Environmental Management Plan

Prepared For;

OCEAN CAY

MSC MARITIME RESERVE

THE BAHAMAS

PREPARED BY;

ISLANDS BY DESIGN

IN ASSOCIATION WITH;

CUMMINS | CEDERBERG

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MSC MARITIME RESERVE
OCEAN CAY
THE BAHAMAS
Environmental Management Plan

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2	6/25/2016	17, A1, A2,	Turbidity mixing zone reduced to 250 m, inserted Appendix 1 and Appendix 2
3	7/4/2016	A1, A2, A3	Revised Appendices 1,2 and 3 to reflect requested changes

A COPY OF THIS ENVIRONMENTAL MANAGEMENT PLAN SHALL BE KEPT ON SITE AND BE AVAILABLE TO ALL STAFF ASSOCIATED WITH THIS PROJECT.

TABLE OF CONTENTS

1 Executive Summary 5
2 Purpose and Scope 5
3 Laws and Regulations 5
3.1 International Environmental Policies 7
4 Requirements for Environmental Compliance 8
4.1 Site Safety and Health 8
4.1.1 Sanitary Conveniences 8
4.1.2 Water Abstraction 8
4.1.3 Existing Conditions 8
4.1.4 Petroleum Hydrocarbon Contaminated Areas 9
4.1.5 Equipment, Maintenance, Fueling and Storage 9
4.1.6 Fire Control Measures 10
4.2 Physical Aspects 13
4.2.1 Water Management 13
4.3 Material Storage 14
4.4 Waste Management Plan 14
4.4.1 Liquid Waste Stream 14
4.4.2 Solid Waste Stream 15
5 Emergency Contingency Plans 15
5.1 Inclement Weather 15
6 Checklist for Environmental Stipulations 15
7 Environmental Monitoring Measures 16
7.1 Environmental Mitigation 16
7.2 Turbidity Monitoring 17
7.3 Lagoon Flushing 19
7.4 Shoreline Stabilization 19
7.5 Debris Removal 19
8 References 19

Appendix A – Flushing Analysis
Appendix 1 – Letter to BEST with Notification of on-Site Coral relocation Monitoring and Environmental Manager
Appendix 2 - Debris Material Clean Up Means and Method and Chain of Custody
Appendix 3 – Dredging Plans

1 Executive Summary

Included in the Environmental Management Plan (EMP) is a site-specific plan developed to ensure that necessary measures are identified and implemented in order to protect the environment and comply with environmental legislation. The EMP will provide construction staff and project managers with guidelines so that they can adhere to the environmental goals of Mediterranean Shipping Company (MSC) Marine Reserve at Ocean Cay. It serves as a reference and manual, containing pertinent environmental information about the site and the project along with Best Management Practices (BMP) designed to optimize environmental conditions. The EMP is based on information presented in the Environmental Impact Assessment (EIA), as well as industry-wide guidelines. The EMP describes how the proposed designs and activities can be implemented and constructed with the least possible impact to the natural environment. In the case that the activities deviate substantially from that described in the EMP, the Bahamian Government and the Bahamas National Trust will be informed of the changes and provided with revised text before such activity occurs.

2 Purpose and Scope

This EMP pertains to the life-cycle of construction and operations of MSC, Marine Reserve at Ocean Cay, as described in a document entitled "Environmental Impact Assessment, MSC Marine Reserve, Ocean Cay, The Bahamas. This document aims to meet the demands and expectations of the Ministry of the Environment and Housing, The Bahamas Environment, Science and Technical Commission (BEST) to ensure utilization and adherence to international standards for sustainable tourism practices.

An Environmental Management Plan (EMP) is a written guide that identifies relevant management techniques, including Best Management Practices and Emergency Response Plans based on site-specific conditions and potential impacts, as documented in an Environmental Impact Assessment or report of similar scope.

An EMP is the key to ensure human health and safety, as well as a clean environment. The EMP envisages the plans for the proper implementation of mitigation measures to reduce the adverse impacts that may result from project activities during pre-construction, construction and throughout operation. Effective management and frequent monitoring provide the tools necessary to manage potential impacts and to introduce corrective action if required.

3 Laws and Regulations

Relevant government agencies and entities include, but are not limited to:

a). The Bahamas Environment, Science and Technology (BEST) Commission.
b). The National Creeks and Wetlands Restoration Sub-Committee.
c). Department of Agriculture.
d). Department of Fisheries.
e). Ministry of Public Works and Transport.
f). The Port Authority.
g). Ministry of Health.
h). Department of Environmental Health Services.
i). Ministry of Maritime Affairs.
j). Water and Sewerage Corporation.

k). Ministry of Tourism.
l). District Councils and Town Committees.
m). Town Planning Committee.

Additionally, a series of laws have been accepted in The Bahamas which affect activities occurring within the coastal zone include:

a). Antiquities, Monuments and Museum Act (1998)
b). Conservation and Protection of the Physical Landscape of the Bahamas Act (1997)
c). Local Government Act (1996)
d). Archipelagic Waters and Maritime Jurisdiction Act (1993)
e). International Persons Land-Holding Act (1993)
f). Environmental Health Services Act (1987)
g). Wild Birds Protection Act (1987)
h). Plant Protection Act (1987)
i). Fisheries Resources (Jurisdiction and Conservation) Act (1977)
j). Water Supply Corporation Act (1976)
k). Wild Animals (Protection) Act (1968)
l). Coast Protection Act (1968)
m). Agriculture and Fisheries Act (1963)
n). Town Planning Act (1961)
o). Bahamas National Trust Act (1959)
p). Immovable Property (Acquisition by Foreign Persons) Act and Quieting of Titles Act (1959)
q). Water Skiing and Motor Boat Control Act
r). Hotels Act
s). Port Authorities Act
t). Marine Mammal Protection Act

Relevant Legislation of the Commonwealth of the Bahamas

Bahamas National Trust Act, 1959

The Bahamas National Trust Act and Amendment founded the Bahamas National Trust and granted it authority for the provision and oversight of National Parks in the Bahamas.

Water and Sewerage Corporation Act, 1976

The Water and Sewerage Act established the Water and Sewerage Corporation for the grant and control of water rights, protection of water resources, the regulation of extraction, use and supply of water, and the disposal of sewage.

Wild Animals (Protection) Act, 1968

Animals restricted for capture, export, or attempt to export:

1. Wild horses on the Island of Abaco, that is to say, any member of the species *Equus caballus* in that Island in a state of nature, including the young of that species.
2. Agouti or Hutia (Geocapromys ingrahami).

3. Iguana (*Cyclura* species).

Wild Birds Protection Act, 1952

Name of Birds	Duration of Close Season
All wild birds other than those enumerated in items 2 and 3 of this schedule.	The Whole Year
White Crowned Pigeon (Columba Leucocephala) Zenaida or Wood Dove (Zenaida aurita) Ringnecked Pheasant (Phasianus colchicus) Guinea Fowl (Numida meleagris)	1st March to 28th September
Bob White Quail (Colinus virginianus) Chuckar Partridge (Alectorisgraeca) Wilson's or Jack Snipe (paella gallinago delicata) Coot (Fulicia americana) All wild ducks and geese (Family Anatidae) EXCEPT Whistling Duck (Dendrocygna arborea) Bahama Duck (Anas ahamensis) Ruddy Duck (Oxyrua jamaicensis)	1st April to 28th September
Eurasia-collared or 'Ringnecked' Dove (Streptopelia decoacta) Mourning or Florida Dove (Zenaidura macroura)	1st March to 14th September

Wild Birds Protection RESERVES, 2008
A listing of all reserves for the protection of wild birds.

Wildlife Conservation & Trade Chapter, 2004
An Act to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), with a view to the protection of wild species from harm through unsustainable exploitation.

Conservation and Preservation of the Physical Landscape Act, 1997
This Act makes provisions for the regulation of activities including excavation, landfill, quarrying, mining, and listing of protected trees in the Bahamas for the purpose of conservation or maintenance of the environment.

3.1 International Environmental Policies

The Bahamas is a signatory to several international environmental agreements that either affect or may affect the management of the coastal resources of The Bahamas. For example, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (The Cartagena Convention) (1986), coordinated by United Nations Environmental Program (UNEP), includes three protocols: The Oil Spill Protocol, the Specially Protected Areas and Wildlife (SPAW) Protocol, and the Land Based Sources of Marine Pollution (LBSMP) Protocol (not yet finalized). The SPAW Protocol (2000) calls for the protection, management and development of marine and coastal resources individually and jointly among countries. Although The Bahamas is not a party to the Protocol, several other Caribbean countries have entered into these agreements and their actions may have impacts on the coastal zone of The Bahamas. Additionally, noise pollution standards of the World Bank and World Health Organization will be met. Also, the United Nations Convention on the Laws of the Sea should apply during construction and operations, to protect the marine waters of the Bahamas.

The Ramsar Convention

The Bahamas is a signatory to the Convention on Wetlands of International Importance, also known as the Ramsar Convention. This convention provides a framework for the international protection of wetlands as contributors for human resources and moreover, for avifauna which do not adhere to international boundaries. Ramsar defines wetlands as 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters'.

The Convention on Biological Diversity

The Bahamas is a signatory to the Convention on Biological Diversity which came into force December 1993. It has three main goals:

1. The conservation of biological diversity
2. The sustainable use of components of biological diversity
3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources

4 Requirements for Environmental Compliance

4.1 Site Safety and Health

4.1.1 Sanitary Conveniences

The contractor shall supply proper and efficient sanitary conveniences for staff and Employees. The contractor shall equip the convenience with water closets of approved pattern and shall maintain them in a proper and sanitary condition. Temporary toilet facilities, if not connected to main drainage, shall be of the sealed cess tank type. Tanks shall be monitored for level and emptied regularly. Septic tanks shall not be used. On removal of the convenience the sites shall be properly disinfected and the ground restored.

4.1.2 Water Abstraction

The installation and use of groundwater wells for any purpose, including manufacturing require approval by the Department of Forestry and the Water and Sewerage Corporation (WSC). It is not anticipated that any aquifer has developed on this man-made island and no ground water abstraction will be conducted.

4.1.3 Existing Conditions

Ocean Cay is a manmade cay developed as the site of aragonite mining operations of Marcona Ocean Industries from approximately 1970 through today. The island was developed to provide a shipping, storage and transfer facility for fine sands from the dredged material and a loading area for shipment of aragonite sands for use in chemical, agricultural and construction supplies, as well as a source of fill for nourishment projects within the Caribbean region (Michel, 1971; Tabb et al., 1971). It was also used as a minor source of sand fill for beach nourishment projects in southeast Florida in the early 1990's (Bodge and Olsen, 1992). However, strict regulations in the US have since restricted this use. Dredging and export activities continue presently albeit at a lower level of activity.

4.1.4 Petroleum Hydrocarbon Contaminated Areas

Site investigations (soil investigations) have been conducted throughout the cay. Analysis of Laboratory results found no evidence of excessive petroleum contaminated surface soils. Engineering controls will be implemented that will allow contaminated soils to remain in place such as capping with a minimum of two feet of uncontaminated soil and/or other methods. Where permanent structures are to be erected these structures will require a vapor barrier be installed as per the requirements of The Bahamas Building Code (Edition III).

4.1.5 Equipment, Maintenance, Fueling and Storage

The contractor shall perform cleaning as is necessary to maintain a general and tidy appearance of the site. The extent of the areas required for maintaining shall include all areas that the contractor is granted access to or is required to access. Such cleaning will include any and all human introduced waste and other waste materials. The contractor shall take into account the actual site conditions before work commences each day.

The contractor shall ensure that all plant/equipment maintenance, fueling and storage is performed in such a manner that no fuels, oils, lubricants, chemicals or other toxic materials can gain access to the soil, groundwater and surface water. The contractor shall submit a detailed plan to the Developer detailing proposed locations of construction sites/compounds and access routes. Suitable fueling and maintenance areas shall be established in these areas and at all corridors, subject to the approval by the Engineer of Record (E.R.), before work starts on Site.

The location of the fuel farm will be located at a location that is agreed to by the E.R. and should not interfere with daily operations. Preferably, the temporary fuel farm will be located at or near any permanent fuel storage.

The US National Fire Protection Association (NFPA) recommends that an above ground fuel storage system be located on a high, well-drained site, a minimum of 40 feet (including fuelling apron) from any buildings and other combustible materials. The storage area shall be free from weeds and other combustible materials. Smoking, open flames and the like shall not be permitted in the area.

The tanks should be installed in a north-south orientation. This reduces the amount of solar radiation the tank receives and keeps evaporation losses and condensation within the tank to a minimum.

The purpose of the EMP in respect to Fuel Storage is the protection of ground water resources. In the Bahamas, quality ground water is one of the most valuable and vulnerable of natural resources.

Fuel storage systems can be designed to be placed either above ground or below ground. The primary choices for below ground systems are:

- Reduced fire and explosion risks
- Reduced evaporation risks
- Reduced condensation problems

In the Bahamian context and for monitoring purposes, it is proposed that only above ground installations be considered. Above ground installations will avoid rain and associated surface-water runoff in the containment systems. However, above ground containment could be damaged in the case of catastrophic weather events. However, below ground alternatives require extensive and often unreliable monitoring equipment.

The above ground system is made up of tanks, a containment system (to contain the product in the event of a tank rupture) and a concrete pad to prevent any subsurface seepage. As all of the elements in the fuel storage system are above ground, leaks can be readily detected visually as they occur. The containment system stores the spilled product it can be properly disposed of. The containment system is designed to accommodate 125% of the total stored capacity.

The tank plumbing is made of materials resistant to corrosion and the effects of petroleum attack and deterioration. All plumbing in the vicinity of the storage areas will be visible for the purpose of fuel spill detection. Automatic shut-off valves between the components will be installed to prevent mechanical or catastrophic failure in the event of a disaster.

All electrical components used within the system for fuel pumps, lights or other electrical components will be water and explosion proof in accordance with section 3902 of The Bahamas Building Code, Second Edition 1987 and subject further to the specific requirements of the Inspector of Volatile Substances, Ministry of Public Works and Urban Renewal Commission.

4.1.6 Fire Control Measures

The contractor shall comply with NFPA 550 which describes the purpose, structure, and application of the NFPA® Fire Safety Concepts Tree. This systems-based methodology examines the interrelation of fire safety features and their effect on achieving specific fire safety goals and objectives. It identifies tools to help fire safety practitioners communicate fire safety and fire protection concepts so they can develop effective strategies and solutions. The following Guidelines will assist the contractor in the development of a Fire Protection Plan.

The following elements, at a minimum, will be included in the Fire Prevention Plan:

- A list of the major workplace fire hazards and their proper handling and storage procedures
- Potential ignition sources (such as welding, smoking and others) and their control procedures, and the type of fire protection equipment or systems which can control a fire involving them.

- Names or regular job titles of those personnel responsible for maintenance of equipment and systems installed to prevent or control ignitions or fires. Names or regular job titles of those personnel responsible for control of fuel source hazards.
- Housekeeping for fire Prevention-Supervisors will control accumulations of flammable and combustible waste materials and residues so that they do not contribute to a fire emergency. The housekeeping procedures will be included in the written fire prevention plan.
- Training -The contractor will apprise employees of the fire hazards of the materials and processes to which they are exposed. The contractor will review with each employee upon initial assignment those parts of the fire prevention plan which the employee must know to protect the employee in the event of an emergency.
- Plan location-The written plan will be kept in the workplace and made available for employee review.
- Maintenance -The contractor will regularly and properly maintain, according to established procedures, equipment and systems installed on heat producing equipment to prevent accidental ignition of combustible materials. The maintenance procedures will be included in the written fire prevention plan.
- Equipment control devices- Employees and supervisors will be aware of the specific type of control devices and equipment involved with combustible materials in the workplace and should make sure, through periodic inspection or testing, that these controls are operable. Manufacturer recommendations should be followed to assure proper maintenance procedures.
- Portable Fire Suppression Equipment- The requirements of this section apply to the placement, use, maintenance, and testing of portable fire extinguishers provided for the use of employees of ABC Corporation (this section does not apply to extinguishers provided for use on the outside of workplace buildings or structures).

General Requirements for Fire Control Measures

The contractor shall provide portable fire extinguishers and shall mount, locate and identify them so that they are readily accessible to employees without subjecting the employees to possible injury. Only approved portable fire extinguishers shall be used to meet the requirements of this section. The contractor shall not provide or make available in the workplace portable fire extinguishers using carbon tetrachloride or chlorobromomethane extinguishing agents. Any employee finding such an extinguisher should report it to a designated Safety Officer. The contractor shall assure that portable fire extinguishers are maintained in a fully charged and operable condition and kept in their designated places at all times except during use.

The contractor shall permanently remove from service all soldered or riveted shell self-generating soda acid or self-generating foam or gas cartridge water type portable fire extinguishers which are operated by inverting the extinguisher to rupture the cartridge or to initiate an uncontrollable pressure generating chemical reaction to expel the agent. Any employee finding such an extinguisher should report the find to a designated Safety Officer. Portable fire extinguishers shall be provided for employee use and selected and distributed based on the classes of anticipated workplace fires and on the size and degree of hazard which would affect their use.

Protocol for Different Classes of Fires

- Class A fires- Class A fires are classed as ordinary combustibles or fibrous material, such as wood, paper, clothe, rubber and some plastics. Portable fire extinguishers for use by employees on Class A fires will be distributed so that the travel distance for employees to any extinguisher is 75 feet (22.9 m) or less.
- Class B fires- Class B fires are classed as flammable or combustible liquids such as gasoline, kerosene, paint, paint thinners and propane. Portable fire extinguishers for use by employees on Class B fires will be distributed so that the travel distance from the Class B hazard area to any extinguisher is 50 feet (15.2 m) or less.
- Class C fires- Class C fires are classed as energized electrical equipment, such as appliances, switches, panel boxes and power tools. Portable fire extinguishers for use by employees on Class C fires will be distributed so that the travel distance from the Class C hazard area to any extinguishing agent is 50 feet (15.2 m) or less.
- Class D fires- Class D fires are classed as certain combustible metals, such as magnesium, titanium, potassium and sodium. Portable fire extinguishers or other containers of Class D extinguishing agent used by employees will be distributed so that the travel distance from the combustible metal working area to any extinguishing agent is 75 feet (22.9 m) or less.

Inspection, Maintenance and Testing

The contractor shall be responsible for the inspection, maintenance and testing of all portable fire extinguishers used by this company. Portable extinguishers or hoses used in lieu thereof will be visually inspected monthly and documented. Portable fire extinguishers will be subjected to an annual maintenance check, which will be documented. The contractor shall record the annual maintenance date and retain this record for one year after the last entry or the life of the shell, whichever is less.

The contractor shall assure that hydrostatic testing is performed by trained persons with suitable testing equipment and facilities. Alternate equivalent protection will be provided when portable fire extinguishers are removed from service for maintenance and recharging. The contractor shall maintain and provide upon request, evidence that the required hydrostatic testing of fire extinguishers has been performed at appropriate time intervals. Such evidence shall be in the form of a certification record which includes the date of the test, the signature of the person who performed the test and the serial number, or other identifier, of the fire extinguisher that was tested. Such records shall be kept until the extinguisher is hydrostatically retested at an appropriate time interval or until the extinguisher is taken out of service, whichever comes first.

The contractor shall assure that stored pressure dry chemical extinguishers that require a 12-year hydrostatic test are emptied and subjected to applicable maintenance procedures every six years. Dry chemical extinguishers having non-refillable disposable containers are exempt from this requirement. When recharging or hydrostatic testing is performed, the six-year requirement begins from that date. In addition to an external visual examination, an internal examination of cylinders and shells will be made prior to being tested or subjected to hydrostatic tests. Portable extinguishers will be hydrostatically tested at appropriate intervals, except under any of the following conditions:

- When the unit has been repaired by soldering, welding, brazing, or use of patching compounds.
- When the cylinder or shell threads are damaged.
- When there is corrosion that has caused pitting, including corrosion under removable name plate assemblies.
- When the extinguisher has been burned in a fire.
- When a calcium chloride extinguishing agent has been used in a stainless steel shell.

4.2 Physical Aspects

4.2.1 Water Management

No aquifers at Ocean Cay will be utilized as a water source. All water requirements both for construction phases and operational phases will be derived from salt water reverse osmosis (SWRO). The SWRO will be designed in accordance with the requirements of the Water and Sewerage Corporation.

4.2.1.1 Protection of Water bodies

Measures will be taken to minimize erosion and sedimentation in facilities yards and work sites. Silt traps and cut-off drains around yards will be incorporated into site works to restrict runoff wash and transport of sediments, reducing the potential for pollution of adjacent land from any local sources of contamination.

The contractor shall ensure that pollution of the water bodies, wetlands and watercourses does not occur. Pollution of coastal areas, wetlands, groundwater and surface water arising from fuel and oil spillages, sanitary and other wastes is a potential impact for which appropriate mitigation measures should be included in the contractor's methods of working. Silt-traps and turbidity barriers shall be provided by the contractor and managed to the approval of the E.R.

4.2.1.2 Soil Erosion and Runoff

Runoff from construction sites can be a source of sediment in areas under development. There are two main reasons why construction activities increase pollutant loads in runoff. First, the volume and rate of runoff typically increase, providing a larger capacity to transport pollutants to rivers and lakes. Second, the vegetation is removed; leaving bare soil that is much more vulnerable to erosion, resulting in sediment moving into receiving waters.

The contractor will be required to install sediment control structures which may require settlement ponds where flows are not contained and incorporate filtration measures where required. No direct open water discharge will be permitted.

4.3 Material Storage

All materials that can be moved (e.g. wheelbarrows, picks, axes etc.) and all vehicles that remain overnight on the site must be stored in the contractor's camp.

All fuels that are stored on site shall be bunded to 125% of the capacity of the bulk fuel storage container. This must be protected from damage by vehicles. The fuel storage area must not be located near any water resource or surface water body.

Hazardous materials such as oils and paints should also be stored in specifically designed storage facilities.

Vehicle repairs must only take place within the confines of the contractor's camp. An appropriate work surface (i.e. bunded concrete floor) must be provided that can collect oils, fuels and the like and these must be collected into an appropriate bin.

Where there have been oil/fuel leakages, contaminated soil must be removed and disposed of at an appropriately permitted site.

Cleaning of cement mixing and handling equipment should be done using proper cleaning trays and all empty cement containers should be removed from the site for appropriate disposal.

4.4 Waste Management Plan

4.4.1 Liquid Waste Stream

Liquid waste streams shall be managed and treated to prevent pollution of the groundwater. The contractor and owner shall ensure that all plant/equipment maintenance, fueling and storage is performed in such a manner that no fuels, oils, lubricants, chemicals or other toxic materials can gain access to the soil, groundwater and surface water.

Best Management Practices for liquid waste stream include:

- Designated wash down areas. A designated wash down area for equipment will be identified and used. Wash down will be restricted in a Special Management Zone (SMZ).
- No reuse of wash down water. Wash down of equipment shall not be used to wash any chemicals or occur near the storage of hydrocarbon products, if any, on site.
- Proper disposal of oils. Proper collection and disposal of used oil is necessary to prevent soil and water contamination. During equipment maintenance used oil should be collected and stored until properly disposed.
- No discharge of pollutants to water bodies. Do not discharge pollutants, oils and other liquid waste to water bodies. This does not include Type – II marine sanitation device associated with temporary labor accommodation barge.

4.4.2 Solid Waste Stream

A sufficient number of garbage bins and containers will be made available at the worker camps and at the main work sites during construction. Garbage and other waste will be regularly collected and transported to a designated waste transfer site. These containers/bins will be emptied at regular intervals and the collected waste will then be transported to transfer site.

Suitable sanitary and solid waste collection and disposal facilities or systems will be provided at all camps, workshops, stores, offices, main work sites. Personnel will be provided to operate and maintain the systems. During construction phase, labor, clerical staff and technical personnel are likely to congregate. During operational phases and anticipated increases in solid waste, Developer will ensure that sufficient personnel and equipment are available to handle the increased loads. All materials stored at the transfer station will be transported for final disposal offsite.

BMPs for waste management:

- Do not stockpile or store solid waste near or close to any water bodies.
- Practice fire prevention.
- Provide continuing education and training for crew and staff on waste management.
- Identify transportation methods between front of house operations, transfer site storage, and vessel loading.
- Scheduled removal of waste debris to local transfer and on board storage.
- Promote recycling of waste materials within the local community.

5 Emergency Contingency Plans

5.1 Inclement Weather

Anticipated weather events are discussed in the EIA. The Bahamas lies within the North Atlantic Hurricane Belt. If a hurricane approaches and extreme wind speeds or flooding is anticipated, the island will be evacuated and material/equipment secured as feasible.

6 Checklist for Environmental Stipulations

At all times, contractors shall be required to conform with the following particular stipulations in implementing construction works:

(a) Health and safety equipment (including protective clothing and boots) shall be available and in use at work sites and construction facilities/camps. First aid boxes will be mandatory at all sites.
(b) Fuel storage sites shall be bounded by a small berm to confine and mitigate the effects of spillage. The capacity of the confined area to be 125% of volume of fuel stored and protected from rainwater.
(c) Discharge of fumes shall be minimized and there will be no burning of toxic substances.
(d) There will be no disposal of non-biodegradable materials on site without the express permission of the E.R. or local authorities. Oil collection traps will be in use in workshop areas.
(e) Used oils shall be containerized and transported to an approved local agent for safe disposal or transported with other scrap equipment to an approved facility elsewhere.

(f) No disposal of material in environmentally sensitive areas, e.g. mangroves, marshes, protected vegetation, and the marine environment. This does not include proposed reclaimed areas or previously dredge holes or channels.
(g) The contractor shall remove all construction equipment and scrap waste from the site upon completion.

7 Environmental Monitoring Measures

Objective-Manage the impacts to matters of environmental significance associated with the works and limit turbidity from marine works.

Monitoring

- Monitoring of any visible plume after a suitable mixing zone and the effectiveness of the turbidity containment measures undertaken for retention, stability and fate of dredge spoils.
- Monitoring of contractor activities to minimize or mitigate any adverse environmental impacts.
- Water quality monitoring as applicable.
- Contingency measures to be implemented should they be required and any management actions to verify the efficacy of those implements measures.
- Monitoring to determine that environmental performance standards are being achieved.

Reporting

- In accordance with the Environmental Management Plan, periodic reports shall be drafted and made available to relevant stakeholders and further be publically available if so required.
- Specific incident reporting will be conducted, if required.

7.1 Environmental Mitigation

Approximately 400 corals will be relocated from the southern region of the marine environment of Ocean Cay to designated areas. Stony corals will be collected from direct and indirect impact areas within the Project site, including: the existing piles, the previously dredged footprint and various small patch reefs. Corals will be collected using hand tools, such as; chisels, chipping hammers, stainless steel surgical bone-cutters and needle-nose pliers.

Once removed from their current habitat, the corals will be carefully placed in large plastic tubs, which will be tethered to the boat on the surface. With the assistance of divers, the surface support team will lift the coral- filled containers on board the vessel, where the corals will temporarily remain in seawater (to avoid exposure to air) before being transported to the recipient site for reattachment. The time in the tubs, and/or above water, prior to transplantation shall be minimized as much as possible. While in the boat, the tubs should be kept away from direct sunlight.

To increase the overall chance of survival, the relocation sites will be selected based on similar depth, light and temperature conditions as the removal site. Recipient sites will also be selected based on wave-action, habitat type and sediment loads. The relocation site should also be a sufficient distance from reefs to reduce predation by fire worms, but still allow herbivorous fish to visit the structures regularly for cleaning. Proximity to reef or other structures that may attract fish will be considered during site selection.

The marine environment surrounding Ocean Cay and some of the existing dredge holes provides adequate hard-bottom habitat, limited wave-action and minimal loose, fine grain sediment. Therefore, corals will be relocated to designated existing or artificial reef locations throughout this region.

The coral will be attached using a two-part underwater epoxy. The epoxy will be mixed under-water and applied directly to the sites so that the coral can be attached. The coral will be held in place until the epoxy sits. Each coral will be positioned to allow adequate room for growth. Small corals may be affixed directly to submerged rocks or hard-bottom using only two- part epoxy. The surface of the substrate in the recipient location shall be cleaned of algae, cyanobacteria, and sediments with a wire brush.

A 1-year monitoring program has been established to assess the health of the reattached coral colonies, colonization of the artificial habitat and document reef fish associated with the recipient site. Photos and measurements will be taken to document any changes over time. Monitoring is to occur 3, 6 and 12-months after relocation. Coral will be documented through the use of photo.

Corals will also be analyzed to identify the number of surviving colonies, difference in live tissue cover, rate of disease, bleaching, boring sponges or other invading organisms, as well as overall health. If algae or other fouling organisms (tunicates, sponges, hydroids, etc.) are found invading the coral, those organisms will be removed. Wire brushes and hand tools will be used to clean the mesh, so that algae does not outcompete coral.

7.2 Turbidity Monitoring

To widen the existing channel and turning basin to provide safe navigation, dredging will occur. Throughout the dredging process, dredged material will be discharged to and contained on the island to limit turbidity and contain runoff. Excess material will be used in the existing sandy dredge shoal area or to fill existing dredge holes/channels.

Turbidity will be regularly monitored throughout the duration of dredging activity to document potential turbidity within and outside the prescribed mixing zone beyond the dredge limits. If test results exceed prescribed levels, dredging will temporarily cease.

Background and compliance measurements should be taken to identify baseline turbidity levels. Prior to construction, turbidity measurements will be taken to establish background levels at the proposed dredge and discharge locations. The distance between these locations should also be documented. Turbidity is generally reported in nephelometric turbidity units (NTUs). A

Nephelometer, also called a turbidimeter, will be used to measure turbidity. This measurement generally provides a strong correlation with the concentration of particles in the water that affect clarity.

Prescribed monitoring of turbidity levels will be engaged to document potential turbidity within and outside the dredge limits. Dredging operations will cease if test results exceed prescribed levels. Background and compliance measurements are to be taken at the dredging site.

The Bahamas does not have legislation mandating acceptable turbidity levels associated with construction. Therefore, this Project will follow the Florida Department of Environmental Protection's (FDEP) turbidity criteria of 29 NTU. A 250 m mixing zone originating from activity location will be utilized. Turbidity shall not exceed 29 NTU's above the associated background turbidity levels beyond the 250-meter mixing zone. If turbidity levels of 29 NTU's (above background levels) are exceeded, dredging activity will temporarily cease. If construction methodology cannot meet the above standards, new NTU limits will need to be negotiated with the BEST Commission in order to complete the project.

In order to monitor turbidity levels at designated locations, measurements will be conducted during the active dredging operations once daily to verify results are consistently below above mentioned threshold. Measurements should be recorded and analyzed relative to construction activity and weather conditions. Monitoring will occur approximately 1,000 meters upstream to test background turbidity levels and 250-meter downstream of dredging activity. Samples should be taken at the densest part of the turbidity plume.

Samples will be collected using a turbidity meter that is calibrated to manufacturer's standards. The measurements will be recorded and analyzed. Dredging will cease and operations/ methodology will be modified as needed if turbidity readings exceed 29 NTUs above background levels at the 250-meter testing site.

Following the completion of all construction activities, turbidity should be measured to establish post-construction baseline data. All records will be available to BEST for review. The BEST Commission is encouraged to participate and observe testing and monitoring procedures at any time. Turbidity monitoring will be performed for all dredging work, both for initial construction and future maintenance events.

Daily monitoring logs will include the following information for each sample: 1) date and time of day of sampling, 2) weather conditions, 3) Tidal stage and direction of flow, 4) Wind direction and magnitude, 5) Latitude / Longitude coordinates of each sampling location, 6) A description of any factors influencing the dredging at the time of the monitoring and 7) Final measurements. Logs will be generated daily when turbidity generating activity occur.

7.3 Lagoon Flushing

A lagoon will be constructed in the northern section of the island by excavating inland areas. The lagoon will be connected to the ocean through an eastern and a northern flushing channel, which will promote sufficient water circulation within the lagoon. A numerical flushing analysis was conducted to evaluate the flushing time of the lagoon.

The results of a flushing study indicated a flushing time of less than 1 day, a value which is acceptable within published standards. A detailed description of the flushing analysis is provided in Appendix A.

7.4 Shoreline Stabilization

Rock revetment is proposed as shoreline stabilization in specific exposed locations. The rock revetment will serve as anchor points for softer shoreline areas such as beaches. The beaches have been designed with sufficient setback and slopes to allow for the natural cross and longshore beach dynamics. Each beach area is stabilized by natural rocky shoreline or revetment and functions as pocket beaches. Therefore, erosion within each beach cell or downdrift impacts to adjacent beaches are not anticipated. The rock revetment will also serve as important marine habitat and as additional mitigation.

7.5 Debris Removal

Debris will be removed from the island and along the shoreline as well as in the nearshore area.

8 References

United States Environmental Protection Agency – "Ecological Risk Assessment – Process for designing and Conducting Ecological Risk Assessments".

UNEP / IPCS " Training Module – Human Risk Assessment".

Climatology of Caribbean Hurricanes – Caribbean Hurricane Network

Laws of The Bahamas Online - http://laws.bahamas.gov.bs/cms/en/

Environmental Impact Assessment Ocean Cay, Island by Design/Cummins Cederberg, Inc.

Appendix A – Flushing Analysis

Flushing Analysis

MSC Marine Reserve
Ocean Cay, Bahamas

March, 2016

Prepared for:
Bermello Ajamil & Partners, Inc.
2601 S Bayshore Dr, #1000
Miami, FL 33133

Prepared by:
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CUMMINS | CEDERBERG
Coastal & Marine Engineering

TABLE OF CONTENTS

1 ADDENDUM TO COASTAL ENGINEERING ANALYSIS 1
1.1 Background 1
1.2 Objective 1
2 SITE CONDITIONS 2
2.1 Tides 2
2.2 Lagoon Characteristics 2
3 FLUSHING ANALYSIS 3
3.1 Water Circulation Criteria 3
3.2 Numerical Modeling 3
3.3 Results 4
4 CONCLUSIONS 5
APPENDIX A – FIGURES .... A
Figure A2.1: Location Map A-1
Figure A2.2: Proposed Lagoon A-2
Figure A3.1: DHI Model Tidal Comparison A-3
APPENDIX B – MODEL RESULTS – 0.9M LAGOON .... B
Hour 0 of 12 in Flushing Analysis B-1
Hour 1 of 12 in Flushing Analysis B-2
Hour 2 of 12 in Flushing Analysis B-3
Hour 3 of 12 in Flushing Analysis B-4
Hour 4 of 12 in Flushing Analysis B-5
Hour 5 of 12 in Flushing Analysis B-6
Hour 6 of 12 in Flushing Analysis B-7
Hour 7 of 12 in Flushing Analysis B-8
Hour 8 of 12 in Flushing Analysis B-9
Hour 9 of 12 in Flushing Analysis B-10
Hour 10 of 12 in Flushing Analysis B-11
Hour 11 of 12 in Flushing Analysis B-12
Hour 12 of 12 in Flushing Analysis B-13
APPENDIX C – MODEL RESULTS – 2M LAGOON C
Hour 0 of 12 in Flushing Analysis C-1
Hour 1 of 12 in Flushing Analysis C-2
Hour 2 of 12 in Flushing Analysis C-3

Hour 3 of 12 in Flushing Analysis C-4
Hour 4 of 12 in Flushing Analysis C-5
Hour 5 of 12 in Flushing Analysis C-6
Hour 6 of 12 in Flushing Analysis C-7
Hour 7 of 12 in Flushing Analysis C-8
Hour 8 of 12 in Flushing Analysis C-9
Hour 9 of 12 in Flushing Analysis C-10
Hour 10 of 12 in Flushing Analysis C-11
Hour 11 of 12 in Flushing Analysis C-12
Hour 12 of 12 in Flushing Analysis C-13

1 ADDENDUM TO COASTAL ENGINEERING ANALYSIS

1.1 Background

Cummins Cederberg, Inc. (Cummins Cederberg) was retained by Bermello Ajamil & Partners, Inc. (Client) to prepare a flushing analysis relative to the proposed lagoon at the MSC Marine Reserve at Ocean Cay, Bimini Islands, Bahamas.

1.2 Objective

A salt water lagoon is proposed at the northern end of the island. The lagoon will be excavated connected to the ocean on the northern side and eastern side via two flushing channels. The creation of the lagoon will provide additional beachfront area for the proposed development and a protected swimming area for families. The objective of the present analysis was to evaluate the flushing conditions at the proposed lagoon to ensure adequate water circulation.

2 SITE CONDITIONS

Ocean Cay is part of the Bimini Island chain, which is situated in the western region of The Bahamas, as illustrated in Figure A2.1 in Appendix A. Specifically, Ocean Cay is one of the southernmost islands of the Bimini Islands, with an approximate central latitude and longitude of 25°24 N and 79°12' W, respectively. The island of Ocean Cay is approximately 700 m (2,300 feet) in length and 550 m (1,800 feet) in width.

The proposed lagoon is located in the northern part of the island as illustrated in figure A2.2. The lagoon will be connected to the ocean on the north side and east side via two flushing channels, and will be dredged to an approximate elevation of -0.9 m on the project datum.

2.1 Tides

Tides in the Project vicinity are predominately semi-diurnal with an average extreme range of approximately 1.1 m (3.4 feet) and a period of approximately 12.4 hours. A tide gauge was installed at the Site during field operations, and recorded water level variations for 22 days. The data was subsequently analyzed and filtered using a low pass filtering process.

TABLE 2.1

Tidal Water Levels, Ocean Cay

Water Level	Elevation (m, project datum)
Project High Water	1.0 m (3.3 feet)
Project Low Water	-0.1m (-0.4 feet)

2.2 Lagoon Characteristics

The proposed lagoon has an approximate length of 520 m (1,700 ft), a proposed bottom elevation between -0.9 m (-3.0 ft) and -2.0 m (-6.5 ft). Two entrance channels are proposed, one connecting with the ocean on the north side of the island with an approximate width of 45 m (150 ft), and one connecting with the east side of the ocean with an approximate width of 30 m (100 ft). The interior beaches of the lagoon are sloped at 1V:20H and at the mouth of the channel where rock revetments are proposed as shoreline stabilization the slopes are 1V:2H.

3 FLUSHING ANALYSIS

3.1 Water Circulation Criteria

The term "flushing time" is typically used to the described the time required to exchange a percentage of water with the ambient area based on water circulation, tidal variations and other mechanisms.

In the United States, the EPA defines the flushing time as the time to reduce a concentration to 10% of its original concentration. Water quality standards in Florida require a flushing time of less than 4 days.

Mangor defines the flushing time as the time to reduce a concentration to 50% of its original concentration and states a flushing time of 7 days is normally adequate for swimming in artificial lagoons. For non-swimming lagoons, a higher flushing time would likely be adequate.

3.2 Numerical Modeling

To analyze the flushing time, a hydrodynamic numerical model was developed utilizing the MIKE21 Hydrodynamic Model (HD) engineering software package. The MIKE21 HD numerical model simulates two-dimensional water level variations and flows in response to a variety of forcing mechanisms in canals, lakes, estuaries and coastal areas. In the aforementioned hydrodynamic model, the water levels and flows are resolved on a flexible triangular grid covering the area of interest when provided with the bathymetry, bed resistance coefficients, wind field, and hydrographic boundary conditions. The output of the numerical model includes a time series of water surface elevation, flux, current velocity, and directions at specified grid points.

The AD module of the MIKE21 HD FM model simulates the transport of suspended substances based on the flow conditions from the hydrodynamic calculations. In the two-dimensional simulation, described herein, the dispersion coefficient is calculated as the eddy viscosity, used in the solution of the flow equations, multiplied by a scaling factor. In a typical MIKE21 HD FM simulation with the AD module, the substance concentrations are resolved on a flexible triangular grid covering the area of interest, when provided with the inputs to the hydrodynamic model, initial concentration and decay characteristics, along with boundary conditions. The output of the AD module includes a time series of substance concentrations and current velocities at all specified grid points.

Other model parameters found in the MIKE21 HD FM model include bed resistance and eddy viscosity. Bed resistance is the resistance of the seabed to the current and can be used for model calibration. In the simulations performed for this study, the bed resistance formulation implemented the Manning Equation, in which the Manning number was set to the constant value of 32 $m^{1/3}/s$. Eddy viscosity is used to model the turbulence encountered within the simulation. Specifically, the Smagorinsky formulation, (which calculates the eddy viscosity as a time-varying function of the local velocity gradients multiplied by a constant value) was applied with a constant value of 0.28.

The numerical model was developed to simulate the flow patterns under the proposed conditions during a typical tidal cycle. In order to establish the numerical model, the project area was digitized using varying triangle sizes incorporating bathymetric data collected by Cummins Cederberg and the anticipated dredge elevation of the proposed lagoon. Simulation with varying water depths and configurations were conducted to assess the impact on the flushing time. The results of a seabed elevation of -0.9 m (3.0 ft) and -2.0 m (6.5 ft) are presented herein.

The water surface elevations for input at the boundary were obtained from the DHI Water & Environment Global Tide model. The DHI tide model closely matched the measurements obtained by Cummins Cederberg. A comparison between the DHI Water & Environment Global Tide model and the site measurement is presented in Figure A3.1. In addition, no wind was added to the model to obtain a conservative estimate from the analysis, though the effect of wind would reduce the flushing time significantly.

3.3 Results

The results of the numerical modeling show the flushing time to be approximately 12 hours for 0.9 m and 2 m water depths, values which are both acceptable within published standards by Mangor and the EPA. Therefore, the characteristics of the lagoon provides adequate flushing conditions to avoid common problems associated with stagnant waters. For the interior water depth of 0.9 m, flow speeds at the north channel peaked at 0.2 m/s (0.7 ft/sec), and on the narrower eastern channel flow speeds peaked at 0.3 m/s (1 ft/sec). For the interior water depth of 2 m, flow speeds at the north channel peaked at 0.2 m/s (0.7 ft/sec), and on the narrower eastern channel flow speeds peaked at 0.4 m/s (1.3 ft/sec).

Appendix B illustrate the results of the analysis on an hourly basis for both water depth scenarios. The concentration of the water in the lagoon is diluted as the incoming tide allows new water to flow through the proposed channel channels. The flow of this new water allows mixing between the existing water and therefore reduces the original concentration of the saltwater lagoon. Once the outgoing tide sets in, the remaining concentration is flushed out of the lagoon.

4 Conclusions

A numerical flushing analysis was conducted to evaluate the flushing conditions of a proposed lagoon at Ocean Cay, Bahamas. Flushing channels are proposed on both the north and east side of the island to connect with the ocean. A hydrodynamic numerical model was developed with bathymetry data collected on site and anticipated dredge elevation data to evaluate the water circulation conditions exhibited in the proposed saltwater lagoon.

The following conclusions were obtained based on the analyses results:

- The inflow of water due to varying tidal conditions along with the characteristics of the lagoon exhibit a flushing time of approximately 12 hours for interior water depths of 0.9 m and 2 m.
- The peak flow velocity in the north channel is 0.2 m/s (0.7 ft/sec) and 0.3 m/s (1 ft/sec) in the eastern channel for interior water depths of 0.9 m.
- The peak flow velocity in the north channel is 0.2 m/s (0.7 ft/sec) and 0.4 m/s (1.3 ft/sec) in the eastern channel for interior water depths of 2 m.

This report was prepared in accordance with industry standards and practice for the exclusive use in the architectural / engineering design for the proposed development project located on Ocean Cay, Bahamas.

APPENDIX A – FIGURES

CUMMINS | CEDERBERG
Coastal & Marine Engineering

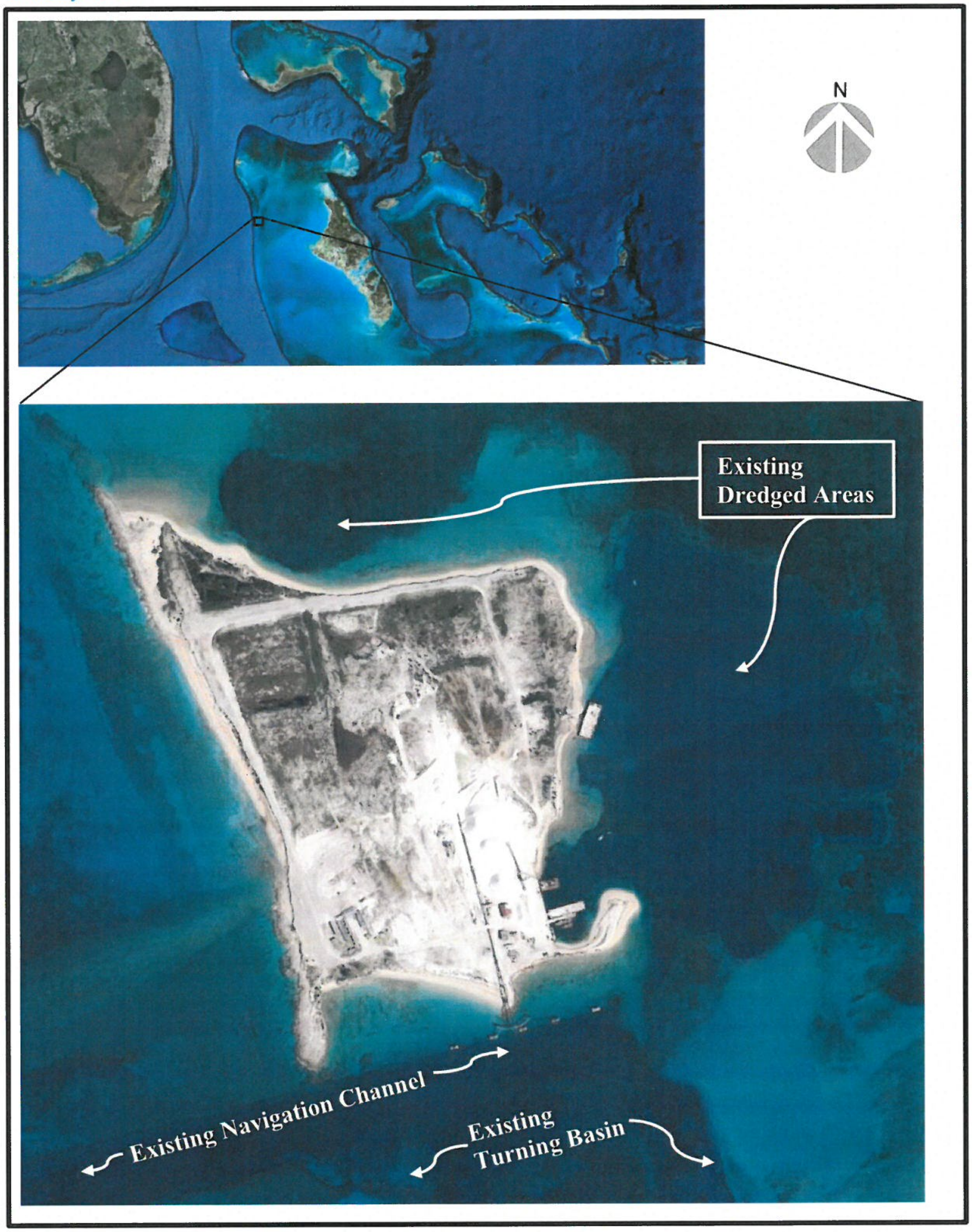

Figure A2.1: Location Map
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

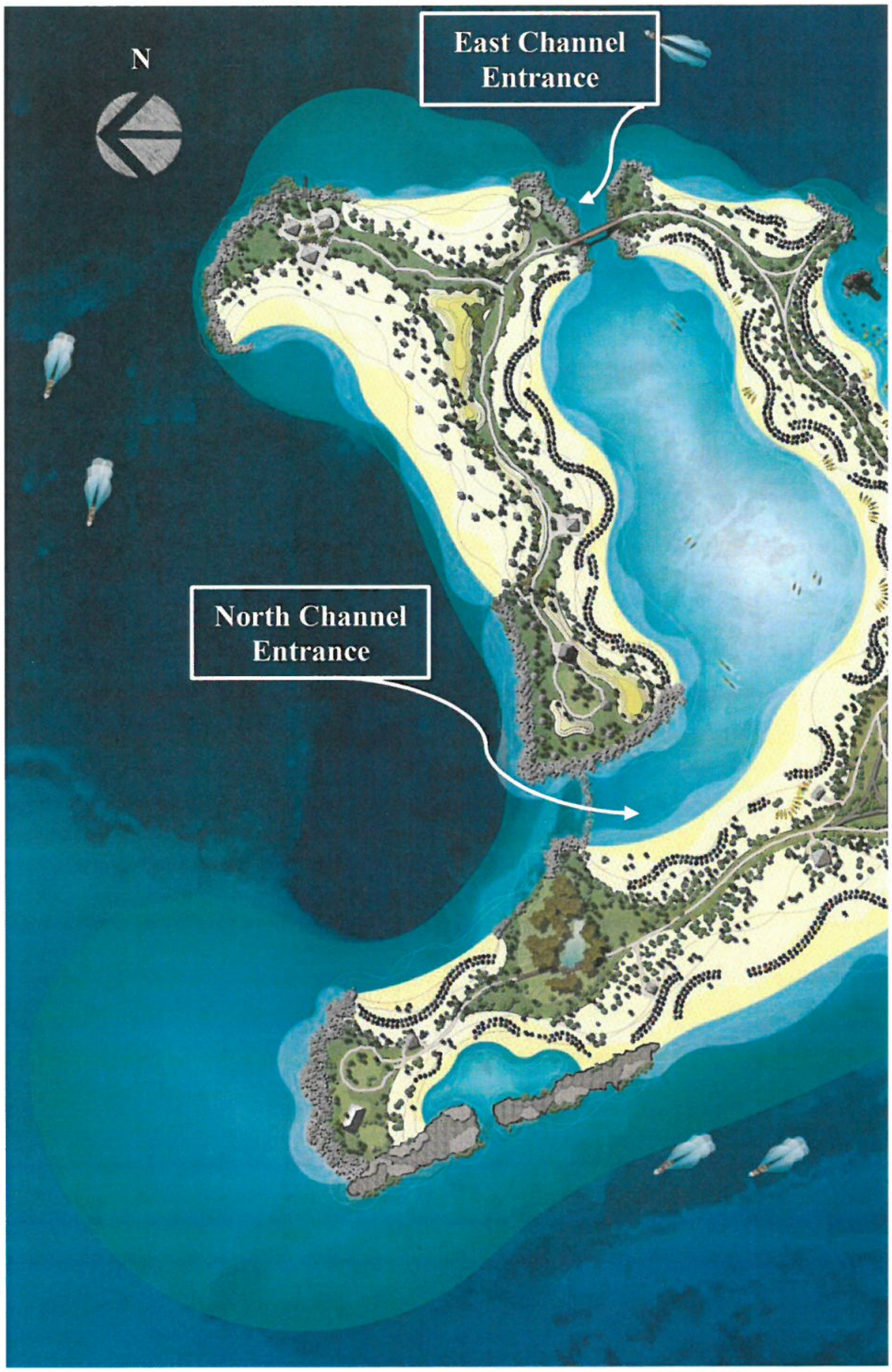

Figure A2.2: Proposed Lagoon
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

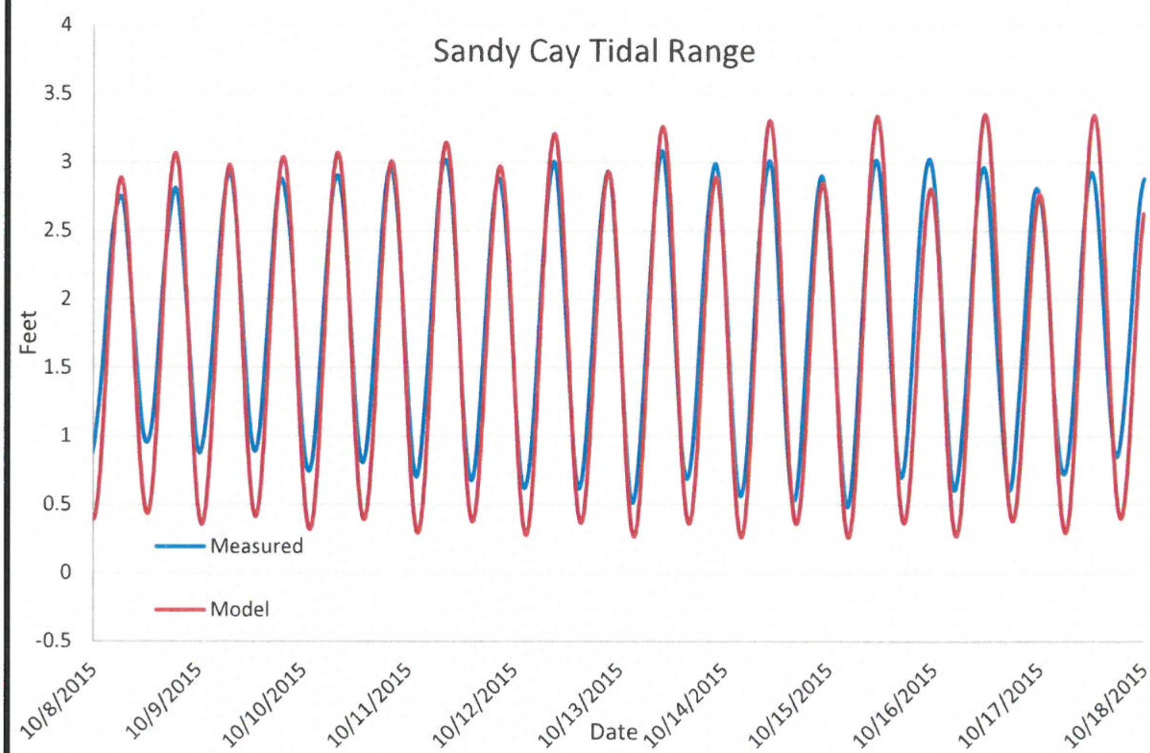

Figure A3.1: DHI Model Tidal Comparison
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

APPENDIX B – MODEL RESULTS – 0.9M LAGOON

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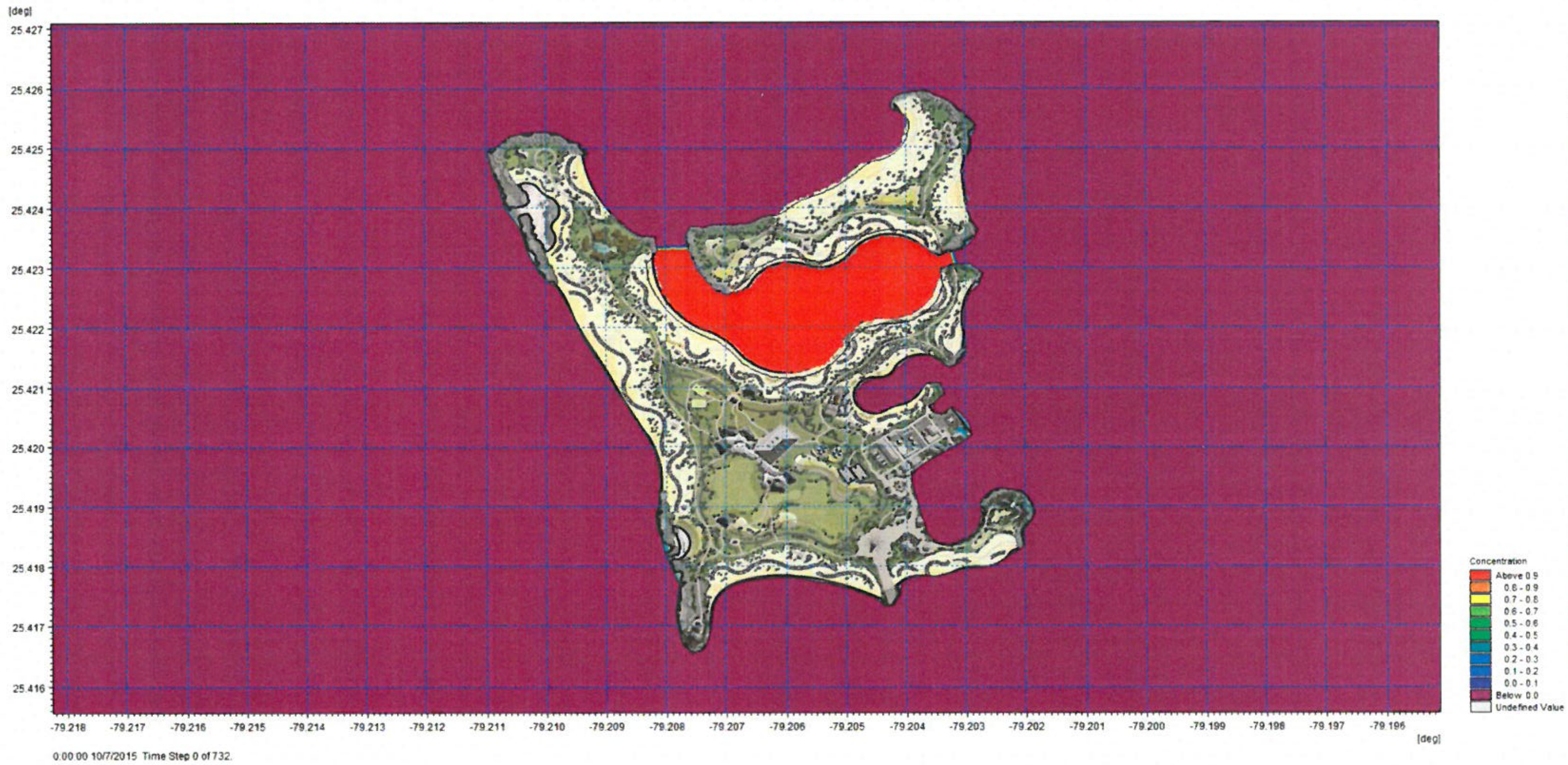
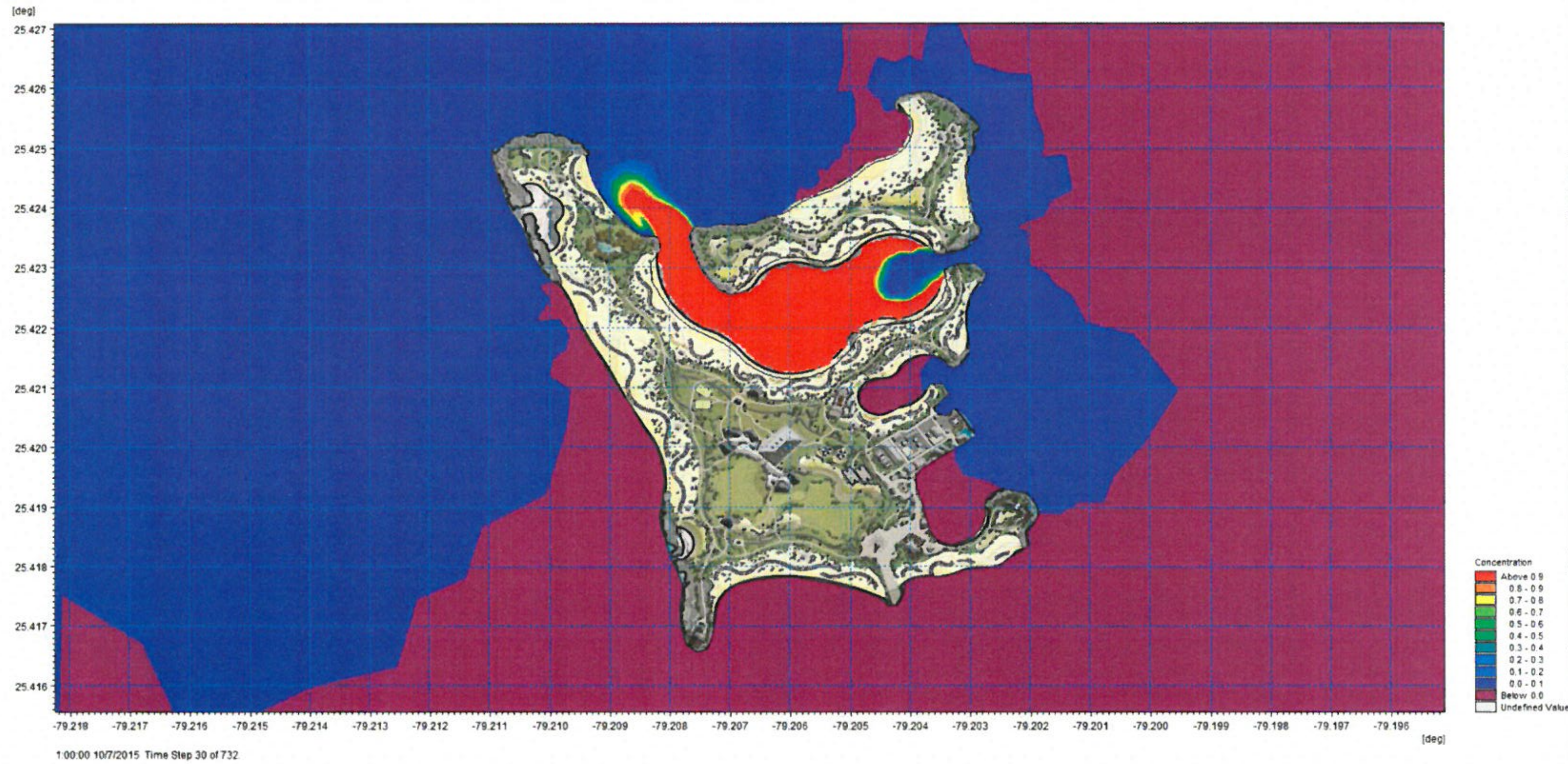


Hour 0 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas



Hour 1 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

Flushing Analysis
MSC Marine Reserve
March 2016

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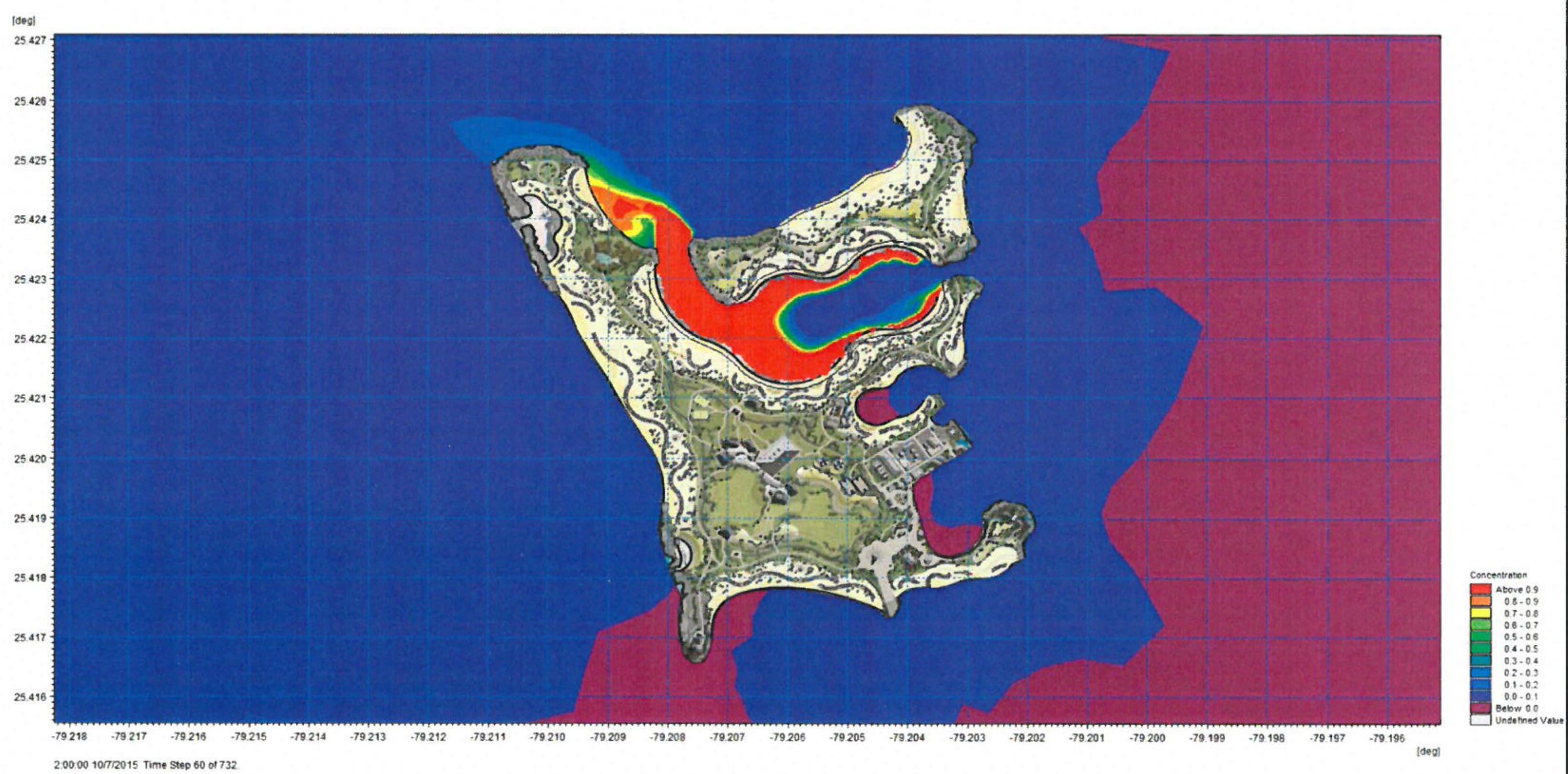

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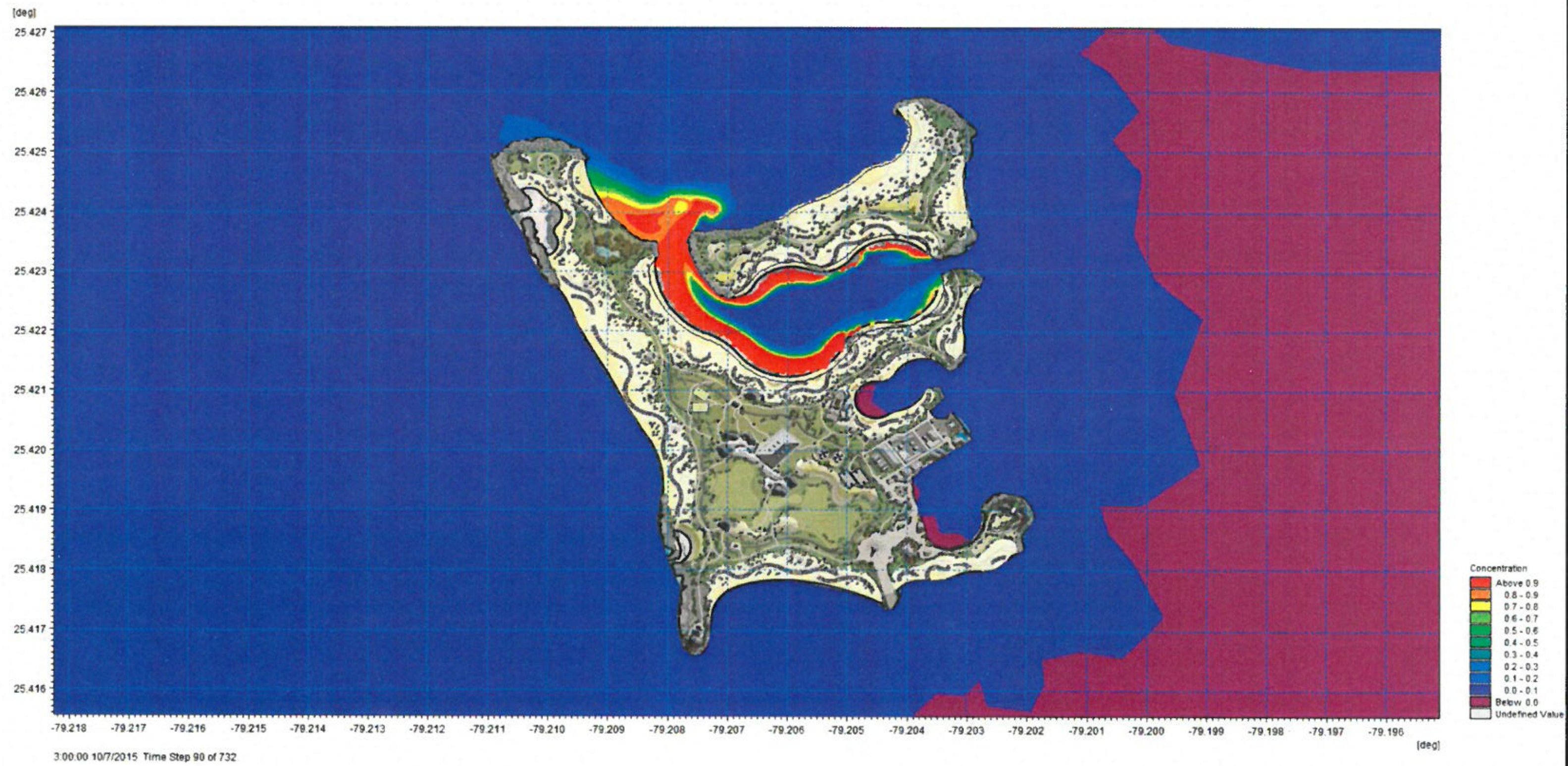

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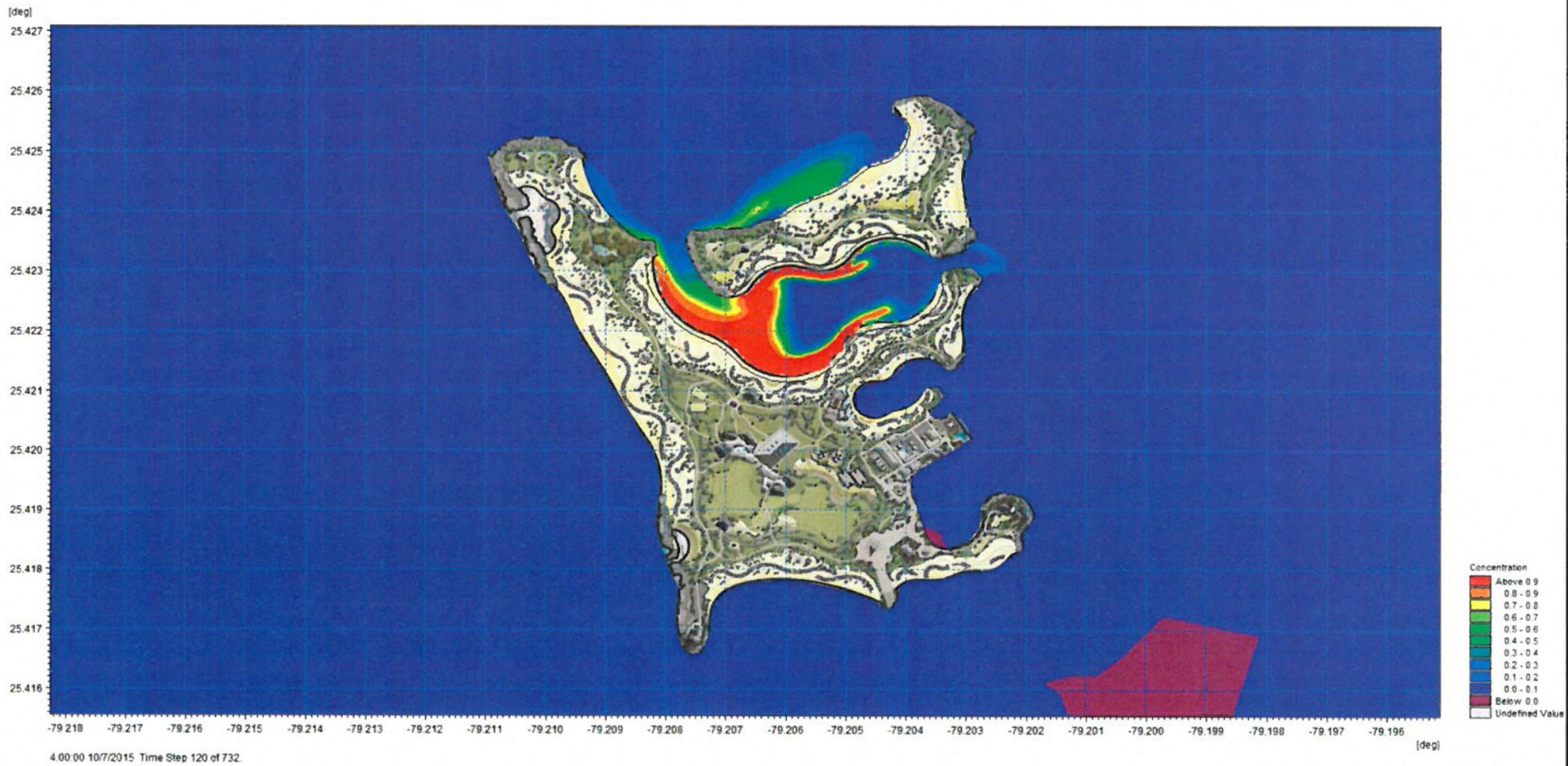

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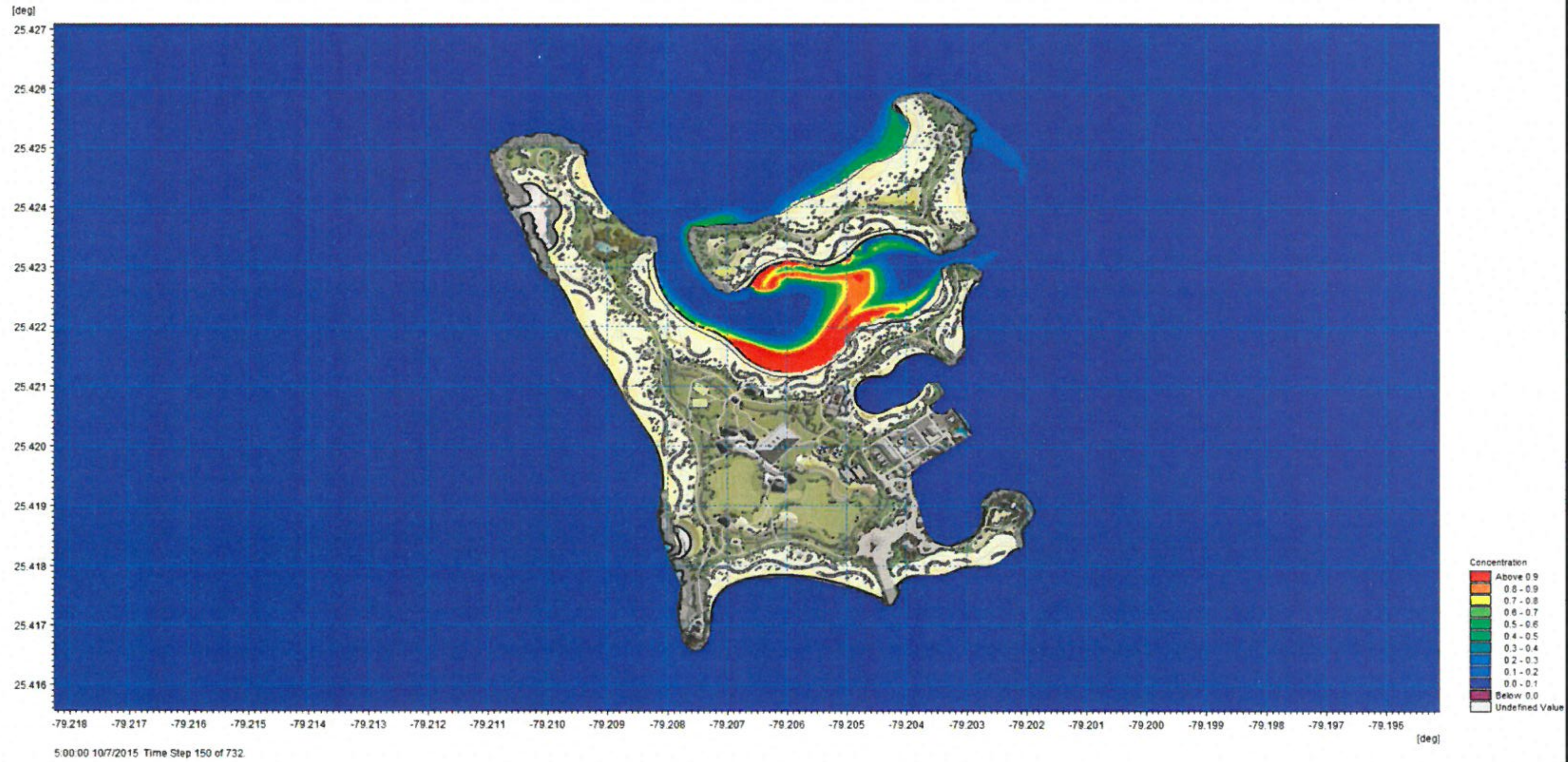

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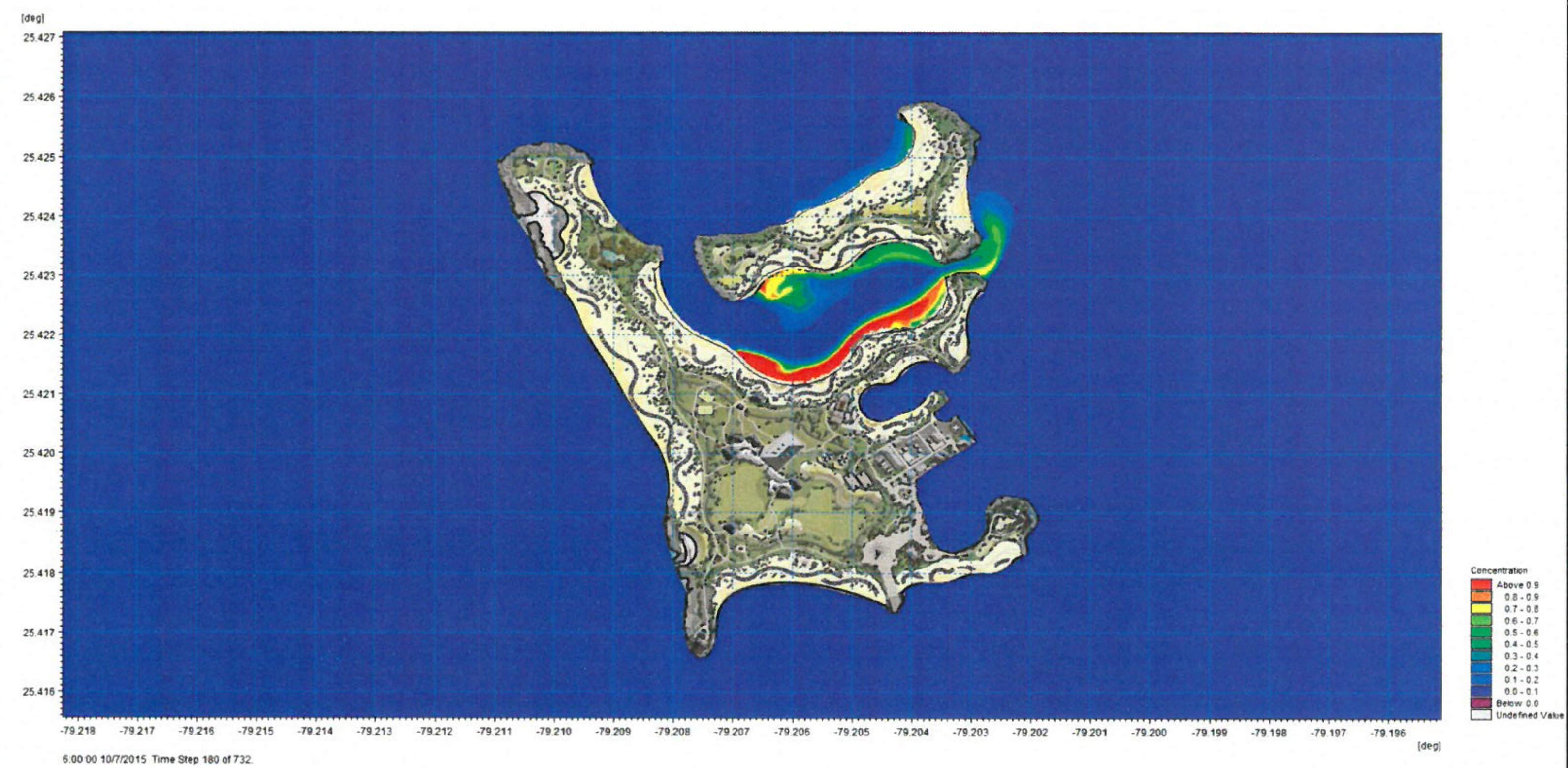

Hour 6 of 12 in Flushing Analysis
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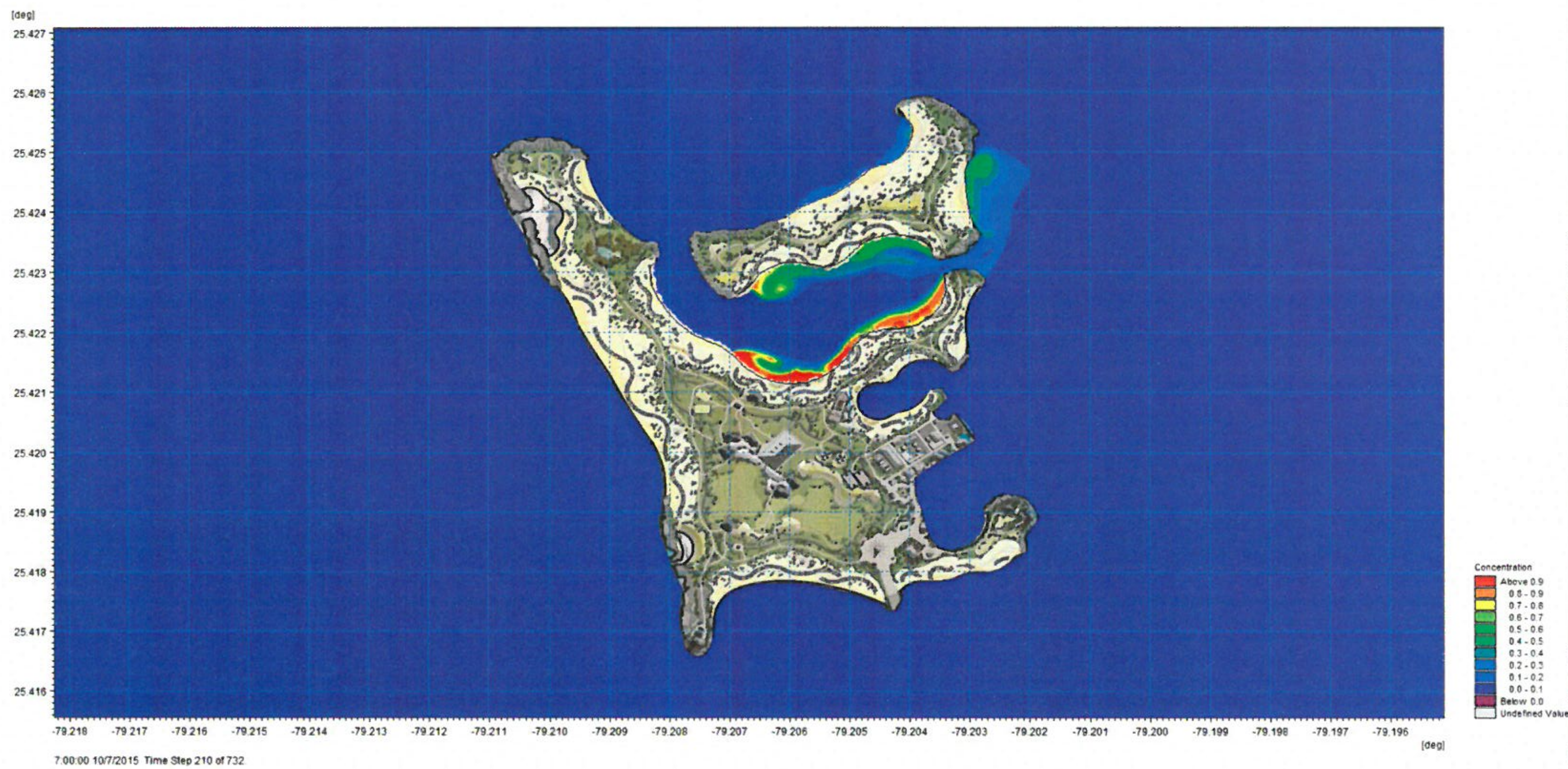

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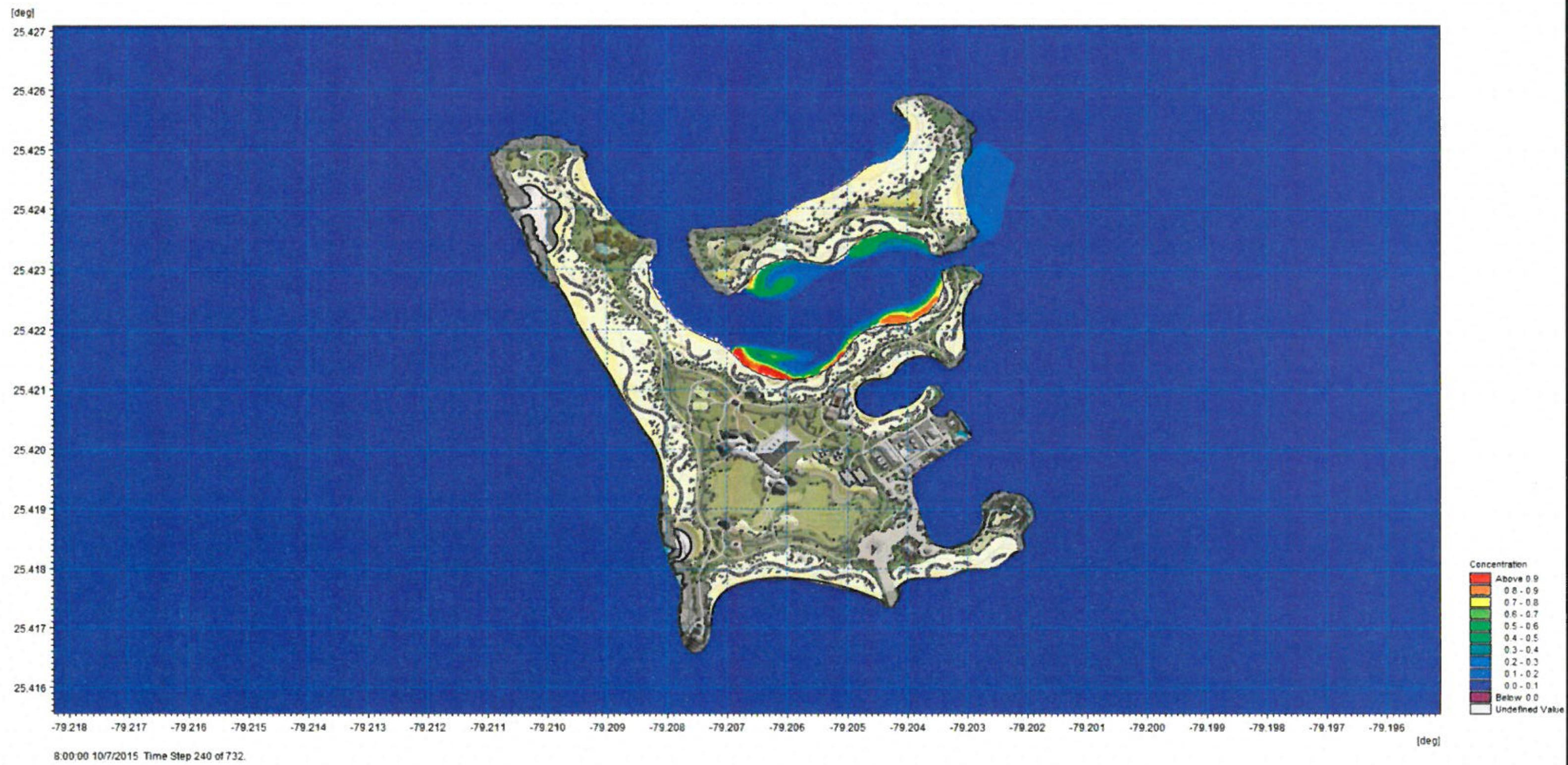
Proposed MSC Marine Reserve, Ocean Cay, Bahamas



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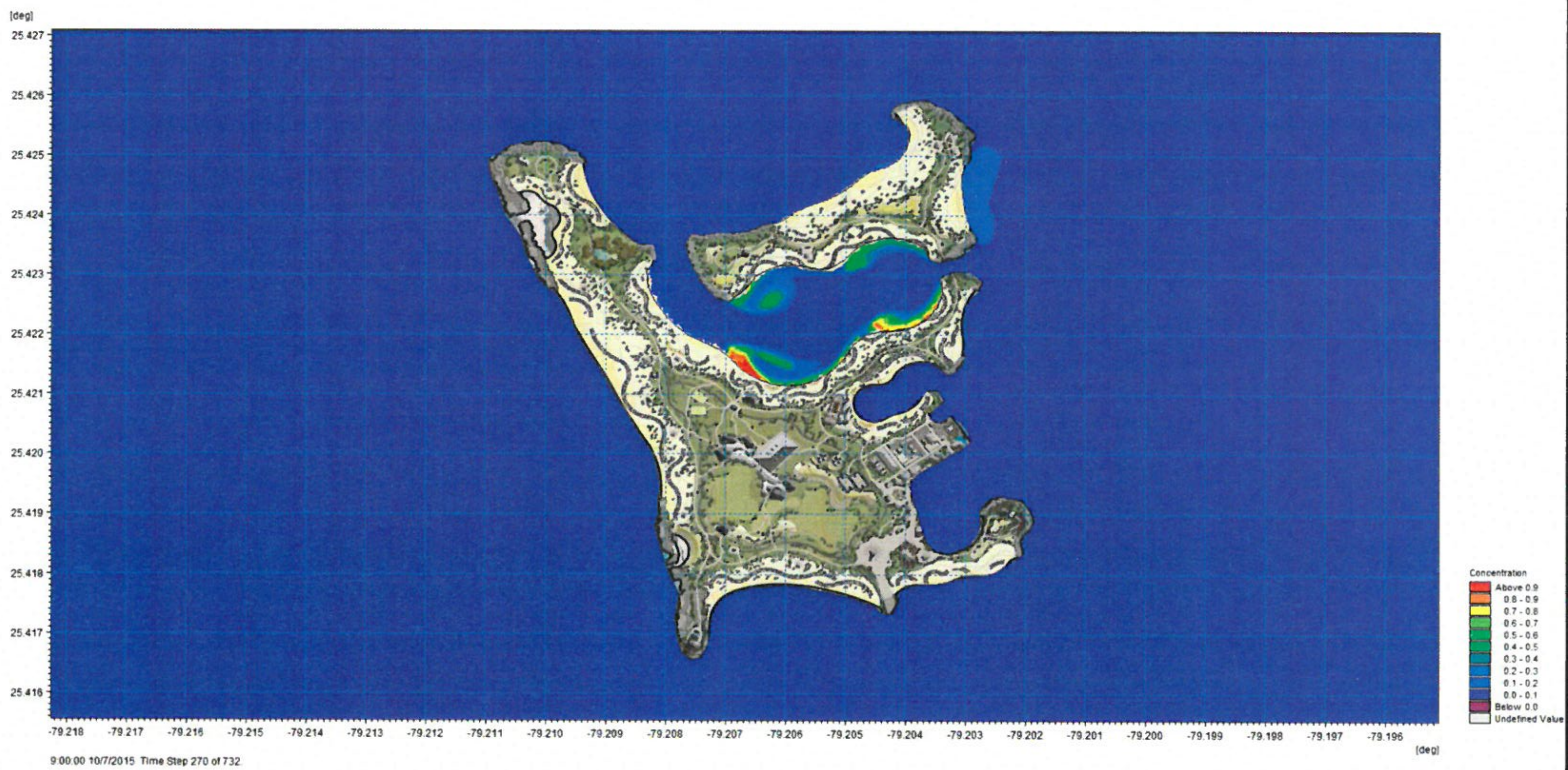

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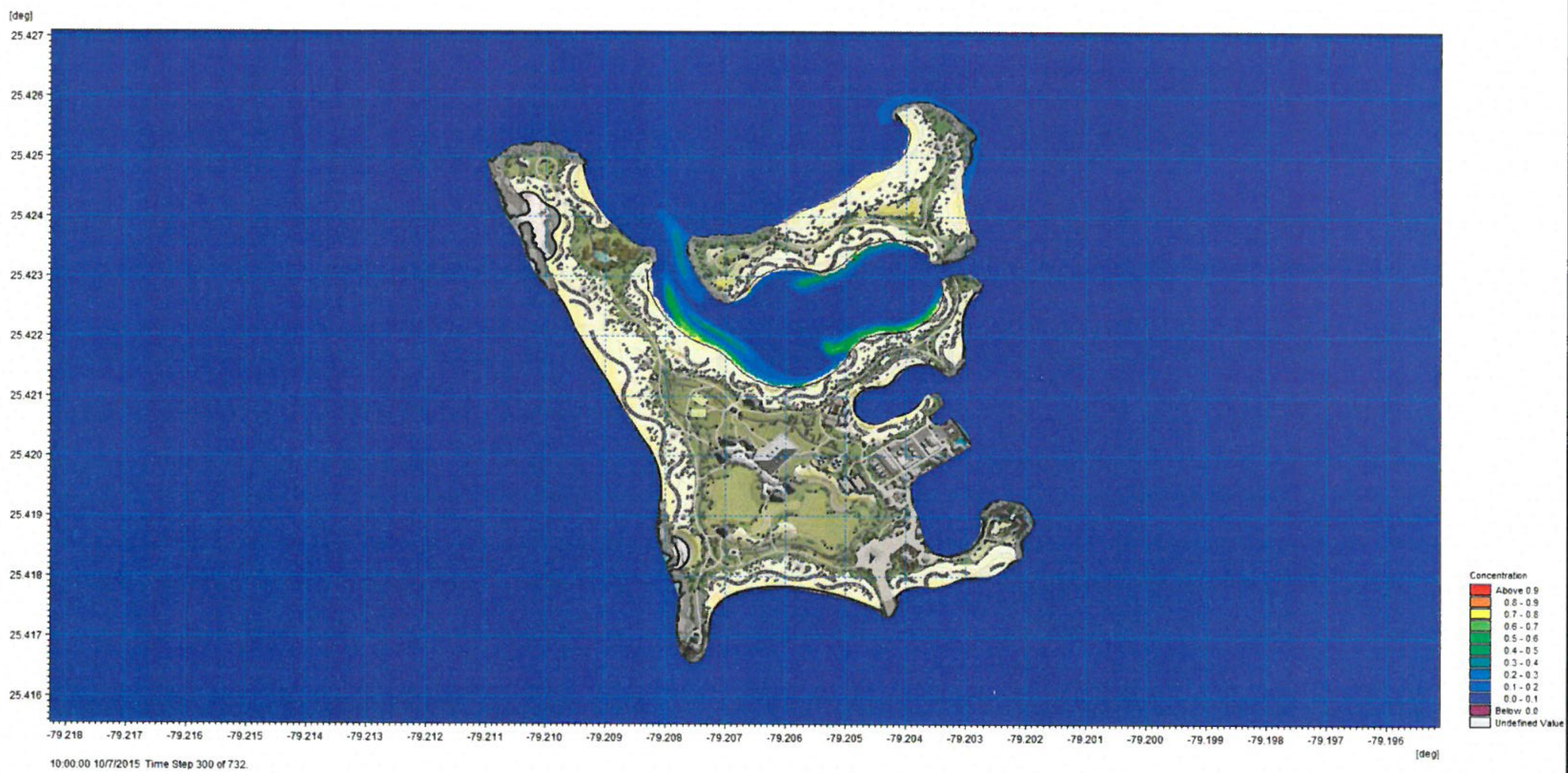

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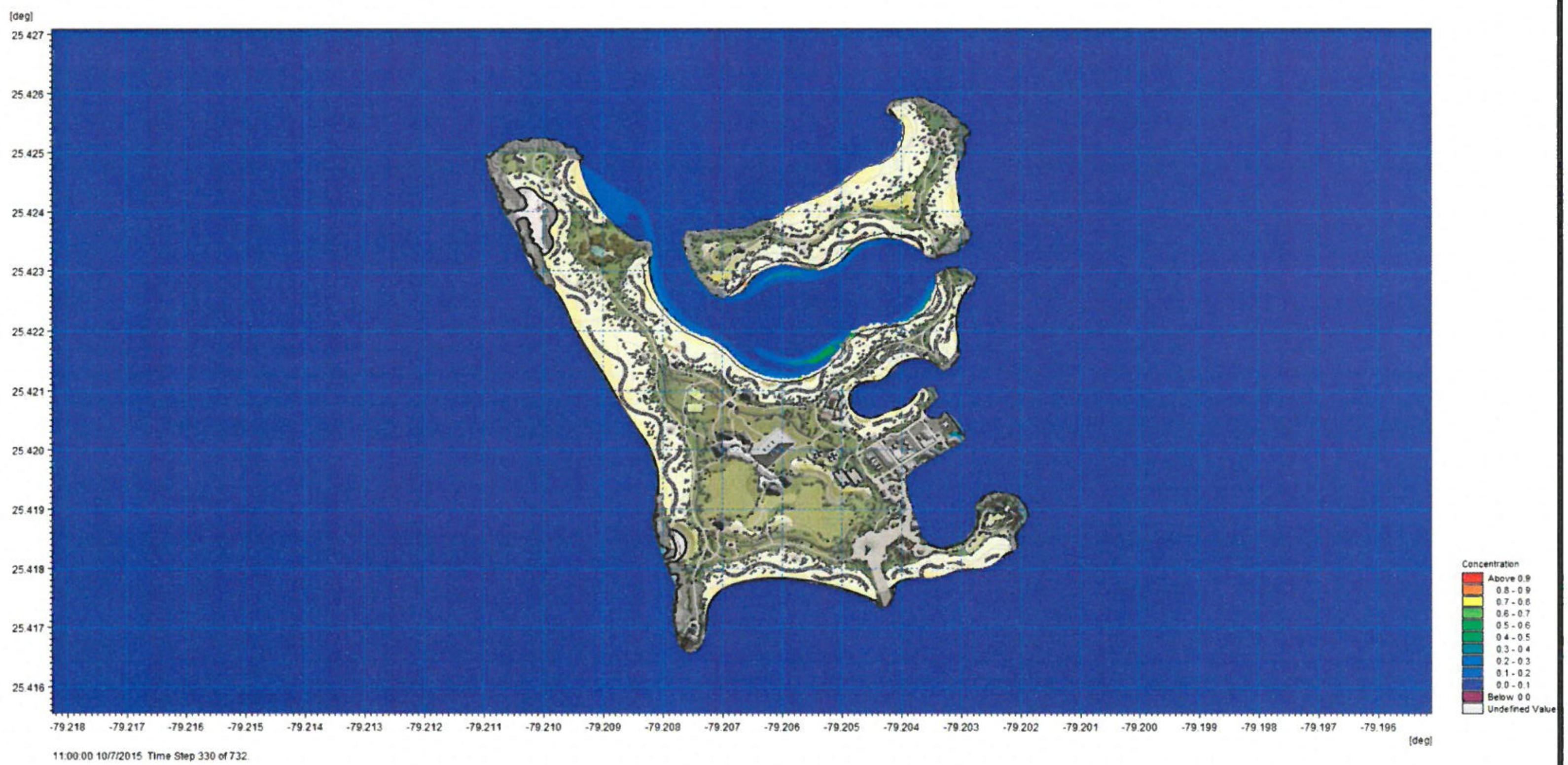
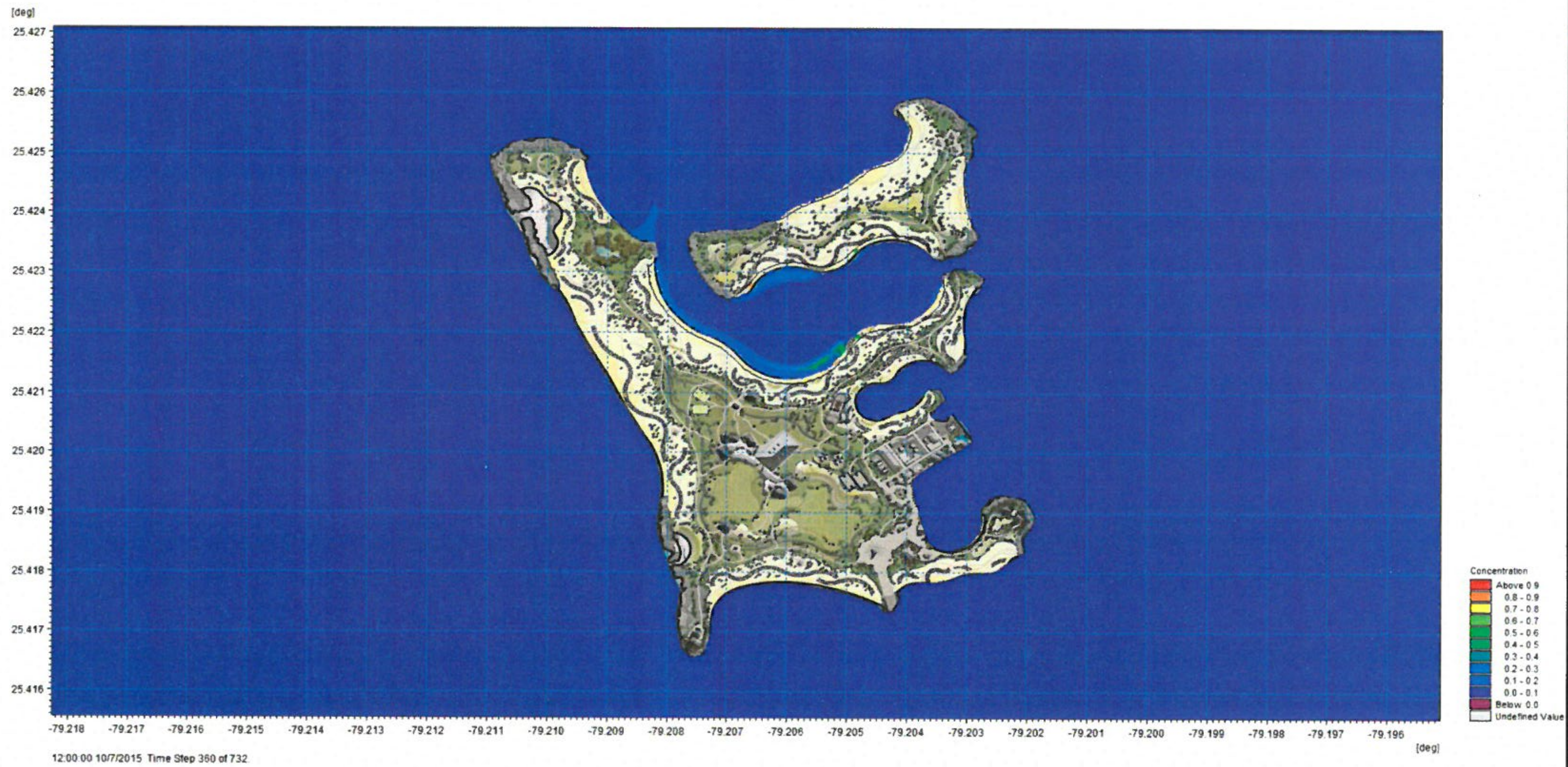


Hour 11 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas



Hour 12 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

APPENDIX C – MODEL RESULTS – 2M LAGOON

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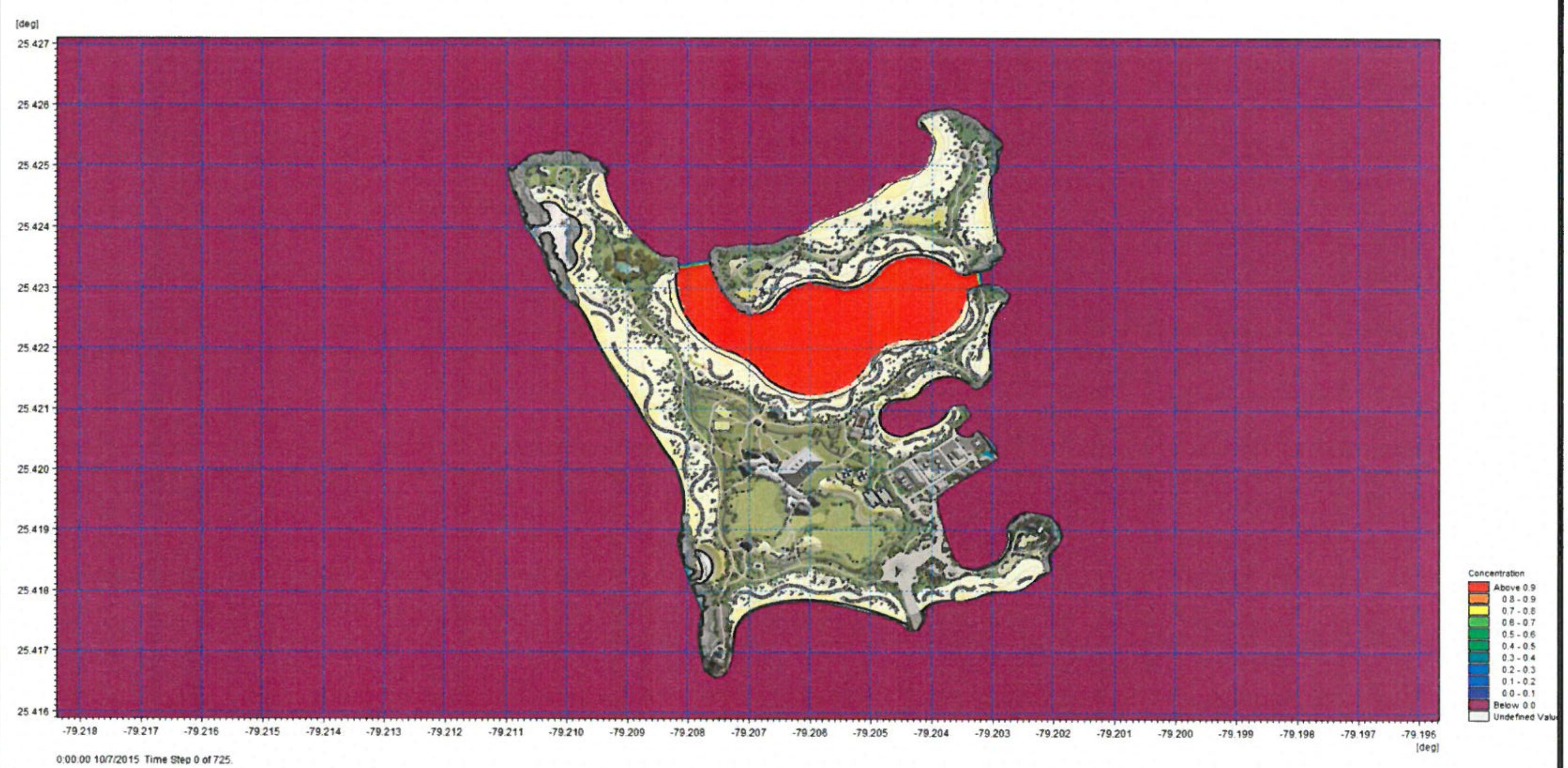
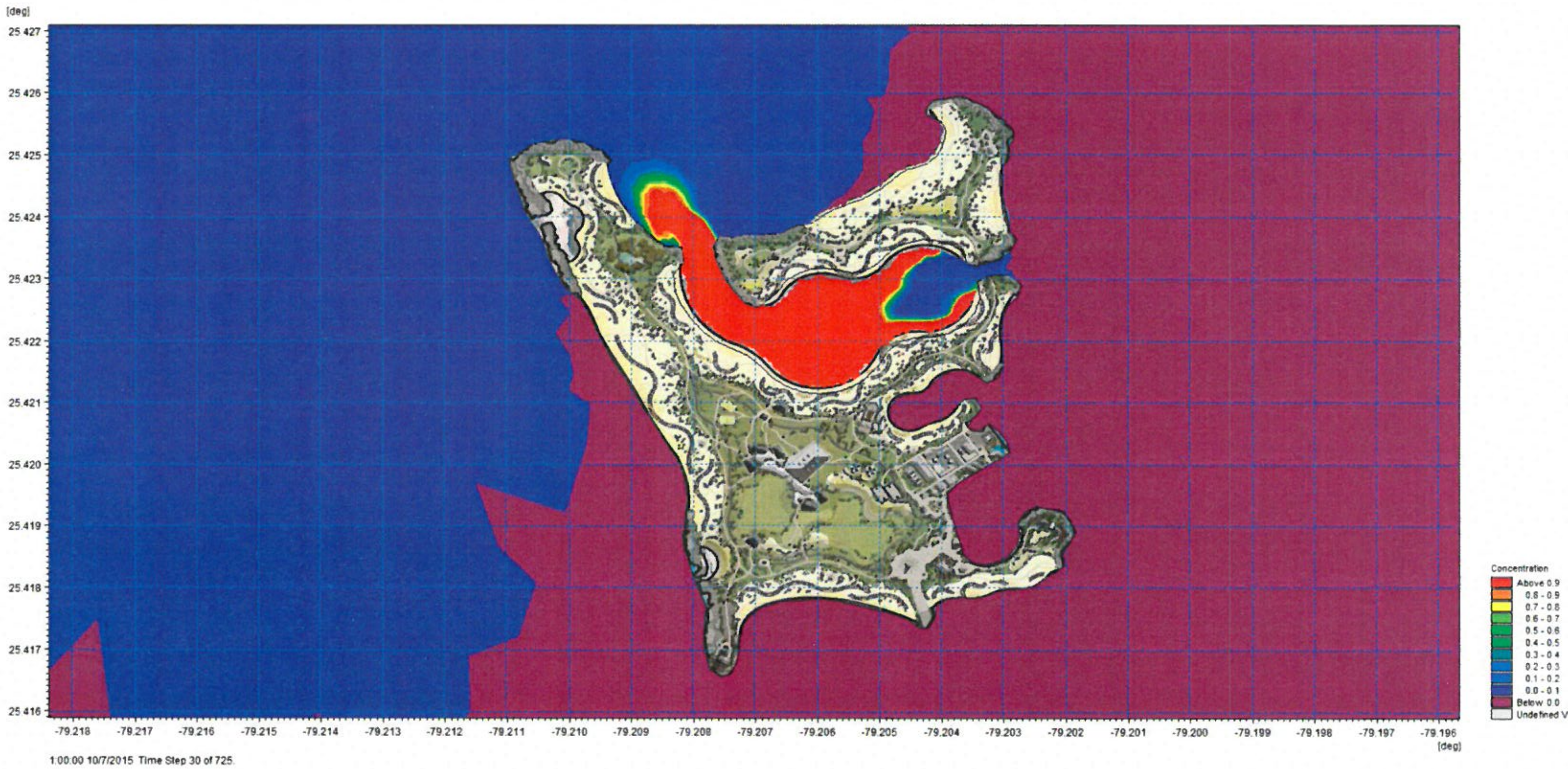
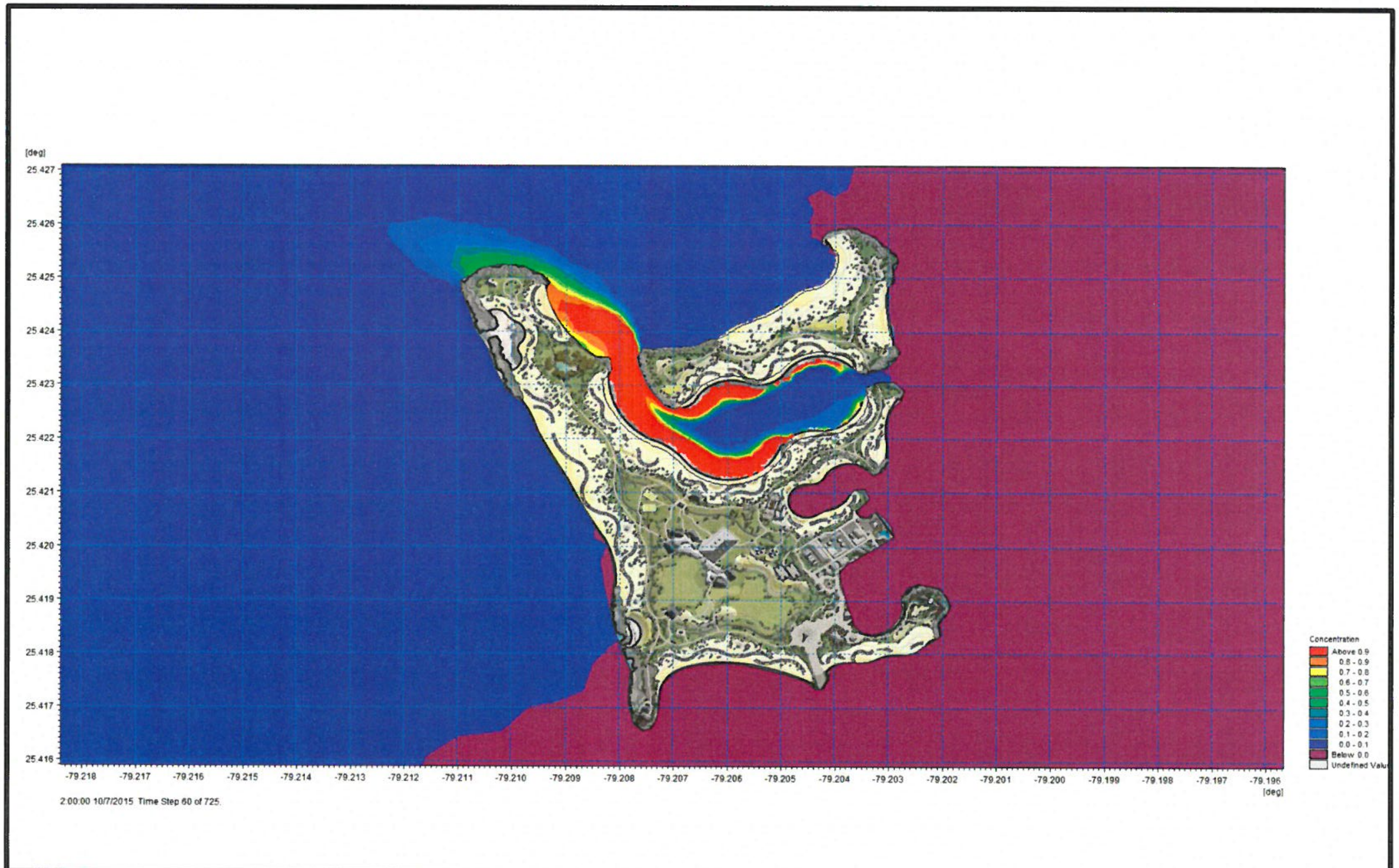


Hour 0 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas



Hour 1 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas



Hour 2 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

Flushing Analysis
MSC Marine Reserve
March 2016

CUMMINS | CEDERBERG
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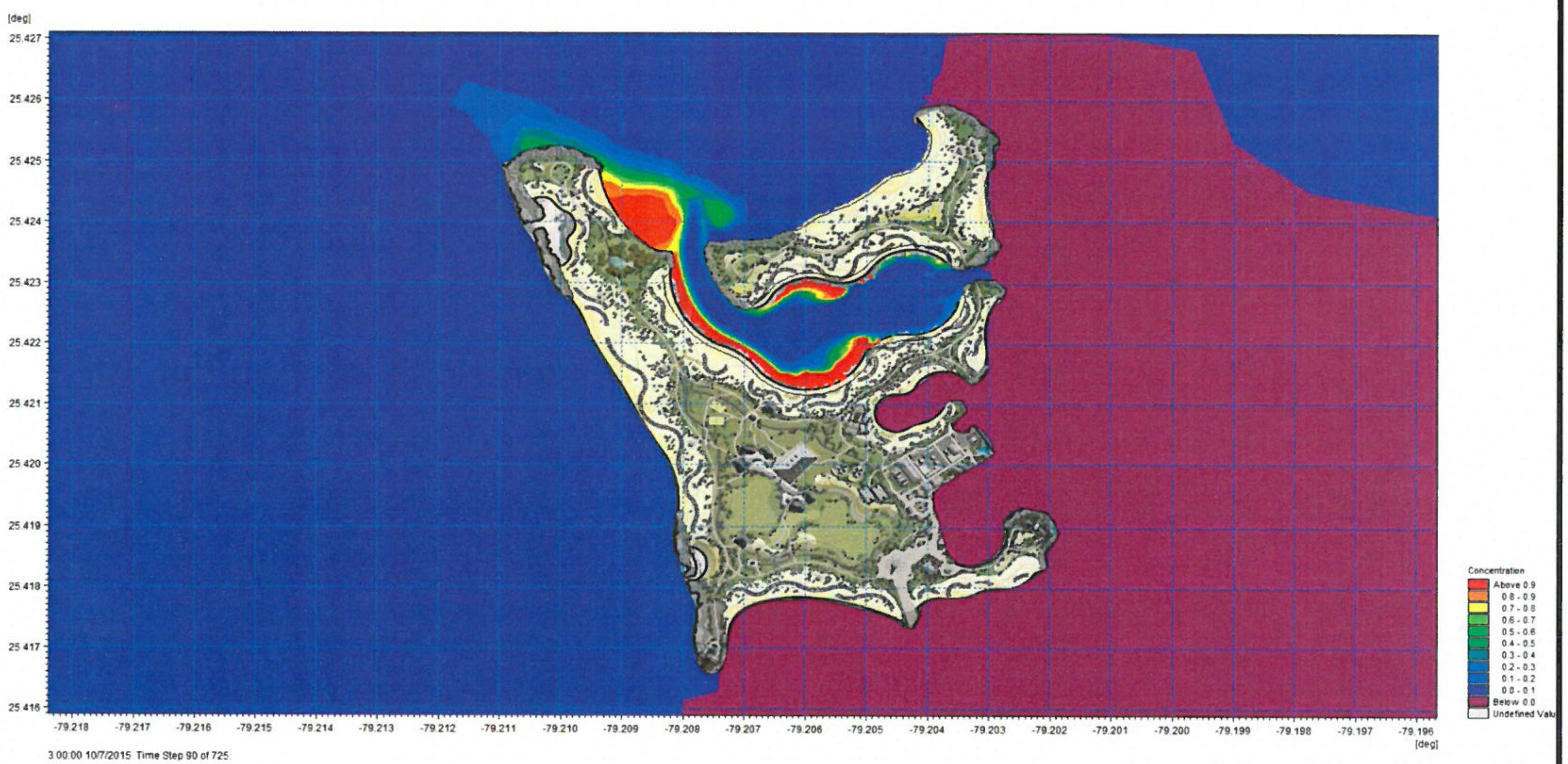

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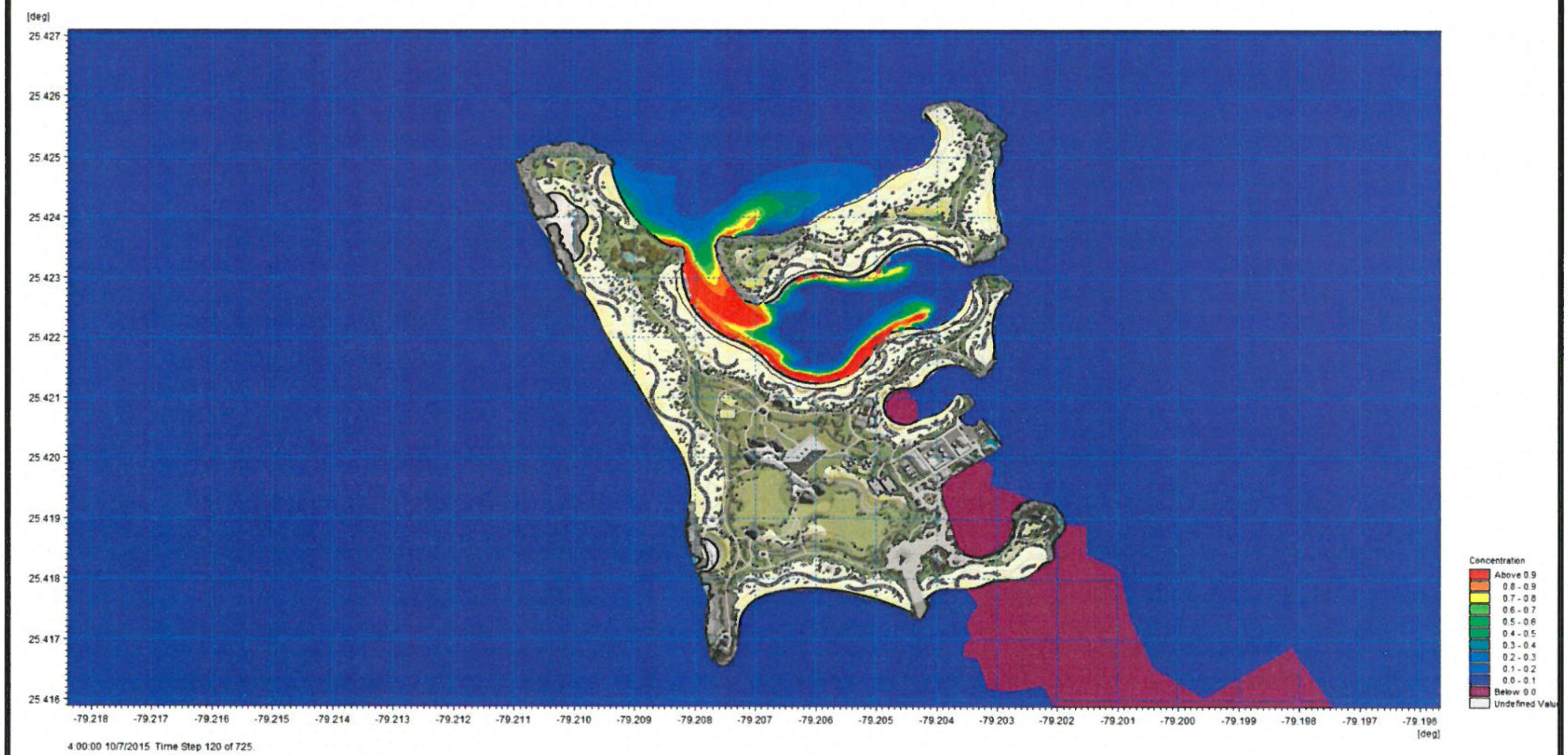

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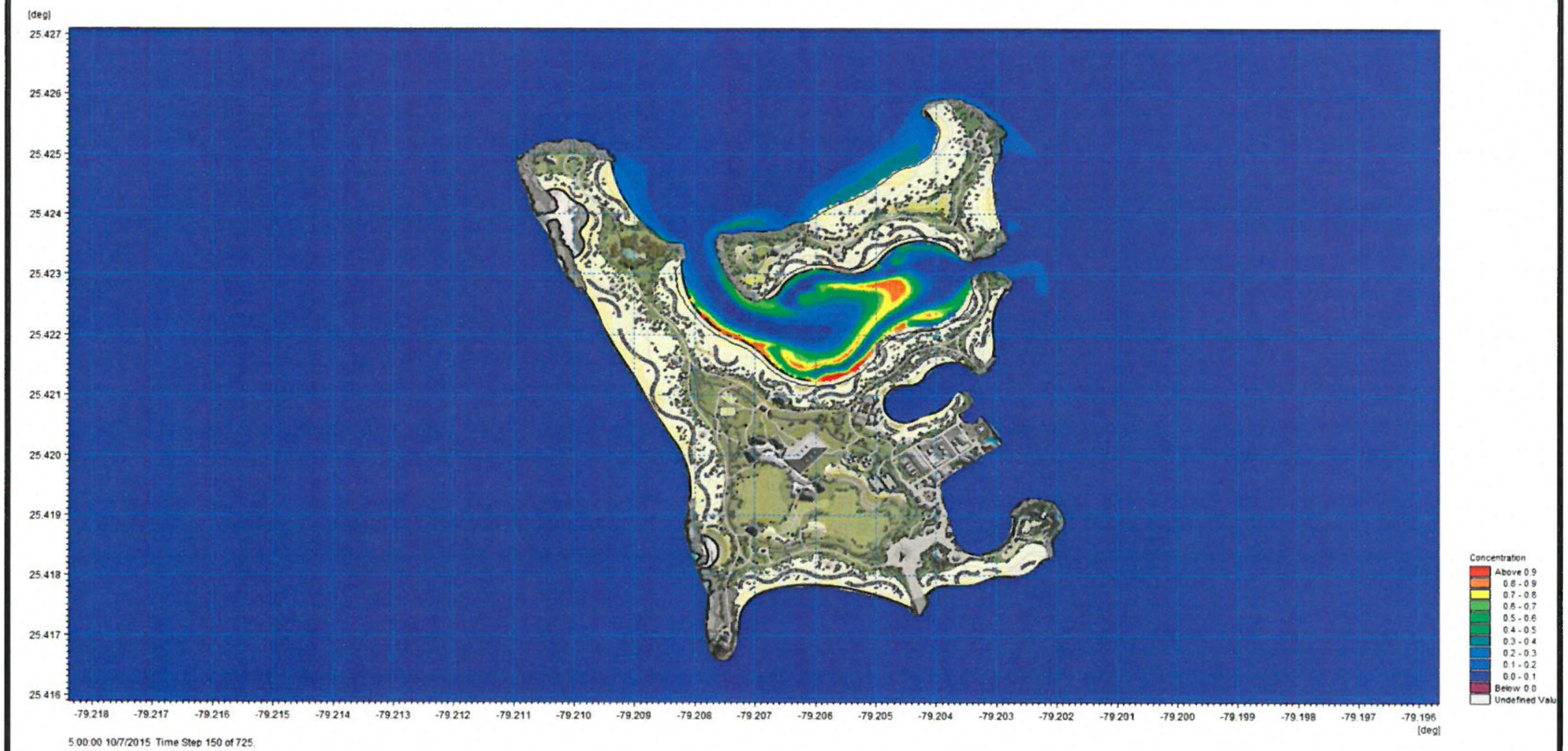

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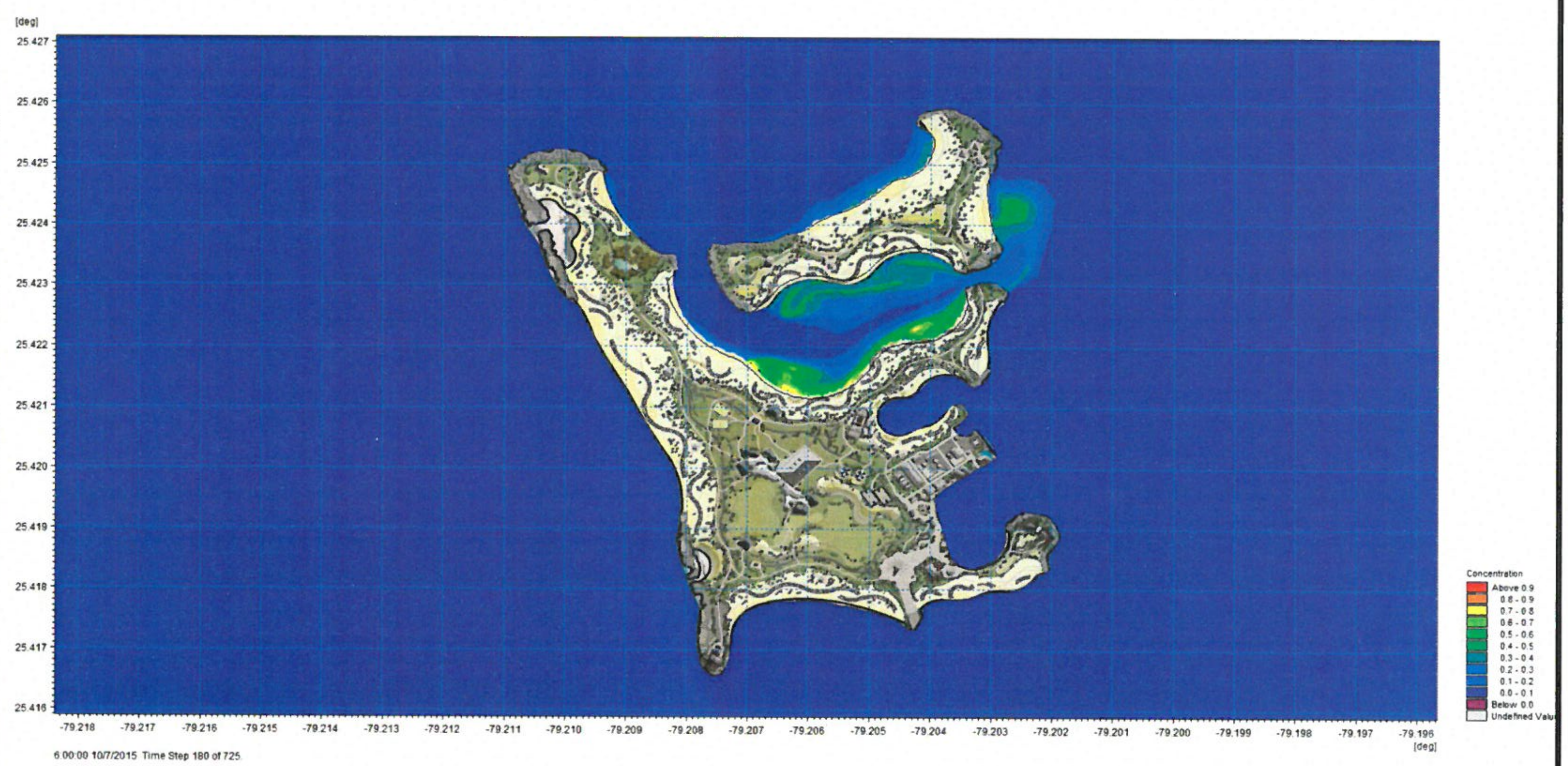

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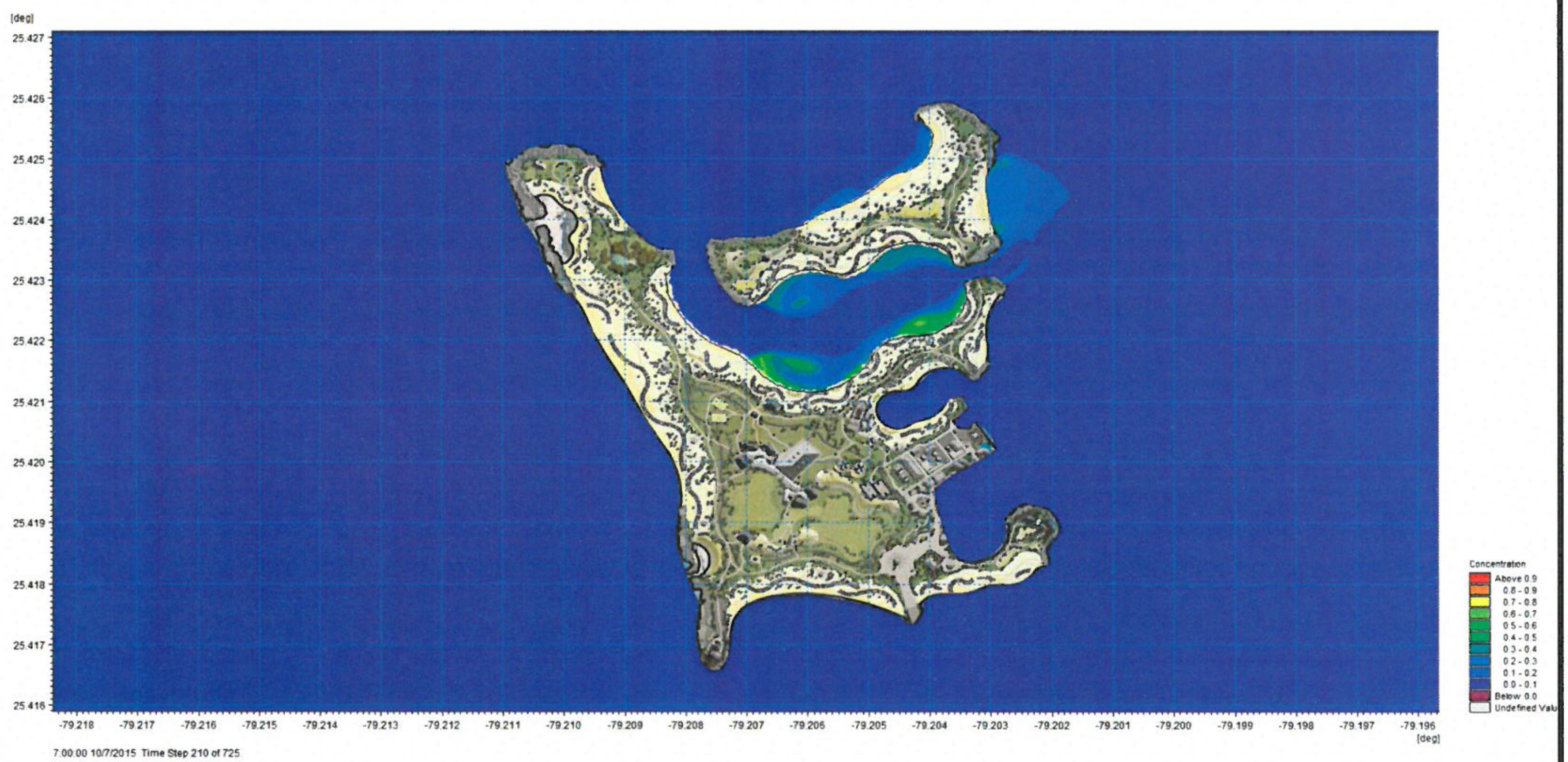
Proposed MSC Marine Reserve, Ocean Cay, Bahamas



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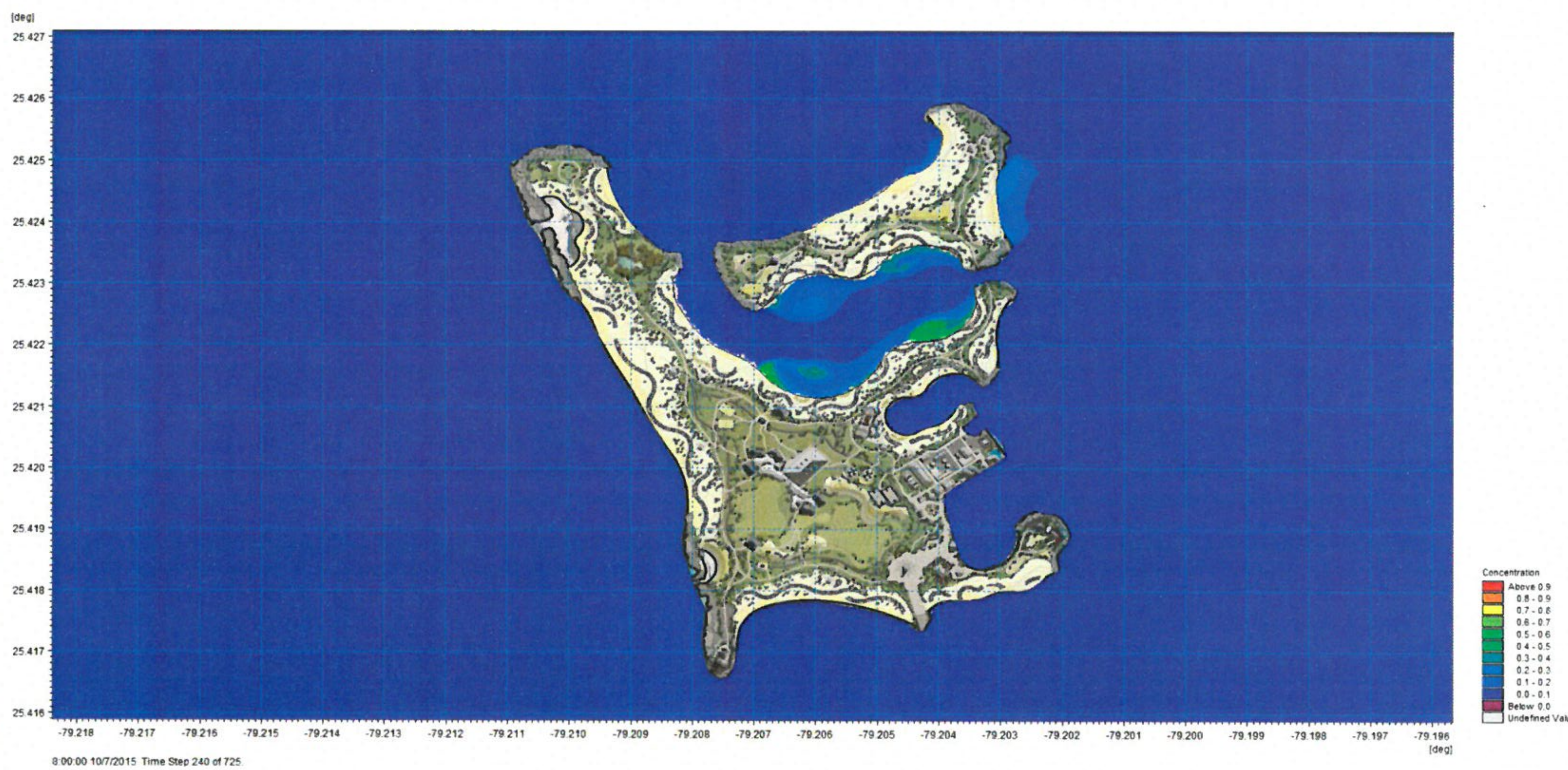
Proposed MSC Marine Reserve, Ocean Cay, Bahamas



Hour 8 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

Hour 9 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

Flushing Analysis
MSC Marine Reserve
March 2016

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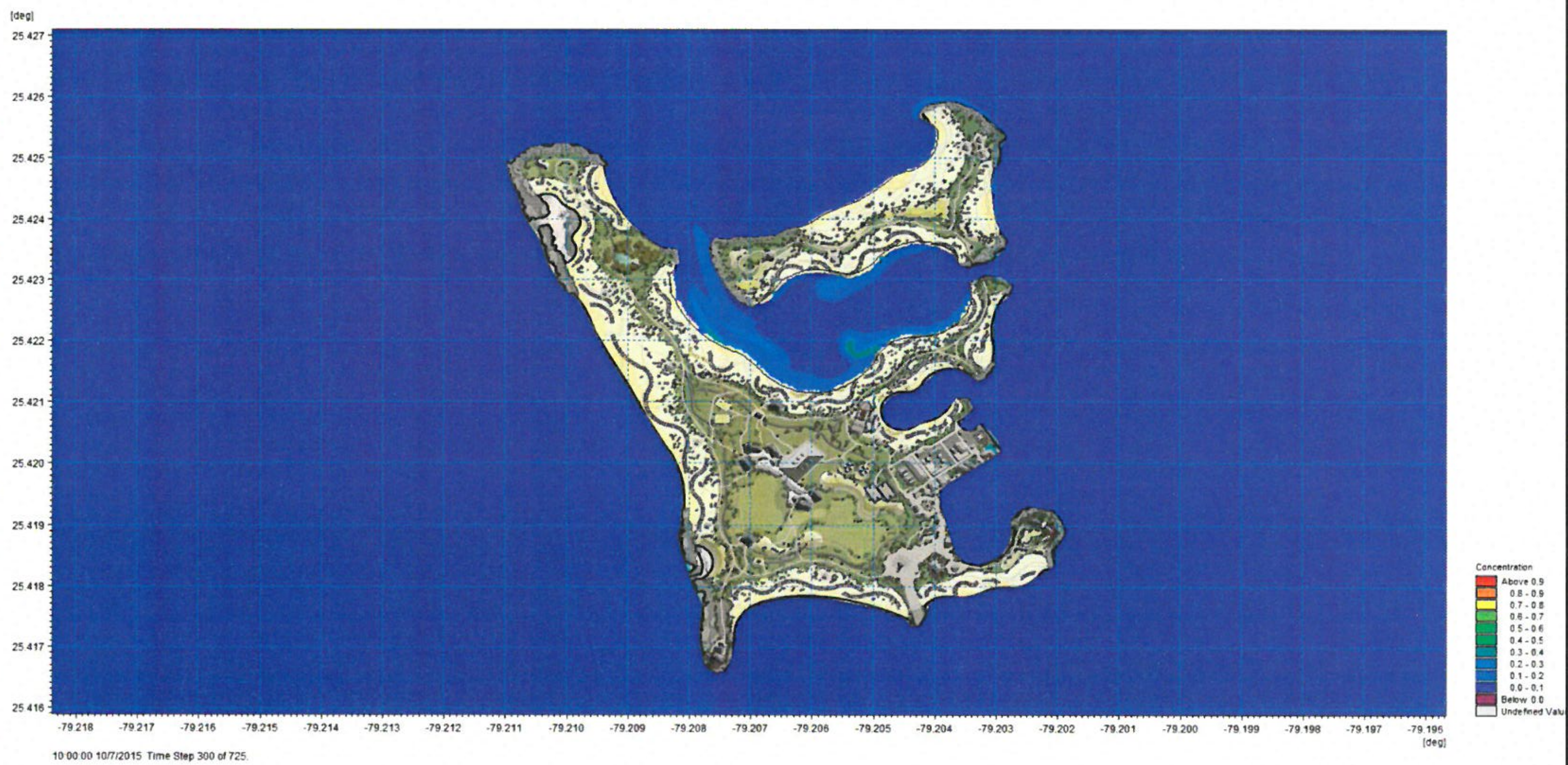

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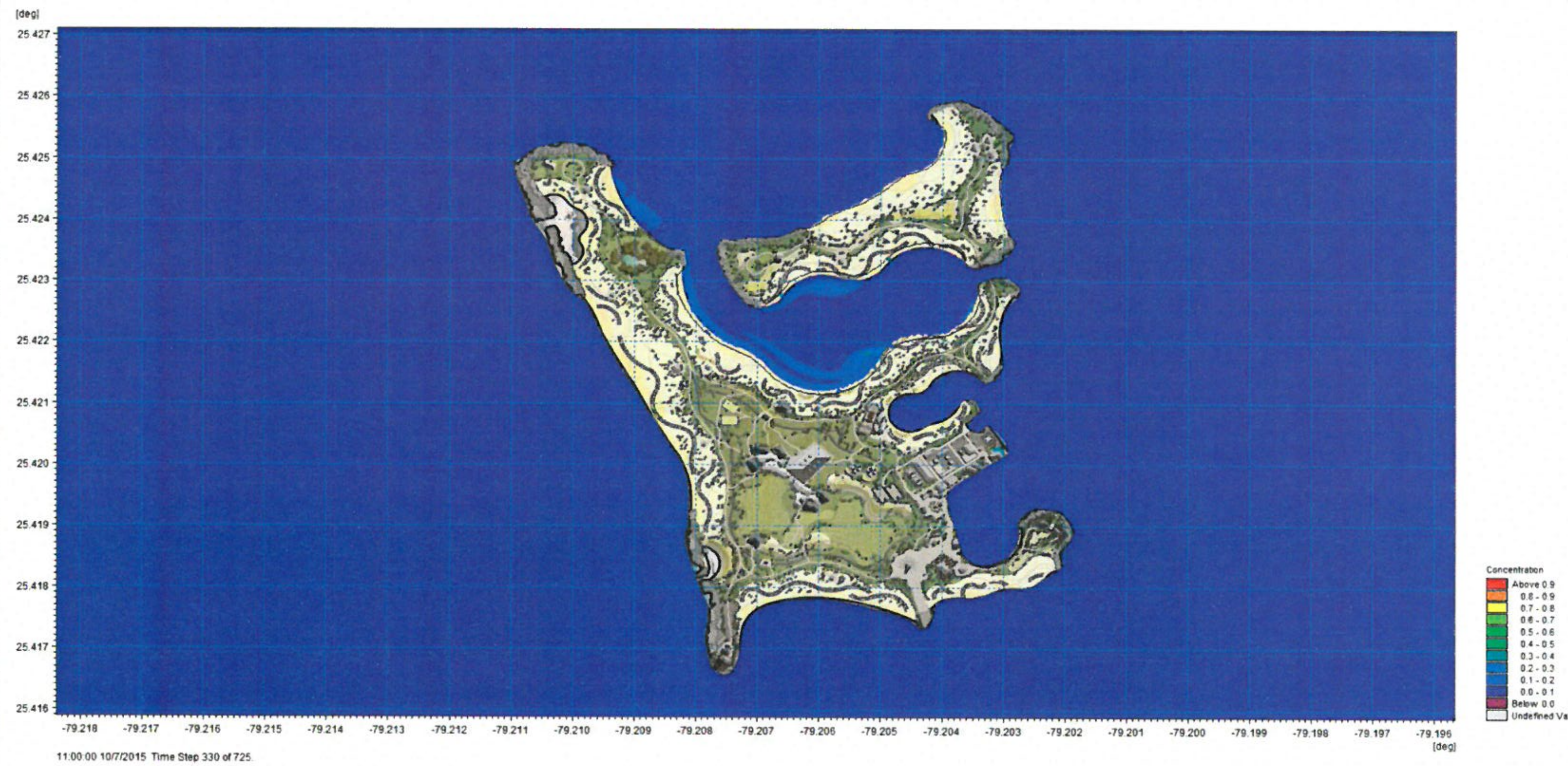
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

Flushing Analysis
MSC Marine Reserve
March 2016

CUMMINS | CEDERBERG
Coastal & Marine Engineering



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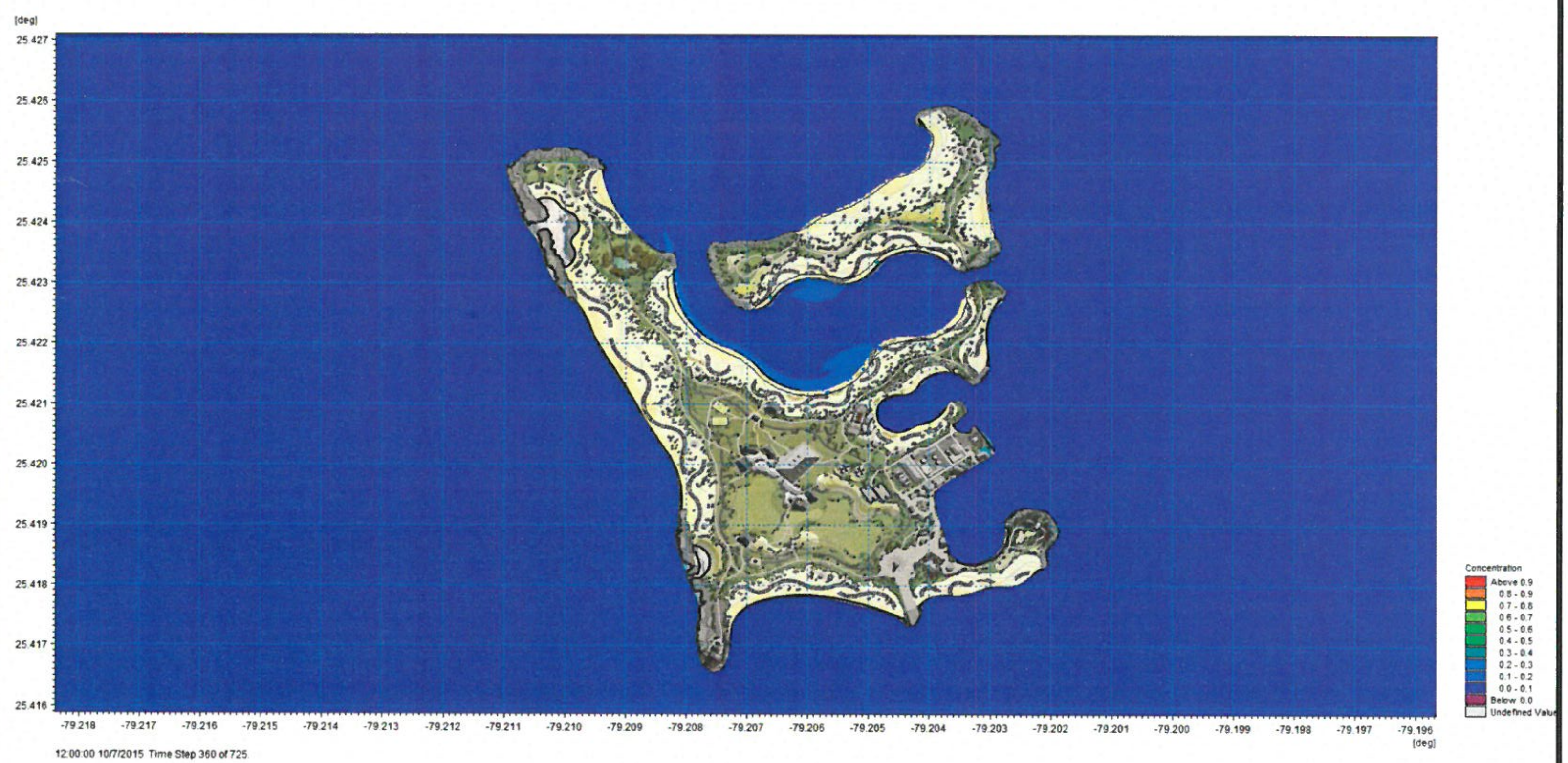


Hour 12 of 12 in Flushing Analysis
Proposed MSC Marine Reserve, Ocean Cay, Bahamas

Appendix 1- Notification of on-site Coral Relocation Monitoring and Environmental Manager

Bermello Ajamil & Partners, Inc.

Architecture
Engineering
Planning
Interior Design
Landscape Architecture

July 4, 2016

Mr. Philip Weech
Director
BEST Commission
Ministry of the Environment and Housing
Nassau, Bahamas

APPENDIX 1

Re: MSC Ocean Cay
- Coral Relocation Monitoring Notification
- Onsite Environmental Manager Notification

Director Weech,

Per your letter dated May 31, 2016, with reference to the Environmental Management Plan (EMP) provided by Island by Design and pursuant to recent conversations, the following responses are hereby set forth:

Item b. As the BEST Commission requests the name of the firm or person that will carry out the independent verification inspections and reporting for the Coral Relocation Plan, we hereby propose Design Elements, Ms. Tanya Ferguson.

Item c. As the BEST Commission requests submission of the credentials of the identified Environmental Manager, we hereby propose Design Elements, Ms. Tanya Ferguson.

Pursuant to subsequent requests for information:

1. The Coral Relocation means and method remains the same as set forth and approved in the EMP

2. The dredging mixing zone is amended in the EMP from 750 meters to 250 meters.

Please feel free to contact me should you need further information.

Regards,

Michiel Johan van de Kreeke
Sr. Project Manager
Bermello Ajamil & Partners

cc: Candia Ferguson – BIA
Carol Young – BIA
Steven Melvin – Higgs and Johnson
Luis Ajamil, Bermello Ajamil
Gianluca Suprani- MSC
Alberto Hervello-Ibanez- MSC

Appendix 2 – Debris Material Clean Up Means and Method and Chain of Custody

Bermello Ajamil & Partners, Inc.

Architecture
Engineering
Planning
Interior Design
Landscape Architecture

July 4 , 2016

Mr. Philip Weech
Director
BEST Commission
Ministry of the Environment and Housing
Nassau, Bahamas

Re: MSC Ocean Cay EMP - Debris/Material Clean up Means and Method and Chain of Custody

APPENDIX 2

Mr. Weech,

The appointed contractor for the cleanup of the debris on the island shall relocate materials to a designated are as set forth on the attached site plan.

Once the need for removal from the island, the debris will be sized, photographed and weighed via barge draft. The Contractor will provide a formal departure report including photographs, recorded weight and description for submission to BEST.

The debris will be sailed either to Freeport or USA and upon arrival the Contractor will certify the goods, and all parameters as set forth in the departure report, via third party.

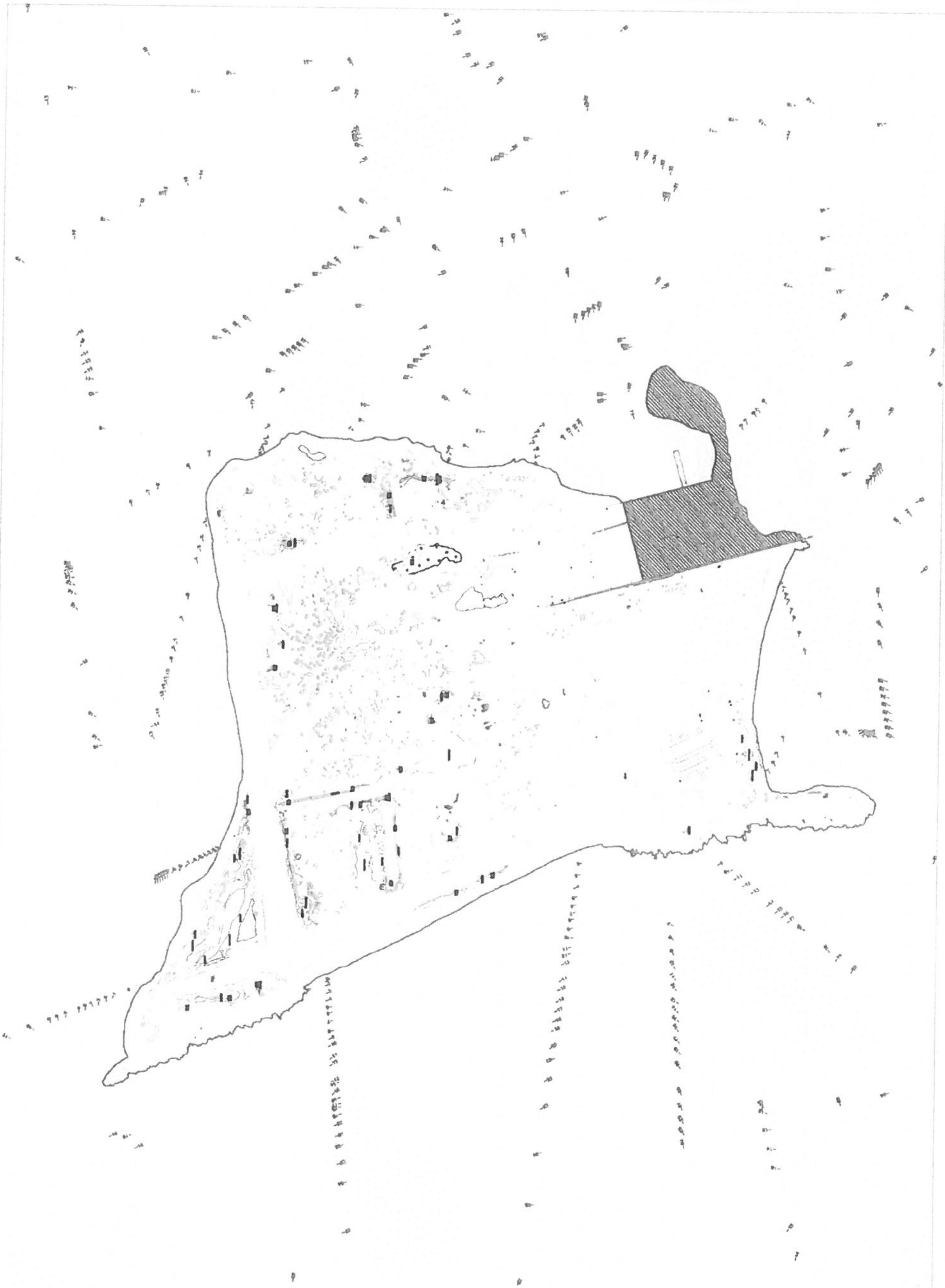
Please feel free to contact me should you need further information.

Regards,

Michiel Johan van de Kreeke
Sr. Project Manager
Bermello Ajamil & Partners

CC:
Candia Ferguson – BIA
Carol Young – BIA
Steven Melvin – Higgs and Johnson

Luis Ajamil, Bermello Ajamil
Gianluca Suprani- MSC
Alberto Hervello-Ibanez- MSC



Appendix 3- Dredging Plans

Bermello Ajamil & Partners, Inc.

Architecture
Engineering
Planning
Interior Design
Landscape Architecture

July 4, 2016

Mr. Philip Weech
Director
BEST Commission
Ministry of the Environment and Housing
Nassau, Bahamas

Re: MSC Ocean Cay EMP - Dredging Plans

APPENDIX 3

Mr. Weech,

Attached please find a copy of the Dredging Plans.

Please feel free to contact me should you need further information.

Regards,

Michiel Johan van de Kreeke
Sr. Project Manager
Bermello Ajamil & Partners

CC:
Candia Ferguson – BIA
Carol Young – BIA
Steven Melvin – Higgs and Johnson
Luis Ajamil, Bermello Ajamil
Gianluca Suprani- MSC
Alberto Hervello-Ibanez- MSC

2601 South Bayshore Drive • 10th Floor • Miami • Florida • 33133 • USA • Main 305 859 2050 • Fax 305 860 3700 www.bermelloajamil.com

CIVIL & STRUCTURAL CONSULTING
P.O. BOX SS 5589
NASSAU, BAHAMAS
TEL: 242-356-0500
FAX: 242-325-8740
EMAIL ETSBAHAMAS@GMAIL.COM

ENGINEERING AND TECHNICAL SERVICES

July 28, 2016

Mr. Philip Weech, Director
BAHAMAS ENVIRONMENT, SCIENCE, & TECHNOLOGY COMMISSION
COMMONWEALTH OF THE BAHAMAS
P.O. Box N-7132
Nassau, New Providence, Bahamas

MSC OCEAN CAY MARINE RESERVE – DREDGE PLAN
NASSAU, BAHAMAS

Dear Sir:

1.0 Introduction

Further to our meetings and discussions the following report represents the proposed dredging plan for the proposed MSC Ocean Cay Marine channel and turning circle dredge. The proposed dredging involves re-cutting portions of the existing marina and channel to achieve a minimum depth of -35.0 MSL. The water depth in the channel and basin presently varies from -18.0 to -48.0 MSL. The proposed dredging is an essential component in the proposed development and reshaping of the 95-acre man-made cay into a cruise ship destination.

Subject to the necessary approvals the dredging is scheduled to commence in September, 2016. Starting the dredging on schedule is critical to the overall project completion schedule because the dredge spoils are required to reshape the north beach of the island. Construction cannot commence on the island until the dredging has been completed.

2.0 Summary of Works

2.1 *Dredging and Disposal Engineering Plans:* See attached dredging and disposal plan which indicate the proposed areas to be dredge and dredge spoil disposal area.

2.2 *Dredge Contractor and Proposed Dredge Methodology:* Three experienced dredging Contractors have submitted proposals in response to the RFP. The final Contractor selection will be carried upon receipt of the approved permit requirements which can potentially alter the conditions of the RFP. Each Contractor is required to provide a suction cutter head type dredge and dispose of all spoils by piping to the upland disposal areas. Without prejudice attached is a copy of the Work Method Statement provided by one of the considered Contractors for your reference. Please note that contents of the Work Statement are based on earlier designs and do not reflect the present configuration showing in the submitted dredge plan drawings.

2.3 *Dredge Footprint:* The dredge footprint consists of approximately 11 acres along the westen edge of the channel and approximately 15 acres along the western side of the turning basin. The width of the dredge footprint in the channel is generally 100 feet along the entire length. The total square footage of dredge area is approximately: 26 acres. See attached plan.

2.4 *Dredge Material Volume:* The total anticipated dredge volume is 429,000 cubic yards. The total anticipated dredge spoil volume is broken down into the following components: 334,000 cubic to be disposed at Site A, see plan, which forms the north beach island reshape. The remaining 95,000 cubic yards will disposed at Site B to be used to regrade island.

ets
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CIVIL & STRUCTURAL CONSULTING
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EMAIL ETSBAHAMAS@GMAIL.COM

2.5 **Intended Use of Dredged Material**: The majority dredge spoil will be used to fill the northern portion of the island and reshape the island. The balance will be used to grade the central portion of the island. Soil borings indicate that the dredge material will be primarily calcareous limestone.

2.6 *Turbidity Curtain Specifications and Anchoring Installation Procedures:* The turbidity curtain layout plan is indicated on drawing DS-15. The specified turbidity requires 18oz nylon reinforced PVC fabric with a minimum depth of 5 feet If necessary an additional 5 foot can be added to the curtain which will result in a 10 foot total panel depth. The curtains will be deployed along the perimeter of reclaimed areas. The turbidity curtains will be secured to concrete block anchors placed on the submerged lands at 50-to-100 foot intervals.

2.7 *Turbidity Control & Water Quality Monitoring Plan:* The Project Environmental officer will supervise the turbidity monitoring. The turbidity will be monitored every 6 hours during dredging operations. Daily reports will be submitted to the BEST Commission for review and approval. Turbidity monitoring will be carried out adjacent to the dredge discharge area. Turbidity in this location will also be measured outside of a 500-foot mixing zone. Turbidity cannot exceed 29 NTUs above background, at 3 feet below the surface, 500 feet from the discharge point. If turbidity exceeds this level, all operations shall cease that are contributing to the high turbidity levels. A double-walled turbidity curtain will be installed immediately adjacent to the discharge point, to assist in blocking the flow of turbid particles in the water column.

2.8 *Initial Dikes and Settlement Ponds:* To control turbidity an initial dike will be constructed along the proposed island reclaimed areas. The dredge material will be disposed of in an initial settlement pond which is located upland. This pond will be separated from another fines settling pond by dikes. The overflow will be carried between dikes through culverts and weirs. Dozers will ensure a steady flow and distribution of the material as it settles out of the flow. At the other end of the final fines settling pond the surface water is decanted again and allowed to flow back into the ocean. Turbidity curtains will be installed to surround the final discharge into the ocean. See copy of Figure 5 from the Work Method Statement for reference.

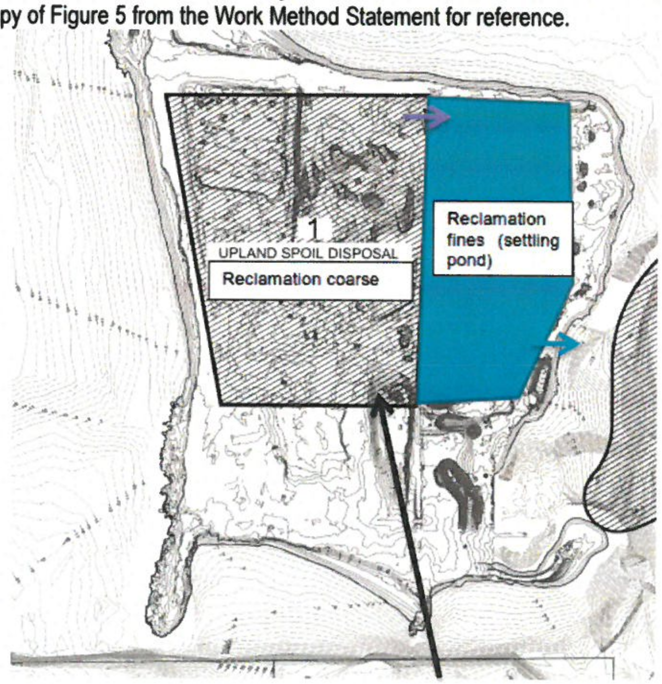

Figure 5 – Typical distribution of reclamation area and flow of mixture

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ENGINEERING AND TECHNICAL SERVICES

2.9 *On Site Construction Supervision:* The Engineer of Record will provide construction observation services of the dredge discharge area during dredging construction. The inspectors will be on site monitoring the dikes in conjunction with the dredging contractor. The Inspector will advise Contractor of areas of the dikes that need improvements. The inspector will have the authority to stop the dredging operation on behalf of the Client non-compliant conditions for the dikes and discharge area. The Inspector will prepare daily observation reports that will be compiled weekly and submitted to the applicable Government Agency.

3.0 *Independent Inspector:* The Owner will engage an Independent Consultant to observe the dredge discharge area, piping and general dredging operations. The Independent Consultant will oversee, monitor, and control the operation of the placement area. The Independent Consultant reports shall be submitted separately to BEST and the EOR.

3.1 *Contingency Plan:* I the event of turbidity levels greater than authorized, operations will cease until such time as the BEST Commission has been notified, and proper measures are taken to reduce turbidity levels to acceptable standards.

3.2 *Dredge Submittals:* The following submittals shall be issued during the operations:

a. Confirmation of dredge ship arrival.
b. Confirmation of discharge pipe placement and testing complete.
c. Confirmation of turbidity curtain placement.
d. Daily submittal of background turbidity measurements.
e. Daily submission of daily progress reports, including volume of dredge material.
f. Confirmation of dredging completion.
g. Submittal of dredge verification as-built survey.

Please do not hesitate to contact us if you have any questions or would like to discuss any aspect of the above.

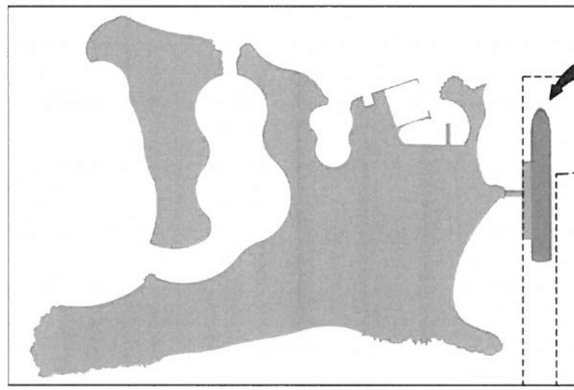
Sincerely

ENGINEERING & TECHNICAL SERVICES, LTD.

Lambert Knowles, P.E.

DREDGING PROJECT
OCEAN CAY MSC MARINE RESERVE

OCEAN CAY, BAHAMAS



LOCATION SKETCH
N.T.S.

MARINE PLANS INDEX

DS-1	COVER SHEET
DS-2	ESTIMATED DREDGE LIMITS
DS-3	CHANNEL BASE LINE
DS-4	BASIN STATION
DS-5	CHANNEL STATION 1 OF 3
DS-6	CHANNEL STATION 2 OF 3
DS-7	CHANNEL STATION 3 OF 3
DS-8	TYP. CHANNEL SECTION
DS-9	TYP. BASIN SECTION
DS-10	SPOIL DISPOSAL SITES
DS-11	DISPOSAL SITE CAPACITY
DS-12	SECTION LOCATIONS
DS-13	SECTIONS A,B,C, & D
DS-14	SECTION E
DS-15	TURBIDITY CONTROL PLAN & DETAILS
DS-16	EXISTING BORING LOCATION PLAN EXISTING BORING PROFILE A-A EXISTING BORING PROFILE B-B EXISTING BORING PROFILE C-C, D-D, & E-E

PERMIT APPLICATION

ARCHITECTURE/PLANNING
BERMELLO AJAMIL & PARTNERS INC
2601 SOUTH BAYSHORE DRIVE 10TH FLR
MIAMI, FLORIDA 33133 USA
Phone: (305) 859-2050

CLIENT
MSC CRUISES S.A.
CHEMIN RIEU, 12-14
1208 GENEVA (SWITZERLAND)

Ocean Cay
MSC Marine Reserve

Updated Set
Date: 12.22.2015
Scale: N.T.S.

COVER SHEET

DS-1

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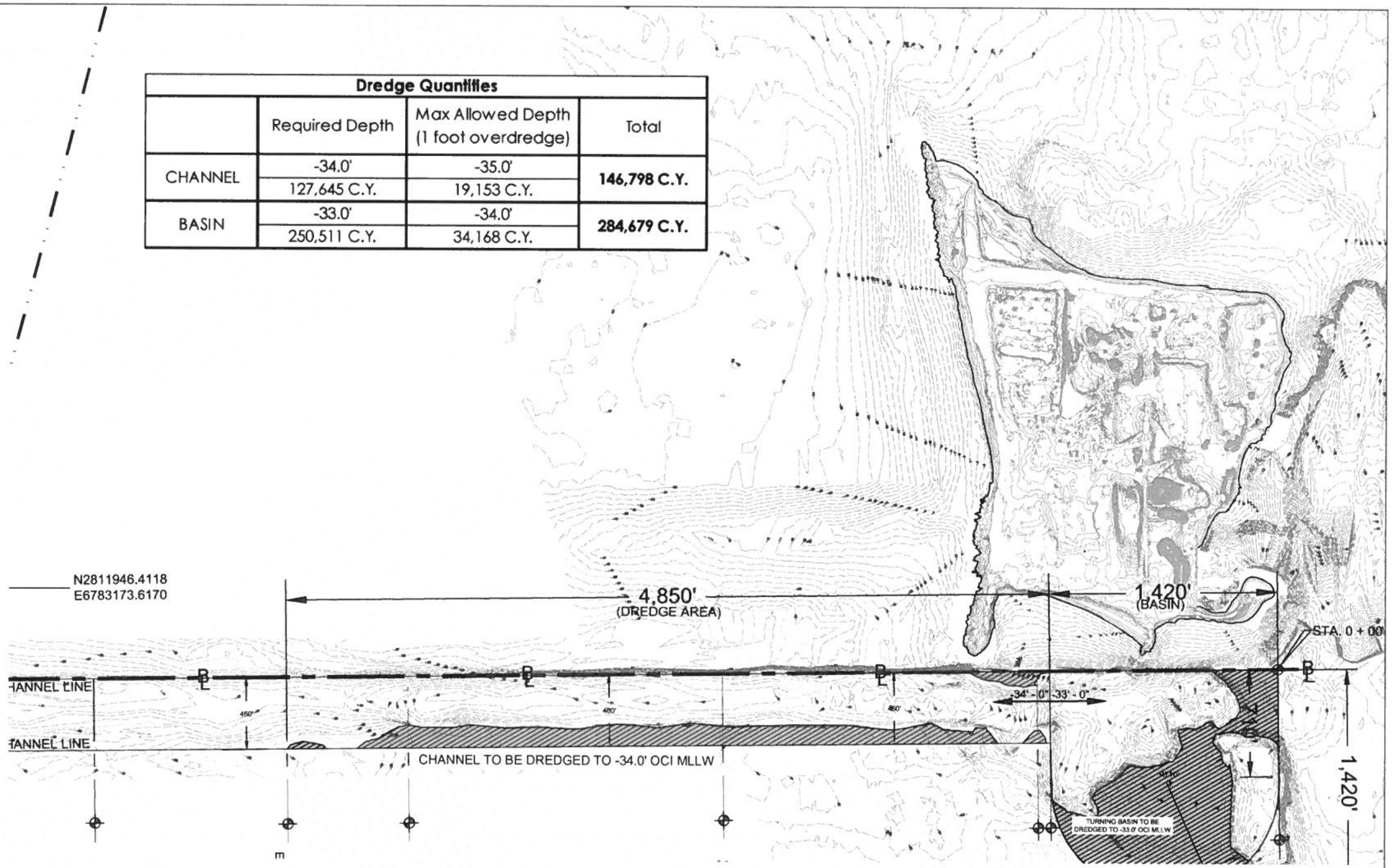
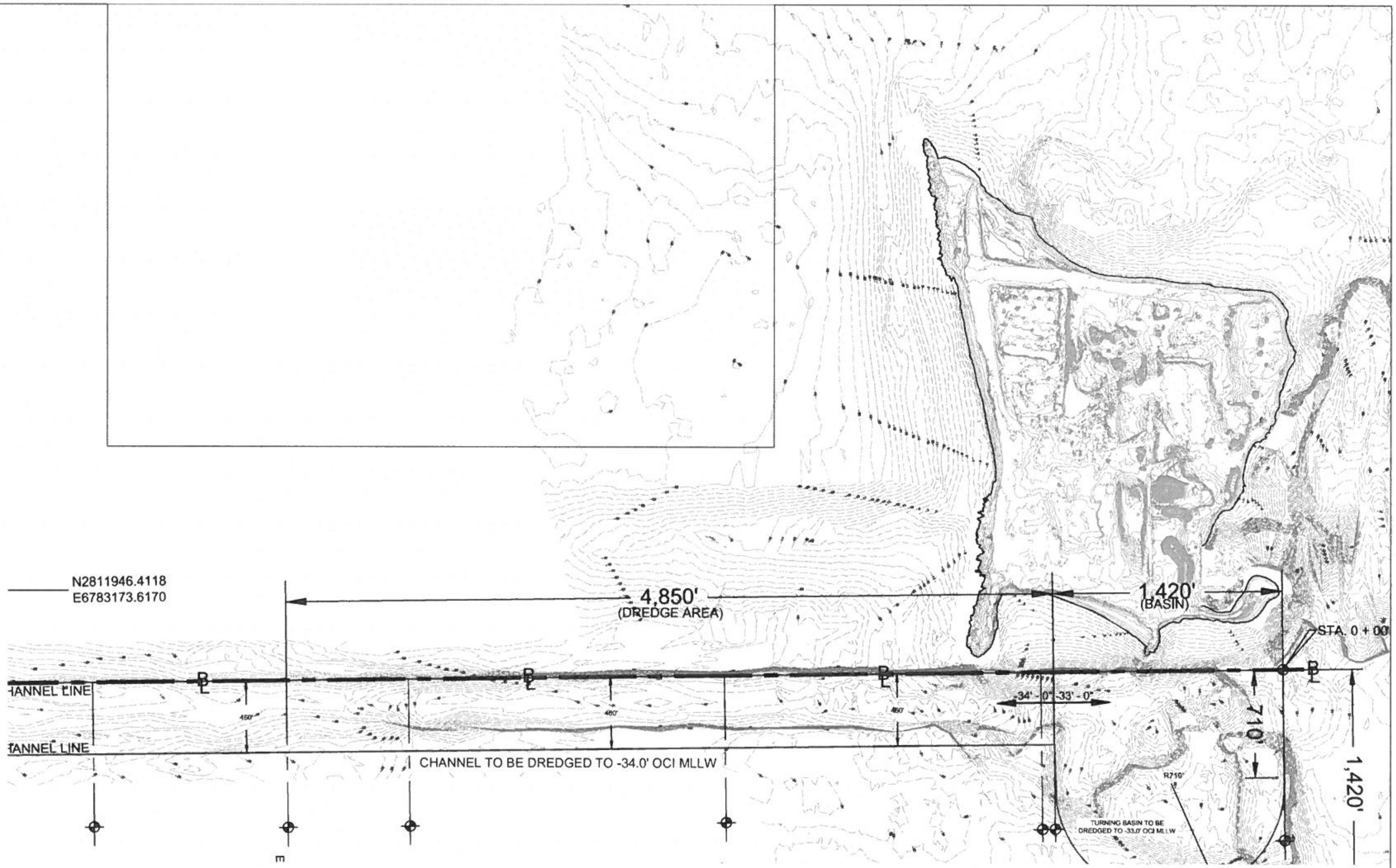
MSC

ets

Dredge Quantities			
	Required Depth	Max Allowed Depth (1 foot overdredge)	Total
CHANNEL	-34.0' 127,645 C.Y.	-35.0' 19,153 C.Y.	146,798 C.Y.
BASIN	-33.0' 250,511 C.Y.	-34.0' 34,168 C.Y.	284,679 C.Y.





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MSC

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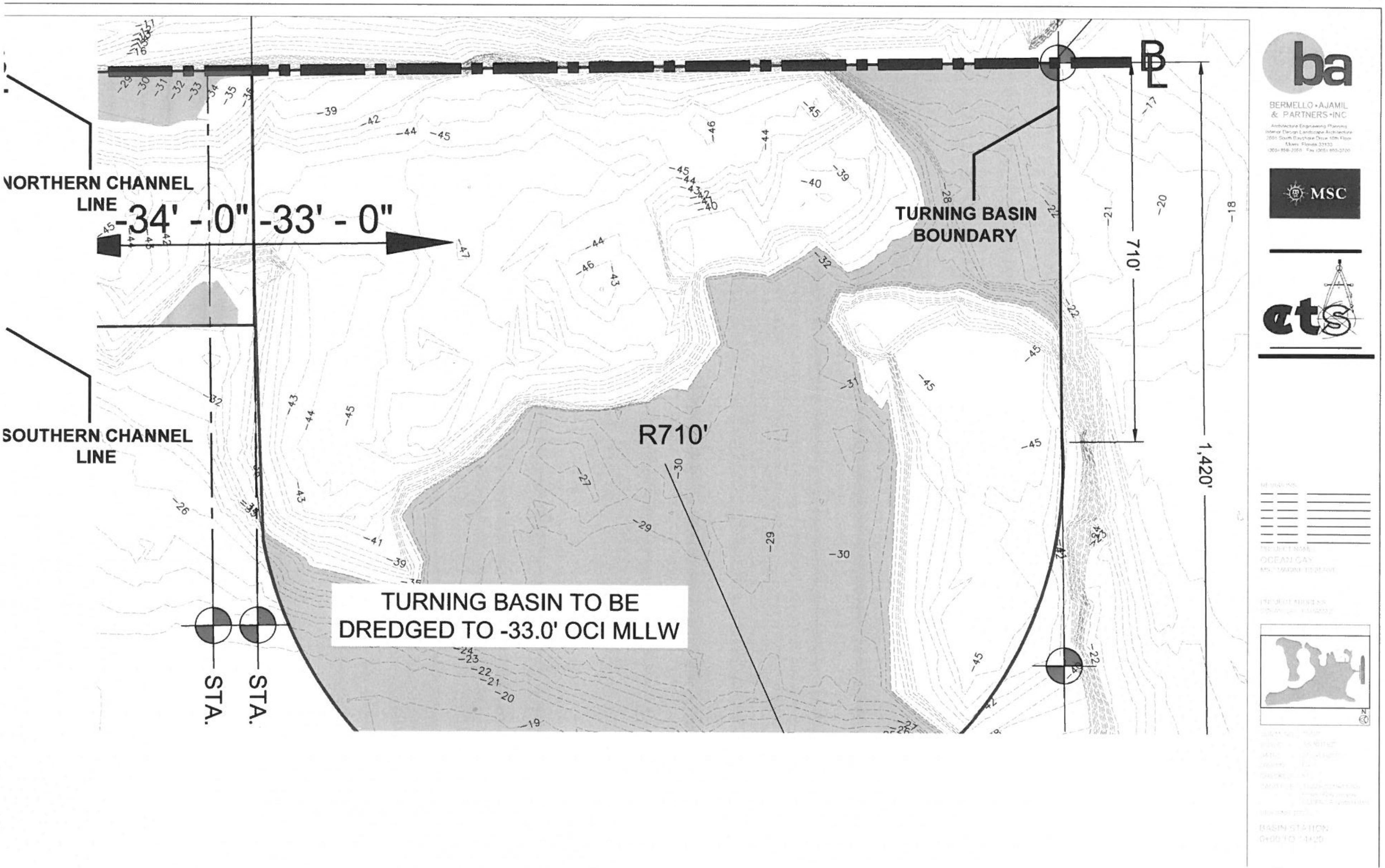

NORTHERN CHANNEL LINE
SOUTHERN CHANNEL LINE
-34' - 0"
-33' - 0"
TURNING BASIN BOUNDARY
710'
1,420'
R710'
TURNING BASIN TO BE DREDGED TO -33.0' OCI MLLW
STA.
STA.
ba
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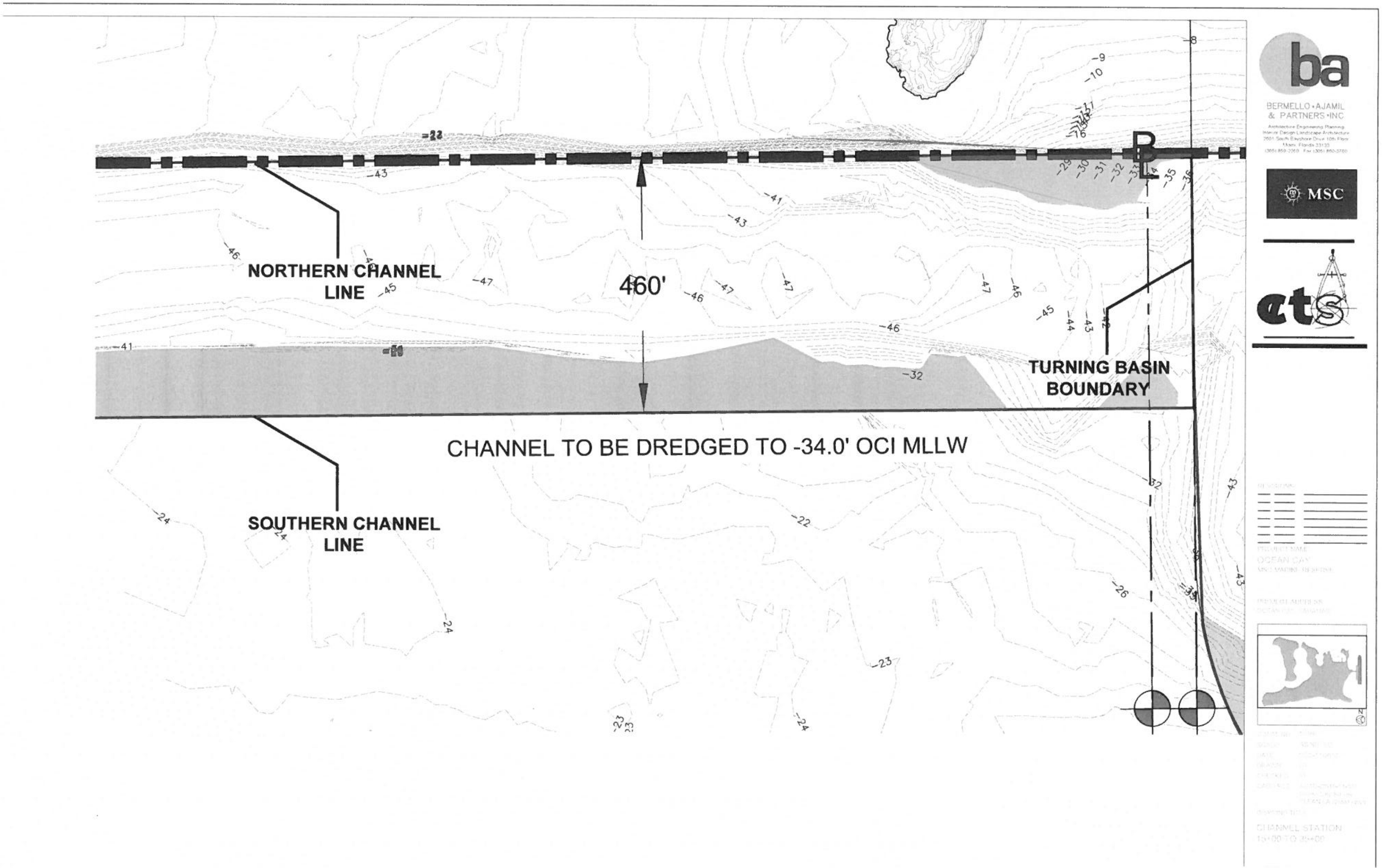

NORTHERN CHANNEL LINE
460'
TURNING BASIN BOUNDARY
CHANNEL TO BE DREDGED TO -34.0' OCI MLLW
SOUTHERN CHANNEL LINE
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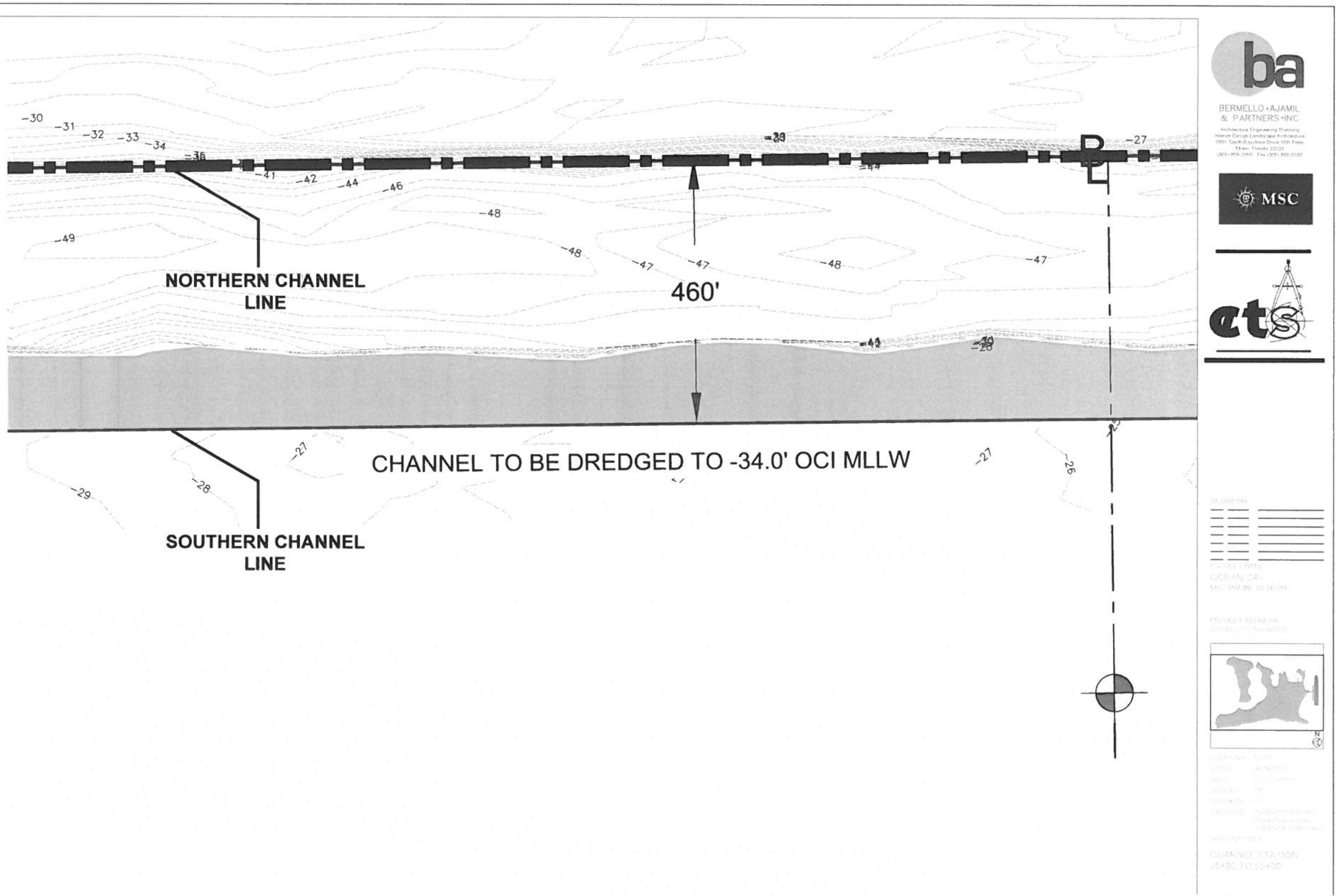
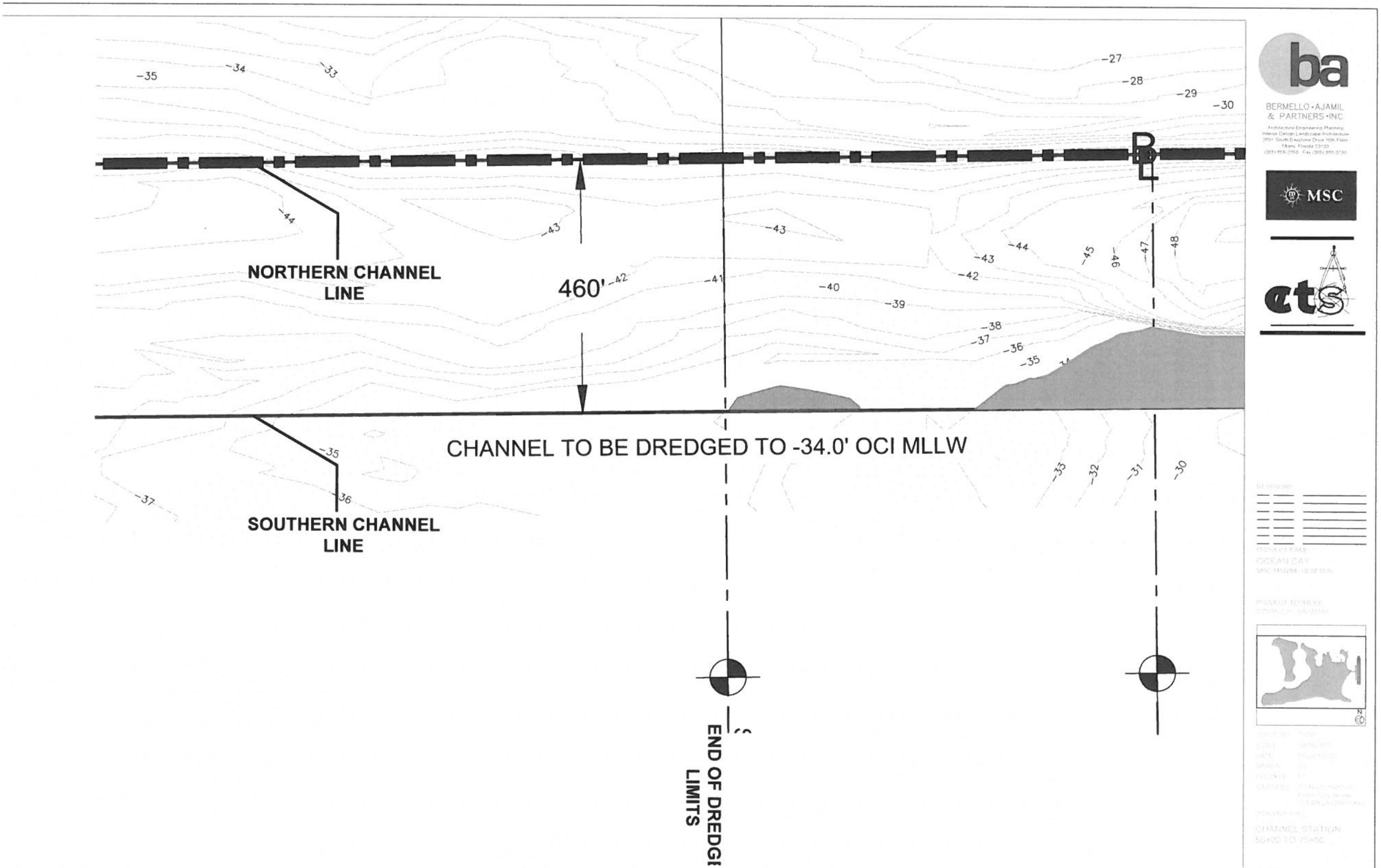
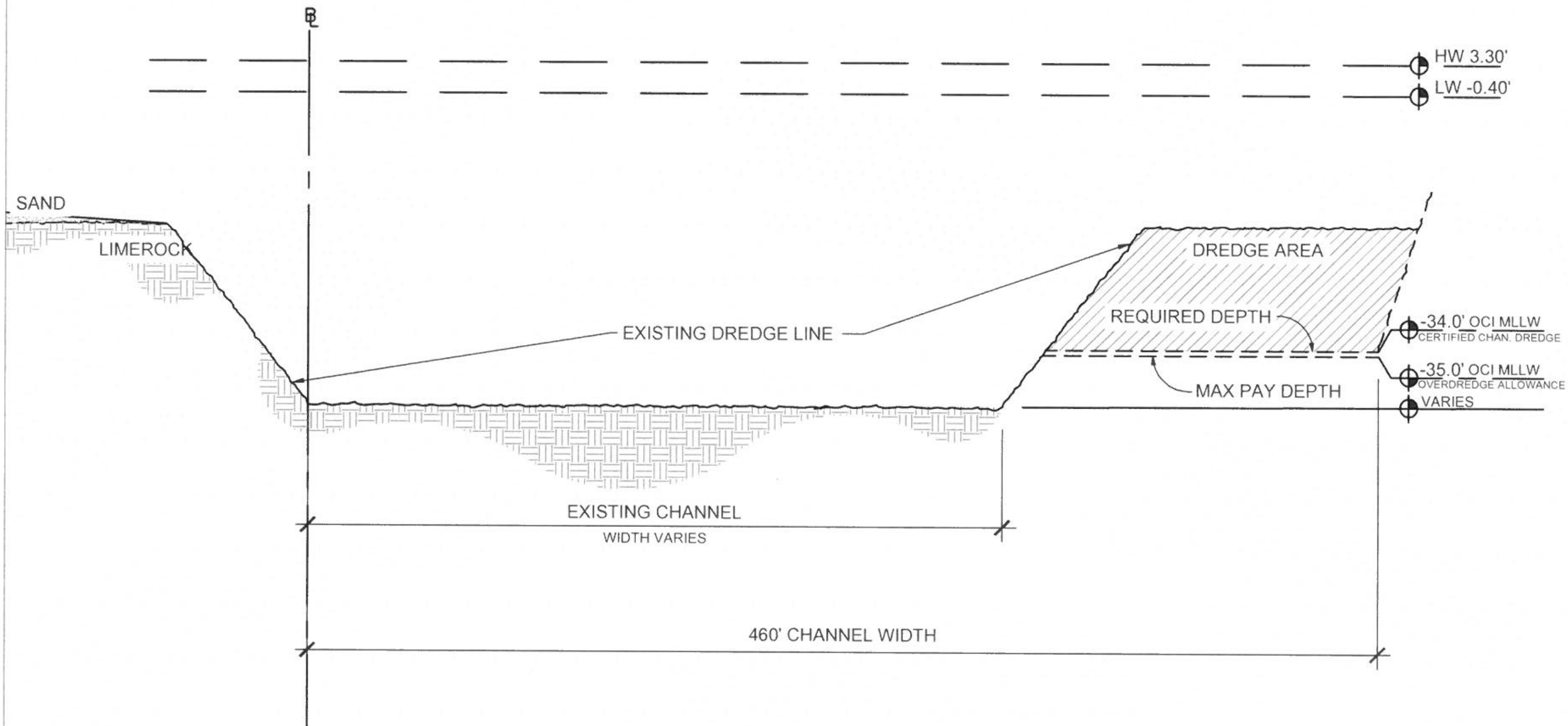
cts



NORTHERN CHANNEL LINE
460'
CHANNEL TO BE DREDGED TO -34.0' OCI MLLW
SOUTHERN CHANNEL LINE
BERMELLO • AJAMIL & PARTNERS • INC
MSC
CHANNEL STATION



NORTHERN CHANNEL LINE
460'
CHANNEL TO BE DREDGED TO -34.0' OCI MLLW
SOUTHERN CHANNEL LINE
END OF DREDGE LIMITS
BERMELLO • AJAMIL & PARTNERS • INC
MSC
CHANNEL STATION



TYPICAL SECTION - CHANNEL
STA. 14 + 20 TO STA. 62 + 70

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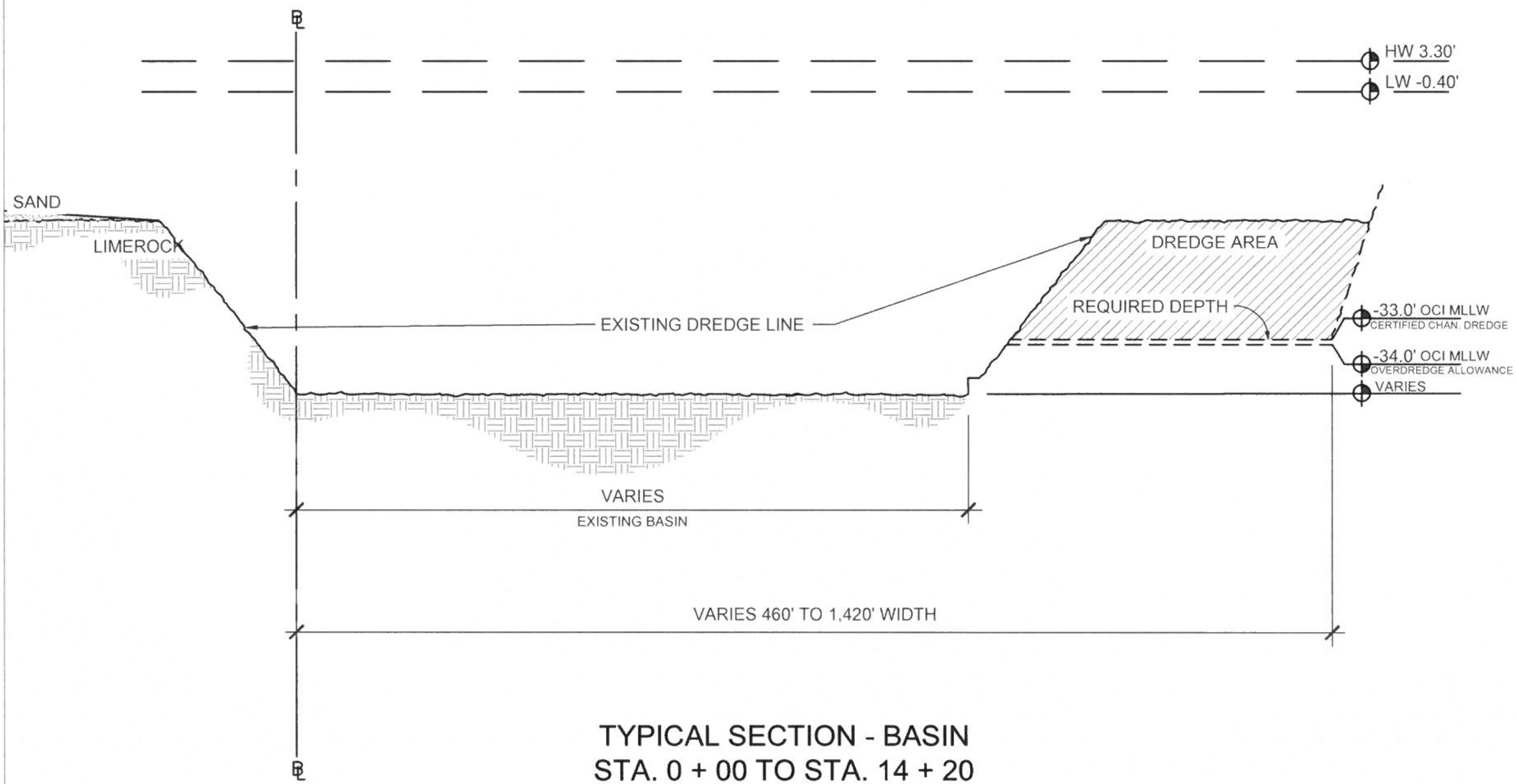
MSC

cts

DS-8



TYPICAL SECTION - BASIN
STA. 0 + 00 TO STA. 14 + 20

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MSC

ets

OCEAN CAY

TYP. SECTION - BASIN

DS-9

NOTES:

1. CONTRACTOR WILL COMPLY WITH THE TURBIDITY STANDARDS AND MONITORING AS SET FORTH BY THE BAHAMIAN GOVERNMENT.

2. TESTING FOR TURBIDITY WILL BE DONE AT A DISTANCE OF 250 METERS FROM THE DISPOSAL AREA.

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& PARTNERS • INC

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cts

OCEAN CAY

SPOIL DISPOSAL SITE

DS-10

SITE A (N. BEACH)	
AREA	VOLUME AVBL.
801,517 ft^2	333,996 yd^3

SITE B (UPLAND)	
AREA	VOLUME AVBL.
180,000 ft^2	95,000 yd^3

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PROJECT NAME
OCEAN CAY
MSC MARINE RESERVE

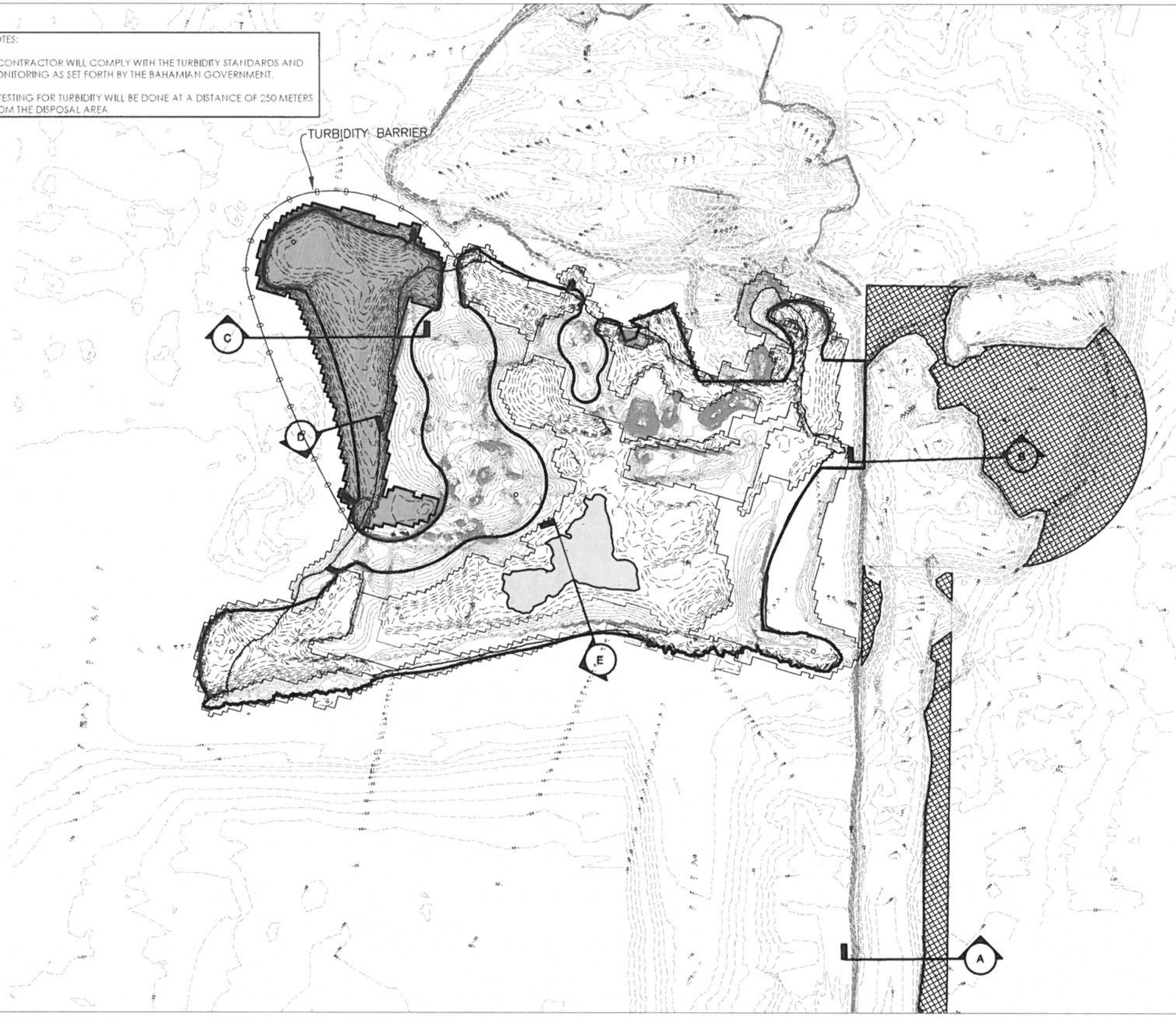
DISPOSAL SITE
CAPACITY

DS-11

NOTES:

1. CONTRACTOR WILL COMPLY WITH THE TURBIDITY STANDARDS AND MONITORING AS SET FORTH BY THE BAHAMIAN GOVERNMENT.

2. TESTING FOR TURBIDITY WILL BE DONE AT A DISTANCE OF 250 METERS FROM THE DISPOSAL AREA.



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MSC

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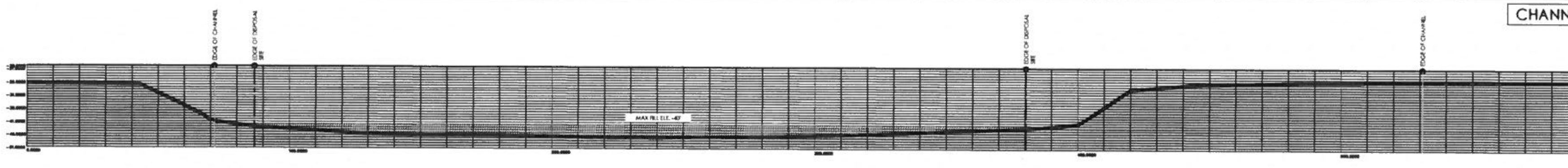
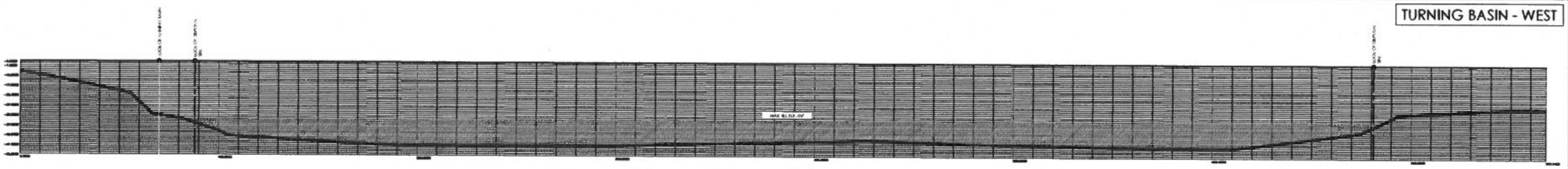
OCEAN CAY

SECTION LOCATIONS

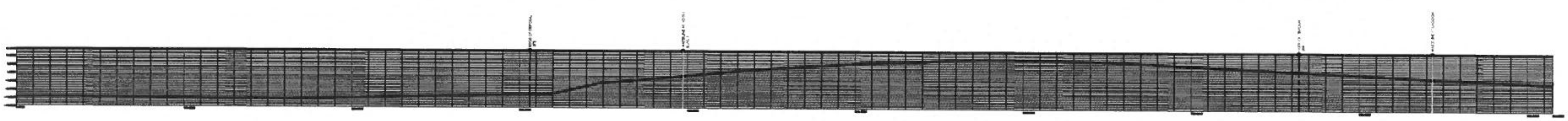
DS-12



SECTION A-A
N.T.S.



SECTION B-B
N.T.S.



SECTION C-C
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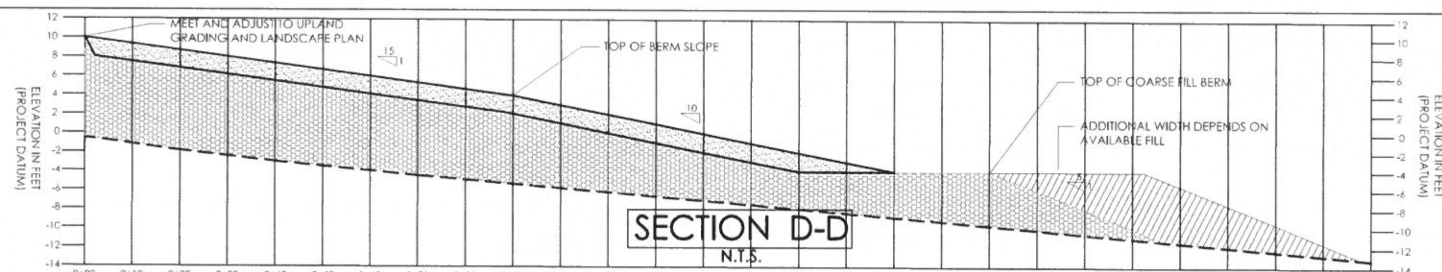


SECTION D-D
N.T.S.

BERMELLO • AJAMIL & PARTNERS • INC
Architecture Engineering Planning Interior Design Landscape Architecture
2601 South Bayshore Drive 10th Floor
Miami, Florida 33133

MSC

cts

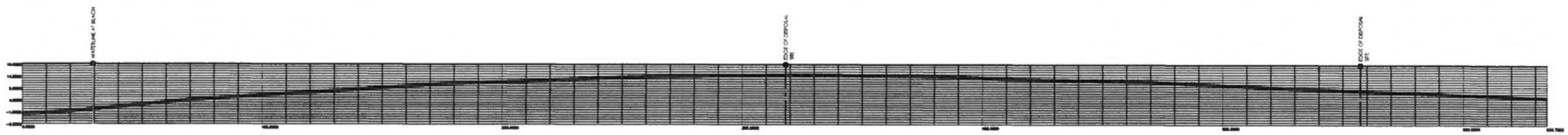
REVISIONS

PROJECT NAME:
OCEAN CAY
MSC MARINE RESERVE

PROJECT ADDRESS:
OCEAN CAY, BAHAMAS

DRAWING TITLE:
DISPOSAL SITE SECTIONS

SHEET NO.:
DS-13



SECTION E-E
N.T.S.

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Architecture Engineering Planning
Interior Design Landscape Architecture
2601 South Bayshore Drive 10th Floor
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(305) 859-2050 Fax (305) 860-3700

MSC

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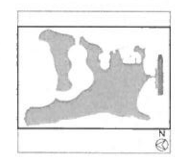
REVISIONS

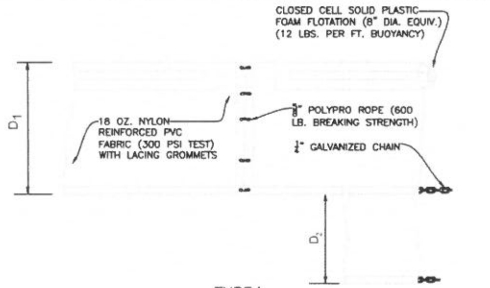
PROJECT NAME
OCEAN CAY
MSC MARINE RESERVE

PROJECT ADDRESS
OCEAN CAY, BAHAMAS

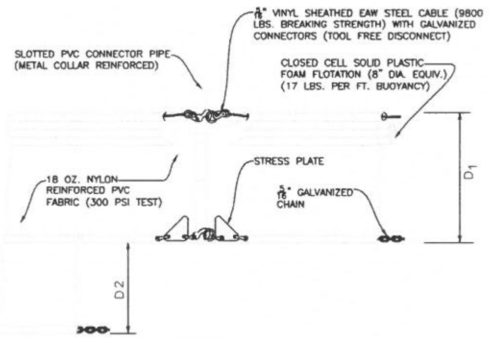


DRAWING TITLE
DISPOSAL SITE SECTIONS

SHEET NO.
DS-14



TYPE I



TYPE II

D 1=5' STD. (SINGLE PANEL FOR DEPTHS 5' OR LESS).
D 2=5' STD. (ADDITIONAL PANEL FOR DEPTHS > 5').

CURTAIN TO REACH BOTTOM UP TO DEPTHS OF FEET. TWO(2) PANELS TO BE USED FOR DEPTHS GREATER THAN FEET UNLESS SPECIAL DEPTH CURTAINS ARE SPECIFICALLY CALLED FOR IN THE PLANS OR AS DETERMINED BY THE ENGINEER.

NOTICE: COMPONENTS OF TYPES I AND II MAY BE SIMILAR OR IDENTICAL TO PROPRIETARY DESIGNS. ANY INFRINGEMENT ON THE PROPRIETARY RIGHTS OF THE DESIGNER SHALL BE THE SOLE RESPONSIBILITY OF THE USER. SUBSTITUTIONS FOR TYPES I AND II SHALL BE AS APPROVED BY THE ENGINEER.

FLOATING TURBIDITY BARRIERS

N.T.S.

BERMELLO • AJAMIL & PARTNERS • INC

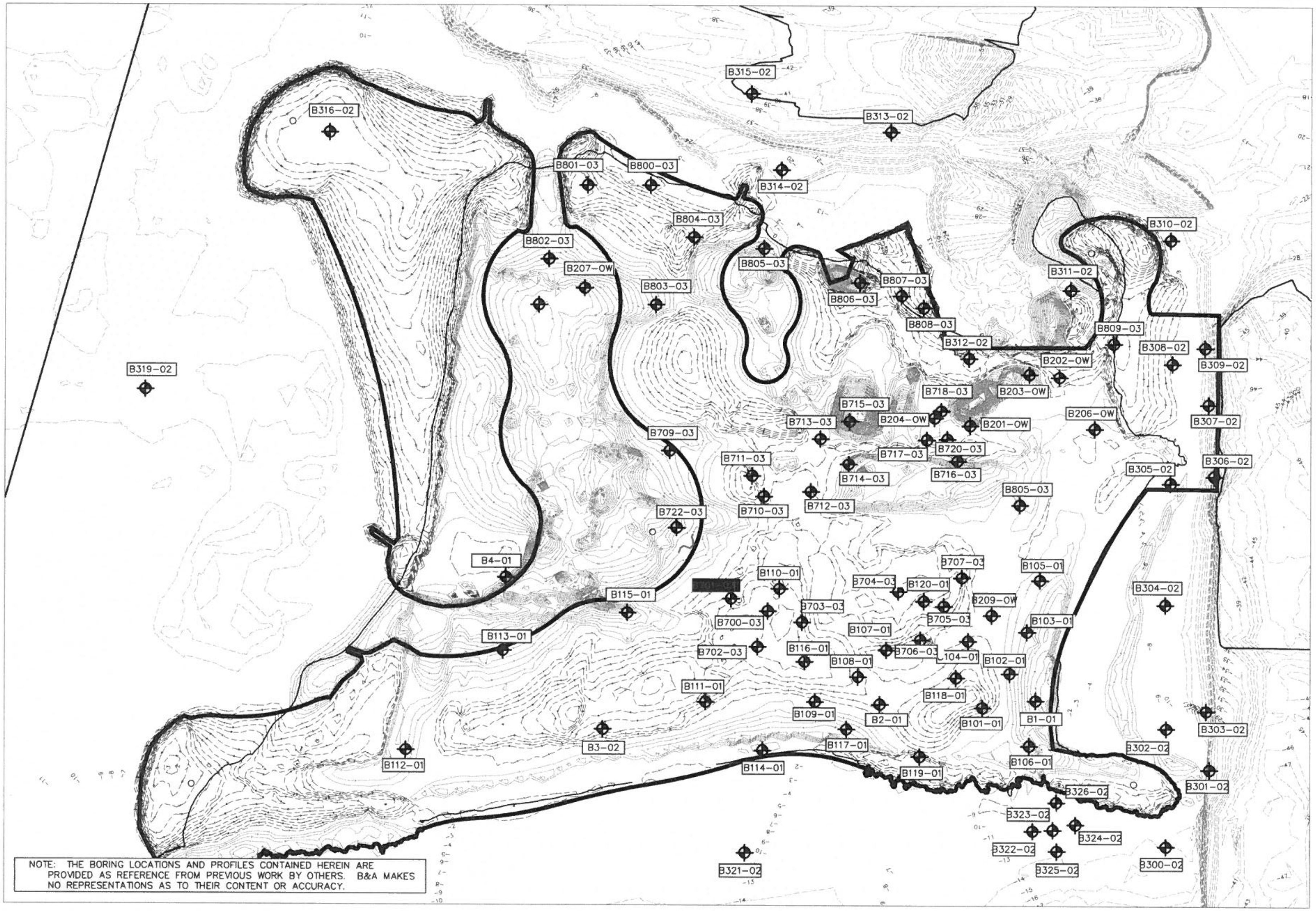
REVISIONS

PROJECT NAME
OCEAN CAY
MSC MARINE RESERVE

PROJECT ADDRESS

DRAWING TITLE
TURBIDITY CONTROL PLAN AND DETAILS

SHEET NO.
DS-15



NOTE: THE BORING LOCATIONS AND PROFILES CONTAINED HEREIN ARE PROVIDED AS REFERENCE FROM PREVIOUS WORK BY OTHERS. B&A MAKES NO REPRESENTATIONS AS TO THEIR CONTENT OR ACCURACY.

MSC

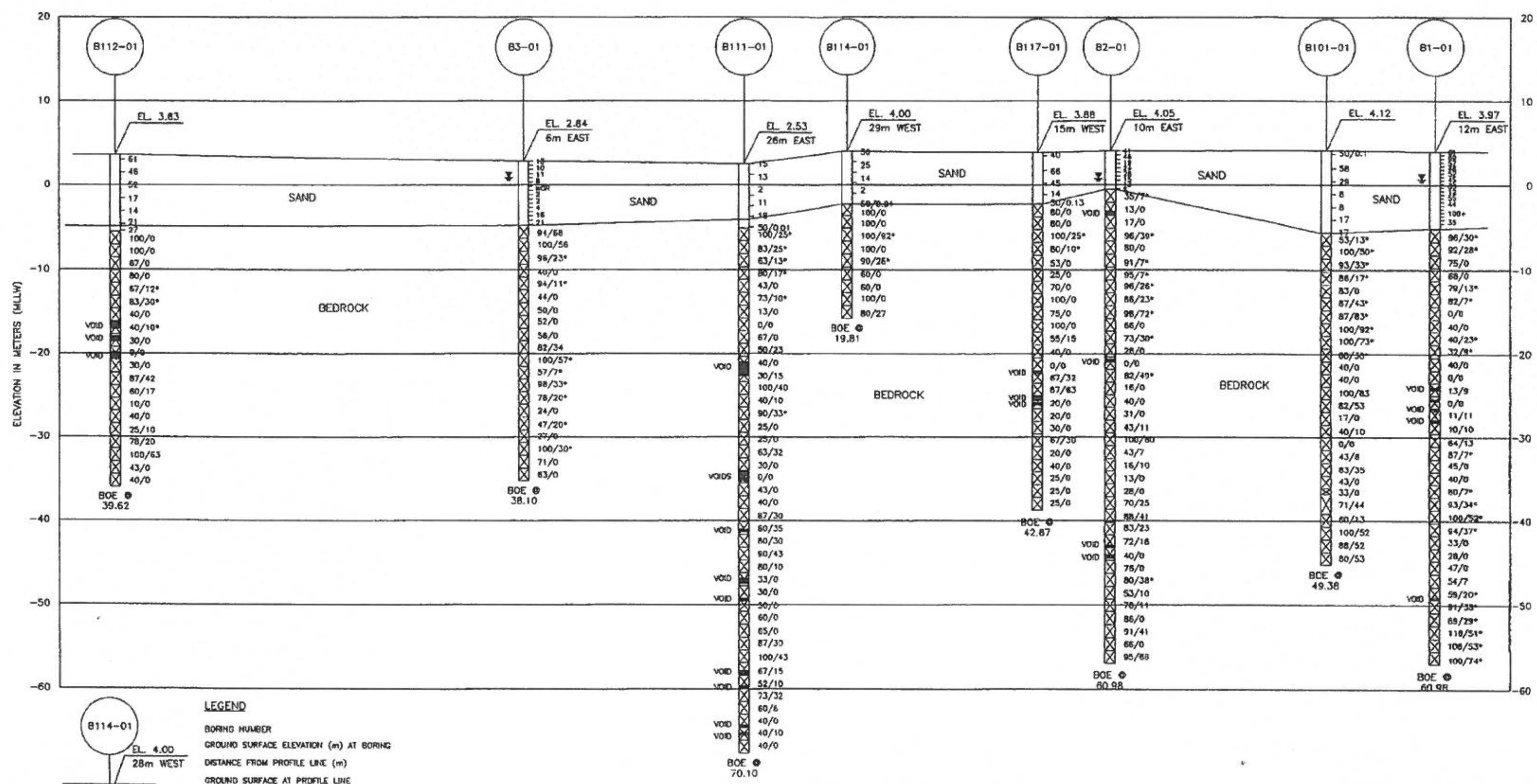
cts

OCEAN CAY

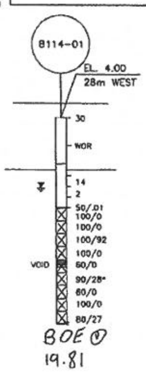
MSC MARINE RESERVE

BORING LOCATIONS

DS-16



PROFILE A–A



LEGEND

BORING NUMBER

GROUND SURFACE ELEVATION (m) AT BORING

DISTANCE FROM PROFILE LINE (m)

GROUND SURFACE AT PROFILE LINE

STANDARD PENETRATION RESISTANCE N-VALUE = NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT SPOON SAMPLER (51 mm O.D., 35 mm I.D.) 305 mm UNDER THE FREE-FALL WEIGHT OF 63.5 kg FALLING 760 mm.

INDICATES THAT STANDARD SPLIT SPOON SAMPLER WAS ADVANCED BY THE STATIC WEIGHT OF DRILLING RODS AND HAMMER

STRATA CHANGE AT BORING
STRATA CHANGE ALONG PROFILE

INDICATES WATER LEVEL RECORDED IN OBSERVATION WELL INSTALLED IN COMPLETED BOREHOLE

ROCK CORING DATA– PERCENT OF ROCK CORE RECOVERY/ROCK QUALITY DESIGNATION (RQD). RQD=PERCENTAGE RATIO OF TOTAL LENGTH OF 83 mm DIA. CORE GREATER THAN 102 mm IN LENGTH DIVIDED BY LENGTH OF CORE RUN

INDICATES APPARENT VOID NOTED DURING CORING

INDICATES ROCK IS MODERATELY TO HIGHLY WEATHERED AND LESS SOUND THAN OTHER ROCK OF SIMILAR RQD.

DEPTH BELOW GROUNDSURFACE OF BOTTOM OF EXPLORATION (m)

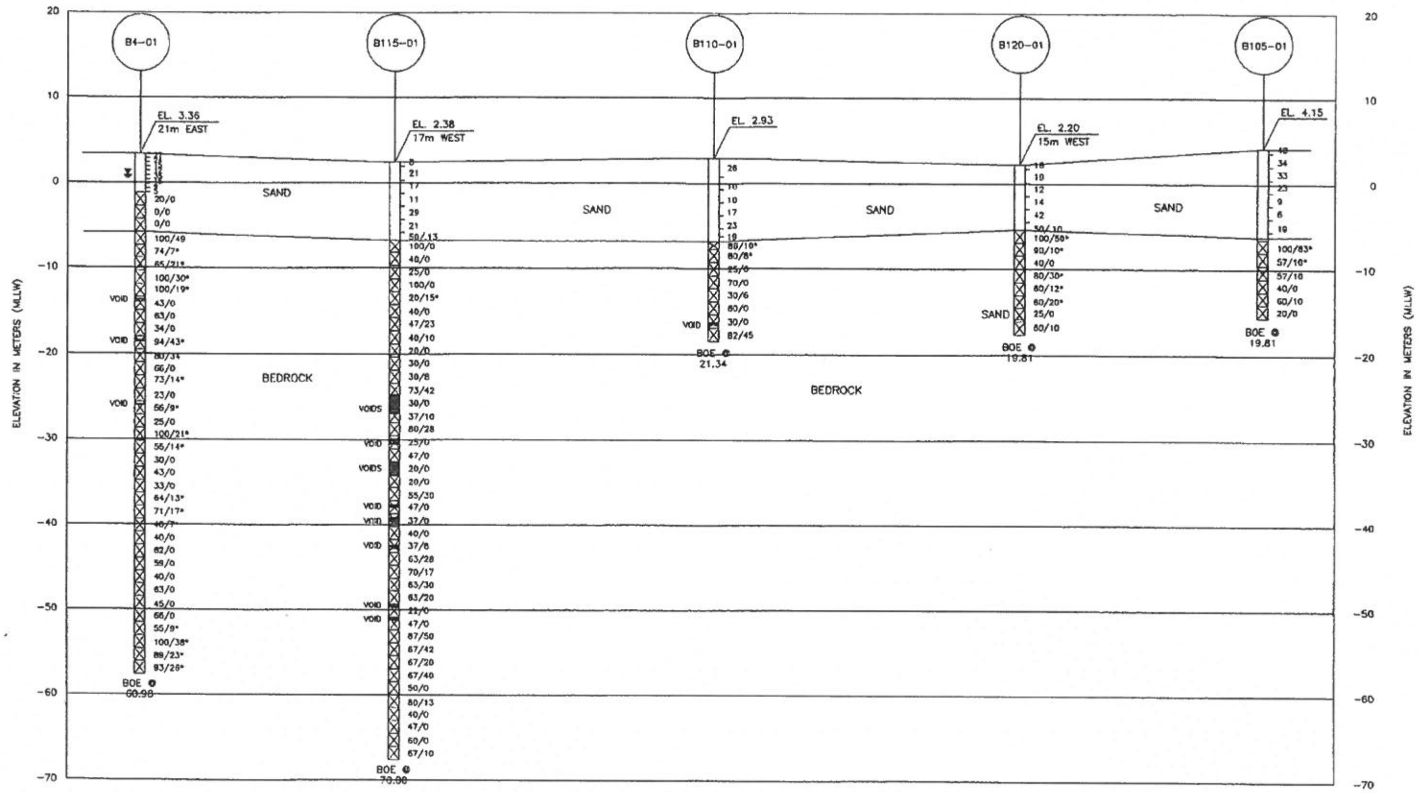
NOTES

1. ELEVATIONS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. STRATA LINES BASED ON LINEAR INTERPOLATION BETWEEN BORINGS. ACTUAL STRATA CHANGES MAY VARY FROM THOSE SHOWN BY LINEAR INTERPOLATION.
3. SEE BORING LOGS FOR DETAILED DESCRIPTION OF MATERIALS.
4. SEE FIGURE 2 FOR APPROXIMATE LOCATION OF SUBSURFACE PROFILE.
5. ELEVATION OF GROUND SURFACE AND PROFILE STRATA LINES ARE ALONG PROFILE LINE SHOWN ON THE ONSHORE AND OFFSHORE BORING PLAN. BORINGS THAT ARE OFFSET FROM THE PROFILE LINE MAY NOT REFLECT THE GROUND SURFACE OR SUBSURFACE [illegible]

CHANGE ELEVATIONS Show ON THE PROFILE

1:1000 10 0 50 m
1:250 5 0 10 m

NOTE: THE BORING LOCATIONS AND PROFILES CONTAINED HEREIN ARE PROVIDED AS REFERENCE FROM PREVIOUS WORK BY OTHERS. B&A MAKES NO REPRESENTATIONS AS TO THEIR CONTENT OR ACCURACY



PROFILE B-B

1:1000

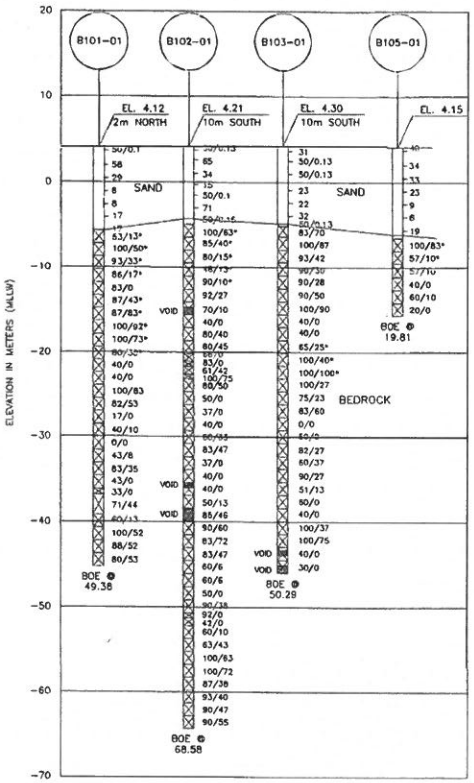
1:250

NOTE

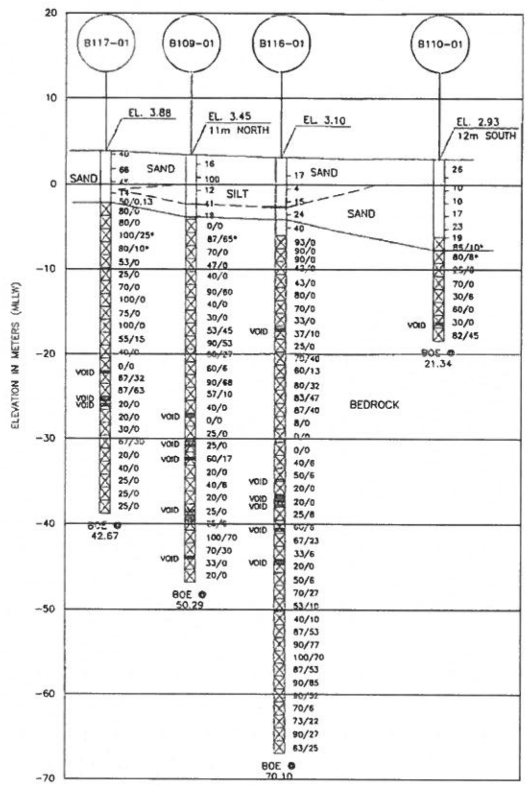
1. REFER TO DRAWING NO. C-101 FOR NOTES AND LEGEND.

IF SHEET IS LESS THAN 594mm X 841mm IT IS A REDUCED PRINT. SCALE ACCORDINGLY

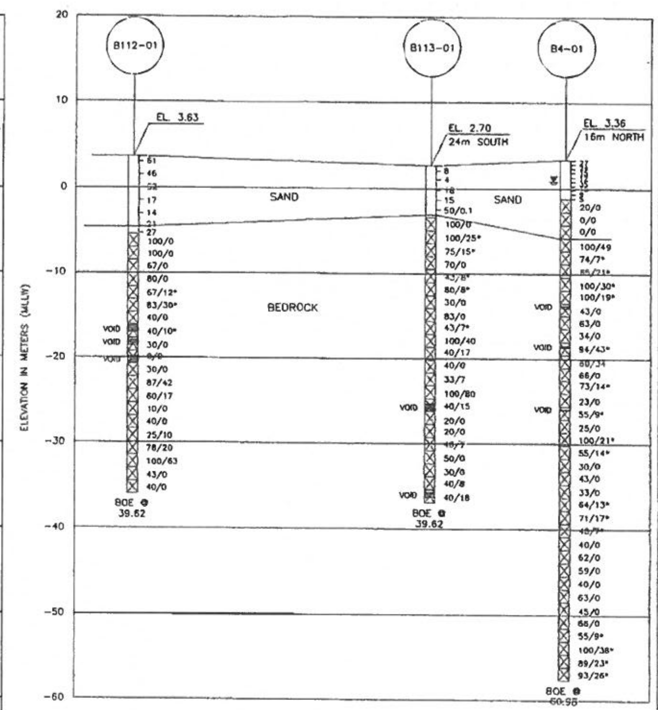
NOTE: THE BORING LOCATIONS AND PROFILES CONTAINED HEREIN ARE PROVIDED AS REFERENCE FROM PREVIOUS WORK BY OTHERS. B&A MAKES NO REPRESENTATIONS AS TO THEIR CONTENT OR ACCURACY



PROFILE C–C



PROFILE D–D



PROFILE E–E

1:1000 10 0 50 m

1:250 5 0 10 m

NOTE

1. REFER TO DRAWING NO. C-101 FOR NOTES AND LEGEND.

IF SHEET IS LESS THAN 594mm X 841mm IT IS A REDUCED PRINT. SCALE ACCORDINGLY

NOTE: THE BORING LOCATIONS AND PROFILES CONTAINED HEREIN ARE PROVIDED AS REFERENCE FROM PREVIOUS WORK BY OTHERS. B&A MAKES NO REPRESENTATIONS AS TO THEIR CONTENT OR ACCURACY

WORK METHOD STATEMENT

OCEAN CAY – MSC CRUISES DESTINATION

CLIENT NAME : MSC Cruises
PROJECT LOCATION : Ocean Cay, Bahamas
PROJECT NUMBER : 044-10013

Controlled Copy no. ....

Revision Status

Rev	Issue Date	Reason for Issue	Prepared	Checked	Approved
0.0	2016.05.18	Issue for tender phase	WCAS	WCAS	PBUI
1.0					
2.0					

Controlled Copy Distribution list			
No.	Company	Function	Name
01	CLIENT	PROJECT DIRECTOR	Alberto Hervello Ibanez
02	CLIENT REP	CLIENT's Authorised Representative	Michiel van der Kreeke
03			
04			
05			

TABLE OF CONTENTS

Table of contents **3**
Definitions **4**
CLIENT's document **4**
1 Introduction **5**
1 Description of the project **6**
2 Scope of Work **7**
2.1 Scope of Work 7
3 Work method **7**
3.1 Selection of work method 7
3.2 Dredging Plan 9
4 Plant and equipment **13**
4.1 Description primary equipment 13
4.2 Description auxiliary equipment 13
4.3 Cutter Suction Dredger (CSD) 14
5 Survey and monitoring **18**
5.1 General 18
5.2 Horizontal and vertical control 18
5.3 Topographical survey (onshore measurements) 18
5.4 Hydrographical survey (offshore measurements) 19
5.5 Dredging equipment 19
5.6 Dredge View system 20
6 Used abbreviations **21**
7 Appendix A: Specifications of POTENTIAL Cutter suction dredgers **22**

DEFINITIONS

Term	Definition
PROJECT	Ocean Cay Develepment as Cruise destination
CLIENT	Mediterranean Shipping Company Cruises [MSC Cruises]
CONTRACTOR	Boskalis International BV

CLIENT'S DOCUMENT

Ref	Document Number	Title
1	Various	Loose documents in various emails
2		
3		

1 INTRODUCTION

Boskalis International bv is a leading global services provider operating in three market segments, Dredging & Earthmoving, Maritime Infrastructure and Maritime & Terminal services. We provide creative and innovative all-round solutions to infrastructural challenges in the maritime, coastal and delta regions of the world. Our operations are broadly spread across all continents, giving the company a stable foundation, the flexibility to capture a wide range of projects and excellent prospects for balanced growth.

Our main product segment is Dredging & Earthmoving, which includes the following activities:

- Construction and maintenance of ports and waterways;
- Land reclamation;
- Coastal defence and riverbank protection;
- Offshore services for the oil and gas industry;
- Dry infrastructure and soil improvement;
- Underwater rock fragmentation;
- Mining;
- Gravel and sand trading;
- Environmental activities;
- Contaminated sediment remediation.

Boskalis has, including its share in partnerships, over 15,000 employees and operates in 65 countries across six continents. Boskalis has a versatile fleet of over 1,500 units, including trailing suction hopper dredgers, self-propelled seagoing heavy-duty cutter suction dredgers, backhoe dredgers, grab dredgers, fall-pipe vessels and side stone dumping vessels. The relevant vessels meet the strict requirements of the international ISM and ISPS codes.

The company's commitment to safety, health, environment and quality is reflected in the acquired ISO 9001, ISO 14001 and OHSAS 18001 certification. In addition to the Occupational Health and Safety certification, the JV partner Boskalis initiated the NINA safety program which will be applied during the project, see the information box below.

Safety program NINA (No Injuries No Accidents)

Safety has been a priority within the Boskalis organisation for years and this has resulted in a clear improvement of our safety record. To further improve our safety culture and reach our goal of an incident-free working environment, Boskalis has launched the NINA safety program. NINA - No Injuries, No Accidents - setting clear standards and explaining what we expect from our people with regard to their safety behaviour.

NINA is supported by an extensive training and workshop program so that all our employees understand the NINA principles and how to lead by example. NINA is embedded in our organisational systems and managed by leading indicators.

Our Safety Vision

Our vision statement clearly expresses what we stand for with regard to safety:

"Our people are our most valuable assets, making safety a core value. Our goal is: No Injuries No Accidents. This is embedded in our company's culture and supported through Values and Rules. All employees, including our sub-contractors, are expected to take these values and rules to heart."

The vision statement is supported by five Values and five Rules that have been specifically developed to further detail where we stand on safety and to provide guidance to all employees, including those of subcontractors, with regard to both expected behaviour and risk management.

For more information, visit: www.boskalis-nina.com

1 DESCRIPTION OF THE PROJECT

The present project is to take a relatively deserted island (Ocean Cay, 25 km South of Bimini) and make the necessary developments to enable the creation of a first class exclusive cruise destination. The required developments to be carried out by Boskalis are the deepening of the access channel and the placement of the material generated onto the island itself.

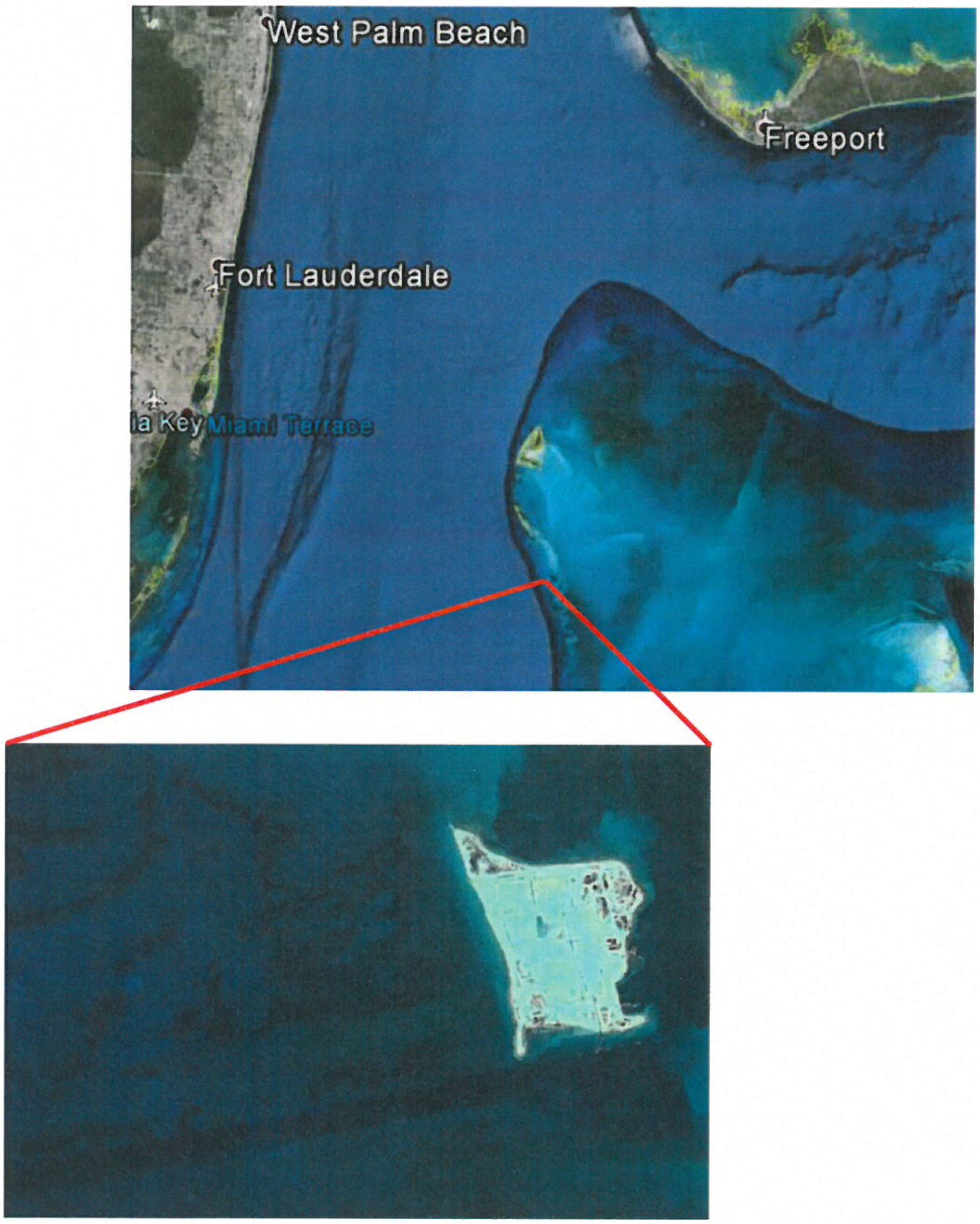


Figure 1 – Project location, Ocean Cay, Bahamas

2 SCOPE OF WORK

This chapter covers the Scope of Work as defined by the CLIENT, along with expected, described and observed site conditions.

2.1 Scope of Work

The Scope of Work to be carried out is the deepening of the access channel and turning basin. More specifically:

- Dredging channel from STA 14+20 to 62+70 to 34 feet below Chart Datum (CD)
- Dredging Turning Basin from STA 00+00 to 14+20 to 33 feet below Chart Datum (CD)

The client has specified a paid vertical overdepth of 1 foot. Dredging below this paid overdepth is not restricted but will not be considered when calculating the volume removed to be paid.

The present scope of works includes the associated laying of pipelines and building and maintenance of the reclamation bunds and weir boxes. Material will be distributed at **the contractor's discretion over the** extent of the reclamation area.

In addition to above, the CONTRACTOR will execute a bathymetric in-survey, intermediate survey and out-survey of the dredging areas.

3 WORK METHOD

The following proposed work method for Dredging and Transportation of dredged material to the disposal area is based on our technical knowledge and experience as well as the information made available in the Tender Documents. This work method is a preliminary document that may be adjusted if circumstances so dictate. Upon award of contract the proposed work method will be reassessed in light of the actual conditions and requirements and may be subject to changes.

The dredging works will be executed during 24 hours a day, 7 days a week.

3.1 Selection of work method

The selection of the work method is primary based on the project layout and soil conditions. To be able to dredge rock layer in the project area a Cutter Suction Dredger (CSD) will be deployed. The material dredged by CSD will be hydraulically pumped directly to the disposal area through a pipeline system consisting of floating, flexible and submerged (sinker) pipelines.

To optimize the work program the CSD will shift freely between the basin and the channel depending in the weather conditions, **discharge distances and other factors to be evaluated by the contractor's project** manager.

Figure 2 below illustrates the project location and required dredging areas (dark hatch).

Dredge Quantities			
	Required Depth	Max Allowed Depth (1 foot overdredge)	Total
CHANNEL	-34.0'	-35.0'	146,798 C.Y.
	127,645 C.Y.	19,153 C.Y.	
BASIN	-33.0'	-34.0'	284,679 C.Y.
	250,511 C.Y.	34,168 C.Y.	

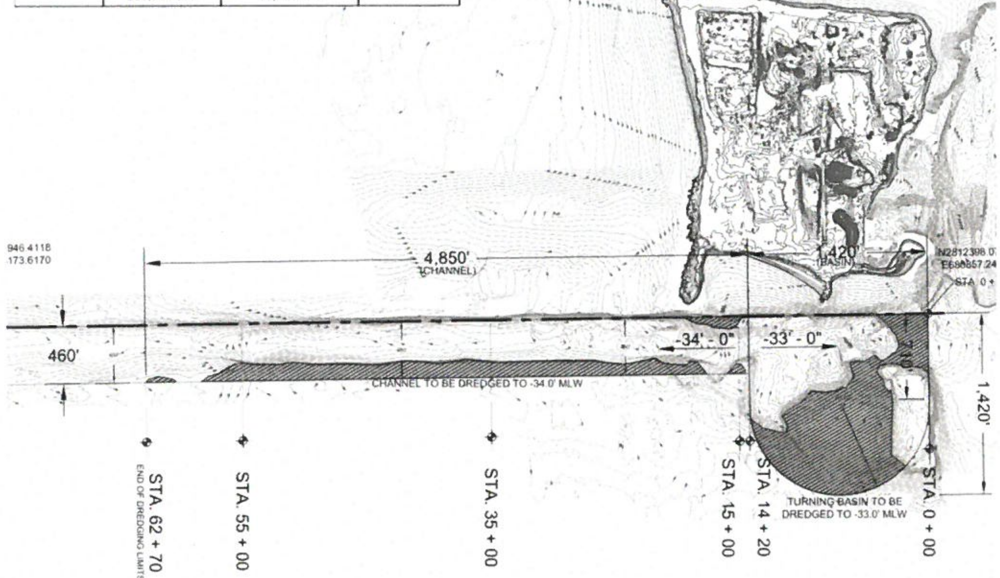


Figure 2 – Sketch of Dredging Work

3.2 Dredging Plan

This section explains the general work sequence intended to be executed by the CONTRACTOR. The dredging plan is based on the dredging and pumping/transporting of the dredged material to the proposed disposal area.

The steps described below may run parallel or alter in sequence due to operational requirements. It is noted that the figures are indicative only. The ratios between the progresses of certain items could therefore deviate from the realized works at a certain point in time.

Step 1:
Prior to the start of the dredging work, the project area (dredging area and pipeline area) is surveyed by a survey team. These bathymetric survey data and the design are integrated into DV2-CDMS (Dredge View 2 – Cutter Dredging Monitoring System) to visualize the dredge area and the layers which have to be dredged.

During the preparation phase, the necessary floating pipeline, sinker pipeline and onshore pipeline towards the reclamation area will be installed, see Figure 3. This will include the positioning of a sinker line in the basin to access the northern portions of the basin.

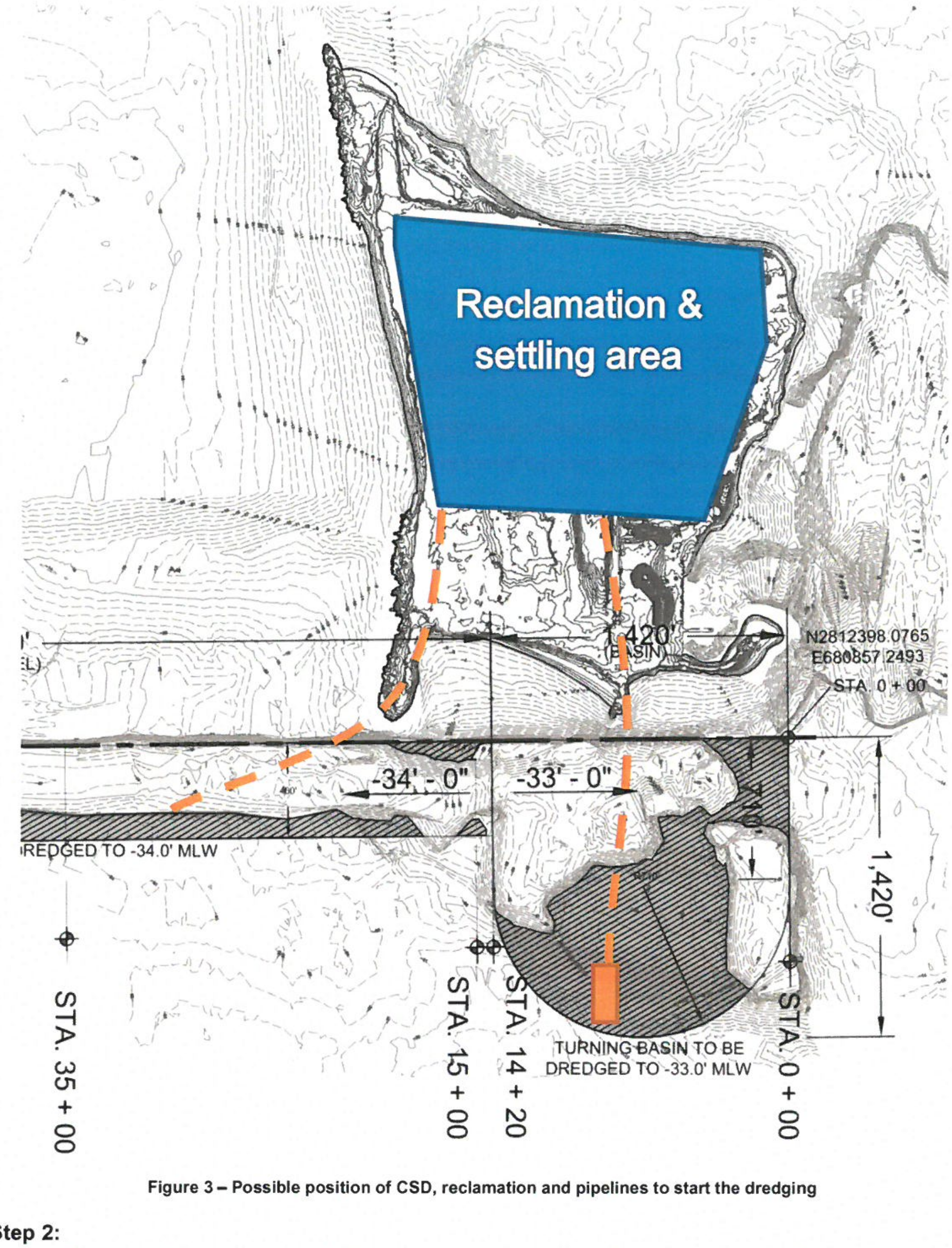


Figure 3 – Possible position of CSD, reclamation and pipelines to start the dredging

Step 2:
Depending on the weather conditions the CSD is positioned in the channel or basin to start the dredging. The CSD maintains its position with its spud(s) and the two side wires connected to the cutterladder. When the positioning of CSD is completed, the floating pipeline is connected to the shorepipeline. Fig 3 shows an example of the possible position of the CSD as well as the primary and secondary pipelines.

Step 3:
Upon completion of step 1 and 2 the CSD will start the dredging. During the dredging the cutter head of the dredger is pushed into the rock layer to cut the rock. The anchor wires at the front of the CSD assist the CSD to move to starboard and to portside. The dredged material is being transported to the reclamation area by pumping it through the floating, sinker and land pipeline. Fig 4 below shows a typical layout of the CSD and shows 2 alternative pipeline configurations: with and without a sinker line.

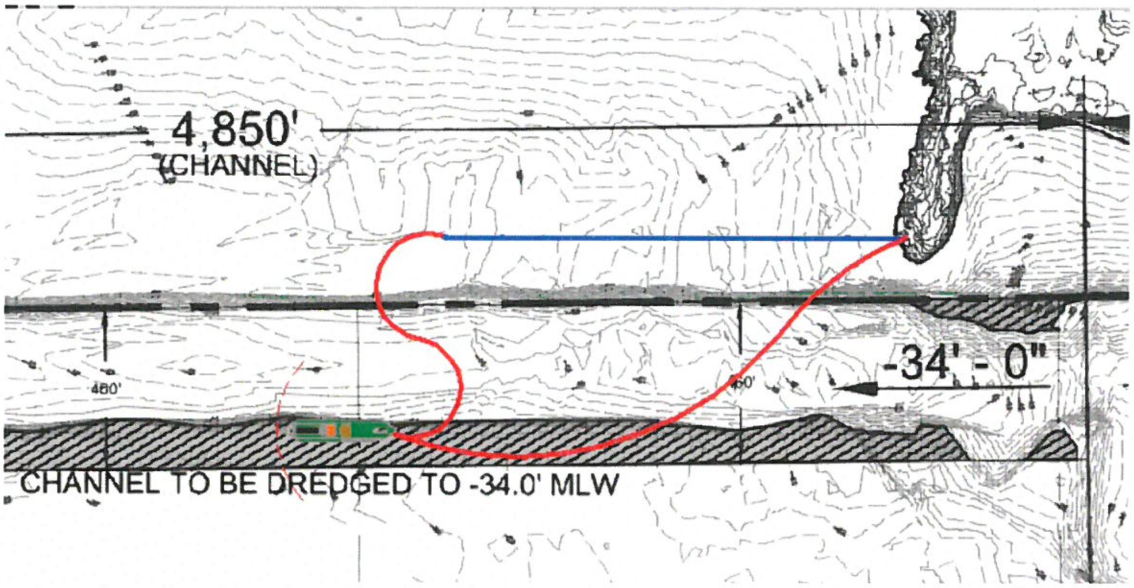


Figure 4 – Typical dredger and pipeline layout of the CSD in the channel

Step 4:
The dredged material is transported as a slurry to the reclamation area through the pipelines and discharged inside the bunds. A set of dozers and assisting equipment ensure a steady flow and distribution of the material as it settles out of the flow. The resulting turbid water is allowed to decant into a separate settling pond. At the other end of the settling pond the surface water with minimum fines is decanted again and allowed to flow back into the ocean.

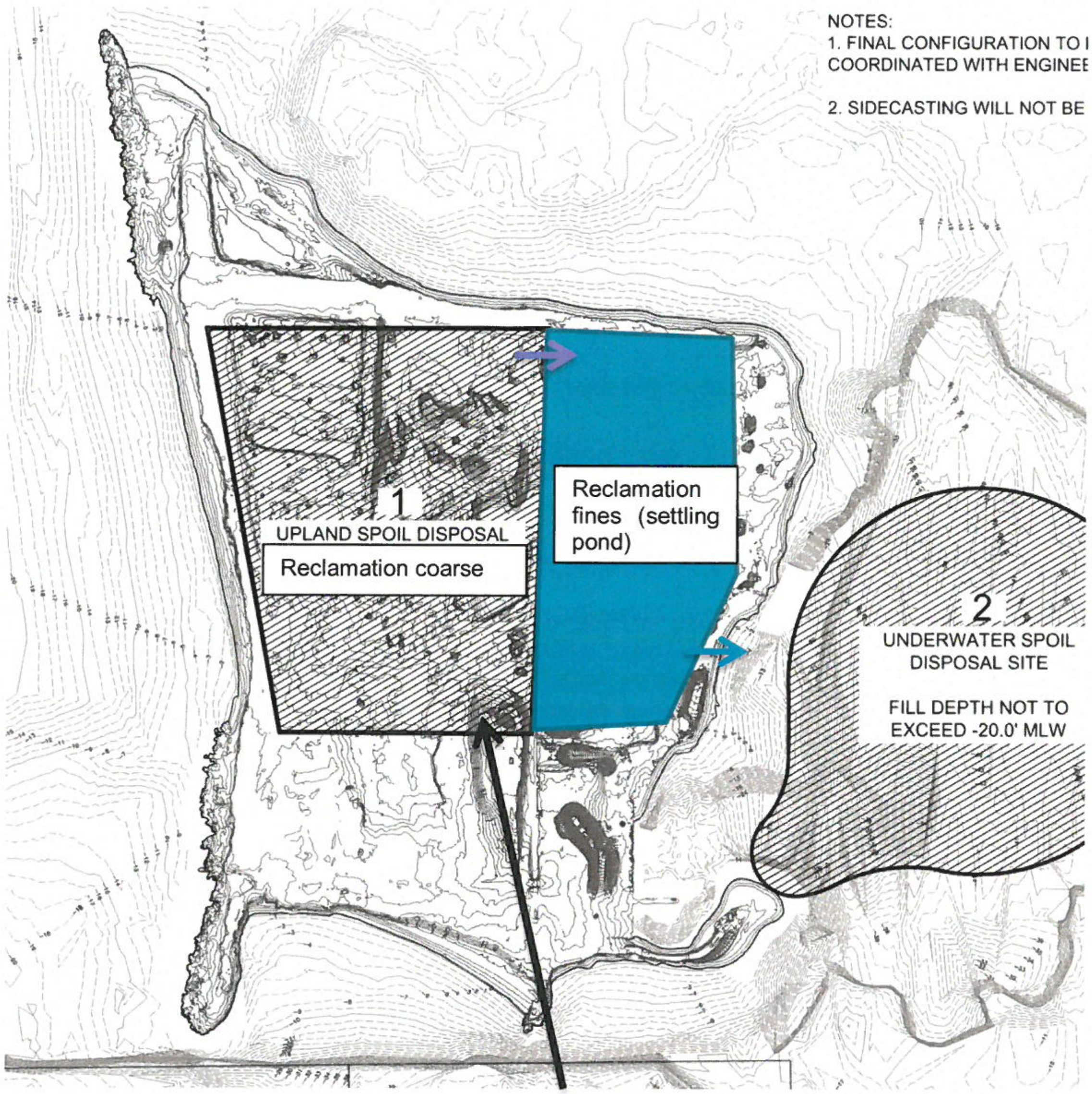


Figure 5 – Typical distribution of reclamation area and flow of mixture

4 PLANT AND EQUIPMENT

This chapter covers the equipment which are proposed to be used, both primary units and auxiliary, supporting units.

4.1 Description primary equipment

The following vessels, or similar units, are foreseen to execute the works:

- CSD, **type 'Cyrus', see equipment specification** in the appendix;

4.2 Description auxiliary equipment

The following auxiliary equipment is proposed to assist the above mentioned primary equipment during the execution of the works:

- Multicat support vessel; type BKM 104 or similar, see Fig. 6
    - Assisting of the CSD for positioning and anchor handling
    - Connecting of the floating pipeline to the CSD and shore
    - General logistical support
- Tug support vessel; Locally chartered vessel
    - Positioning the floating pipeline at the dump site
- One survey and monitoring vessels; type Marieke or similar, see Fig. 7
    - Executing of Multibeam survey (in-survey, intermediate survey and out-survey)

Figure 6 – Multicat BKM 104

Figure 7 – Survey boat Marieke

4.3 Cutter Suction Dredger (CSD)

4.3.1 Introduction CSD

A CSD is a suction dredger equipped with a rotating cutter head. The CSD is positioned on spuds and anchor wires during dredging operations. A CSD is suitable for dredging silts, sand, clay and rock. The dredging process consists of cutting the seabed (loosening the soil) with the cutter-head, then transporting a mixture of soil and water by the dredge pump through a discharge pipeline for further transport to a discharge location. Some CSDs are self-propelled (see Figure 10) while other CSDs require towage between work sites.

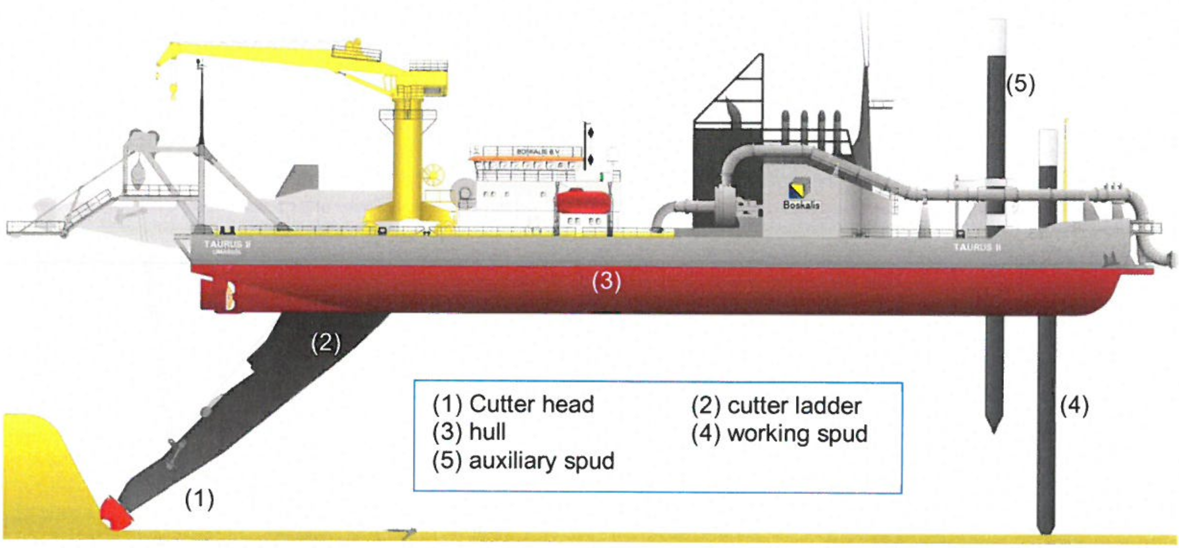


Figure 10 - General layout of a Cutter Suction Dredger (CSD)

The main parts of a CSD, as depicted in Figure 10, are:

- The hull, containing the engines, (propulsion), pump(s), the crew quarters, the bridge with the dredging and navigational control etc.;
- The cutter ladder (2), containing the cutter head (1), suction pipeline and first dredge pump (optional);
- The discharge system, consisting of dredge pump(s) and pipeline(s);
- The spud poles (4 & 5) and carriage which provide a stable position and forward movement;
- The anchors and side winches which provide the sideward movement.

Different cutter heads can be fitted depending on the expected soil conditions. Cutter heads are interchangeable on site, providing maximum flexibility when dredging different soil types. CSDs maintain a stock of consumable cutting 'teeth'.

4.3.2 Work method positioning CSD

Before the start of dredging operations, the CSD will sail or be towed to the dredging location. The CSD maintains its position with its spud(s) and the two side wires. The working spud or main spud is dropped onto the seabed securing the stern of the dredger. During dredging, the CSD makes a pivoting movement around the main spud. To create the required swinging motion, the CSD deploys side anchors on both sides of the cutter ladder, these are connected by steel wires to the side winches onboard the CSD. By simultaneously reeling in one side-wire and reeling out the other side-wire the dredger pivots around its spud. Depending on the water depth and the length of the CSD, a CSD can dredge a cut width varying between 5 and 120m wide.

The CSD's spud system consists of 2 spuds. The working, or main, spud is installed within a movable carriage which can move forward and backward relative to the hull. The dredger is pushed forward by hydraulic rams in 'steps' in the order of 1m on either end of the swing. The actual stepping distance depends mainly on the soil conditions, each step allows the CSD to make a new cut. This process is illustrated in Figure . The auxiliary spud is installed in a static hull mounted arrangement and is kept in raised position during dredging.

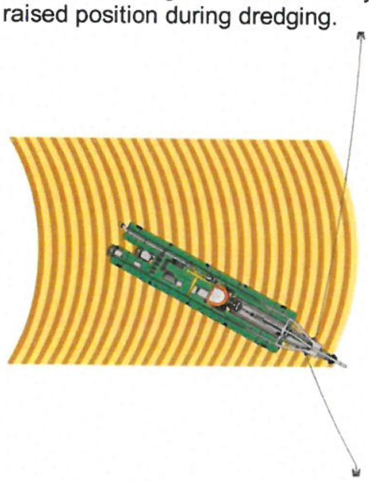


Figure 11- CSD start port side swing

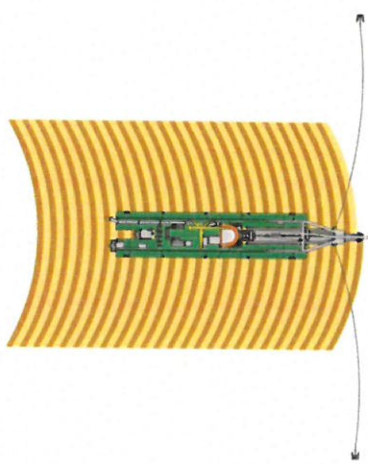


Figure 12 - CSD in center line

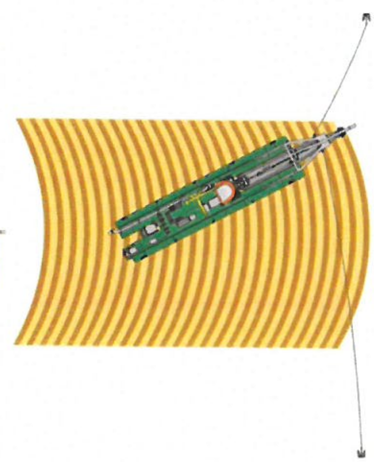


Figure 13 - CSD completing portside swing

When the working spud ram is fully extended (4 to 6m) the dredger hauls itself to the centre line of the cut (see Figure 12). Once in this position, the CSD lowers the auxiliary spud, lifts the working spud and retracts the hydraulic ram, moving the spud carrier forward to the start position. Once in position, the working spud is lowered, the auxiliary spud raised and dredging recommences.

The side anchors are moved forward when the angle between the side wire and the dredger becomes unfavourable for effectively pulling the cutter head from one side to another. The type of anchors and locations are determined on site in order to suit soil and operational conditions. Anchors are handled using a support vessel such as a Multicat or by dry equipment on shore, depending on local conditions.

4.3.3 Work method dredging CSD

To begin dredging works the cutter ladder is lowered. The cutter head rotates, loosening the soil which makes up the seabed. The suction inlet is positioned inside the cutter head. The pump lifts a mixture of the loosened soil and water from this inlet through the suction pipe to the pump and out through the discharge system. The mixture flow is schematised in Figure .

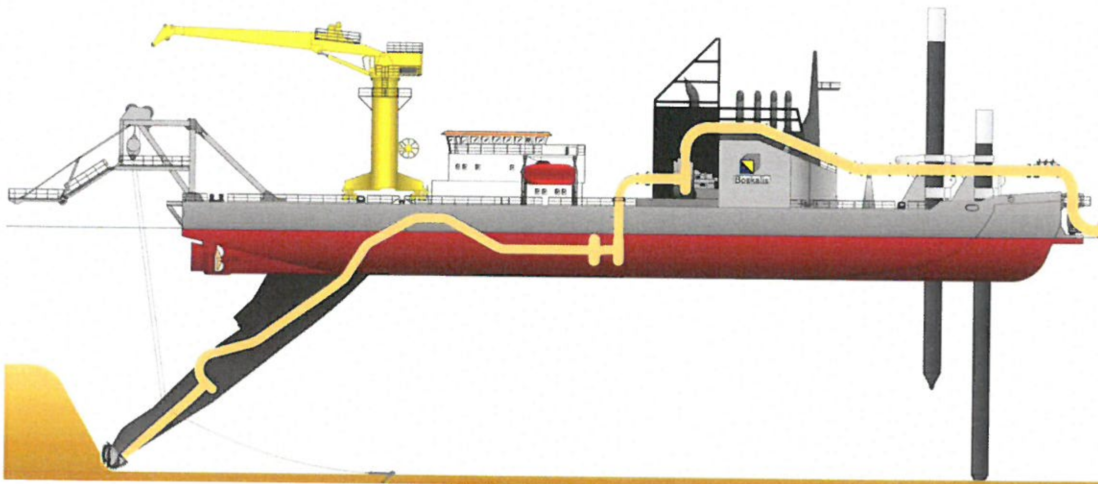


Figure 14 - Mixture flow through a CSD

The side slopes of channels or trenches can be dredged by following the side slope angle with the cutter head, or with the more economical method of dredging box-cuts. The stability of side slopes must be considered when dredging channels or trenches. **This stability is a function of the seabed's soil characteristics, which must be considered when designing the slope angle. An example of a 'Box-cut'** cross-section is given below, in Figure .

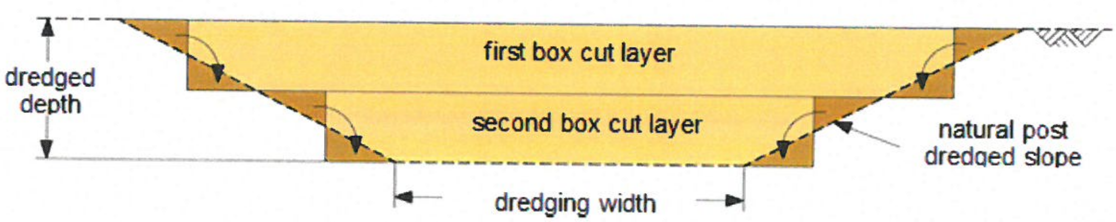


Figure 15 - Principle of box-cut method (not to scale)

Some dredging beyond the design depth may be required to create an additional buffer for siltation. During the dredging operations, regular interim surveys will be carried out to verify the achieved depth and alignment of the works and to calculate the dredged volumes of material.

The dredged material will be pumped directly to the dumplocation, as Figure 16 demonstrates.

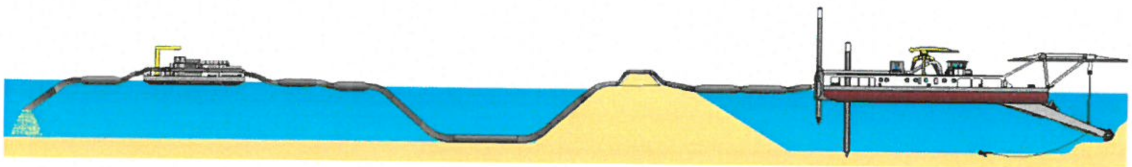


Figure 16 – Pumping of dredged material to dump by CSD

4.3.4 Dredging control & tolerances CSD

A dredging plan will be prepared by the superintendent and the Captain of the CSD with the data from the in-survey of the dredging areas. The dredging process is monitored using the CSD dredging computer which runs Boskalis developed in-house software Dredge View 2.0 – Cutter Dredger Monitoring System (DV2-CDMS). The survey data and the dredging plan are uploaded into the system which provides the dredge operator with a complete overview of process information.

Input variables for DV2-CDMS are:

- Positioning in vertical and horizontal planes, based on a commercially available DGPS signal or using more accurate RTK-DGPS signal (see chapter survey);
- Tide signal receiver, providing the real-time water level;
- Heading of the CSD, derived from a gyro-compass.
- List, trim and draft measurements on the CSD;
- Angle and water pressure transmitters on the ladder of the CSD;
- The Digital Terrain Model (DTM) comprising at least of the following layers:
    - Design, which is the desired situation, as defined by the Contract;
    - In-survey, which is the initial situation of the seabed as observed at the start of the works;
    - Intermediate survey, which is the situation of the seabed at regular intervals during the actual dredging campaign.

Information displayed by the DV2-CDMS includes the power and pump parameters. The position of the vessel and cutter head are visualised on screen against a background of bathymetric data, cut level and obstacles (buoys and special features such as the presence of existing cable(s) or pipeline(s)). For example; a plan view is displayed with a coloured differential chart (intermediate survey level to design level) showing the areas to be dredged, a longitudinal and cross sectional profile indicate the seabed level and design. DV2-CDMS allows the operator maximum control over the dredge area, both in the horizontal and vertical planes. Impressions of the DV2-CDMS operator's displays are given below, in Figure 17.

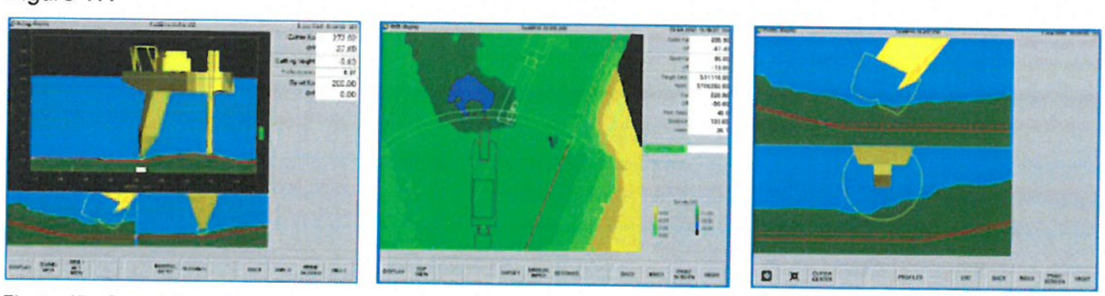


Figure 17 - Cutter Dredger Monitoring System

Dredging tolerance is a function of the positioning accuracy of the vessel, tidal variations, swell, soil characteristics and operator skill and experience. In view of these technical and physical limitations, the following feasible dredging tolerances are anticipated:

- Vertical ±0.5m;
- Horizontal ±3.0m.

5 SURVEY AND MONITORING

The sections below present an overview of the survey and positioning systems.

5.1 General

The purpose of the survey works is to control and support the dredging works and comprises the following main items:

- Survey equipment will be mobilised, set-up, calibrated and maintained at the project site, equipment will be provided for horizontal (RTK-DGPS) and vertical (RTK-DGPS or online tide gauge) positioning control.
- Input of design geometry.
- Provide actual survey data and design data to the monitoring systems on board the (dredging, reclamation, rock placement, support, or other) equipment.
- In-Survey (or Pre-Contract Survey): A bathymetric and topographic survey will be carried out to establish the actual sea bed levels and land in the working areas prior to commencement of the works. Results are included in an In-Survey survey report with details on datum and projection used, summary of events, all calibrations and checks performed, bathymetric charts, topographic charts, contour charts.
- Intermediate (or progress, or interim) Surveys: During the works intermediate bathymetric and topographic surveys will be carried out to monitor the progress of the works. The results of these surveys will be delivered as Digital Terrain Models (DTM) for usage onboard the dredgers and supporting vessels.
- Out-Survey (or Post-Contract Survey): On completion of (separate) portions of the works, a bathymetric and topographic survey will be performed for acceptance of completed areas. The results of this survey will be included in an Out-Survey report and presented to CLIENT with details on datum and projection used, survey method, summary of events, all calibrations and checks performed, bathymetric charts, topographic charts, contour charts, difference charts and volume calculations.
- Computation of volumes of dredged material, sand fill and surcharge progress.

5.2 Horizontal and vertical control

All survey works are performed using a grid as specified by the CLIENT. Horizontal positioning control will be obtained from a (RTK-DGPS) system. The system will be set-up before and maintained during the execution of the dredging and survey works. The reference station will be set up to provide continuous differential corrections for the working area(s).

All depths will be reduced to the local Datum as specified by the CLIENT, which for marine work is normally Chart Datum (CD) or Lowest Astronomical Tide (LAT). For vertical position control in relation to Datum the z value as obtained from the RTK-DGPS system may be used, or alternatively a recording and radio transmitting tide (or water level) gauge.

5.3 Topographical survey (onshore measurements)

For topographical surveys, the following equipment can be used:

- Electronic positioning base station(s);
- Alignment laser (back-up for electronic system);
- Tide gauge including a transmitter;
- Total Station;
- Level instrument;
- Measuring tape.

A RTK-DGPS will be used which comprises of a receiver and logger enclosed within a 'backpack rover

RTK-DGPS system' which receives RTK corrections from the main base station for enhanced horizontal and vertical accuracy of the GPS signals. This is illustrated below, in Figure .

Figure 18 - Typical manual topographic GPS survey

5.4 Hydrographical survey (offshore measurements)

Depths will be measured using a dual frequency single beam hydrographic echo sounder operating the 33 and 210 KHz frequencies. The calibration for the Index Error (transducer depth) and the sound velocity will be done by the 'bar check' method, also transducer draft and sound velocity will be recorded.

Alternatively a Simrad EM3002 multi beam echo sounder may be used for the survey operations. When using the swath sounding system special attention will be paid to the quality of the required bathymetric data and steps will be taken in accordance with written procedures and manufacturer's instructions.

The accuracy of swath depth measurements depends on the following parameters:

- Speed of sound;
- Horizontal alignment of the transducer with respect to the longitudinal axis of the vessel;
- Vertical alignment of the transducer with respect to an inclination of the entire transducer array
- Heave, pitch and roll compensation, which is installed as close as possible to the echo sounder transducers.

5.5 Dredging equipment

The dredging equipment will be fitted with the following equipment:

- RTK-DGPS receiver, or C-NAV receiver based on Real Time GYPSY® technology;
- Tide receiver;
- Gyro repeater;
- Navigation computer with dredging navigation software (see section 5.6 Dredge View system).

These systems will be interfaced to the ships sensors. On monitors the location of the vessel, as well as the ground engaging parts relative to the vessel will be constantly updated and displayed in plan-view with the outline of the dredger in its surroundings, such as contour lines, buoys, dredging centrelines, dredging toe lines, obstacles, chainage and offset etc.

5.6 Dredge View system

The software which is used is Dredge View 2 (DV2) which is an 'in-house' development of Boskalis. The basic capabilities of DV2 are:

- Data Logging: During surveys, the vessel position is made visible relative to the centre line of the Works and the desired survey line and the echo-sounder, positions and depths are logged and concurrently time-stamped.
- Data Processing: During post processing of the survey data the surveyor checks for anomalies. The data is then reduced (corrected to a specified datum) by subtracting the tidal level which can be obtained from the RTK-DGPS positioning system or alternatively the online recorded tidal information, including corrections for squat and latency. This process creates a set of data in an X, Y & Z format for interpretation by a variety of DTM software packages. Using these DV2 DTM bathymetric maps, difference maps and cross sections will be drawn and volume calculations will be performed.
- Data Presentation: Pre-construction level, the design profile and the intermediate level bathymetric charts, topographic charts, difference charts, (annotated) contours, longitudinal profile and cross section drawings can be prepared on file or on paper, once internally approved. These area available to project management team and onboard our dredger(s).
- Volume Calculation: performed by either subtraction of In-survey, Intermediate Surveys and Out-survey DTM layers or surface areas of cross-sections, for Quality Control (QC) purposes.

In order to optimize the dredging operations, DV2 allows the graphical display of the dredger's position, including the position of the suction heads, objects of interest such as channel centre, toe lines, buoys, quay walls, dredging limits and potential hazards, etc.

The DV2 system comprises of the following different packages:

- DV2-BMS, DV2 Booster Monitoring System;
- DV2-HMS, DV2 Hopper Monitoring System;
- DV2-CMS, DV2 Crane Monitoring System, for hydraulic excavators, Backhoe Dredgers and Wire Cranes;
- DV2-CDMS, DV2 Cutter Dredger Monitoring System;
- DV2-DMS, DV2 Dump Monitoring System, for rock dumping using Zeepaard or Zinkoon 6 type pontoons;
- DV2-Office, for the survey office;
- DV2-RDMS, DV2 Rock Dumper Monitoring System, for rock dumping control on a Side Stone Dumping Vessel (SSDV);
- DV2-SND, for Survey vessels;
- DV2-SPMS, DV2 Spray Pontoon Monitoring System;
- DV2-VTSAMS, DV2 Vessel Traffic System or Anchor Monitoring System.

6 USED ABBREVIATIONS

Abbreviation	Description
CD	Chart Datum
CSD	Cutter Suction Dredger
DRD	Dredging Depth
DV2-CDMS	Dredge View 2.0 Cutter Dredger Monitoring System
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWN	Mean Low Water Neap
MLWS	Mean Low Water Spring
MSL	Mean Sea Level
QA	Quality Assurance
MWD	Mean Water Depth
QC	Quality Control
RBW	Royal Boskalis Westminster nv
SHE-Q	Safety, Health, Environment and Quality
TSHD	Trailing Suction Hopper Dredger
WGS84	World Geodetic System 1984
WMS	Work Method Statement

7 APPENDIX A: SPECIFICATIONS OF PROPOSED CUTTER SUCTION DREDGER

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EQUIPMENT SHEET

CYRUS II
CUTTER SUCTION DREDGER

CONSTRUCTION/CLASSIFICATION

Built by	Shipyard "De Merwede"
Year of construction	1978
Year of modification	2003
Classification	RINA Deepsea 100-A-1.1-NAV.I.L.-DG

FEATURES

A heavy duty rock cutting sea-going self-propelled dredger designed for operations in sheltered and coastal waters up to 15 miles offshore.

Suitable for both shallow and deep water conditions.

Equipped for working in hot, tropical climates and isolated locations.

Spud carriage and anchor boom installation.

MAIN DATA

Gross tonnage	3,256
Length overall	107.00 m
Length pontoon	84.70 m
Breadth	19.00 m
Moulded depth	7.60 m
Max. draught	4.85 m
Suction pipe diameter	0.85 m
Discharge pipe diameter	0.85 m
Max. dredging depth	25.00 m
Anchoring system	Spuds/positioning anchors
Sailing speed	11.5 kn
Total installed power	12,904 kW
Cutter output	2,650 kW
Suction pump output	1,764 kW
Inboard pump output	6,250 kW
Propulsion power sailing	3,528 kW

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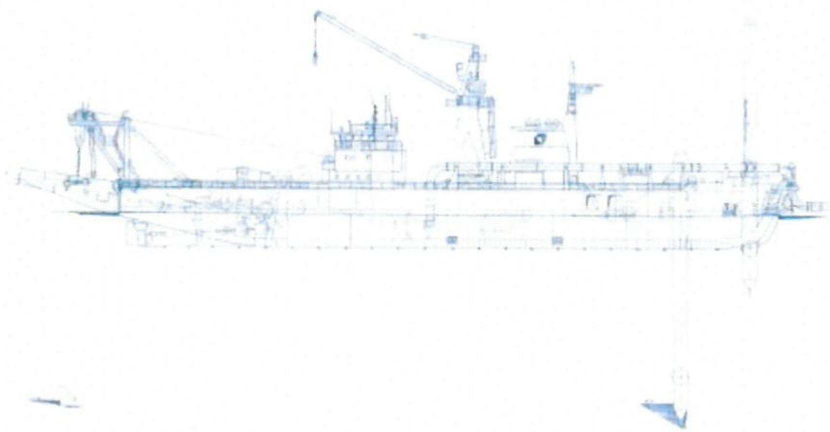
CYRUS II
CUTTER SUCTION DREDGER



SIDE VIEW

TOP VIEW DECK LEVEL

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