Development of a Boat Hull Wash Wastewater Treatment System Final Report

December 2009
Project# 207084

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Executive Summary

Recreational and commercial boating is an important economic activity in New Jersey's coastal communities. Recreational boating is a seasonal activity that occurs between spring and fall. At the end of the season, boats are removed from the water, their hulls are cleaned and they are placed into winter storage. During the boat hull cleaning process, chemical constituents become entrained in the wash wastewater. Historically, this wash wastewater was allowed to drain as waste into the surrounding soil and waterways.

In an effort to reduce the chemical load to ground and surface waters, the U.S. Environmental Protection Agency (EPA) specified management measures for sources of nonpoint pollution in coastal waters, such as those produced by marinas, in section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990. Under its mandate, the New Jersey Department of Environmental Protection (NJDEP) is requiring facilities to eliminate the exposure of industrial source materials to storm water that is discharged to the surface and/or ground water of the State. Marinas that do not cease these operations by March 1, 2010 will be in violation of both the Water Pollution Control Act (N.J.S.A. 58:10A-6) and the NJPDES rules (N.J.A.C. 7:14A). For the many marinas that engage in boat hull washing, ceasing these activities is not a financially feasible option because it is likely to reduce business. With recent and future enforcement, marinas are now financially burdened with regulation compliance. To date, the management of hull wash wastewater discharge has been expensive and problematic for marina operators. This is especially true for small marinas lacking the capital to install permanent and/or complex capture and treatment systems.

To help reduce the financial burden placed on small marina owners with seasonal boat cleaning services, an economical boat hull wash wastewater treatment system was developed and tested for two seasons by Ocean and Coastal Consultants, Inc. This portable recycle system collects and treats the wash wastewater so it can either be reused in the boat wash process, evaporated or disposed of in Publically Owned Wastewater Treatment (POTW) systems.

Ocean and Coastal Consultants, Inc. set out to design an affordable system that would effectively treat the boat hull wash wastewater at small marinas and bring them into compliance with EPA and NJDEP regulations. As a result of this goal, the Zeolite Apatite Reclaim Recycle System (ZARRS) for boat hull wash wastewater treatment was developed. ZARRS is a simple reclaim/recycle system for small marinas with seasonal boat hull washing activities. The partnership with All Seasons Marina provided a testing facility to develop and refine the system. Only minor modifications would be necessary to transport this system to any other small marina with seasonal boat hull washing activities.

Using the ZARRS system, wash wastewater from the boat hull cleaning operations was collected on an impervious wash pad and then treated with both chemical and filtration methods. The processed wash wastewater is stored and is available when further boat hull washing operations occur during the washing season. Following the wash season, if necessary, the processed wash wastewater and filter medium must be properly disposed of in accordance with proper disposal of solid waste.

In order to determine the effectiveness of the ZARRS, the concentration parameters of the boat hull wash wastewater collected from the wash pad (RAW) was compared to the processed water (PROC). However, due to the inhomogeneous nature of the materials sampled from the wash pad, a large statistical variation

was present within the RAW data. For this reason, a "nine fold change" in a parameter's concentration" criterion was defined in order to distinguish sample variation from significant changes produced by the ZARRS. *Therefore, for the system to be deemed successful, differences in concentration of parameters between the RAW and PROC samples must be greater than 9 times.*

Use of the "nine fold change" in a parameter's concentration" criterion shows the 2007 Season ZARRS had no positive effect on the captured boat hull wash wastewater. In both testing cycles, all changes in parameters concentrations were determined to be statistically insignificant by the "nine fold change in a parameter's concentration" criterion. Reduction in the concentration of contaminants ranged from 1.0 (no change) to 7.5 times. Therefore, all the “reductions” were within the realm of being due to the inhomogenous nature of the sampling. Also, several criteria saw small increases in concentration. This is likely the result of the inhomogenous nature of the sampling or the compounding of contaminants in the wash wastewater.

In the 2008 season, improvements were made to the boat hull wash wastewater treatment system. Larger changes included the addition of both a Zeolite sand and a Reactive Core Mat containing apatite to remove more of the heavy metal that were found during the 2007 season testing. During the 2008 season testing of the improved ZARRS, the concentration parameters of the boat hull wash wastewater collected from the wash pad (RAW) were again compared to the processed water (PROC) using the "nine fold change in a parameter's concentration" criterion. Analysis showed the 2008 Season ZARRS to have a statistically significant and large positive effect on the captured boat hull wash wastewater (up to a 480 times reduction).

One of the main goals of the ZARRS system was to provide an economical alternative to currently available commercial wash wastewater treatment systems. The initial capital cost for all of the components to run the system was $4,800. The major cost of the system is the wash pad which cost $3,200. Although the wash pad will periodically need to be replaced, the lifetime of the wash pad can be increased by using a geotextile separator between the wash pad and the ground to reduce punctures. The temporary pad could be replaced by a concrete or asphalt pad with sump. Additional expected long term maintenance costs for the ZARRS system includes the seasonal replacement of the filter materials. This includes the filter tote geotextile liner and the sand filtration medium which cost $200. Costs for the acceptance of the recycled wash wastewater at most Municipal Utilities Authority is under $20 per storage tote load (not including pick up and transportation). With proper care of the components, the ZARRS system is an economical solution for small, seasonal boat hull washing activities.

Acknowledgement

The work described within this report was funded by a cost share program between the I–Boat NJ program (90%) and All Seasons Marina (10%). The I-Boat NJ Program is within the New Jersey Department of Transportations Office of Maritime resources and provides grant funds to selected eligible applicants to promote, improve and enhance the marine industry in the State of New Jersey for the benefit of the general boating public.

All Seasons Marina is one of South Jersey's largest and most full-service marine facilities. The marina is located on the Intracoastal Waterway at channel marker 282 behind Ocean City, NJ. All Seasons Marina provided the location to perform the work described herein, as well as in-kind services throughout the project including materials (heavy equipment, pumps, batteries, etc.), man-power and technical assistance.

Ocean and Coastal Consultants, Inc. (OCC) is a recognized leader in waterfront engineering services. OCC has been serving waterfront clients since 1982 with a staff of 50 engineers and scientists. OCC is proud of its innovative approach to problem solving and being at the leading edge. Design work, system set-up and testing, and reporting were completed by Ocean and Coastal Consultants, Inc. Douglas Gaffney, P.E., Edward Gorleski, Ronnie Munoz, E.I.T., and Matthew Dalon undertook the primary efforts to generate the information within.

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1. INTRODUCTION

Recreational and commercial boating in New Jersey is an important activity to the coastal communities as well as important to the economy. Due to New Jersey's climate limitations, recreational boating is a seasonal activity that occurs between spring and fall. During the recreational boating season, individuals have the opportunity to keep their boats in the water at local marinas for a fee. At the end of the season boats are removed from the water, their hulls are cleaned and they are placed into winter storage.

During the boat hull cleaning process, chemical constituents become entrained in the wash wastewater. Historically, this wash wastewater was allowed to drain as waste into the surrounding soil and waterways. In an effort to reduce the chemical load to ground and surface waters, the U.S. Environmental Protection Agency (EPA) specified management measures for sources of nonpoint pollution in coastal waters, such as those produced by marinas, in section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990. Under its mandate, the New Jersey Department of Environmental Protection (NJDEP) is requiring facilities to eliminate the exposure of industrial source materials to storm water that is discharged to the surface and/or ground water of the State. Marinas that do not cease these operations by March 1, 2010 will be in violation of both the Water Pollution Control Act (N.J.S.A. 58:10A-6) and the NJPDES rules (N.J.A.C. 7:14A).

For the many marinas that engage in boat hull washing, ceasing these activities is not a financially feasible option because it is likely to reduce business. With recent and future enforcement, marinas are now financially burdened with regulation compliance. To date, the management of hull wash wastewater discharge has been expensive and problematic for marina operators. This is especially true for small marinas lacking the capital to install permanent and/or complex capture and treatment systems.

To help reduce the financial burden placed on small marina owners with seasonal boat cleaning services, an economical boat hull wash wastewater treatment system was developed and tested for two seasons by Ocean and Coastal Consultants, Inc. This portable recycle system collects and treats the wash wastewater so it can either be reused in the boat wash process, evaporated or disposed of in a Publically Owned Wastewater Treatment (POTW) system.

The system was tested over a period of two seasons. Wash wastewater testing was conducted to collect data on the chemicals and their respective concentrations in boat hull wash wastewater, both raw and processed, over two boating seasons. The intercostals waterway adjacent to the site was also tested to provide background data. Design modifications to the system were made based on the wash wastewater testing and analysis.

2. BOAT HULL WASH WASTEWATER POLLUTION

Boat hull washing and maintenance is an inherent part of boat ownership for boats placed in saltwater for any period of time. Without periodic maintenance the performance and expected lifespan of the boat hull is decreased by marine growth. To combat the marine growth boat hulls are commonly coated in anti-fouling paints and the hull is seasonally washed. Although these methods are effective in reducing the marine growth on boat hulls they do also contribute to the pollution of local waterways, soils and groundwater. The wash wastewater generated during the boat hull cleaning process is the focus of the report.

It is common practice for marinas to use a pressure washer utilizing fresh water (without additional chemicals) to clean boat hulls. The force of the water jet generated by the pressure washer is effective at removing marine growth. However, it also removes paint chips and entrains toxic chemicals within the wash wastewater. Chemicals contained in boat hull wash wastewater are a source for the introduction of environmentally hazardous runoff into surface water, sediments and organisms.

Metal and metal-containing compounds are present on the surface of most vessels. The most abundant pollutants generated from the wash wastewater are heavy metals (Chambers et. al., 2006). Copper, lead, tin and zinc are the metals of major concern in boat hull wash wastewater. Copper, as cuprous oxide, is the most common additive in antifouling coatings and is contained in both leaching and ablative variations. Copper thiocynate, a derivative of cuprous oxide, is used as a replacement for now heavily regulated tin-based antifouling coatings and is generally used over aluminum boat hulls. The concentration of copper in antifouling coatings is usually listed between 10 – 30 %.

The most common applications of lead in hull coatings are as stabilizers, pigments and/or antifouling biocides. Both inorganic and organo-lead forms are used in these application and the concentrations are usually listed between 1 – 5 %. However, more recent technologies are finding ways to replace Lead with Zinc. Zinc has long been used as an anticorrosive coating for metal hulls but is more recently proving itself as a good antifouling agent. Zinc is also found on boat hulls as a sacrificial anode.

Tin is the most heavily regulated metal in boat hull coatings. During the 1960s, organotins, with their excellent antifouling properties, began to replace copper containing antifouling coatings. Tributyl tin (TBT) quickly became the antifouling biocide of choice, with triphenyl tin (TPT) finding similar applications. During their use, the concentration of organotins in coatings was usually listed between 10 - 15 %. As of January 1st, 2003, the International Maritime Organization (IMO) has placed a ban on the application of all organotin based antifouling coatings because of its highly toxic effects on the marine environment. However, some hulls containing organotins still exist.

All of these metal containing compounds have been found and documented at concentration levels high enough to be considered toxic in their respective aquatic environments (Chambers et. al., 2006). Many of the contaminants found in the water do not dissolve well and accumulate to higher concentrations in the surrounding sediments. This accumulation translates into an extremely toxic environment for benthic organisms (those organisms living on or in the sediment) and the pollutants have been demonstrated to accumulate in the organisms themselves. The presence of these pollutants in organisms can lead to poor health, reproductive problems and even death of the organisms. Due to this accumulation of toxicity, the EPA has developed and is enforcing regulations that manage the introduction of boat hull wash wastewater as runoff into surface water and sediment. The introduction of a boat hull wash wastewater system to collect contaminants and prevent their introduction into marinas will improve the life and health of local aquatic environments that surround marinas.

Table 1 presents the study results of boatyard hull pressure-washing wastewater in the Puget Sound area in the early 1990s and helps demonstrate why the concentrations of metals and other pollutants are of concern to environmental regulators. The study by METRO (1992) also concluded by comparing the data that boat hull wash wastewater would require contaminant treatment before being discharged and that a higher level of treatment would be required to discharge to surrounding receiving waters.

The effect of marina design, operation and location plays a crucial role in determining how local water is impacted and on the pollutant concentrations present in the nearby water, sediment and organism tissue. Hence, the management of marina wash wastewater can significantly improve the detrimental effects that any marina has on its surrounding environment.

Table 1: Boatyard Pressure-washing Wastewater Contaminants and Regulatory Limits in the Puget Sound Area (METRO 1992)

				Permit Limit Values			
					Boatyard NPDES		
						Receiving Waters[f]	
Analytical Parameter	Units	Untreated Sample (average)[a]	Untreated Sample (high)	Sanitary Sewers (Metro)	Sanitary Sewers	Marine	Fresh
pH	pH	7.2	6.7 - 8.2	5.5 - 12.0	—[c]	—[d]	—[d]
Turbidity	ntu	469	1700	—[c]	—[c]	—[d]	—[d]
Suspended Solids	mg/L	800	3100	—[c]	—[c]	—[c]	—[c]
Oil/Grease	mg/L	—[b]	—[b]	100	—[c]	—[d]	—[d]
Copper	mg/L	55	190	8.0	2.4	0.006	0.018
Lead	mg/L	1.7	14	4.0	1.2	0.280	0.068
Zinc	mg/L	6.0	22	10.0	3.3	0.190	0.130
Tin	mg/L	0.49	1.4	—[e]	—[e]	—[e]	—[e]
Arsenic	mg/L	0.08	0.1	4.0	3.6	0.138	0.720

[a] Values are based on analysis of 18 samples.
[b] Oil and grease not detected by visible inspections.
[c] No limit set or known for this parameter.
[d] No monitoring requirements, but limits will be based on water-quality criteria.
[e] Tin regulated by restrictions on the application of tributyltin paints.
[f] Limit values based on 8/13/91 draft of the Boatyard General NPDES Permit.

3. BOAT HULL WASH WASTEWATER REGULATIONS

The initial management of boat hull wash wastewater, in addition to pollutant discharges and storm water runoff, was put forth in the National Pollutant Discharge Elimination System (NPDES). In 1987, amendments to the Clean Water Act mandated the EPA to develop a tiered implementation strategy for the NPDES Storm Water Program. In response, two implementation phases were developed. In 1990, Phase I of the NPDES Storm Water Program took effect, but it was not until the introduction of Phase II in 1999, that boat wash wastewater from small marinas was specifically addressed.

Under the Phase II implementation of the Clean Water Act, the discharge of any "processed water" by a small marina or boatyard became illegal nation wide. This now meant that boat wash wastewater, which was defined as "processed water" by the NPDES Storm Water Permit Program, could no longer be discharged without a formal permit from the EPA or a state government.

3.1. BASIC INDUSTRIAL STORMWATER GENERAL PERMIT

The New Jersey Department of Environmental Protection (NJDEP) is the issuing authority for NPDES permits in the state of New Jersey, and issues those permits as part of the New Jersey Pollutant Discharge Elimination System (NJPDES). In 1992 the NJDEP issued the Basic Industrial Storm Water Permit (NJ0088315) which permit manages the exposure of storm water to industrial source materials and eliminates the discharge of such material to surface and/or ground water. This permit also requires that facilities prepare and implement a Storm-water Pollution Prevention Plan (SPPP), conduct annual inspections, and submit an annual certification of employee training. This permit expires every five years and has since been renewed in 1997, 2002, and 2007.

In the 2007 permit renewal, new language was adopted to specifically address boat wash wastewater within marinas. According to the updated Basic Industrial Stormwater General Permit, on or before March 1, 2010 facilities must eliminate any unpermitted discharge of equipment and vehicle wash wastewater to the waters of the State by either:

- installing a vehicle wash wastewater reclaim/recycling system;
- capturing and hauling the wash wastewater for proper disposal;
- connecting to sanitary sewer (where applicable and approved by local authorities);
- ceasing the activity; or
- applying for and obtaining a separate NJPDES permit.

Current wash wastewater discharges from boat bottom cleaning has been given a temporary authorization by the NJDEP. Previously, these discharges were in violation of both the Water Pollution Control Act (N.J.S.A. 58:10A-6) and the NJPDES rules (N.J.A.C 7:14A). This temporary authorization was granted to allow marinas to continue current operations while transitioning to comply with federal and State regulations.

3.2. PERMIT-BY-RULE

In order to facilitate marinas transition to comply with the updated Basic Industrial Stormwater General Permit the NJDEP issued a Permit-By-Rule on December 15, 2008 for the construction and/or installation of boat wash wastewater systems and associated infrastructure. The Permit-By-Rule is available to any marina, boatyard, or boat sales facility that installs a boat wash wastewater system.

The Permit-By-Rule enables marinas to install a boat wash wastewater system and any related infrastructure without having to obtain a coastal or general permit as long as the guidelines in the permit are followed. Marinas will still need to obtain any required local permits. Additionally marinas do not need to submit any additional paperwork or updates to the NJDEP when they install and are in compliance with NJDEP regulations. Marinas only need to maintain an updated SPPP.

4. WASTEWATER COMPLIANCE

For most marinas in New Jersey, steps must be taken to comply with the Basic Industrial Stormwater General Permit by March 1 2010 for boat hull washing activities. The available options to eliminate unpermitted discharge mentioned in the general permit allow marinas flexibility in selecting an option that best suites their site. Depending on the selected option the wastewater may need to be treated with one or more treatment technologies. Systems that comply with federal and state regulations are available for purchase or a marina may chose to develop its own system.

4.1. OPTIONS

The current NJDEP Basic Industrial Stormwater General Permit lists options to eliminate any unpermitted discharge of vessel hull wash wastewater. These options are discussed in more detail within the Marina Edition of the Basic Industrial Stormwater General Permit (NJDEP, 2007).

4.1.1. Reclaim/Recycle System

A reclaim/recycle system is a closed loop system that collects the wastewater from boat hull wash operations, treats the water, and re-uses the water. In order to collect the wastewater boat hull washing must be conducted over an impervious surface. The impervious surface may be permanent (i.e. concrete slab) or temporary (i.e. portable plastic wash pad). The wastewater that collects on the impervious surface is then transferred to a storage system, commonly via pump. The wastewater in the storage system is often treated to remove the pollutants. The technology behind the treatment is discussed in the following section.

4.1.2. Capture - Haul - Dispose

The capture-haul-dispose method collects wastewater from boat hull wash operations and transports the wastewater for proper disposal. For this system boat wash operations must be conducted over an impervious surface to collect the wastewater. Often for proper disposal the waste must be characterized by performing testing. Proper disposal options may include a sewage treatment plant or hazardous waste landfill.

4.1.3. Discharge to Sewer

Depending on the location of the marina, boat wash wastewater may be collected and discharged directly to a sanitary sewer. Prior approval from local authorities is necessary and will often require a characterization of the waste and associated fees. Depending on the waste characterization, on-site treatment may be required prior to sewer discharge. A wastewater monitoring plan may also need to be developed to assure quality standards are met for discharge. If a marina exceeds the discharge requirements, local authorities may levy a fine to the marina. Additionally, local authorities may charge an initial connection fee and monthly sewer discharge fees.

4.1.4. Apply for a NJPDES Permit

A marina may apply for an individual NJPDES permit that specifically authorizes discharge of boat hull wash wastewater. In order to receive a NJPDES permit the wastewater must meet surface and ground water quality standards set by the NJDEP. The wastewater would need to be tested and treated in order to meet the effluent requirements. A monitoring plan would need to be developed which would include periodic monitoring of the wastewater discharge and the submission of discharge monitoring reports (DMRs). Marinas that exceed the maximum effluent limits or fail to submit DMRs are subject to mandatory penalties. Additionally, the NJPDES permit has a required yearly fee based on pollutant load.

4.1.5. Cease Activity

A marina may choose to cease providing boat hull washing services. However, individual boat owners may chose to wash their boats within their slips. If cleaning solutions are used, the NJDEP recommends that a non-toxic biodegradable cleaning solvents and mixtures be used.

4.2. Basic Treatment Technologies

Several of the wash wastewater disposal options require a type of treatment technology to be utilized. Common treatment technologies include settling, filtration, electrocoagulation, chemical, and biological. Depending on the chosen disposal method, present contaminants, and desired level of treatment, one or more treatment technologies may be used to process the wastewater. A summary of each technology is presented below.

4.2.1. Settling

Gravitational settling is a simple and effective method for removing particles from wastewater. In order for settling to be effective, the gravitational (or resulting buoyant) force on a particle must be sufficient to overcome the resisting forces of the fluid. The existence of a net force results in the particle either migrating upward (floating) to the surface or migrating downward (sinking) to the bottom. This migration requires that there is little flow in the fluid to alter the course of the particle.

To date, settling is the simplest and most cost effective form of treatment capable of separating a mixture into three regions: floating particles, sinking particles (sediment) and a fluid containing dissolved material and particles too small to overcome the resisting forces of the fluid. Both the dissolved material and suspended particles must then be removed from the water using additional methods since further treatment is often necessary to meet regulatory limits. No amount of additional time will allow dissolved material or suspended particles to become part of the floating or sediment layer. This is the single limitation of settling. Regular removal and disposal is also required to prevent the build up of sediment and floating waste.

4.2.2. Filtration

Filtration is the separation of particles from a fluid using an interposing medium. In its most simple case, successful filtration requires the size of a particle to be large enough to be excluded by a porous barrier while allowing the fluid to pass through. The most common types of filter media are sieves and granular material. Because filtration in it's purest form can not remove dissolved materials, filtering media is some times constructed from material (or coated with material) that can interact chemically and/ or biologically with the particles and dissolved material entrained in the fluid. For instance, activated carbon can be used to remove dissolved organic compounds and zeolite sand can be used to remove dissolved heavy metals.

During the filtering process, there is a tendency for the particles to adhere to or become lodged in the filtering media. A large enough build up of the particles can inhibit the flow of fluid through the filtering media and result in clogging. In order to prevent clogging, regular maintenance is required. Typically this maintenance falls into one of three categories: changing out the filter, cleaning of the filter or backwashing of a clean fluid through the filter. Additional filter maintenance requires the disposal of solid waste generated from the successful exclusion of the particles.

4.2.3. Electrocoagulation

Electrocoagulation utilizes two oppositely charged electrodes to remove particles or dissolved material from a fluid. Electricity is used to apply a direct current to the two electrodes, creating a cathode and anode pair. This cathode and anode pair can electrically interact with the surface charges present on the particles or dissolved material. As the interactions progress, one of two things happens: the particles or dissolved material bind to an electrode and/or the surface charge is inactivated resulting in coagulation. Any generated solid waste plating the electrode can then be disposed of by mechanical cleaning or replacement. The coagulation that forms is removed by additional separation processes like filtration and/or settling. The resulting solid waste must then eventually be disposed of.

Electrocoagulation is very effective over a wide range of concentrations and flow rates. It has been successfully used to remove hydrocarbons, oils, suspended solids and heavy metals. Some electrocoagulation units require large amount of electricity and all require regular maintenance because the more anodic of the two electrodes will slowly dissolve.

4.2.4. Chemical Treatment

The use of chemicals to neutralize, remove and/or separate particles and dissolved material from wastewater can be very effective. In order for chemical treatment to be successful, the wastewater must be sufficiently characterized to accommodate the various effects of the chosen chemicals. Certain chemicals may be added to adjust or neutralize pH, precipitate dissolved material and/or form a stable flocculation. The resulting precipitate or flocculation can then be separated by settling or filtration.

Some of the advantages of chemical treatment can include low energy consumption and easy separations. However, the concentration of the treatment chemicals added depends heavily on the concentrations, pH and general characteristics of the wastewater. Because these factors can change readily, either trained personal with monitoring equipment or highly sophisticated systems are needed. In the end, chemical treatment also produces solid waste that must be properly disposed of.

4.2.5. Biological Treatment

Biological treatment utilizes bacteria and/or funguses to remove organic material from wastewater. Specifically, the organisms feed on the nutrients, organic mater, oil and grease in the wastewater. Wastewater generated from boat hull washing has moderate to minute amounts of biodegradable material and does not generate continuing stream. This limits the ability of the organisms to thrive and therefore is not usually considered a viable technology for this application.

4.3. Available Treatment Systems

New Jersey is not alone in figuring out how to cost effectively treat boat hull wash wastewater pollution. Other states have similar regulations related to the handling of boat hull wash wastewater based on NPDES Phase II. This has led to the development and production of multiple treatment systems from a variety of distributors and manufactures. A list of companies with available systems is provided on the New Jersey Clean Marine Program website (http://www.nj.gov/dep/njcleanmarina/).

The most common type of available system is the reclaim/recycle system which is consistent with the New Jersey's Clean Marina Program Advisory Committee recommendation. Most of the systems require a permanent on-site installation. The size of the installation space that is required can be large, which can be a problem for small marina owners, as land is a valuable commodity. Typical system flow rates range from 10 gpm to 20 gpm volume for boat washing applications. The included components for each company's system can vary. Most of the systems only include the filtering and treatment components. The most common treatment method is filtration and electrocoagulation. The effectiveness of each systems treatment method is largely unknown due to a lack of published data. Often the treatment components need to be cleaned or replaced to effectively treat the wastewater which can increase long term operations costs. A wastewater collection system, which is a necessary component, is not often included in the system. This requires the purchase of a wash pad or the installation of an impervious surface with drainage plumbing. Additionally the disposal of excess recycled water of solid waste is not included. These additional components to the system can increase cost to the already expensive systems. The costs of these systems range from $5,000 for a single filtration component to over $75,000 for a complete system. Without a standard for recycled water quality and published data on each system it is difficult to identify a system that is suitable for small marina owners with seasonal boat washing activities.

4.4. Wastewater Disposal

Following boat hull washing activities or when the recycled water becomes unsatisfactory to be re-used, the excess wastewater in the system must be properly removed and treated for disposal. One method of disposal is through the local wastewater treatment facility for a specified fee. The wastewater may be directly connected to a sewer line or the wastewater may be hauled by truck to the disposal facility. Water quality data and expected volumes need to be submitted to the wastewater treatment facility to ensure their system can handle the boat hull wash wastewater. Typically, boat hull wash wastewater volumes and contaminant concentrations are small and therefore place little additional strain on the capabilities of local wastewater treatment facilities. Currently there are not any published standards provided by local wastewater treatment facilities in New Jersey related to boat hull wash wastewater and the disposal of the wastewater is site specific. Additional options for disposal of wastewater include an evaporation tank or placement into a septic system (additional permitting and testing may be required).

4.5. Disposal of Solid Waste

All boat hull wastewater treatment systems will generate some form of solid waste. Correct disposal of the solid waste requires knowledge of regulations governing proper disposal. Typically the volumes generated by boat hull wash wastewater systems are not enough to warrant sludge dewatering. If dewatering is required to reduce the volume or to concentrate the sludge, then filter presses or evaporation can be used.

Filter presses and evaporation are the two most common methods for dewatering sludge. Filter presses place the sludge under compression while allowing the water to escape. They are often expensive and used to dewater large amounts of sludge. For that reason, if sludge dewatering is required at a small facility, evaporation is the suggested method. Sludge evaporation can be accelerated by increasing the surface area, the temperature or the amount of air blowing over the sludge. The most cost effective way of doing this often involves some form of solar heating.

Typically, there are two ways of moving the solid waste to an appropriate disposal facility: a waste disposal company can be contracted to remove the material or coordination with the local health department or municipal utilities authority can be made for transportation of the waste to a landfill.

5. OCC System Design

Of the available treatment systems, there are not many economical choices for small marina owners with seasonal boat washing activities. Ocean and Coastal Consultants, Inc. set out to design an affordable system that would effectively treat the wastewater and bring boat washing at small marinas into compliance with current EPA and NJDEP regulations. As a result of this goal, the Zeolite Apatite Reclaim Recycle System (ZARRS) boat hull wash wastewater treatment system was developed.

ZARRS is a simple reclaim/recycle system for small marina's with seasonal boat hull washing activities. The partnership with All Seasons Marina provided a testing facility to develop and refine the system. Only minor modifications would be necessary to transpose this system to any other small marina with seasonal boat hull washing activities.

The ZARRS system design is based on the reclaim/recycle option with site specific disposal options. Wastewater from the boat hull washing operation is collected on an impervious wash pad and then treated with both chemical and filtration methods. The processed wastewater is stored and is available when further boat hull washing operations occur during the washing season. Following the wash season, if necessary, the processed wastewater and filter medium must be properly disposed of in accordance with proper disposal of solid waste. The final disposal options are site specific.

The initial prototype was tested in the winter of 2007-2008. Following the results of the testing, some modifications were made to address critical issues. The updated system was tested during the winter of 2008-2009. The following sections will describe the system parts, technology used, testing procedures, testing results and a discussion of the prototype.

5.1. System Components

5.1.1. Definition and Description

The following is a list of the components that were used in the ZARRS system. Not all components were utilized in each testing cycle. Figure 1 shows a schematic of the 2007 system setup.

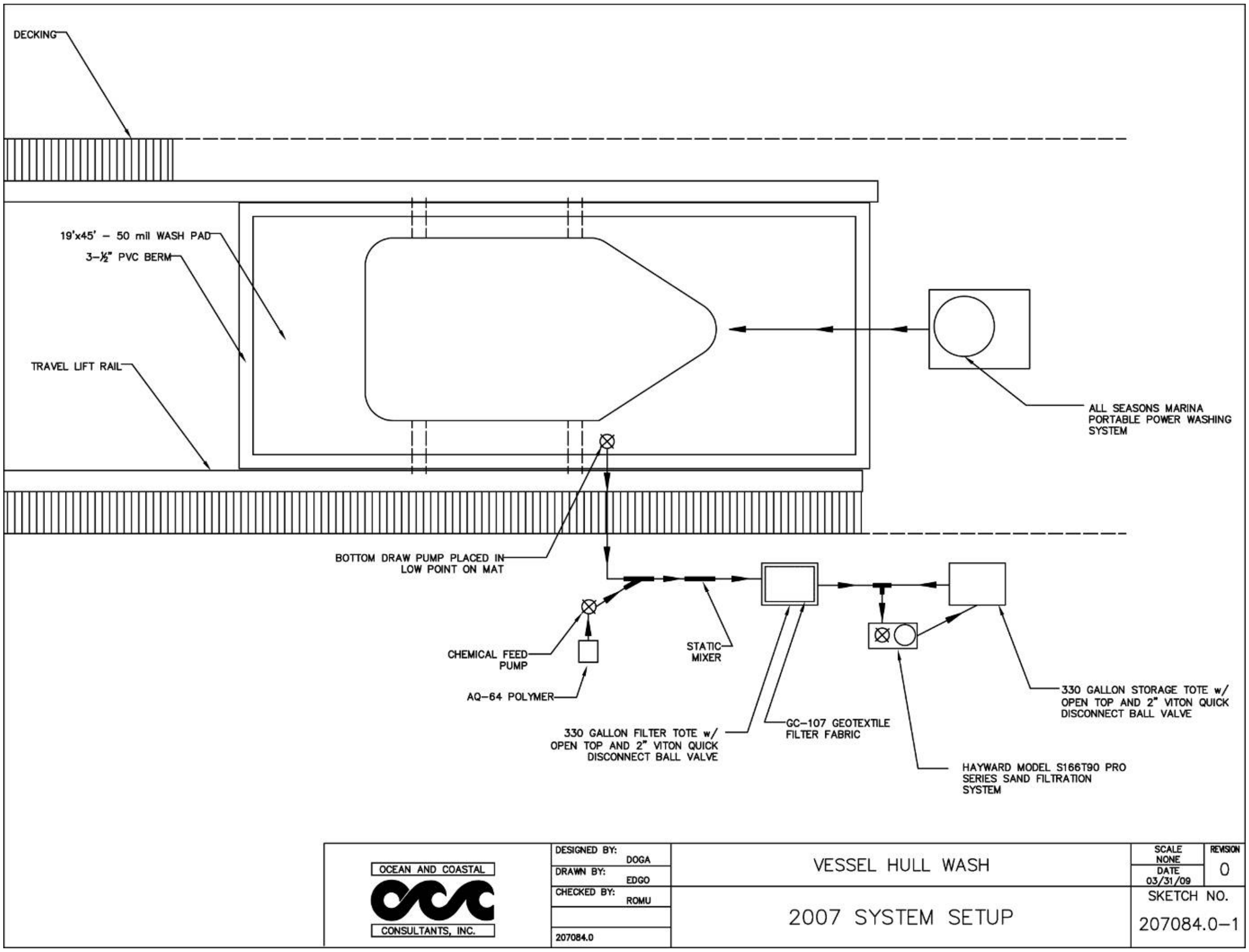

Figure 1: Schematic of 2007 system setup

<u>Wash pad</u>

The wash pad serves as the impervious surface to collect the water. The wash pad is constructed of an impermeable 50 mil thick polyvinyl chloride (PVC) plastic measuring 19 feet by 45 feet (Figure 2). The width of the pad is designed to fit between the wheels of the mechanical boat lift. The length of the pad is designed to collect wastewater from boats up to approximately 40 feet in length. Along the perimeter of the wash pad there are openings to insert PVC pipes measuring 2 inches in diameter to create a berm. This berm prevents the water from leaving the wash pad. Grading the wash pad area with a slight slope promotes wastewater pooling so that it may be easily pumped. Additionally, a nonwoven polypropylene geotextile fabric was placed below the wash pad to prevent puncture from the gravel below.

Figure 2: Polyvinyl chloride (PVC) wash pad (19 feet by 45 feet by 50 mil thick)

Bilge Pump

Generic 12 volt bilge pumps (Figure 3) are used to transport the wastewater to the first stage of the treatment system. Bilge pump rates as listed by the manufacture were approximately 500 gph. A filter cage may be placed around the bilge pump to prevent large debris (seaweed, plant material, large paint chips, etc.) from clogging the pump. A 12 volt power supply must be connected to the pumps for power. Minimal head is produced from bilge pumps (350 GPH at 3.3 feet) therefore the height of the discharge pipe should be limited above the bilge pump inlet.

Figure 3: Bilge Pump

Static Mixer

A chemical flocculant was added to the wash wastewater prior to being pumped into the first of a series of 330 gallon storage totes. A static mixer (Figure 4) was placed in the incoming line to induce a turbulent flow to accelerate mixing of the flocculent and the wash wastewater. A flocculent is a chemical additive that causes the suspended particles in a liquid to adhere to each other and form a large size cluster. AQ-64, an acidic polyaluminium chloride flocculent, was added to cause the materials within the boat hull wash wastewater to flocculate so that they could be more readily filtered.

Figure 4: Static Mixer

Sand Pump/Filter

A Hayward S166T90 pump/sand filter (Figure 5) is used to transport wastewater between two 330 gallon storage totes and the sand filter. Depending on the filter medium, sand filters can filter out organics and inorganic compounds. During the first installation sand was used as the filter medium and could only filter particulates. During the second installation three filter medium were used; a bottom layer of sand, a reactive core mat, and a zeolite sand medium.

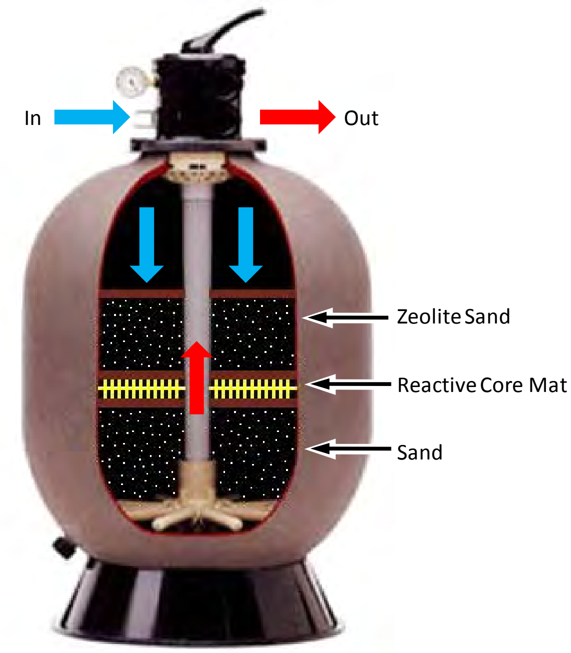

Figure 5: Pump and Sand Filter (Left) and internal design (Right)

Sand Filter Medium

The sand filter medium is the filtration agent that effectively removes particulates and possible contaminates from the water that enters it. Three types of filter media were used during the project:

Sand : Sand is the typical medium that is used in this type of a filter. The most common form used is silicon dioxide in the form of quartz. The typical size of filtering sand is 100 to 400 microns (0.1 to 0.4 mm diameter), with 20 to 50 % of the particles in the 100 to 200 micron range.

Zeolite Sand: Zeolites are naturally occurring hydrated aluminosilicate minerals. Most natural zeolites are formed by alteration of glass-rich volcanic rocks (tuff) with water. The structures of zeolites consist of three-dimensional frameworks with molecular sized pores. These pores contain within themselves net negative charges that allow them to remove positively charged heavy metals from wastewater (Blanchard, et. al., 1983; Erdem, et. al., 2004; Garcia-Sosa, et. al., 2001; Inglezakiset, et. al., 2002). A few commercial manufactures market zeolite, usually clinoptilolite, as a substitute for common filtering sand. As a filtering media, zeolite sand is very similar to regular filtering sand in its external dimensions. Typical sizes of zeolite filtering sand is also 100 to 400 microns (0.1 to 0.4 mm diameter), with 20 to 50 % of the particles in the 100 to 200 micron range.

Reactive Core Mat: A reactive core mat is a layered composite material consisting of a reactive material encapsulated in a nonwoven core matrix bounded between two geotextiles. The reactive core mat treats and removes contaminates depending on the reactive material selected. For this application apatite was used to treat the heavy metals in the water. Apatite is a phosphate mineral that reacts with certain metals to yield a very stable phosphate salt that remains within the reactive core mat.

Treatment Tote

During the 2008-09 season (Year 2), a treatment tote replaced the static mixer for chemical treatment of the wastewater. The treatment tote was a generic rectangular plastic 24 gallon tote. During treatment chemical additives including lime and flocculant were mixed within the treatment water prior to pumping to the filtration tote.

Filtration Tote

A 330 gallon plastic tote with a geotextile bag liner (Figure 6) was used for primary physical filtration. The totes were constructed with high strength plastic and encapsulated in an aluminum framework and 2” Viton quick disconnect ball valves on the bottom of the tote. The top of the filter tote was removed to install the filter liner.

Geotextile Liner - The geotextile liner used was a woven polyester fabric (product number GC 107 purchased from Syntex). This type of geotextile is commonly used in de-watering materials.

Tri-planer Fabric - A tri-planer fabric is a plastic composite that is used to create void spaces between two layers. The rigid openings of the fabric provide void space for water flow. The tri-planer fabric was placed between the storage tote walls and the geotextile liner to allow for better drainage of the geotextile liner.

Figure 6: Filtration Tote with Geotextile Liner

Chemical Treatment Products

Two chemical treatments were utilized to form a stable flocculation that could be more readily filtered by the geotextile fabric liner in the filtering tote.

Lime: Lime is a caustic material composed of calcium oxide (CaO). The addition of lime to water will cause and elevation in the pH. This change in the wastewater alters the surface charge on the dissolved material or particles in such a way that a stable flocculation can be formed.

Polymer (Flocculant): Polymers are large molecules composed of a repeating structural unit. When placed in water, they develop a negative or positive charge that interacts with oppositely charged particles or dissolved material. This interaction results in the formation of a stable flocculation. For this application Aquamark AQ-64 was used. This is a polyaluminium chloride and promotes coagulation and flocculation of fine materials.

Storage Tote

A 330 gallon tote (Figure 7), identical to the filtration tote, is used to collect water that has passed through the sand filter. A valve at the bottom of the tote allows the wastewater to be re-filtered through the chemical filtration process.

Figure 7: Storage Tote

5.1.2. ZARRS System Capital Cost

One of the main goals of the ZARRS system was to provide an economical alternative to vessel hull washing at small marina facilities. The initial capital cost for all of the components to run the system was $5,000. The major cost of the system is the wash pad which cost $3,200. Although the wash pad will periodically need to be replaced, the lifetime of the wash pad can be increased by using a geotextile separator between the wash pad and the ground to reduce punctures. Additional expected long term maintenance costs for the ZARRS system includes the seasonal replacement of the filter materials. This includes the geotextile liner within the filter tote and the pool filter medium which cost $200. Costs for disposal of the recycled wastewater is under $20 per storage tote load (not including transportation). With proper care of the components the ZARRS system is an economical solution for small, season boat hull washing activities.

6. OCC SYSTEM TESTING

Full scale testing of the ZARRS system was conducted in partnership with the All Seasons Marina. System performance was analyzed based on its ability to treat the wastewater and its ability to function.

6.1. FIELD SITE DESCRIPTION

OCC partnered up with All Seasons Marina to develop and test the prototype design. All Seasons Marina is located at 551 Roosevelt Blvd., Marmora, NJ 08223. This facility is a recreational marina accessible to the public and located along the Intracoastal Waterway at channel marker 282 behind Ocean City, New Jersey (see Figure 8). The system was assembled on site and tested during the 2007-08 and the 2008-09 winter seasons. Figure 9 shows the general layout of the marina. The travel lift area (right center in Figure 9) is also the location of boat washing operations at All Seasons Marina.

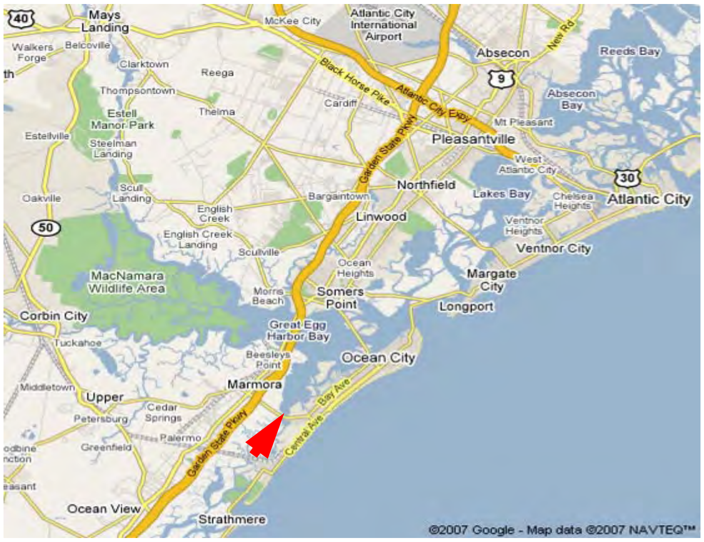

Figure 8: General Location of All Season Marina, Maramora, NJ

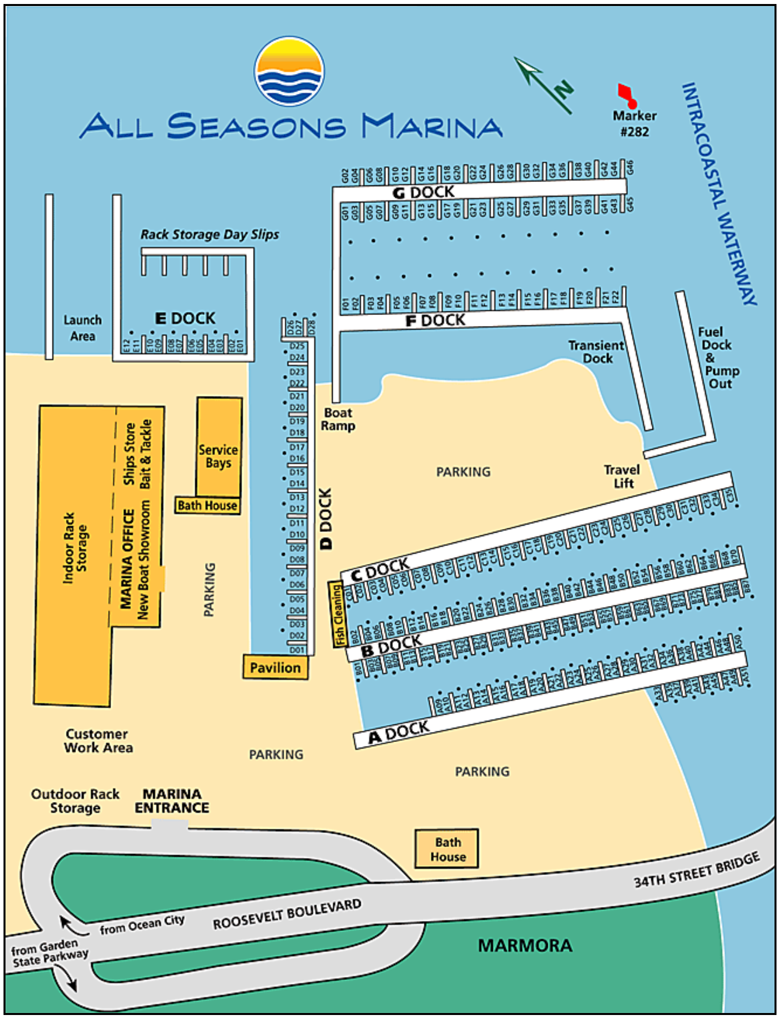

Figure 9: All Seasons Marina Map

6.2. EXISTING BOAT WASH OPERATIONS

All Seasons Marina provides boat washing services to its clients that maintain a boating slip within their marina. The majority of boat washing occurs between September and January and is dependant upon favorable weather. Starting after September and continuing through the early winter months boats are removed from their slips, washed, and placed in storage. Depending on boat size and weather, All Seasons Marina is capable of washing 1-5 boats per day.

At the All Seasons Marina boats are removed from the water using a travel lift located between C dock and the fuel deck and pump out dock (Figure 10). This lift utilizes two straps and hydraulics to lift the boat out of the water. Once lifted over land the lift transports the boat to the adjacent land to be washed. A pressure washer using fresh water is used to wash the boat hull.

Figure 10: Travel lift at All Seasons Marina

6.3. BOAT HULL WASTEWATER CHARACTERIZATION AT ALL SEASONS MARINA

The monitoring of sixteen (16) different parameters was used in the boat hull wastewater investigation, (Table 2). The analysis of these parameters aided in characterizing the materials present in the wastewater produced by small marina boat hull operations, determining the efficacy of the designed ZARRS and determining the concentration of materials present in the surrounding waters for reference and possible wastewater disposal alternatives.

As previously discussed, boat hull washing is an abrasive action resulting in the suspension of numerous particles. This is true whether the hull is washed using aggressive pressure washing or more gentle hand washing techniques. The wastewater generated by typical boat hull washing activities is usually turbid in appearance containing a gamut of organic, suspended and dissolved material (Figure 11). Some of the materials are foreign to the original hull like algae, sea weed, barnacles and other marine organisms, while others come directly from it like coating chips and anti fouling chemicals.

Table 2: Boat hull wastewater (RAW) characterization parameters at All Seasons Marina

Parameters (mg/L)	Date of Boat Hull Wastewater Sampling (RAW)						Standards (mg/L)	
	Dec. 7, 2007	Dec. 18, 2007	Dec. 9, 2008	Dec. 16, 2008	Jan. 6, 2009	Average	NJSWQS (Aquatic Acute)	NJGWQS (GW Quality Criterion)
Copper Suspended	14.90	10.90	28.80	23.90	8.21	17.342	(1)	(1)
Copper Dissolved	4.35	5.40	3.45	0.5090	0.7550	2.8928	0.0031	0.010
Lead Suspended	0.0160	0.0377	0.1690	0.1220	0.0450	0.0779	(1)	(1)
Lead Dissolved	ND	0.0089	ND	ND	ND	0.0015	0.024	0.005
Tin Suspended	ND	ND	0.1740	0.6190	ND	0.1586	(2)	(2)
Tin Dissolved	ND	ND	ND	ND	ND	ND	(2)	(2)
Zinc Suspended	0.4930	4.85	7.39	4.13	2.69	3.9106	(1)	(1)
Zinc Dissolved	0.0917	3.49	2.40	0.8970	1.5500	1.68574	0.081	2.0
Total Hardness	126.00	275.00	367.00	55.70	92.00	183.14	(1)	(1)
Hexae Extr.-SGT (Oil & Grease)	ND	ND	ND	ND	ND	ND	(3)	None Noticeable
Fecal Coliform-MF	<10 col/100ml	<10 col/100ml	<10 col/100ml	<10 col/100ml	<10 col/100ml	<10 col/100ml	(3)	(3)
Total Suspended Organic Carbon	42.5000	84.90	124.00	9.10	10.40	54.1800	(3)	(3)
Total Dissolved Organic Carbon	33.3000	70.30	101.00	9.62	9.74	44.7920	(3)	(3)
Total Suspended Solids	200.0000	134.0000	660.00	448.00	208.00	330	(3)	(3)
Total Dissolved Solids	896.00	1620.00	1270.00	217.00	331.00	866.8	(3)	500
pH	8.19	7.37	7.71	7.15	7.86	7.66	(3)	6.5 - 8.5

(1) No limit set or know for parameter
(2) Tin regulated by restrictions on Tributyltin paints
(3) No monitoring requirements, but limits will be based on water quality criteria
ND = Not Detected NT = Not Tested

Figure 11: Untreated boat hull wastewater produced at All Seasons Marina on December 12, 2009

The four metals of largest concern in boat hull wash wastewater, copper, lead, tin and zinc, were monitored during the investigation over two separate winter seasons at All Seasons Marina. Both suspended and dissolved concentrations were monitored. A 0.45 μm filter is used to distinguish dissolved particles, those passing through the filter, and suspended particles, those retained by the filter. In all, a total of five (5) boat hull wastewater samples were collected from pools formed on the wash pad. The five samples, labeled RAW, were collected after recent boat hull washings on five separate days, Table 2.

Of the four metals monitored, copper is the major dissolved and suspended contaminant of concern. As the most common antifouling agent currently utilized in boat hull coatings, this result was expected. The average concentrations of suspended and dissolved copper are 17 mg/L and 2.4 mg/L, respectively. Zinc is the second largest contaminant of concern with average suspended and dissolved concentrations of 3.9 mg/L and 1.7 mg/L, respectively. The multiples uses of zinc as an antifouling agent and anticorrosive agent are responsible for the higher concentrations. The third largest contaminant of concern is tin. No dissolved tin was detected in any of the five samplings and was only present in the suspended form in two of the samplings. The averaged suspended concentration of tin was 0.16 mg/L (for all five samplings). The restrictions on tin as an antifouling agent are responsible for its absence in multiple tests. Lead, with an average suspended and dissolved concentrations of 0.078 mg/L and 0.0015 mg/L, respectively, was the contaminant of least concern. This is true even though the average dissolved concentration of lead is higher than tin because the average total concentration (which is the sum of dissolved and suspended concentrations) of lead is lower than the average total concentration of tin. The limited use of lead as an antifouling agent accounts for these smaller concentrations.

NJ Water Quality Standards only provide dissolved concentration limits for copper lead and zinc contaminants. It provides two separate standards for surface water and ground water. The average concentrations of copper and zinc were 930 and 20 times larger, respectively, than limits set by the NJ Surface Water Quality Standard (NJSWQS). The dissolved concentration of lead was found to be in compliance with the NJSWQS limits.

The average concentration of copper was 290 times larger than limits set by the NJ Ground Water Quality Standard (NJGWQS). The dissolved concentration of lead and zinc was found to be in compliance with the NJGWQS limits.

The average concentration of total hardness in boat hull wastewater is 183 mg/L. This is considered to be a moderate level and is similar to levels found in municipal water sources. Because of their comparable concentrations, the source of total hardness within the boat hull wastewater is most likely from the water source used for cleaning. Total hardness is a measure of the combined concentrations of calcium and magnesium. The presence of magnesium and calcium in water has been demonstrated to affect the transfer of nutrients and waste products through cell membranes and can affect egg fertility, proper functioning of internal organs such as kidneys and growth. Within reason, most fish and plants can successfully adapt to local total hardness conditions, although breeding may be impaired.

The average concentration of fecal coliform, oil and grease in all boat hull wastewater is not detectable. The average concentration of fecal coliform is listed as <10col per100ml, which is considered to be not detectable per the analytical methods used. These results are expected because fecal coliform, oil and grease are not present in the either the boat hull coating or surrounding marina waters. The reason fecal coliform concentration tests were conducted was to explore municipal sewer discharge opportunities.

The average concentration of organic carbon is monitored to measure the biodegradable organic content in the wastewater. The average concentration of total suspended organic carbon, 54 mg/L, is found to be larger than the average concentration of total dissolved organic carbon, 45 mg/L. Both concentrations are large enough to sustain biological growth for organisms that can produce low oxygen conditions, odors and replication that can lead to biological fouling of treatment systems if not controlled.

The average concentration of total suspended solids, 330 mg/L, is lower than the average concentration of total dissolved solids, 867 mg/L. NJ Water Quality Standard only provides a Ground Water limit for Total Dissolved Solids. The average total dissolved solids was found to exceed the 500mg/L limit by 0.7 times the amount. From a system design standpoint, the ratio between dissolved and suspended solids is important. Practically, it means that approximately 72% of the particles present will not separate out by simple settling. They will have to be removed by another previously mentioned technology.

The last parameter monitored was pH. Boat hull wastewater has an average pH value of 7.66. This is within the NJGWQS of 6.5 - 8.5. Because boat hulls have little to no materials that can change the alkalinity of water, little change was expected in the pH.

6.4. 2007 SYSTEM

6.4.1. Set-up

The wash wastewater treatment system was designed to capture, treat and recycle the wash wastewater used during the cleaning of vessel bottoms. The overall goal of the system is to be portable with minimal permanent modifications necessary to install the wash wastewater system. Additionally, materials and methods were used that promoted the use of marina labor and reduced the need for heavy equipment. A schematic layout of the 2007 system design can be found in Figure 1 (page 10).

The majority of vessels washed throughout the process were suspended on the All Season's Marina travel lift. Vessels are suspended from the travel lift with two straps and the vessel is moved over the wash pad where the bottom of the vessel is power washed prior to being stored for the winter. The wash pad over which the vessels were washed is a 50 mil plastic material with dimensions of 19 feet wide by 45 feet long. A non-woven polypropylene geotextile fabric was placed below the wash pad to provide a padded barrier between plastic wash pad and the ground which consisted of a combination of sand, gravel and shell fragments.

The wash pad was delivered to the site on a flatbed truck and a forklift. After removed from the palette and unfolded, the wash pad was moved into position below the travel lift with four people, then pulled tight to remove as many wrinkles as possible. A box filled with approximately five-foot sections of 3-inch diameter foam pieces was included with the pad to be installed into the slotted area bordering the pad to create a berm preventing water from leaving the pad. Installation of these foam sections proved to be very difficult and was replaced with 12-foot sections of 3 inch diameter sections of PVC plumbing pipe cemented together.

All Seasons marina then provided a squeegee and a 500 gallon per hour bilge pump to pump water collected on the wash pad through ½" flexible tubing to the filter totes. For this project, two 330-gallon totes were utilized for the washwater filtering cycle. The totes were delivered to the site and easily moved into position by two people. The totes were placed in close relative proximity to the wash pad and the bilge pump to reduce the length of pumping and amount of flexible tubing needed.

Prior to being deposited into the first tote, the polymer AQ-64 was added to the wash wastewater to create a floc that could be retained by the geotextile fabric lining the first tote (see below). To do this, a pail of AQ-64 (approximately 5 gallons) was purchased and a chemical feed pump with flexible tubing and a T-joint was joined to the ½" flexible tubing carrying the wash-water from the pad to the first tote. A ½" static mixer was placed downstream of the T-joint to thoroughly mix the polymer with the wash wastewater to encourage flocculation prior to reaching the first tote.

The first tote in the series of two was used as a means of filtering solids form the wash wastewater. A GC-107 woven polyester geotextile fabric liner was special-ordered and designed to fit inside the tote, being suspended from the top of the aluminum tote frame (Figure 6 on page 14). The purpose of the geotextile fabric was to filter large solids from the wash wastewater that were either pumped from the wash pad (algae, paint chips, etc) or formed after the addition of the polymer to the wash wastewater.

The totes were constructed with 2" Viton quick disconnect ball valves on the bottom of the tote. This made it possible for water to enter the tote first tote from the top, be filtered through the geotextile fabric liner, and exit the tote through the bottom. From the first tote, the wash-water was pumped to a sand filter. For this project, a Hayward Model S166T90 ProTM Series High-Rated Sand Filtration System was utilized. This system included a Power-Flo series high performance pump to draw water from the first tote and into the sand filter. Due to space requirements at the site, the pump was placed in line with the totes, put on top of a 24-inch retaining wall. The pump was not self-priming and thus needed to be primed to start the flow of water from the first tote, through the sand filter and into the second tote. The purpose of the sand filter was to remove chemical constituents from the wash wastewater. The sand filter is a small piece of equipment that could be moved by two people (Figure 5 on page 12).

The discharge hose from the sand filter pumped the water to a second 330-gallon tote. The purpose of this tote was for storing the treated wash wastewater for reuse during vessel washing. This tote also had a 2" Viton quick disconnect ball valves on the bottom which allowed water to be drawn form the bottom of the tote and into the wash wastewater treatment cycle after being drawn from the first tote and prior to being sent through the sand filter. This created a continuous loop for water to go through the sand filter, into the second tote, and back through the sand filter until the bottom valve of the second tote was closed. The continuous filtering of the wash wastewater provided additional cycles through the chemical filtering process to further reduce the presence of chemical constituents in the wash-water.

6.4.2. 2007 Testing Results

In order to determine the effectiveness of the ZARRS, the concentration parameters of the boat hull wash wastewater collected from the wash pad (RAW) was compared to the processed water (PROC). Samples of processed water were always obtained from the storage tote. However, due to the inhomogeneous nature of the materials sampled from the wash pad, a large statistical variation was present within the RAW data. For this reason, a "nine fold change in a parameter's concentration" criterion was defined in order to distinguish sample variation from significant changes produced by the ZARRS.

The "nine fold change in a parameter's concentration" criterion was developed through statistical analysis. The minimum and maximum concentration for each of the fifteen parameters was found (pH was not used because it is logarithmic). The maximum concentration was then divided by the minimum concentration for each parameter to determine how large a variation existed. The variation for all fifteen parameters was then averaged together. The result of this average was nine. This number serves to define a statistically significant change. *Therefore, for the system to be deemed successful based on the "nine fold change in a parameter's concentration" criterion, differences in concentration of parameters between the RAW and PROC samples must be greater than 9 times.*

Use of the "nine fold change in a parameter's concentration" criterion shows the 2007 Season ZARRS had no statistically significant effect on the captured boat hull wash wastewater (Table 3). In both the

December 7th and December 18th testing, all changes in parameters concentrations were determined to be statistically insignificant by the "nine fold change in a parameter's concentration" criterion. Reduction in the concentration of contaminants ranged from 1.0 (no change) to 7.5 times. Therefore, all the “reductions” were within the realm of being due to the inhomogenous nature of the sampling. Also, several criteria also saw small increases in concentration. This could also potentially be a result of the inhomogenous nature of the sampling.

The reason "lead suspended" in the December 18th test is not considered statistically significant even though there is a reduction from 0.038 mg/L to not detectable is because the reporting limits of the analytical testing procedures used is only 0.005 mg/L. The change in concentration from 0.038 mg/L to 0.005mg/L is not statistically significant.

The only change that is statistically significant is the change in pH. The pH of a sample is equal to the negative log of the hydrogen ion concentration ($pH = -Log[H^+]$). Therefore, a single unit of change is equivalent to a ten fold change in the hydrogen ion concentration. Testing on both December 7th and December 18th shows a decrease in pH to approximately 4.3. The reduction is the result of the AQ-64, an acidic polyaluminium chloride flocculent added to cause the materials within the boat hull wash wastewater to be more readily filtered. A portion of the statistically insignificant increase in total dissolved solids can be contributed to the addition of this polymer, as is seen in both the December 7th and December 18th testing.

Table 3: Boatyard Pressure-washing Wastewater Parameters and NJ Regulatory Limits for 2007 Season ZARRS

Parameters (mg/L)	December 7, 2007		December 18, 2007		Standards (mg/L)	
	RAW	PROC	RAW	PROC	NJSWQS (Aquatic Acute)	NJGWQS (GW Quality Criterion)
Copper Suspended	14.90	4.88	10.90	12.50	(1)	(1)
Copper Dissolved	4.35	3.54	5.40	8.69	0.0031	0.010
Lead Suspended	0.0160	ND	0.0377	ND	(1)	(1)
Lead Dissolved	ND	ND	0.0089	0.0183	0.024	0.005
Tin Suspended	ND	ND	ND	ND	(2)	(2)
Tin Dissolved	ND	ND	ND	ND	(2)	(2)
Zinc Suspended	0.4930	0.5320	4.85	4.54	(1)	(1)
Zinc Dissolved	0.0917	0.5610	3.49	3.45	0.081	2.0
Total Hardness	126.00	52.70	275.00	211.00	(1)	(1)
Hexae Extr.-SGT (Oil & Grease)	ND	ND	ND	ND	(3)	None Noticeable
Fecal Coliform-MF	<10 col/100ml	<10 col/100ml	<10 col/100ml	<10 col/100ml	(3)	(3)
Total Suspended Organic Carbon	42.50	20.40	84.90	65.80	(3)	(3)
Total Dissolved Organic Carbon	33.30	18.80	70.30	62.30	(3)	(3)
Total Suspended Solids	200.00	896.00	134.00	260.00	(3)	(3)
Total Dissolved Solids	896.00	7260.00	1620.00	3640.00	(3)	500
pH	8.19	4.31	7.37	4.35	(3)	6.5 - 8.5

(1) No limit set or know for parameter
(2) Tin regulated by restrictions on Tributyltin paints
(3) No monitoring requirements, but limits will be based on water quality criteria
ND = Not Detected NT = Not Tested

6.5. 2008 ZARRS SYSTEM

6.5.1. Set-up

Based on the results from the 2007 set-up and testing some modifications were made to improve the system. Figure 12 below is a schematic of the 2008 system set-up. While the same basic principles used in designing the original wash wastewater treatment system were employed during the 2008 design and testing cycle, several additions and changes were made to streamline the process and remove more physical and chemical constituents from the wash wastewater. The basic changes/additions to the system are as follows:

- The bilge pump used to pump water from the wash pad was placed in a small metal cage to prevent large pieces of algae and paint chips from being pumped to the static mixer and the totes. One of the issues with the 2007 design was this algae clogging the static mixer and the GC-107 geotextile filter fabric that lined the first tote. The purpose of the metal cage was to provide a first step physical filtering process of the wash wastewater.

- An additional, smaller setting tote was added to the system. Water was pumped from the pad and into this settling basin prior to adding polymer. The reason for this was that, although bench scale testing of the AQ-64 was successful at flocculating the solids, the water did not separate well during the full scale process. The settling tote was added as a step to add lime (to raise the pH, which was found to increase the ability of the AQ-64 to separate the wash wastewater from the solids) and to add the AQ 64 polymer. This increased the ability of the polymer to create a floc. After the floc was formed, the wash wastewater was manually poured into the first tote.

- During the initial running and testing of the system, the GC-107 filter fabric was easily clogged and the clung to the sides of the tote, making it difficult for water to leave the tote through the bottom valve and enter the sand-filter phase of the treatment process. Based on this, a tri-planar fabric was added to line the tote and create a gap between the geotextile filtering fabric and the plastic walls of the tote.

- Testing performed during the first year of the project showed that concentration of Copper, Tin, Zinc and Lead were consistently high compared to N.J. Water Quality Standards. Two additional items were added to the sand filter to try to reduce these concentrations. First, half of the sand was removed from the filter and a Reactive Core Mat (RCM) was cut to fit inside the filter and zeolite sand was placed on top of the RCM. The RCM is a permeable composite of non-woven geotextiles and granular apatite that sequesters certain heavy metals from water. As a filtering media, zeolite sand is very similar to regular filtering sand in its external dimensions. However, the structures of zeolites consist of three-dimensional frameworks with molecular sized pores that contain within themselves net negative charges that allow them to remove positively charged heavy metals (cationic adsorption) from wastewater.

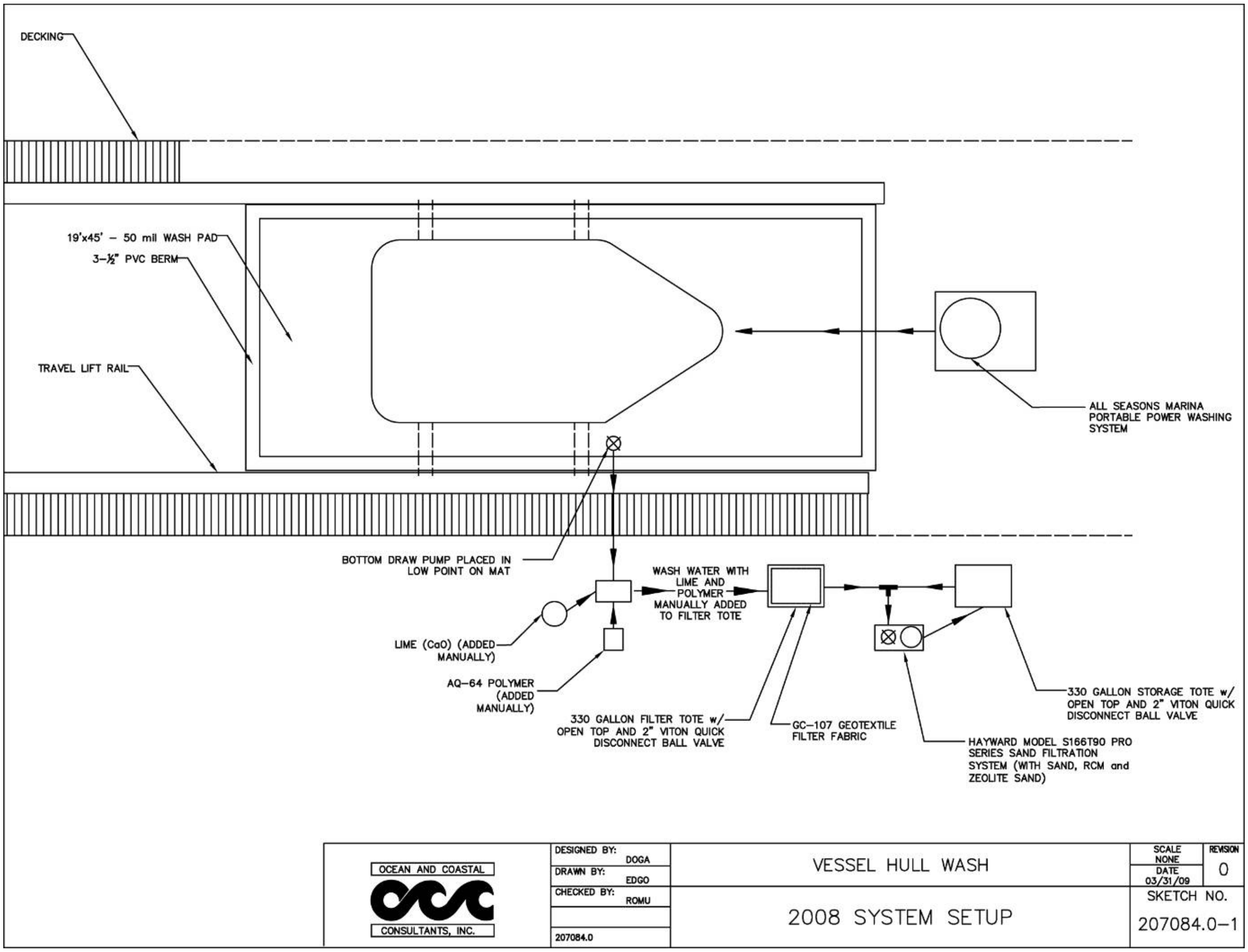

Figure 12: Schematic of 2008 system design

6.5.2. 2008 Testing Results

In order to determine the effectiveness of the 2008 season ZARRS, the concentration parameters of the boat hull wash wastewater collected from the wash pad (RAW) were again compared to the processed water (PROC) using the "nine fold change in a parameter's concentration" criterion. Use of the "nine fold change in a parameter's concentration" criterion shows the 2008 Season ZARRS to have a statistically significant and large positive effect on the captured boat hull wash wastewater (Table 4).

Table 4: Boatyard Pressure-washing parameters and NJ Regulatory Limits for 2008 Season ZARRS

Parameters (mg/L)	December 9, 2008		December 16, 2008		January 6, 2009		Standards (mg/L)	
	RAW	PROC	RAW	PROC	RAW	PROC	NJSWQS (Aquatic Acute)	NJGWQS (GW Quality Criterion)
Copper Suspended	28.80	0.3310	23.9000	0.1660	8.2100	0.2290	(1)	(1)
Copper Dissolved	3.45	0.0543	0.5090	0.0919	0.7550	0.1110	0.0031	0.010
Lead Suspended	0.1690	ND	0.1220	ND	0.0450	ND	(1)	(1)
Lead Dissolved	ND	ND	ND	ND	ND	ND	0.024	0.005
Tin Suspended	0.1740	ND	0.6190	ND	ND	ND	(2)	(2)
Tin Dissolved	ND	ND	ND	ND	ND	ND	(2)	(2)
Zinc Suspended	7.39	0.03	4.13	0.0116	2.69	0.0811	(1)	(1)
Zinc Dissolved	2.40	ND	0.8970	ND	1.55	0.0441	0.081	2.0
Total Hardness	367.00	1370.00	55.70	305.00	92.00	291.00	(1)	(1)
Hexae Extr.-SGT (Oil & Grease)	ND	ND	ND	ND	ND	ND	(3)	None Noticeable
Fecal Coliform-MF	<10 col/100ml	<10 col/100ml	<10 col/100ml	<10 col/100ml	<10 col/100ml	<10 col/100ml	(3)	(3)
Total Suspended Organic Carbon	124.00	117.00	9.10	28.20	10.40	7.37	(3)	(3)
Total Dissolved Organic Carbon	101.00	101.00	9.62	27.50	9.74	7.62	(3)	(3)
Total Suspended Solids	660.00	55.00	448.00	12.80	208.00	27.00	(3)	(3)
Total Dissolved Solids	1270.00	8600.00	217.00	1510.00	331.00	1260.00	(3)	500
pH	7.71	10.26	7.15	10.36	7.86	8.60	(3)	6.5 - 8.5

(1) No limit set or know for parameter
(2) Tin regulated by restrictions on Tributyltin paints
(3) No monitoring requirements, but limits will be based on water quality criteria
ND = Not Detected NT = Not Tested

The suspended and dissolved concentrations of all four metals monitored showed statistically large reductions. The only two exceptions are for "copper dissolved" on December 16th and January 6th testing, for which there was only and 5.5 fold and 6.8 fold reduction, respectively. This stands in contrast to 63 fold reduction in concentration for "copper dissolved" seen in the December 9th testing. The "copper suspended" saw similar statistically significant reductions ranging from 144 fold to 36 fold.

The "lead suspended" and "tin suspended," when present in the collected RAW samples saw reduction in concentration levels to "not detectable" limits. For the 0.005 mg/L reporting limit, this resulted in statistically large reductions ranging from 34 fold to 9 fold and 124 fold to 35 fold, respectively. For the 2008 season, no "lead dissolved" and no "tin dissolved" was detected in both the RAW water sampled and the processed water of the ZARRS. The "zinc suspended" and zinc dissolved" saw the largest statistically significant reductions from 356 fold to 33 fold and from 480 fold to 33 fold, respectively.

The large reduction in suspended and dissolved concentration of metals can be contributed to the cationic adsorption capabilities of the zeolite and apatite materials. Together, these materials were able to significantly reduce concentrations to levels that met the more stringent of the NJSWQS or NJGWQS and in some instances, reduce the concentrations to "not detectable" levels. For the more stringent NJSWQS of 0.081 mg/L of "zinc dissolved," the final concentrations of the processed water were below the required limit. In addition, all though there are no known NJGWQS or NJSWQS for "lead suspended" and "tin suspended," the concentrations of the processed water were reduced to "not detectable" limits. This would put them in compliance with any existing standard. The concentration of "copper dissolved" was the only metal found not to be in compliance with either the NJSWQS or the NJGWQS for all three tests.

The "total hardness" for all three test of the 2008 season saw a statistically insignificant increase that can be contributed to the lime (Calcium Oxide with some Magnesium Oxide present) flocculating agent. The statistically insignificant concentration increases in "total hardness" ranged from 5.5 fold to 3.2 fold.

For the 2008 season, no fecal coliform, oil or grease was detected in both the RAW water sampled and the processed water of the ZARRS.

The "total suspended organic carbon" and the "total dissolved organic carbon" remained relatively the same, with statistically insignificant changes in concentration for each test. Reductions in "total suspended solids" were statistically significant and ranged from 35 fold to 7.7 fold. Reductions in "total suspended solids" can be contributed to successful filtration of the AQ-64/lime flocculation. The "total dissolved solids" underwent a statistically insignificant increase from 7.0 fold to 3.8 fold for all three tests. These statistically insignificant increases can be contributed to the addition of dissolved AQ-64/lime flocculating agents to the RAW water. The additions of flocculating agent are also responsible for the increases in pH. The RAW solutions were adjusted to basic levels using lime to provide AQ-64 with a more alkaline solution for forming a better floc. The addition of the lime left all pH values above the 8.5 value set by the NJGQWS.

7. CONCLUSIONS

Based on the results of the 2008 testing cycle, the ZARRS system is an effective way to reduce the concentration of pollutants resulting from the power washing of vessel hulls, Figure 13. This conclusion is based on the "nine fold change in a parameter's concentration" criterion developed through statistical analysis.

Figure 13: Untreated raw sample (left) and processed sample (right) of boat hull wastewater from All Seasons Marina on December 12, 2009

Parameters of specific concern were metals (Copper, Lead, Tin and Zinc). While test results for the 2007 season indicated that the system did not effectively reduce the concentrations of these parameters between the RAW and PROC water, modifications to the system for the 2008 system proved successful. Most importantly, the addition of the apatite Reactive Core Mat and the Zeolite sand into the sand filter were integral.

An overall purpose of this demonstration project was to test the ability of the ZARRS system to treat vessel hull wash wastewater to reduce contaminant levels to below those listed in the New Jersey Water Quality Standards (NJWQS). Specific results for the metals of concern during the 2008 testing cycle and how they compare to NJWQS are as follows:

Copper (Cu): Suspended and Dissolved Cu were present in all of the RAW samples. While the suspended Cu showed statistically large reductions between the RAW and PROC samples, dissolved Cu showed lower reduction factors. For example, on the December 16th and January 6th testing, results for the dissolved Cu showed a 5.5 fold and 6.8 fold reductions, respectively. This stands in contrast to 63 fold reduction in concentration for dissolved copper seen in the December 9th testing. The suspended copper saw similar statistically significant reductions ranging from 144 fold to 36 fold. While there is no NJWQS for suspended Cu, there are surface water (NJSWQC) and groundwater quality (NJGWQS) for dissolved Cu. During all three testing cycles for the 2008 season, the amount of dissolved copper was reduced, but did not fall below the NJSWQS or the NJGWQS.

Lead (Pb): While the NJSWQS and NJGWQS set limits on the concentration of dissolved lead, this parameter was not detected in any samples during the 2008 testing season. Suspended lead, which does not have written NJWQS standards, was found in all three samples from 2008. In all three cases, the ZARRS treatment system reduced the concentration of suspended lead to the Not Detected (ND) levels.

Tin (Tn): The regulation of Tin concentrations are done by restrictions on Tributyltin paints. For the testing performed during the 2008 season, no dissolved tin was detected in the samples. Suspended tin was detected in two of the three sampling efforts and, in both cases, the ZARRS system reduced the concentration of dissolved tin to ND.

Zinc (Zn): NJWQS has set standards for concentration of dissolved zinc, but not suspended zinc. The zinc suspended and zinc dissolved saw the largest statistically significant reductions from 356 fold to 33 fold and from 480 fold to 33 fold, respectively. For two of the three samples performed during the 2008 testing season, concentrations of dissolved zinc were reduced from levels above NJWQS to ND. In the third case, the PROC sample showed levels of dissolved zinc that were detectable, but below both NJSWQS and NJGWQS standards.

8. RECOMMENDATIONS

Based on the results of two seasons of design development and prototype testing, several recommendations can be made to refine the system and develop a fully-functioning, portable vessel hull wash wastewater treatment system:

Chemical Additives:

The initial system design specified a polymer (AQ-64) to create a floc in the wastewater prior to entering the filter tote. While bench scale testing of the wash wastewater and polymer were successful, the full scale addition of polymer to the treatment line was not as successful at separating suspended materials from the water. Lime (CaO) was added to the wash wastewater prior to adding the polymer. The theory was that the addition of lime would raise the pH and thus increase the effectiveness of the polymer. However, field tests during the 2008 testing season showed that the addition of lime (without the AQ-64) was sufficient to create a floc. The downside of this is that the pH of the wash wastewater was increased.

It is recommended for future efforts utilizing the ZARRS system that an alum-lime combination additive be utilized to create a floc in the wash wastewater while maintaining a neutral pH. The addition of an Alum-Lime combination has been well documented in research (Bache 2007, Bhattacharjee 2007, Bratby 2006, Gregor 1997, Hwa 1997, Mohamed 2001, Nason 2009, Perrin 1974, Sharrer 2009, Shekkholeslami 2002, Stechemesser 2005). Alum ($Al_2(SO_4)$) is a acidic form of hydrated aluminum that can be made neutral when mixed with an alkaline material like lime. Both Alum and lime are relatively inexpensive additives that have been demonstrated to form a good floc.

Physical Filtration:

Despite the addition of polymer and lime to the vessel hull wash wastewater, the geotextile filter fabric (GC-107) in the filtering tote became easily clogged. The chosen geotextile was polyester with a nonwoven as a constituent. It is recommended that a woven polypropylene be used to allow much more flow without clogging.

Furthermore, while the alum-lime additives to the treatment process may increase the flocculation potential of the wash wastewater, it is also recommended that a settling chamber be added to the treatment line prior to the 330 gallon filtering tote. After the alum-lime combination has been added to the wash wastewater, water can be pumped to a similar sized settling chamber and given sufficient time to settle. Then, wash wastewater could be pumped off of the top layers of settling water into the filtering tote and continue along the treatment process. Solids retained in the bottom layer of the settling chamber would require periodic cleaning and disposal. However, removing these solids from the wastewater should increase the effectiveness of other filtering processes utilized by the ZARRS system. Similar processes utilizing an alum-lime flocculation that is then filtered through a geotextile have been demonstrated in research (Sharrer 2009).

Additional Filtering:

While the alum-lime additive should create a good floc, the one downside to this is the amount of calcium and magnesium added to the wash wastewater, thus creating "hard water." To account for the addition of this calcium and magnesium, it is recommended that future applications of the ZARRS system utilize a sodium-free soft water filter (since the Zeolite sand preferentially binds with sodium, the soft water filter should have no sodium). This filter should be placed after the filtering tote, but before the zeolite sand filter.

Copper Reduction:

The only heavy metal that the ZARRS system did not effectively treat was copper. It is recommended that synthetic apatite and synthetic zeolite sands be tested as a part of the ZARRS system to test their effectiveness at reducing copper concentrations. The synthetic apatite and zeolite sand could be incorporated into the sand filtering phase of the treatment process. While these synthetic forms are slightly more expensive, prior research has shown that synthetic zeolite is capable of removing copper from industrial waste (Inglezakis 2003, Qui 2009, Svilovic 2008)

Based on the recommendations herein, a modified flow diagram of the treatment process is presented below in Figure 14.

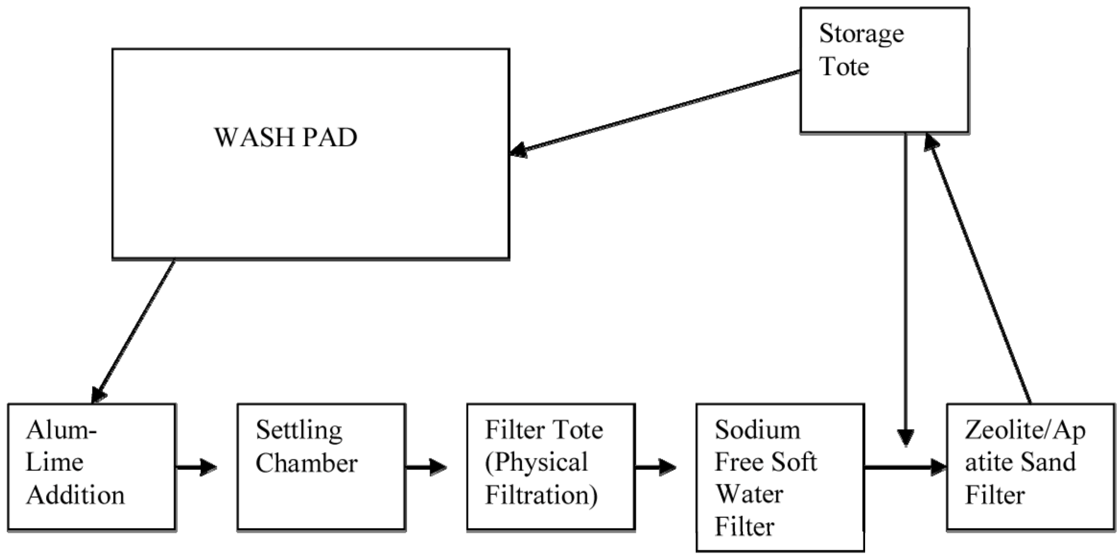

Figure 14: Modified flow diagram based on report recommendations.

9. REFERENCES

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APPENDIX A - ZEOSAND FILTER MEDIA & APATITE REACTIVE CORE MAT

ZeoSand® Filter Media

Material Safety Data Sheet

1. Product and company identification

Trade name:	ZeoSand	
Manufacturer:	ZEO, Inc.	800-530-8283
	P.O. Box 2353	972-542-0053
	McKinney, TX 75070	972-542-0211 Fax
	www.zeoinc.com	Revised: Dec 31, 2006

2. Composition/information on ingredients

Composition:	100% natural zeolite ore
Common names:	Clinoptilolite, clino, zeolite,
	Hydrated sodium potassium calcium aluminosilicate
Empirical formula:	$(Na^{+}, K^{+}, Ca^{++}, Mg^{++})^{+6}[(AlO_2)_6(SiO_2)_{30}]^{-6} \cdot 24\ H_2O$
CAS Registry No.:	001318-02-1

3. Hazards identification

Contains less than 0.1% crystalline silica.

4. First aid measures

Skin and Eye Contact:	Flush with water.
Inhalation:	Move to dust free air. Administer oxygen and CPR if breathing stops.
Ingestion:	Drink 16 ounces (500 ml) of water.

5. Fire fighting measures

Flash point None Flammable limits: None

Not a fire or explosion hazard; ZeoSand may be used in place of sand to extinguish Class A and B fires.

6. Accidental release measure

Wear dust protection. Sweep or scoop up and dispose in non-hazardous waste.

7. Handling and storage

Handle in a way to minimize dust. Store at ambient temperature

8. Exposure controls / Personal protection

Wear dust mask or safety glasses to prevent nuisance dust from entering nose, mouth, and eyes

9. Physical and chemical properties

Appearance:	Green solid	Odor:	None
Sp. gr. (water=1):	0.85	Melting point (°C):	> 1,200

10. Stability and reactivity

Stability:	Stable	Incompatibility:	None
Hazardous polymerization:	None		

11. Toxicological information

OSHA:	Free silica is not listed as a carcinogen.

12. Ecological Information

Waterfowl Toxicity	Not applicable	Aquatic toxicity:	Not applicable
Food chain concentration:	Not applicable	Biochemical oxygen demand:	Not applicable
Atmospheric:	Not applicable		

13. Disposal Considerations

Natural zeolites are not classified as hazardous under RCRA.

14. Transport information

Natural zeolites are not classified as hazardous material by the US DOT.

15. Regulatory information

CLERCLA:	Not classified as a hazardous substance.

16. Other information

None

Disclaimer: Although reasonable care was taken in preparing this document, no warranties are extended, and no representations are made as to the accuracy or completeness of the information contained in this document, and no responsibility is assumed regarding the suitability of this information for the user's intended purposed or the consequences of its use. Each individual should make a determination as to suitability of the information for their particular purpose(s).

CETCO LINING TECHNOLOGIES

Certified Properties

APATITE
REACTIVE CORE MAT™

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY	VALUE
APATITE			
Bulk Density Range	ASTM D2854	1/lot	90-95 lbs/ft^3 (wet wt.)
FINISHED RCM PRODUCT			
Apatite Mass per Area	Modified ASTM D5993	1/40,000 sq.ft.	0.8 lb/ft^2
Mat Grab Strength	ASTM D4632	1/200,000 sq.ft	200 lbs. MARV
Grab Elongation	ASTM D4632	1/200,000 sq.ft.	50% min.
Permeability	ASTM D 2434	1/lot	1 x 10^{-3} cm/s min.

Description: A permeable composite of geotextiles and granular apatite that sequesters certain heavy metals from water.
Roll Width and edge closure: Total Roll width is ~16' 2". Effective product width measures 15'-10" as approximately 2" will be folded and sealed along each edge without apatite in it.
Roll Length: 100'
Packaging: Packaged on min. 4" I.D. core tubes, and wrapped with polyethylene plastic packaging.

APPENDIX B - TEST RESULTS

QC Laboratories

Analytical Report

ACCREDITED IN ACCORDANCE WITH nelac
12/26/07 03:40pm

Regarding:

ED GORLESKI
OCEAN AND COASTAL CONSULTANTS, INC.
20 E. CLEMENTON ROAD
SUITE 201N
GIBBSBORO, NJ 08026

ED GORLESKI
OCEAN AND COASTAL CONSULTANTS, INC.
20 E. CLEMENTON ROAD
SUITE 201N
GIBBSBORO, NJ 08026

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   P.O. No: Inv. No: 935153
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-1	VESSEL HULL WASH* RAW Received Temp: 36 F Iced (Y/N): Y	12/07/07 01:00pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	Calculation Method(200.7)	1.96 mg/l	0.500 mg/l	12/20/07 01:39PM
MAGNESIUM HARDNESS	Calculation Method(200.7)	ND mg/l	0.500 mg/l	12/20/07 01:39PM
TOTAL HARDNESS	Calculation Method(200.7)	ND mg/l	5.00 mg/l	12/20/07 01:39PM
CALCIUM	EPA 600 Method 200.7	0.783 mg/l	0.100 mg/l	12/20/07 01:39PM BAB
COPPER	EPA 600 Method 200.7	0.00550 mg/l	0.00300 mg/l	12/20/07 01:39PM BAB
MAGNESIUM	EPA 600 Method 200.7	ND mg/l	0.100 mg/l	12/20/07 01:39PM BAB
LEAD	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/20/07 01:39PM BAB
TIN	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	12/20/07 01:39PM BAB
ZINC	EPA 600 Method 200.7	0.157 mg/l	0.00500 mg/l	12/20/07 01:39PM BAB
COPPER DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.00300 mg/l	12/20/07 01:43PM BAB
LEAD DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/20/07 01:43PM BAB
ANTIMONY DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.0200 mg/l	12/20/07 01:43PM BAB
ZINC DISSOLVED	EPA 600 Method 200.7	0.0899 mg/l	0.00500 mg/l	12/20/07 01:43PM BAB

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
- Definitions: ND=not detected; NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC=too numerous to count
- A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
- All analysis, except field tests are conducted in Southampton, PA unless otherwise identified.
- The test"pH lab"is analyzed upon receipt at the laboratory, the result will not be suitable for regulatory purposes.
- Actual times of analysis for parameters reported <24 hrs are available upon request. All testing is completed within the required holding time unless otherwise noted..
- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
- All samples are collected as "grab" samples unless otherwise identified.
- MCL= is the EPA recommended "maximum contaminant level" for a parameter. PLs=customer specific permit limits.

Regulatory authorities are assessing substantial fines for testing omissions. Please track your sample collections and results on a weekly, monthly, or quarterly basis to ensure compliance. QC's internet program 'LIVE ACCESS' will provide you with real-time access to collection dates and results. Please contact Customer Service for further information on acquiring LIVE ACCESS.

Serial Number: 918116

Thomas J. Hines
Thomas J. Hines, President

1205 Industrial Blvd., P.O. Box 514, Southampton, PA 18966-0514 Phone: 215-355-3900 Fax: 215-355-7231 www.qclaboratories.com

QC Laboratories

Analytical Report

12/26/07 03:40pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   P.O. No: Inv. No: 935153
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-1	VESSEL HULL WASH* RAW	12/07/07 01:00pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
HEXANE EXTR.-SGT (NON POLAR O+G)	Method 1664A SGT(@PHC)	ND mg/l	5.00 mg/l	12/18/07 02:15PM JW
DISSOLVED ORGANIC CARBON	SM 20th Ed. 5310C	ND mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL DISSOLVED SOLIDS	SM 20th Ed. 2540C	157 mg/l	20.0 mg/l	12/11/07 11:00AM MJP
TOTAL ORGANIC CARBON	SM 20th Ed. 5310C	ND mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL SUSPENDED SOLIDS	SM 20th Ed. 2540D	2.00 mg/l	2.00 mg/l	12/11/07 12:50PM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/07/07 04:15PM KLM

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-2	PAD Received Temp: 36 F Iced (Y/N): Y	12/07/07 01:30pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	Calculation Method(200.7)	21.5 mg/l	0.500 mg/l	12/20/07 01:45PM
MAGNESIUM HARDNESS	Calculation Method(200.7)	104 mg/l	0.500 mg/l	12/20/07 01:45PM
TOTAL HARDNESS	Calculation Method(200.7)	126 mg/l	5.00 mg/l	12/20/07 01:45PM
CALCIUM	EPA 600 Method 200.7	8.62 mg/l	0.100 mg/l	12/20/07 01:45PM BAB
COPPER	EPA 600 Method 200.7	14.9 mg/l	0.00300 mg/l	12/20/07 01:45PM BAB
MAGNESIUM	EPA 600 Method 200.7	25.3 mg/l	0.100 mg/l	12/20/07 01:45PM BAB
LEAD	EPA 600 Method 200.7	0.0160 mg/l	0.00500 mg/l	12/20/07 01:45PM BAB
TIN	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	12/20/07 01:45PM BAB
ZINC	EPA 600 Method 200.7	0.493 mg/l	0.00500 mg/l	12/20/07 01:45PM BAB
COPPER DISSOLVED	EPA 600 Method 200.7	4.35 mg/l	0.00300 mg/l	12/20/07 01:48PM BAB
LEAD DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/20/07 01:48PM BAB
ANTIMONY DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.0200 mg/l	12/20/07 01:48PM BAB

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
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- All analysis, except field tests are conducted in Southampton, PA unless otherwise identified.
- The test"pH lab"is analyzed upon receipt at the laboratory, the result will not be suitable for regulatory purposes.
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- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
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Serial Number: 918116

Thomas J. Hines

Thomas J. Hines, President

QC Laboratories

Analytical Report

12/26/07 03:40pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC

P.O. No:
PWSID No:

Inv. No: 935153

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-2	PAD	12/07/07 01:30pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
ZINC DISSOLVED	EPA 600 Method 200.7	0.0917 mg/l	0.00500 mg/l	12/20/07 01:48PM BAB
HEXANE EXTR.-SGT (NON POLAR O+G)	Method 1664A SGT(@PHC)	ND mg/l	5.00 mg/l	12/18/07 02:15PM JW
DISSOLVED ORGANIC CARBON	SM 20th Ed. 5310C	33.3 mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL DISSOLVED SOLIDS	SM 20th Ed. 2540C	896 mg/l	20.0 mg/l	12/11/07 11:00AM MJP
TOTAL ORGANIC CARBON	SM 20th Ed. 5310C	42.5 mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL SUSPENDED SOLIDS	SM 20th Ed. 2540D	200 mg/l	2.00 mg/l	12/12/07 12:00PM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/07/07 04:15PM KLM

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-3	PT Received Temp: 36 F Iced (Y/N): Y	12/07/07 02:20pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	Calculation Method(200.7)	19.4 mg/l	0.500 mg/l	12/20/07 01:50PM
MAGNESIUM HARDNESS	Calculation Method(200.7)	61.8 mg/l	0.500 mg/l	12/20/07 01:50PM
TOTAL HARDNESS	Calculation Method(200.7)	81.2 mg/l	5.00 mg/l	12/20/07 01:50PM
CALCIUM	EPA 600 Method 200.7	7.77 mg/l	0.100 mg/l	12/20/07 01:50PM BAB
COPPER	EPA 600 Method 200.7	10.4 mg/l	0.00300 mg/l	12/20/07 01:50PM BAB
MAGNESIUM	EPA 600 Method 200.7	15.0 mg/l	0.100 mg/l	12/20/07 01:50PM BAB
LEAD	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/20/07 01:50PM BAB
TIN	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	12/20/07 01:50PM BAB
ZINC	EPA 600 Method 200.7	0.592 mg/l	0.00500 mg/l	12/20/07 01:50PM BAB
COPPER DISSOLVED	EPA 600 Method 200.7	7.14 mg/l	0.00300 mg/l	12/20/07 01:58PM BAB
LEAD DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/20/07 01:58PM BAB

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
- Definitions: ND=not detected; NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC=too numerous to count
- A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
- All analysis, except field tests are conducted in Southampton, PA unless otherwise identified.
- The test"pH lab"is analyzed upon receipt at the laboratory, the result will not be suitable for regulatory purposes.
- Actual times of analysis for parameters reported <24 hrs are available upon request. All testing is completed within the required holding time unless otherwise noted..
- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
- All samples are collected as "grab" samples unless otherwise identified.
- MCL= is the EPA recommended "maximum contaminant level" for a parameter. PLs=customer specific permit limits.

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Serial Number: 918116

Thomas J. Hines

Thomas J. Hines, President

QC Laboratories

Analytical Report

nelac — ACCREDITED IN ACCORDANCE WITH
12/26/07 03:40pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC — P.O. No: — Inv. No: 935153
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC — PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-3	PT	12/07/07 02:20pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
ANTIMONY DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.0200 mg/l	12/20/07 01:58PM BAB
ZINC DISSOLVED	EPA 600 Method 200.7	0.538 mg/l	0.00500 mg/l	12/20/07 01:58PM BAB
HEXANE EXTR.-SGT (NON POLAR O+G)	Method 1664A SGT(@PHC)	ND mg/l	5.00 mg/l	12/18/07 02:15PM JW
DISSOLVED ORGANIC CARBON	SM 20th Ed. 5310C	37.2 mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL DISSOLVED SOLIDS	SM 20th Ed. 2540C	12900 mg/l	20.0 mg/l	12/11/07 11:00AM MJP
TOTAL ORGANIC CARBON	SM 20th Ed. 5310C	38.1 mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL SUSPENDED SOLIDS	SM 20th Ed. 2540D	236 mg/l	2.00 mg/l	12/11/07 02:10AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/07/07 04:15PM KLM

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-4	SF Received Temp: 36 F Iced (Y/N): Y	12/07/07 02:30pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	Calculation Method(200.7)	15.5 mg/l	0.500 mg/l	12/20/07 02:02PM
MAGNESIUM HARDNESS	Calculation Method(200.7)	37.2 mg/l	0.500 mg/l	12/20/07 02:02PM
AL HARDNESS	Calculation Method(200.7)	52.7 mg/l	5.00 mg/l	12/20/07 02:02PM
CIUM	EPA 600 Method 200.7	6.22 mg/l	0.100 mg/l	12/20/07 02:02PM BAB
COPPER	EPA 600 Method 200.7	4.88 mg/l	0.00300 mg/l	12/20/07 02:02PM BAB
MAGNESIUM	EPA 600 Method 200.7	9.03 mg/l	0.100 mg/l	12/20/07 02:02PM BAB
LEAD	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/20/07 02:02PM BAB
TIN	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	12/20/07 02:02PM BAB
ZINC	EPA 600 Method 200.7	0.532 mg/l	0.00500 mg/l	12/20/07 02:02PM BAB
COPPER DISSOLVED	EPA 600 Method 200.7	3.54 mg/l	0.00300 mg/l	12/20/07 02:05PM BAB

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- The test"pH lab"is analyzed upon receipt at the laboratory, the result will not be suitable for regulatory purposes.
- Actual times of analysis for parameters reported <24 hrs are available upon request. All testing is completed within the required holding time unless otherwise noted..
- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
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Serial Number: 918116

Thomas J. Hines
Thomas J. Hines, President

QC Laboratories

Analytical Report

12/26/07 03:40pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC

P.O. No:
PWSID No:

Inv. No: 935153

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2512581-4	SF	12/07/07 02:30pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
LEAD DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/20/07 02:05PM BAB
ANTIMONY DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.0200 mg/l	12/20/07 02:05PM BAB
ZINC DISSOLVED	EPA 600 Method 200.7	0.561 mg/l	0.00500 mg/l	12/20/07 02:05PM BAB
HEXANE EXTR.-SGT (NON POLAR O+G)	Method 1664A SGT(@PHC)	ND mg/l	5.00 mg/l	12/18/07 02:15PM JW
DISSOLVED ORGANIC CARBON	SM 20th Ed. 5310C	18.8 mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL DISSOLVED SOLIDS	SM 20th Ed. 2540C	7260 mg/l	20.0 mg/l	12/11/07 11:00AM MJP
TOTAL ORGANIC CARBON	SM 20th Ed. 5310C	20.4 mg/l	1.00 mg/l	12/13/07 07:00AM TS
TOTAL SUSPENDED SOLIDS	SM 20th Ed. 2540D	896 mg/l	2.00 mg/l	12/11/07 02:10AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/07/07 04:15PM KLM

L2512581-1:
1. @1664 SGT/PHC=non-polar materials of petroleum orgin >C12.

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
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- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
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Serial Number: 918116

Thomas J. Hines
Thomas J. Hines, President

01/07/08 03:55pm

ED GORLESKI
OCEAN AND COASTAL CONSULTANTS, INC.
20 E. CLEMENTON ROAD
SUITE 201N
GIBBSBORO, NJ 08026

Regarding:

ED GORLESKI
OCEAN AND COASTAL CONSULTANTS, INC.
20 E. CLEMENTON ROAD
SUITE 201N
GIBBSBORO, NJ 08026

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC — P.O. No: — Inv. No: 937796
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC — PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2520101-1	VESSEL HULL WASH (RD.2) RAW Received Temp: 38 F Iced (Y/N): Y	12/18/07 02:00pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	Calculation Method(200.7)	69.7 mg/l	0.500 mg/l	12/28/07 01:46PM
MAGNESIUM HARDNESS	Calculation Method(200.7)	205 mg/l	0.500 mg/l	12/28/07 01:46PM
TOTAL HARDNESS	Calculation Method(200.7)	275 mg/l	5.00 mg/l	12/28/07 01:46PM
CALCIUM	EPA 600 Method 200.7	27.9 mg/l	0.100 mg/l	12/28/07 01:46PM BAB
COPPER	EPA 600 Method 200.7	10.9 mg/l	0.00300 mg/l	12/28/07 01:46PM BAB
MAGNESIUM	EPA 600 Method 200.7	49.9 mg/l	0.100 mg/l	12/28/07 01:46PM BAB
LEAD	EPA 600 Method 200.7	0.0377 mg/l	0.00500 mg/l	12/28/07 01:46PM BAB
TIN	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	12/28/07 01:46PM BAB
ZINC	EPA 600 Method 200.7	4.85 mg/l	0.00500 mg/l	12/28/07 01:46PM BAB
COPPER DISSOLVED	EPA 600 Method 200.7	5.40 mg/l	0.00300 mg/l	12/28/07 01:49PM BAB
LEAD DISSOLVED	EPA 600 Method 200.7	0.00890 mg/l	0.00500 mg/l	12/28/07 01:49PM BAB
[illegible] DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	12/28/07 01:49PM BAB
ZINC DISSOLVED	EPA 600 Method 200.7	3.49 mg/l	0.00500 mg/l	12/28/07 01:49PM BAB

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
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- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
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Serial Number: 920987

Thomas J. Hines, President

QC Laboratories

Analytical Report

01/07/08 03:55pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC P.O. No: Inv. No: 937796
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2520101-1	VESSEL HULL WASH (RD.2) RAW	12/18/07 02:00pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
HEXANE EXTR.-SGT (NON POLAR O+G)	Method 1664A SGT(@PHC)	ND mg/l	5.00 mg/l	01/03/08 01:30PM JW
DISSOLVED ORGANIC CARBON	SM 20th Ed. 5310C	70.3 mg/l	20.0 mg/l	12/28/07 04:30AM TS
TOTAL DISSOLVED SOLIDS	SM 20th Ed. 2540C	1620 mg/l	20.0 mg/l	12/20/07 11:20AM MJP
TOTAL ORGANIC CARBON	SM 20th Ed. 5310C	84.9 mg/l	20.0 mg/l	12/28/07 04:30AM TS
TOTAL SUSPENDED SOLIDS	SM 20th Ed. 2540D	134 mg/l	2.00 mg/l	12/20/07 11:00AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/18/07 03:45PM KLM

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2520101-2	PROC Received Temp: 38 F Iced (Y/N): Y	12/18/07 02:00pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	Calculation Method(200.7)	63.9 mg/l	0.500 mg/l	12/28/07 01:51PM
MAGNESIUM HARDNESS	Calculation Method(200.7)	147 mg/l	0.500 mg/l	12/28/07 01:51PM
TOTAL HARDNESS	Calculation Method(200.7)	211 mg/l	5.00 mg/l	12/28/07 01:51PM
CALCIUM	EPA 600 Method 200.7	25.6 mg/l	0.100 mg/l	12/28/07 01:51PM BAB
PER	EPA 600 Method 200.7	12.5 mg/l	0.00300 mg/l	12/28/07 01:51PM BAB
NESIUM	EPA 600 Method 200.7	35.8 mg/l	0.100 mg/l	12/28/07 01:51PM BAB
LEAD	EPA 600 Method 200.7	ND mg/l	0.00500 mg/l	12/28/07 01:51PM BAB
TIN	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	12/28/07 01:51PM BAB
ZINC	EPA 600 Method 200.7	4.54 mg/l	0.00500 mg/l	12/28/07 01:51PM BAB
COPPER DISSOLVED	EPA 600 Method 200.7	8.69 mg/l	0.00300 mg/l	01/02/08 07:54AM BAB
LEAD DISSOLVED	EPA 600 Method 200.7	0.0183 mg/l	0.00500 mg/l	01/02/08 07:54AM BAB
TIN DISSOLVED	EPA 600 Method 200.7	ND mg/l	0.0500 mg/l	01/02/08 07:54AM BAB

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
- Definitions: ND=not detected; NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC=too numerous to count
- A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
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- The test"pH lab"is analyzed upon receipt at the laboratory, the result will not be suitable for regulatory purposes.
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- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
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Serial Number: 920987

Thomas J. Hines

Thomas J. Hines, President

QC Laboratories

Analytical Report

01/07/08 03:55pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC

P.O. No:
PWSID No:

Inv. No: 937796

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2520101-2	PROC	12/18/07 02:00pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
ZINC DISSOLVED	EPA 600 Method 200.7	3.45 mg/l	0.00500 mg/l	01/02/08 07:54AM BAB
HEXANE EXTR.-SGT (NON POLAR O+G)	Method 1664A SGT(@PHC)	ND mg/l	5.00 mg/l	01/03/08 01:30PM JW
DISSOLVED ORGANIC CARBON	SM 20th Ed. 5310C	62.3 mg/l	20.0 mg/l	12/28/07 04:30AM TS
TOTAL DISSOLVED SOLIDS	SM 20th Ed. 2540C	3640 mg/l	20.0 mg/l	12/20/07 11:20AM MJP
TOTAL ORGANIC CARBON	SM 20th Ed. 5310C	65.8 mg/l	20.0 mg/l	12/28/07 04:30AM TS
TOTAL SUSPENDED SOLIDS	SM 20th Ed. 2540D	260 mg/l	2.00 mg/l	12/20/07 11:00AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/18/07 03:45PM KLM

L2520101-1:
1. @1664 SGT/PHC=non-polar materials of petroleum orgin >C12.

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
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- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
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Serial Number: 920987

Thomas J. Hines
Thomas J. Hines, President

QC Laboratories® **Analytical Report**

12/23/08 09:52am

Regarding:

ED GORLESKI OCEAN AND COASTAL CONSULTANTS, INC. 20 E. CLEMENTON ROAD SUITE 201N GIBBSBORO, NJ 08026	ED GORLESKI OCEAN AND COASTAL CONSULTANTS, INC. 20 E. CLEMENTON ROAD SUITE 201N GIBBSBORO, NJ 08026

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC P.O. No: Inv. No:
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC PWSID No:

Sample Number L2849641-1 — Sample Description: RAW WATER — Received Temp: 36 F Iced (Y/N): Y
Samp. Date/Time/Temp: 12/09/08 11:15am NA F — Sampled by: Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	CALC (200.7)	101 mg/l	0.500 mg/l	12/19/08 08:24AM
MAGNESIUM HARDNESS	CALC (200.7)	266 mg/l	0.500 mg/l	12/19/08 08:24AM
TOTAL HARDNESS	CALC (200.7)	367 mg/l	5.00 mg/l	12/19/08 08:24AM
CALCIUM	EPA 200.7	40.6 mg/l	0.100 mg/l	12/19/08 08:24AM B B
COPPER	EPA 200.7	28.8 mg/l	0.00300 mg/l	12/19/08 08:24AM B B
MAGNESIUM	EPA 200.7	64.5 mg/l	0.100 mg/l	12/19/08 08:24AM B B
LEAD	EPA 200.7	0.169 mg/l	0.00500 mg/l	12/19/08 08:24AM B B
TIN	EPA 200.7	0.174 mg/l	0.0500 mg/l	12/19/08 08:24AM B B
ZINC	EPA 200.7	7.39 mg/l	0.00500 mg/l	12/19/08 08:24AM B B
COPPER DISSOLVED	EPA 200.7	3.45 mg/l	0.00300 mg/l	12/19/08 08:27AM B B
LEAD DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	12/19/08 08:27AM B B
TIN DISSOLVED	EPA 200.7	ND mg/l	0.0500 mg/l	12/19/08 08:27AM B B
ZINC DISSOLVED	EPA 200.7	2.40 mg/l	0.00500 mg/l	12/19/08 08:27AM B B
HEXANE EXTR.-SGT (NON POLAR O+G)	1664ASGT@PHC	ND mg/l	5.00 mg/l	12/19/08 03:00PM JAZ
DISSOLVED ORGANIC CARBON	SM 5310C	101 mg/l	20.0 mg/l	12/11/08 08:26AM TES
TOTAL DISSOLVED SOLIDS	SM 2540C	1270 mg/l	20.0 mg/l	12/12/08 10:30AM MJP
TOTAL ORGANIC CARBON	SM 5310C	124 mg/l	20.0 mg/l	12/11/08 08:26AM TES
TOTAL SUSPENDED SOLIDS	SM 2540D	660 mg/l	2.00 mg/l	12/16/08 10:00AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/09/08 02:50PM KLM

Sample Number L2849641-2 — Sample Description: PROCESS WATER — Received Temp: 36 F Iced (Y/N): Y
Samp. Date/Time/Temp: 12/09/08 01:30pm NA F — Sampled by: Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	CALC (200.7)	687 mg/l	0.500 mg/l	12/19/08 08:43AM
MAGNESIUM HARDNESS	CALC (200.7)	684 mg/l	0.500 mg/l	12/19/08 08:43AM
TOTAL HARDNESS	CALC (200.7)	1370 mg/l	5.00 mg/l	12/19/08 08:43AM
CALCIUM	EPA 200.7	275 mg/l	0.100 mg/l	12/19/08 08:43AM B B
COPPER	EPA 200.7	0.331 mg/l	0.00300 mg/l	12/19/08 08:43AM B B

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Thomas J. Hines, President

1205 Industrial Blvd., P.O. Box 514, Southampton, PA 18966-0514 Phone: 215-355-3900 Fax: 215-355-7231 www.qclaboratories.com

QC Laboratories

Analytical Report

12/23/08 09:52am

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC P.O. No: Inv. No:
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2849641-2	PROCESS WATER	12/09/08 01:30pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
MAGNESIUM	EPA 200.7	166 mg/l	0.100 mg/l	12/19/08 08:43AM B B
LEAD	EPA 200.7	ND mg/l	0.00500 mg/l	12/19/08 08:43AM B B
TIN	EPA 200.7	ND mg/l	0.0500 mg/l	12/19/08 08:43AM B B
ZINC	EPA 200.7	0.0308 mg/l	0.00500 mg/l	12/19/08 08:43AM B B
COPPER DISSOLVED	EPA 200.7	0.0543 mg/l	0.00300 mg/l	12/19/08 08:46AM B B
LEAD DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	12/19/08 08:46AM B B
TIN DISSOLVED	EPA 200.7	ND mg/l	0.0500 mg/l	12/19/08 08:46AM B B
ZINC DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	12/19/08 08:46AM B B
HEXANE EXTR.-SGT (NON POLAR O+G)	1664ASGT@PHC	ND mg/l	5.00 mg/l	12/19/08 03:00PM JAZ
DISSOLVED ORGANIC CARBON	SM 5310C	101 mg/l	20.0 mg/l	12/11/08 08:26AM TES
TOTAL DISSOLVED SOLIDS	SM 2540C	8600 mg/l	20.0 mg/l	12/12/08 10:30AM MJP
TOTAL ORGANIC CARBON	SM 5310C	117 mg/l	20.0 mg/l	12/11/08 08:26AM TES
TOTAL SUSPENDED SOLIDS	SM 2540D	55.0 mg/l	2.00 mg/l	12/16/08 10:00AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/09/08 02:50PM KLM

L2849641-1:
1. @1664 SGT/PHC=non-polar materials of petroleum origin >C12.

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
- Definitions: ND=not detected; NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC=too numerous to count
- A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
- All analysis, except field tests are conducted in Southampton, PA unless otherwise identified.
- The test"pH lab"is analyzed upon receipt at the laboratory, the result will not be suitable for regulatory purposes.
- Actual times of analysis for parameters reported <24 hrs are available upon request. All testing is completed within the required holding time unless otherwise noted..
- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
- All samples are collected as "grab" samples unless otherwise identified.
- MCL= is the EPA recommended "maximum contaminant level" for a parameter. PLs=customer specific permit limits.

Regulatory authorities are assessing substantial fines for testing omissions. Please track your sample collections and results on a weekly, monthly, or quarterly basis to ensure compliance. QC's internet program 'LIVE ACCESS' will provide you with real-time access to collection dates and results. Please contact Customer Service for further information on acquiring LIVE ACCESS.

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Thomas J. Hines, President

QC Laboratories

Analytical Report

12/30/08 04:47pm

Regarding:

ED GORLESKI OCEAN AND COASTAL CONSULTANTS, INC. 20 E. CLEMENTON ROAD SUITE 201N GIBBSBORO, NJ 08026	ED GORLESKI OCEAN AND COASTAL CONSULTANTS, INC. 20 E. CLEMENTON ROAD SUITE 201N GIBBSBORO, NJ 08026

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   P.O. No: Inv. No:
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2853187-1	VESSEL HULL* BAY Received Temp: 37 F Iced (Y/N): Y	12/16/08 01:15pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	CALC (200.7)	659 mg/l	0.500 mg/l	12/29/08 10:51AM
MAGNESIUM HARDNESS	CALC (200.7)	3490 mg/l	0.500 mg/l	12/29/08 10:51AM
TOTAL HARDNESS	CALC (200.7)	4150 mg/l	5.00 mg/l	12/29/08 10:51AM
COPPER DISSOLVED	EPA 200.7	0.0145 mg/l	0.00300 mg/l	12/29/08 10:54AM B B
LEAD DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	12/29/08 10:54AM B B
TIN DISSOLVED	EPA 200.7	ND mg/l	0.0500 mg/l	12/29/08 10:54AM B B
ZINC DISSOLVED	EPA 200.7	0.00520 mg/l	0.00500 mg/l	12/29/08 10:54AM B B
CALCIUM	EPA 200.7	264 mg/l	0.100 mg/l	12/29/08 10:40AM B B
COPPER	EPA 200.7	0.00820 mg/l	0.00300 mg/l	12/29/08 10:40AM B B
LEAD	EPA 200.7	ND mg/l	0.00500 mg/l	12/29/08 10:40AM B B
TIN	EPA 200.7	ND mg/l	0.0500 mg/l	12/29/08 10:40AM B B
ZINC	EPA 200.7	ND mg/l	0.00500 mg/l	12/29/08 10:40AM B B
MAGNESIUM	EPA 200.7	848 mg/l	1.00 mg/l	12/29/08 10:51AM B B
HEXANE EXTR.-SGT (NON POLAR O+G)	1664ASGT@PHC	ND mg/l	5.00 mg/l	12/29/08 06:20PM JAZ
DISSOLVED ORGANIC CARBON	SM 5310C	1.83 mg/l	1.00 mg/l	12/21/08 08:36AM TES
TOTAL DISSOLVED SOLIDS	SM 2540C	25200 mg/l	20.0 mg/l	12/23/08 10:30AM MJP
TOTAL ORGANIC CARBON	SM 5310C	1.19 mg/l	1.00 mg/l	12/21/08 08:36AM TES
TOTAL SUSPENDED SOLIDS	SM 2540D	32.4 mg/l	2.00 mg/l	12/19/08 09:45AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/16/08 03:15PM KLM

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2853187-2	RAW Received Temp: 37 F Iced (Y/N): Y	12/16/08 01:30pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	CALC (200.7)	27.2 mg/l	0.500 mg/l	12/29/08 11:03AM
MAGNESIUM HARDNESS	CALC (200.7)	28.5 mg/l	0.500 mg/l	12/29/08 11:03AM
TOTAL HARDNESS	CALC (200.7)	55.7 mg/l	5.00 mg/l	12/29/08 11:03AM
COPPER DISSOLVED	EPA 200.7	0.509 mg/l	0.00300 mg/l	12/29/08 11:06AM B B
LEAD DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	12/29/08 11:06AM B B

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Thomas J. Hines, President

1205 Industrial Blvd., P.O. Box 514, Southampton, PA 18966-0514 Phone: 215-355-3900 Fax: 215-355-7231 www.qclaboratories.com

QC Laboratories

Analytical Report

12/30/08 04:47pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC P.O. No: Inv. No:
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2853187-2	RAW	12/16/08 01:30pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
TIN DISSOLVED	EPA 200.7	ND mg/l	0.0500 mg/l	12/29/08 11:06AM B B
ZINC DISSOLVED	EPA 200.7	0.897 mg/l	0.00500 mg/l	12/29/08 11:06AM B B
CALCIUM	EPA 200.7	10.9 mg/l	0.100 mg/l	12/29/08 11:03AM B B
COPPER	EPA 200.7	23.9 mg/l	0.00300 mg/l	12/29/08 11:03AM B B
MAGNESIUM	EPA 200.7	6.92 mg/l	0.100 mg/l	12/29/08 11:03AM B B
LEAD	EPA 200.7	0.122 mg/l	0.00500 mg/l	12/29/08 11:03AM B B
TIN	EPA 200.7	0.0619 mg/l	0.0500 mg/l	12/29/08 11:03AM B B
ZINC	EPA 200.7	4.13 mg/l	0.00500 mg/l	12/29/08 11:03AM B B
HEXANE EXTR.-SGT (NON POLAR O+G)	1664ASGT@PHC	ND mg/l	5.00 mg/l	12/29/08 06:20PM JAZ
DISSOLVED ORGANIC CARBON	SM 5310C	9.62 mg/l	5.00 mg/l	12/18/08 07:46AM TES
TOTAL DISSOLVED SOLIDS	SM 2540C	217 mg/l	20.0 mg/l	12/22/08 12:30PM MJP
TOTAL ORGANIC CARBON	SM 5310C	9.10 mg/l	5.00 mg/l	12/18/08 07:46AM TES
TOTAL SUSPENDED SOLIDS	SM 2540D	448 mg/l	2.00 mg/l	12/19/08 09:45AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/16/08 03:15PM KLM

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2853187-3	PROCESSED Received Temp: 37 F Iced (Y/N): Y	12/16/08 01:40pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	CALC (200.7)	156 mg/l	0.500 mg/l	12/29/08 11:09AM
MAGNESIUM HARDNESS	CALC (200.7)	148 mg/l	0.500 mg/l	12/29/08 11:09AM
TOTAL HARDNESS	CALC (200.7)	305 mg/l	5.00 mg/l	12/29/08 11:09AM
COPPER DISSOLVED	EPA 200.7	0.0919 mg/l	0.00300 mg/l	12/29/08 11:12AM B B
LEAD DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	12/29/08 11:12AM B B
TIN DISSOLVED	EPA 200.7	ND mg/l	0.0500 mg/l	12/29/08 11:12AM B B
ZINC DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	12/29/08 11:12AM B B
CALCIUM	EPA 200.7	62.6 mg/l	0.100 mg/l	12/29/08 11:09AM B B
COPPER	EPA 200.7	0.166 mg/l	0.00300 mg/l	12/29/08 11:09AM B B
MAGNESIUM	EPA 200.7	36.0 mg/l	0.100 mg/l	12/29/08 11:09AM B B
LEAD	EPA 200.7	ND mg/l	0.00500 mg/l	12/29/08 11:09AM B B
TIN	EPA 200.7	ND mg/l	0.0500 mg/l	12/29/08 11:09AM B B
ZINC	EPA 200.7	0.0116 mg/l	0.00500 mg/l	12/29/08 11:09AM B B
HEXANE EXTR.-SGT (NON POLAR O+G)	1664ASGT@PHC	ND mg/l	5.00 mg/l	12/29/08 06:20PM JAZ
DISSOLVED ORGANIC CARBON	SM 5310C	27.5 mg/l	10.0 mg/l	12/18/08 07:46AM TES
TOTAL DISSOLVED SOLIDS	SM 2540C	1510 mg/l	20.0 mg/l	12/22/08 12:30PM MJP
TOTAL ORGANIC CARBON	SM 5310C	28.2 mg/l	10.0 mg/l	12/18/08 07:46AM TES
TOTAL SUSPENDED SOLIDS	SM 2540D	12.8 mg/l	2.00 mg/l	12/19/08 09:45AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	12/16/08 03:15PM KLM

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Thomas J. Hines, President

QC Laboratories

Analytical Report

12/30/08 04:47pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC P.O. No: Inv. No:
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC PWSID No:

L2853187-1:
1. @1664 SGT/PHC=non-polar materials of petroleum origin >C12.

- A result of "ND" indicates the concentration of the analyte tested was either not detected or below the RLs.
- Definitions: ND=not detected; NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC=too numerous to count
- A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
- All analysis, except field tests are conducted in Southampton, PA unless otherwise identified.
- The test"pH lab"is analyzed upon receipt at the laboratory, the result will not be suitable for regulatory purposes.
- Actual times of analysis for parameters reported <24 hrs are available upon request. All testing is completed within the required holding time unless otherwise noted..
- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
- All samples are collected as "grab" samples unless otherwise identified.
- MCL= is the EPA recommended "maximum contaminant level" for a parameter. PLs=customer specific permit limits.

Regulatory authorities are assessing substantial fines for testing omissions. Please track your sample collections and results on a weekly, monthly, or quarterly basis to ensure compliance. QC's internet program 'LIVE ACCESS' will provide you with real-time access to collection dates and results. Please contact Customer Service for further information on acquiring LIVE ACCESS.

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Thomas J. Hines, President

QC Laboratories

Analytical Report

01/15/09 05:25pm

ED GORLESKI
OCEAN AND COASTAL CONSULTANTS, INC.
20 E. CLEMENTON ROAD
SUITE 201N
GIBBSBORO, NJ 08026

Regarding:

ED GORLESKI
OCEAN AND COASTAL CONSULTANTS, INC.
20 E. CLEMENTON ROAD
SUITE 201N
GIBBSBORO, NJ 08026

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   P.O. No: Inv. No: 1037951
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC   PWSID No:

Sample Number: L2875525-1
Sample Description: VESSEL HULL ROUND 3* RAW
Received Temp: 37 F Iced (Y/N): Y
Samp. Date/Time/Temp: 01/06/09 12:40pm NA F
Sampled by: Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	CALC (200.7)	42.2 mg/l	0.500 mg/l	01/12/09 07:47AM
MAGNESIUM HARDNESS	CALC (200.7)	49.8 mg/l	0.500 mg/l	01/12/09 07:47AM
TOTAL HARDNESS	CALC (200.7)	92.0 mg/l	5.00 mg/l	01/12/09 07:47AM
CALCIUM	EPA 200.7	16.9 mg/l	0.100 mg/l	01/12/09 07:47AM B B
COPPER	EPA 200.7	8.21 mg/l	0.00300 mg/l	01/12/09 07:47AM B B
MAGNESIUM	EPA 200.7	12.1 mg/l	0.100 mg/l	01/12/09 07:47AM B B
LEAD	EPA 200.7	0.0450 mg/l	0.00500 mg/l	01/12/09 07:47AM B B
TIN	EPA 200.7	ND mg/l	0.0500 mg/l	01/12/09 07:47AM B B
ZINC	EPA 200.7	2.69 mg/l	0.0100 mg/l	01/12/09 07:47AM B B
COPPER DISSOLVED	EPA 200.7	0.755 mg/l	0.00300 mg/l	01/12/09 07:51AM B B
LEAD DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	01/12/09 07:51AM B B
TIN DISSOLVED	EPA 200.7	ND mg/l	0.0500 mg/l	01/12/09 07:51AM B B
ZINC DISSOLVED	EPA 200.7	1.55 mg/l	0.0100 mg/l	01/12/09 07:51AM B B
HEXANE EXTR.-SGT (NON POLAR O+G)	1664ASGT@PHC	ND mg/l	5.00 mg/l	01/13/09 03:10PM JAZ
DISSOLVED ORGANIC CARBON	SM 5310C	9.74 mg/l	5.00 mg/l	01/08/09 09:57AM TES
TOTAL DISSOLVED SOLIDS	SM 2540C	331 mg/l	20.0 mg/l	01/09/09 11:30AM MJP
TOTAL ORGANIC CARBON	SM 5310C	10.4 mg/l	5.00 mg/l	01/08/09 09:57AM TES
TOTAL SUSPENDED SOLIDS	SM 2540D	208 mg/l	2.00 mg/l	01/08/09 09:45AM GLE
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	01/06/08 01:50PM LRS

Sample Number: L2875525-2
Sample Description: TREATED
Received Temp: 37 F Iced (Y/N): Y
Samp. Date/Time/Temp: 01/06/09 12:50pm NA F
Sampled by: Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
CALCIUM HARDNESS	CALC (200.7)	127 mg/l	0.500 mg/l	01/12/09 07:53AM
MAGNESIUM HARDNESS	CALC (200.7)	163 mg/l	0.500 mg/l	01/12/09 07:53AM
TOTAL HARDNESS	CALC (200.7)	291 mg/l	5.00 mg/l	01/12/09 07:53AM
CALCIUM	EPA 200.7	51.0 mg/l	0.100 mg/l	01/12/09 07:53AM B B
COPPER	EPA 200.7	0.229 mg/l	0.00300 mg/l	01/12/09 07:53AM B B

Serial Number: 1067116

Thomas J. Hines, President

1205 Industrial Blvd., P.O. Box 514, Southampton, PA 18966-0514 Phone: 215-355-3900 Fax: 215-355-7231 www.qclaboratories.com

QC Laboratories

Analytical Report

01/15/09 05:25pm

Account No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC
Project No: B00261, OCEAN AND COASTAL CONSULTANTS, INC. OCC

P.O. No:
PWSID No:

Inv. No: 1037951

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L2875525-2	TREATED	01/06/09 12:50pm NA F	Customer Sampled

Parameter	Method	Result	RLs	Test Date, Time, Analyst
MAGNESIUM	EPA 200.7	39.7 mg/l	0.100 mg/l	01/12/09 07:53AM B B
LEAD	EPA 200.7	ND mg/l	0.00500 mg/l	01/12/09 07:53AM B B
TIN	EPA 200.7	ND mg/l	0.0500 mg/l	01/12/09 07:53AM B B
ZINC	EPA 200.7	0.0811 mg/l	0.0100 mg/l	01/12/09 07:53AM B B
COPPER DISSOLVED	EPA 200.7	0.111 mg/l	0.00300 mg/l	01/12/09 08:18AM B B
LEAD DISSOLVED	EPA 200.7	ND mg/l	0.00500 mg/l	01/12/09 08:18AM B B
TIN DISSOLVED	EPA 200.7	ND mg/l	0.0500 mg/l	01/12/09 08:18AM B B
ZINC DISSOLVED	EPA 200.7	0.0441 mg/l	0.0100 mg/l	01/12/09 08:18AM B B
HEXANE EXTR.-SGT (NON POLAR O+G)	1664ASGT@PHC	ND mg/l	5.00 mg/l	01/13/09 03:10PM JAZ
DISSOLVED ORGANIC CARBON	SM 5310C	7.62 mg/l	5.00 mg/l	01/08/09 09:57AM TES
TOTAL DISSOLVED SOLIDS	SM 2540C	1260 mg/l	20.0 mg/l	01/09/09 11:30AM MJP
TOTAL ORGANIC CARBON	SM 5310C	7.37 mg/l	5.00 mg/l	01/08/09 09:57AM TES
TOTAL SUSPENDED SOLIDS	SM 2540D	27.0 mg/l	2.00 mg/l	01/08/09 12:15PM MJP
FECAL COLIFORM-MF (VINELAND)	SM 9222D	<10 col/100ml	10 col/100ml	01/06/08 01:50PM LRS

L2875525-1:
1. @1664 SGT/PHC=non-polar materials of petroleum origin >C12.

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- QC NELAP ID's:PA 09-00131,NJ PA166,FL E87954,NY 11223,CT PH-0768,DE PA-018,KY 90228,MD 206,EPA PA00018.Bioassay:PA 09-03574,NJ PA034,FL E87953,KS E10373,SC 89020001.
- QC STATE ID's:Wind Gap,NJ PA001,PA 48-01334;E RUTHERFORD NJ02015;Vineland NJ06005; Reading PA 06-03543.
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Serial Number: 1067116

Thomas J. Hines
Thomas J. Hines, President