAM
BOAT WASTEWATER CALCULATIONS

BIOCHEMICAL OXYGEN DEMAND (BOD)

1. Compute Total BOD load for a 20 Gallon Boat Holding Tank

Avg BOD = 3,200 mg/l

Total BOD = 3,200 mg/l x gr/1000mg x lbs/453.59gr x 3.785 liters/gallon x 20 gal

Total BOD = 0.529 lbs

2. Volume of Water Required to Stabilized the BOD Load =
Max Oxygen Reduction 1 Part per Million or 1 mg/l

Volume = ((3172mg/ liters x 3.785 l/gal x 20 gallons) / 1mg/liter) x 1 cu ft/ 28.32 l =

Volume = 8,478.80 Cu. Ft.

CHEMICAL OXYGEN DEMAND (COD)

3. Compute Total COD load for a 20 Gallon Boat Holding Tank

Avg COD = 11,100 mg/l

Total COD = 11,100 mg/l x gr/1000mg x lbs/453.59gr x 3.785 liters/gallon x 20 gal

Total COD = 1.85 lbs

4. Volume of Water Required to Stabilized the COD Load =
Max Oxygen Reduction 1 Part per Million or 1 mg/l

Volume = ((11,100 mg/ liters x 3.785 l/gal x 20 gallons) / 1mg/liter) x 1 cu ft/ 28.32 l =

Volume = 29,670.00 Cu. Ft.