Great Lakes Dredge & Dock Company, LLC
Miami Project Office
46 NE 6th Street, 1st Floor
Miami, FL 33132

21 August 2015 Letter No. S-0069

Sent Via Email

Mr. Nestor Rivera
Alternate Administrative Contracting Officer / Resident Engineer
U.S. Army Corps of Engineers, Jacksonville District
Miami Resident Office
3000 SW 148TH Ave.; Suite 251
Miramar, Florida 33027

RE: Contract No. W912EP-13-C-0015
Miami Harbor Deepening Phase 3
Miami-Dade County, FL

Miami Harbor Deepening Phase 3 – Delineation of Potential Sedimentation Effect Area Within Middle and Outer Reef Habitats Rev.2

Dear Mr. Rivera,

Enclosed please find report revision 2 for the One Month Post-Construction Delineation of Potential Sedimentation Effect Area Within Middle and Outer Reef Habitats with appendices. If you have any questions or comments on this matter, feel free to contact Christopher Pomfret at 239-250-0974.

Best Regards,

GREAT LAKES DREDGE & DOCK COMPANY, LLC.

Christopher Dearing

Digitally signed by Christopher Dearing
DN: cn=Christopher Dearing, o=Great Lakes Dredge and Dock Co., LLC, ou, email=cdearing@gldd.com, c=US
Date: 2015.08.21 08:57:45 -04'00'

Christopher Dearing
Contractor Quality Control Manager

CC: Shealy Bowell, USACE
Russ Zimmerman, GLDD
Chris Pomfret, GLDD

Delineation of Potential Sedimentation Effect Area Within Middle and Outer Reef Habitats Port of Miami Phase III Federal Channel Expansion Project FDEP Permit #0305721-001-BI

FINAL

August 2015

Prepared by
Dial Cordy and Associates Inc.
For
Great Lakes
Dredge and Dock Co. LLC

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EXECUTIVE SUMMARY

Potential sedimentation effect surveys were conducted from April 25 to May 22, 2015 within middle (Reef 2) and outer reef (Reef 3) areas north and south of the Miami Harbor Channel, one month after the completion of offshore dredging activities. Due to the lack of knowledge on the state-of-the-benthic resources outside of FDEP mandated monitoring sites prior to the Miami Phase III Federal Channel Expansion Project commencement or during compliance monitoring, a tiered survey approach was developed to: 1) identify potentially impacted and un-impacted areas to the north and south of channel-side sites at middle and outer reef habitats; and 2), to quantitatively describe coral condition using methods consistent with construction monitoring techniques both within and outside potentially impacted areas. Quantitative surveys focused on the documentation of partial mortality of scleractinian corals as the result of sedimentation, as described at channel-side sites, as the primary indicator of a permanent sedimentation effect.

Construction period monitoring results at channel-side sites demonstrated that sedimentation caused partial mortality of coral colonies in low lying areas, primarily around bases, but also in depressions within a colony. Corals in higher relief habitat were not permanently affected by sedimentation as they were able to effectively shed sediment. Partial mortality of hard corals from sedimentation defined the impact for the purposes of this report.

Away from compliance monitoring channel-side sites, natural sedimentation effects cannot be separated from project related sedimentation effects and therefore the results for sites beyond the channel-side sites reflect both natural and project related sedimentation effects on benthic communities.

The potentially impacted area on the middle and outer reefs were proportional to the influence of the hydrodynamics acting in the area of the Miami Harbor Channel. Estimated potential impacts were greatest on the north side of the middle reef and lowest on the south side of the outer reef. In total 213.7 acres of middle and outer reef habitat area was estimated to be potentially impacted. The majority of impact was on the northern middle reef, with more than 60% of the total affected area located on the north side of the middle reef. While sedimentation has affected mostly low lying areas within the 213.7 acres, its effect on hard corals has been much less than the effect of the ongoing white plague disease event on corals within the region.

To date, white plague disease has caused the total mortality of 18.5% (73 out of 400 marked corals) and has affected (either killed or is actively causing mortality) 23.5% of marked corals at permanent monitoring sites throughout the middle and outer reef habitat. In contrast, sediment related total mortality has only affected 1.25% of marked corals at middle and outer reef compliance monitoring sites (5 out of 400 marked corals at middle and outer reef channel-side and reference sites. Whole colony mortality due to white plague disease within compliance monitoring sites began in September 2014. Despite this relatively recent occurence, white plague related mortality represents over 86% of all scleractinian mortality documented at middle and outer reef compliance monitoring sites since baseline surveys. Observations of white plague disease have been made throughout Miami-Dade County, both near and far from the Port Miami project by William Precht of DCA from November 2014 through present (August 2015).

The estimated potential sediment effect area is an overestimation of actual impact, when defined as coral colony partial mortality. The actual impact, defined as coral colony partial mortality, is the impact to those corals within low lying habitat that were affected by sedimentation from the project. The number of corals affected is unknown at this time because low-lying habitat information has not been quantified throughout the hardbottom, middle and outer reef areas with enough precision

to make these determinations. Additional detailed mapping is a next step in quantifying the total sedimentation effect on benthic resources within the middle and outer reef habitat. Therefore the results of this survey represent the potential sedimentation effect area only and are not a detailed assessment of the total impact to benthic resources of the middle and outer reef.

Follow up surveys of the potentially impacted area are required by permit specifications one month after construction and two times in the following year (FDEP SC 32.ii.d). Methods used during follow up surveys may also include the linear regression model study design employed in 2010 baseline surveys (DCA 2012), where sites were surveyed across a spatial gradient away from the channel, using channel-parallel transects, on both the middle and outer reefs. A comparison of scleractinian and octocoral size class and density values with those data from 2010, may reveal additional relevant information. Monitoring sites established in 2013 for construction monitoring (channel-side and reference stations) should continue to be monitored, as these are the sites where the effect of project-related sedimentation has been best characterized and where recovery would best be documented.

In May 2015, the Florida Department of Environmental Protection (FDEP) conducted surveys within the potential impact area on the outer and middle reef using different metrics than those employed by Dial Cordy (DCA). Based upon FDEP survey results, an additional buffer from 250 m to 500 m has been added to the potential sedimentation effect area north of the channel along the outer reef as a precautionary measure. This will insure that any potential permanent impacts following the project, pursuant to State permit condition requirements, are fully addressed.

Lessons learned from the project will be applied in future projects and should include use of appropriate monitoring methods to detect project effects across a larger area.

INTRODUCTION AND BACKGROUND

Great Lakes Dredge and Dock (GLDD) began dredging operations associated with the Port of Miami Phase III Federal Channel Expansion Project in November 2013 under USACE contract W912EP-13-C-0015. Offshore compliance monitoring was required under FDEP permit number 0305721-001-BI any time a dredge was within 750 meters of a channel-side site (Figure 1). Compliance monitoring at middle and outer reef monitoring sites was conducted between November 2013 and December 2014, when dredging was concentrated in offshore areas, and intermittently from January through March 2015, when a dredge was infrequently offshore, and when weather permitted safe diving operations. Monitoring results were reported to the Corps and FDEP through Compliance Week 69/70, when final offshore dredging was completed (March 22, 2015) (Figure 1).

This potential sedimentation effect survey report presents the data collected from April 25 to May 22, 2015 within middle (Reef 2) and outer reef (Reef 3) areas north and south of the Miami Harbor Channel, one month after the completion of offshore dredging activities.

After months of implementing adaptive management strategies for the dredging operations, corals at channel-side sites were still exhibiting "stress above normal" as defined by the FDEP permit. In April 2015, GLDD initiated additional surveys in consultation with the FDEP and Corps per permit language provided in FDEP Permit Specification 32 (a).(ii).(d). The FDEP permit Specific Condition 32.(a).(ii).d required additional surveys to outline the area(s) of impact:

> Any change of 5% or more in cover by any functional group evaluated in quadrats in two or more adjacent transects, or on average for the zone of monitoring on one side of the channel, or **stress expressed above normal by corals and/or octocorals within transects** (stress scale used for Broward County Segment III project) **will require an additional survey to outline the area(s) of impact.** Impacted areas shall continue to be **monitored monthly** during the construction, one month post-construction, and two times during next year in order to document results of the impact. Final monitoring results shall document permanent impacts, if any, to be used for estimates of additional mitigation using UMAM.

Constraints in documenting project effects or impacts

Means and methods to outline the area of impact were not specified in the FDEP permit nor Corps specifications. DCA relied on information gathered during baseline surveys (2010 and 2013), experience during the 1.5 years of compliance monitoring (over 7,000 monitoring dives) at the project sites, the survey and documentation of impact at adjacent hardbottom resources, and local knowledge, to develop a protocol to document and outline a potential impact area on the middle and outer reef beyond the channel-side sites.

Monitoring methods for the construction phase of the project were designed to compare channel-side sites (effect) to more distant reference (no effect) sites in order to measure project-related effects. No data were required to be collected at locations in between FDEP defined channel-side and reference sites during baseline (2013) or compliance monitoring. This dearth of data has created a knowledge gap, the condition of the benthic habitats between channel-side sites and control sites immediately before, during and after the project were not documented in a systematic way. As a result, natural sedimentation effects cannot be separated from project related sedimentation effects in this post-hoc survey approach.

For this reason, "potential" sedimentation effect area is used throughout the document to describe effects or impacts that may be attributed to the project and/or to natural background sedimentation.

Potential Sedimentation Effect Area and Impact Assessment Approach

This potential sedimentation effect report is an estimate of potential sedimentation effect area and permanent project-related impacts to middle and outer reef benthic resources. Due to the lack of knowledge on the state-of-the-benthic resources between the FDEP defined channel-side and control sites, a tiered survey approach was developed to: 1) identify potentially impacted and un-impacted areas to the north and south of channel-side sites at middle and outer reef habitats and 2), to quantitatively describe coral condition using methods consistent with construction monitoring techniques both within and outside potentially impacted areas. Quantitative surveys focused on partial mortality of scleractinian corals documented as the result of sedimentation, as described at channel-side sites, as the primary indicator of a permanent sedimentation effect.

Scientific observations over the course of the compliance monitoring time period at channel-side sites documented partial mortality of hard coral colonies, but did not document partial mortality, or other measureable deleterious effects of sedimentation on sponges, octocorals or zoanthids. Macroalgae and turfs were not considered as a proxy for impact due to their ephemeral nature. Therefore, this impact assessment relied upon partial mortality of coral colonies to document a potentially affected area.

Middle and Outer Reef Background

The relict reefs of southeast Florida extend from Miami-Dade to Palm Beach County and were formed during the Holocene (Banks et al. 2007). Nearshore hardbottom areas (patch reefs) and parallel ridges or reefs lie offshore in a shore-parallel position, and are dominated by macroalgae, octocorals, sponges and to a lesser extent hard corals (Moyer et al. 2003, Gilliam 2007). Throughout this report, these reef areas are referred to as second or middle reef; and third or outer reef after Moyer et al. (2003) and local nomenclature (personal communication Steve Blair, DERM, April 8, 2010).

Pilot Study 2009 Summary

A Pilot Study was conducted in October 2009 to define hardbottom habitat types within the study area, based on landscape and biological characteristics, so that statistically valid comparisons could be drawn between the habitat types in the Quantitative Baseline Study which followed in 2010 (for full details see DCA 2010). The results of the Pilot Study guided the design for the full Quantitative Baseline Study plan to assess the distribution and abundance of benthic organisms adjacent to the channel in consultation with FDEP, NMFS and the USACE. The study area included hardbottom, second, and third reef sites within 150 meters (m) of the existing outer entrance channel, and also included north and south reference or control sites located on hardbottom, second, and third reefs at comparable depths. Methods were developed to test project hypotheses in consultation with agencies in 2009. The following is excerpted from the Pilot Study Report (DCA 2010):

> To determine a representative sample size for each habitat type, sampling was performed assessing the variance associated with the parameters to be evaluated in the quantitative assessment (e.g., coral colony density and species richness). This variance was used in a power analysis to determine the optimal sample size required to be able to test the project hypotheses.
>
> Minimum detectable difference tests were conducted to detect a 5% change at p=0.05 with a power of 0.80 for macroalgae cover and octocoral counts. Macroalgae cover was the most common cover type besides sand pavement rubble (SPR), while octocorals represent the most abundant organism of interest

across sites. Since scleractinians were rarer than octocorals, it was not considered necessary to conduct minimum detectable difference tests for scleractinians, which would inevitably require a greater sampling effort.

The required sample sizes to detect a 5% change in macroalgae cover at p=0.05 with a power of 0.80, ranged from 275 to 450 transects per site. Octocoral variances were also high. The required sample sizes to detect a 5% change at p=0.05 with a power of 0.80 for octocorals would start at 2200 transects per site. These results show that an ANOVA approach was not practical to carry out in this variable and patchy environment.

Due to the low cover and high patchiness of hard corals and octocorals at the Pilot Study sites, a regression-based approach on the second and third reefs, beginning adjacent to the channel, was recommended for the Quantitative Baseline Study Plan. For nearshore hardbottom communities west of the second reef, a stratified random approach was recommended, based upon octocoral and scleractinian colony density within treatment and control sites identified during the Pilot Study. It was also recommended that all areas be sampled using colony counts rather than estimates of cover, due to the low cover of benthic organisms.

By following the linear regression model study design, post-construction surveys conducted after the dredging operation would allow comparison with the pre-dredging data. Effects of the dredging operation on the second and third reefs, should they have occurred, would be detectable as a significant difference between the pre- and post-dredging states in the relationship between distance from the channel and the magnitude of change. Effects on hardbottom sites would be detectable as significant interaction terms of ANOVA between time (before *versus* after dredging) and treatment (indirect-effect *versus* reference).

Baseline 2010 Summary

Using the results of the Pilot Study, a regression model study was implemented in 2010 to characterize pre-dredging benthic communities across a spatial gradient away from the channel. The study area is located in central Miami–Dade County, along reefs east of the Port of Miami entrance channel (Figure 1). The relict reefs of southeast Florida extend from Miami–Dade to Palm Beach County and were accretional reefs during the early Holocene Epoch, from approximately 10,000 to 6,000 years ago (Banks et al. 2007). Today, nearshore hardbottom areas (patch reefs) and parallel ridges or reefs lie offshore in a shore-parallel orientation, and are dominated by macroalgae, octocorals, sponges, and to a lesser extent hard corals (Moyer et al. 2003, Gilliam 2007, DCA 2012, 2014).

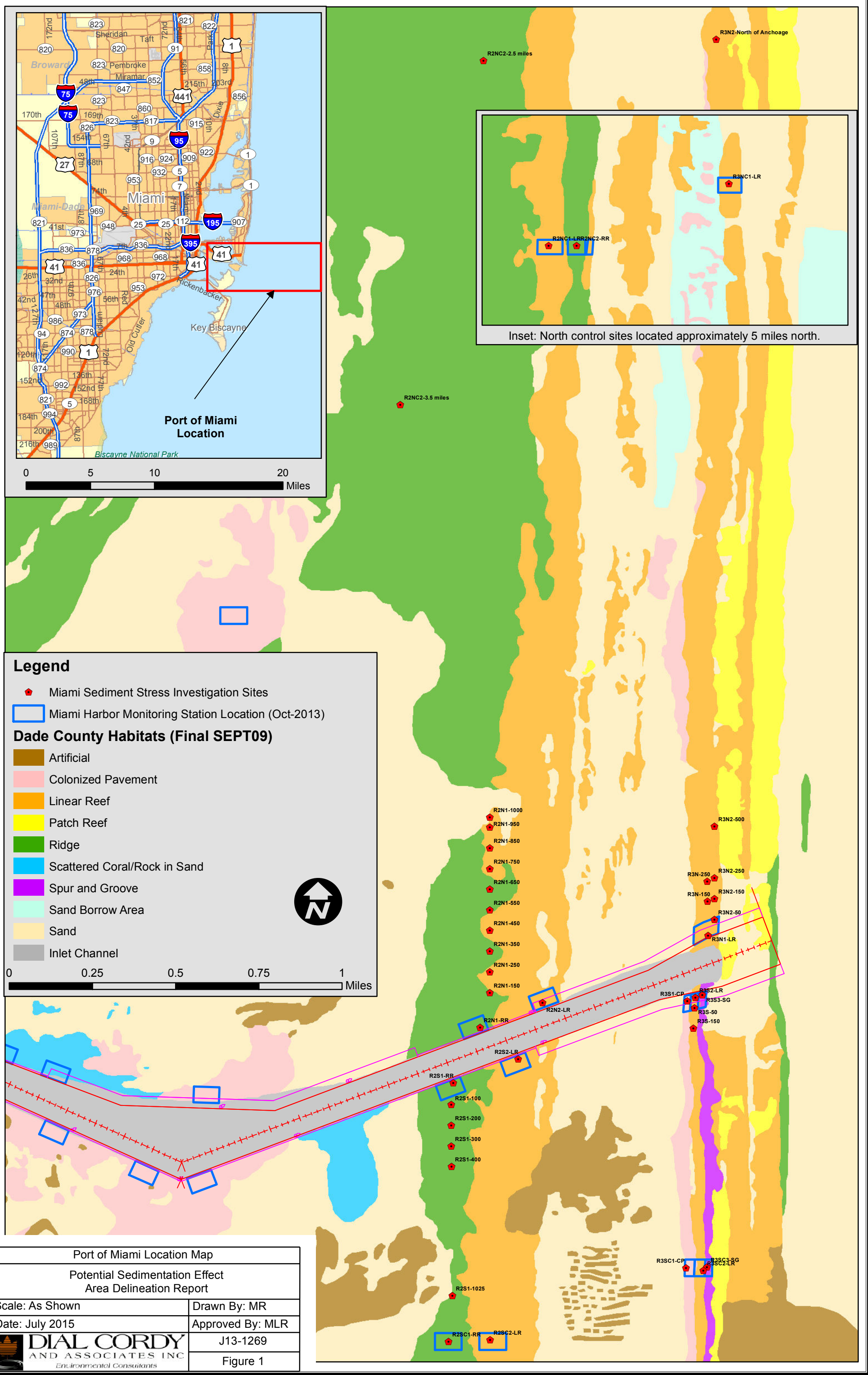
In 2010 the Corps conducted baseline studies to characterize the nearshore, middle and outer reefs in the vicinity of the Miami Phase III dredging project. This baseline study was designed to study the reef areas adjacent to the project and away from the project looking at regularly spaced transects from channel-side to as much as 450 m away from the channel on the north side and 500 m away from the channel on the south side. The study was designed through consultation and coordination with FDEP, NMFS and the Corps to answer the questions:

- What are the pre-disturbance population levels of benthic organisms along a distance gradient (450 m north and up to 500 m south) from the Miami Harbor entrance channel on the second and third reef?

- What are the pre-disturbance population levels of benthic organisms in indirect-effect areas of nearshore hardbottom habitat and associated reference sites?

- What are the pre-disturbance biological characteristics of the benthic populations on Reef 3 within the direct-effect area?

Baseline 2010 results revealed that nearshore hardbottom, second and third reef sites, which were within 450 m north and 500 m south of the Miami entrance channel, were colonized by sponges, octocorals and scleractinian corals, in decreasing order of abundance. The majority of scleractinians were smaller than 10 cm, and octocorals were generally smaller than 25 cm. Octocorals were more dominant in nearshore hardbottom and middle reef areas, whereas sponges were more abundant on the middle and outer reefs. Scleractinians were low in abundance across nearshore hardbottom, middle and outer reefs. Scleractinian density ranged from 0.2 to 4.7 colonies per square meter across sites on Reef 2 and Reef 3, adjacent to and away from the channel as much as 450 m to the north or 500 m to the south. These reefs had little relief or rugosity; and the areas of highest relief were adjacent to the channel or occurred in isolated patches away from the channel. Typical subtropical macroalgae, including *Dictyota*, cyanobacteria, and turf algae were common throughout the study area in 2010. The herbivorous sea urchin *Diadema antillarum* were extremely rare across all sites (DCA 2012).



Port of Miami Location Map	
Potential Sedimentation Effect Area Delineation Report	
Scale: As Shown	Drawn By: MR
Date: July 2015	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J13-1269
	Figure 1

Natural sedimentation was noted at middle reef channel-side sites during the 2010 baseline survey as seen in photos below (Photos 1-3). During that survey period (July 27-August 12, 2010), a fine white sand was noted throughout the habitat and visibility ranged from 20 to 30 feet. Suspended sediment (particles in the water column) was noted on almost all dives conducted in 2010.

Photo 1. Landscape view of north side of channel, middle reef habitat, 10m from the channel edge, summer 2010.

Photo 2. Close up of sponge community on north side of the channel, middle reef habitat, 10m away from channel edge, summer 2010.

Photo 3. Landscape of middle reef, 400 m north of the channel in the summer of 2010. Notice partial mortality of coral colony in left foreground and white appearance of sediment.

Outer reef channel-side sites were largely barren in 2010, being comprised of ancient (fossil and sub-fossil) cemented *Acropora* plates (Lighty 1980), while the north side of the channel had greater relief and a more robust benthic community (Photos 4 and 5). These conditions were consistent with baseline 2013 results and are also consistent with present day observations.

Photo 4. Landscape view of north side of outer reef, 10m away from new channel edge in summer, 2010.

Photo 5. Landscape view of the south side of the outer reef, 10 m away from the new channel edge in 2010. Note exceedingly low cover of stony corals at these sites.

Baseline 2013 Summary

In 2013 pre-construction baseline surveys were conducted using methods proscribed by FDEP permit between October 18 and December 30, 2013. Middle reef sites included 11-17 coral species, with colony density ranging from 0.95 to 2.49 colonies per square meter across the FDEP defined monitoring station sites. The greatest proportions of corals were in the 10-15 cm size range. Coral cover was low at all middle reef sites ranging from 0.54% (R2N2) to 2.55% at the middle reef northern control site (R2NC2). The top three benthic functional group categories were crustose turf and bare substrate (CTB), octocorals, and zoanthids at middle reef sites (DCA 2014).

Outer reef sites included 10-15 coral species, with colony density ranging from 1.03 to 3.51 colonies per square meter across all sites. The greatest proportion of coral colonies at outer reef sites were in the 10-15 cm size range. Coral cover was even lower at the outer reef sites with cover ranging from 0.14% (R3S1) to 1.29% at R3SC2. The top three functional group categories at outer reef sites were CTB, octocorals, and sponges (DCA 2014).

Throughout the project area, numerous colonies of coral *Solenastrea bournoni* started to show outward signs of distress in the late fall of 2013 prior to project commencement. This included disease-like symptoms with mottled coloration and necrotic tissues. As many as 6% of corals at middle and outer reef survey sites were documented with this unknown disease during baseline surveys. Marked corals exhibiting these symptoms are being followed to understand the spread and causality of this coral malady and its impacts on the overall health of the ecosystem (Dial Cordy 2014). These observations were made at both control and channel-side sites. This unknown disease/mottled bleaching syndrome was also documented during the same time period by Ken Nedimyer of the Coral Restoration Foundation at Carysfort Reef in the Florida Keys National Marine Sanctuary (Coral Restoration Foundation personal communication). White plague disease was noted on two permanently marked corals colonies during baseline surveys (DCA 2014).

Baseline quantitative sediment sampling results from middle and outer reef sites documented different average daily sedimentation rates between reef areas (middle and outer) and between channel-side and reference sites. Middle reef sites average daily sedimentation rates were higher than outer reef rates for both coarse (≥ 230 sieve) fraction and fine (< 230 sieve) fraction material. Channel-side sedimentation rates were similar to reference site rates at middle reef southern sites and outer reef sites. Northern middle reef channel-side sedimentation rates were higher than

northern middle reef reference sites. Channel-side sites may have different sedimentation rates when compared to reference (control) sites since the water quality and hydrodynamics of channel-side sites are different than their natural reef reference counterparts (DCA 2014). Photos of middle reef channel-side habitat during baseline studies in 2013 are displayed in Photo 6 and 7.

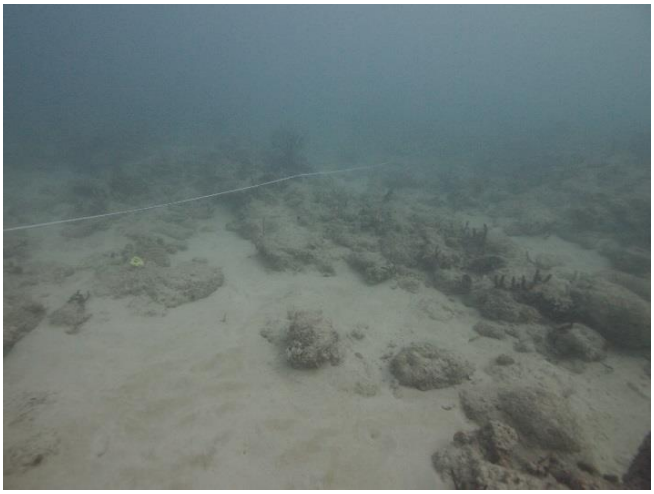


Photo 6. Landscape view of R2N2 during baseline surveys, November, 2013.

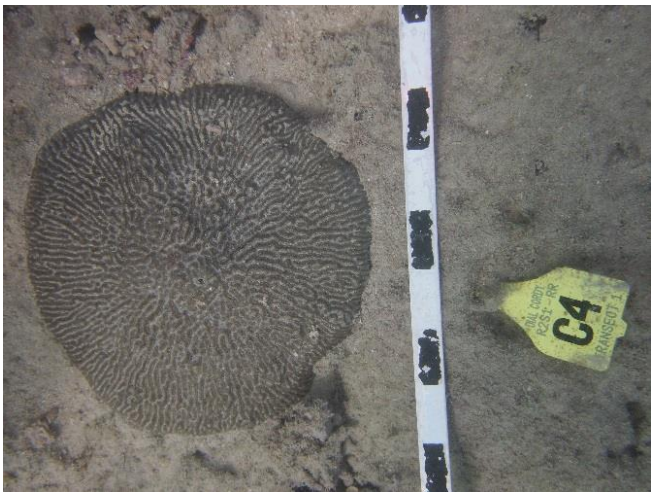


Photo 7. Marked coral colony at R2S1 during baseline surveys (condition code sediment accumulation - SA), November 2013.

Hydrodynamics of the Middle and Outer Reefs

The Miami Harbor Entrance Channel, which is deeper than the surrounding hardbottom, middle and outer reefs, funnels Bay and inland waters from the metropolitan area of Miami-Dade County including discharge of the Miami River. Strong tidally-driven currents associated with the deeper channel water move west to east and east to west effecting channel-side communities twice a day. As you move away from the coast, the tidal effect diminishes, thus hardbottom areas are most affected, middle reef is less affected and the outer reef is least affected by east-west currents and effluent from within the Bay. Similarly, as you move north or south away from the channel, reef areas are less affected by the channel, although there is also influence from Bay waters to the south, from Fisherman's Channel and Norris Cut. During the impact assessment survey period

of April and May 2015, a strong north current prevailed on the middle reef, with tidally transported estuarine waters regularly washing over the middle reef beyond the channel edge, creating low visibility underwater. Although the same northbound current was present on the outer reef, the turbid water from the Bay was not observed at the outer reef during the sampling period, although periods of high winds did create turbidity on the outer reef and reduce visibility during the survey period. A study by the USACE (Figure 2) documented current velocities and direction, demonstrating that eddies may concentrate material on the north side of the middle reef and hardbottom habitat (USACE 2006). Greater deposition on the north side of the middle reef is also consistent with baseline sedimentation study results (DCA 2014).

The hardbottom and northern middle reef is subject to higher sedimentation levels than the outer reef or the south sides of the middle reef, as observed during the compliance monitoring time period. Leading up to and during the course of impact assessment surveys, numerous dives on the north side of the middle reef were conducted in 3-5 feet of visibility. A fine layer of brown silt was commonly found away from the channel on the north side of the middle reef, suggesting a background source of deposition that contributes to the condition of these benthic resources with or without dredging activity. Unfortunately, without pre-construction data, there is no way to distinguish between natural influences versus deposition that may have been associated with the project.

Legend

- Potential Impact Area Investigation Site
- POM Anchorage Area Boundary
- Miami Harbor Monitoring Station Location (Oct-2013)
- Existing Channel Limits

Dade County Habitats (Final SEPT09)

Type

- Artificial
- Colonized Pavement
- Linear Reef
- Patch Reef
- Ridge
- Scattered Coral/Rock in Sand
- Spur and Groove
- Sand Borrow Area
- Sand
- Inlet Channel

0 200 400 800 1,200 Meters

HBNC1-CP
HBN1-CR
HBN2-CR
HBN3-CP
HBS1-CP
HBS2-CP
HBS4-CR
HBS3-CP
R2N1-1000
R2N1-950
R2N1-850
R2N1-750
R2N1-650
R2N1-550
R2N1-450
R2N1-350
R2N1-250
R2N1-150
R2N1-RR
R2S2-LR
R2S1-RR
R2S1-100
R2S1-200
R2S1-300
R2S1-400
R2S1-1025
R2SC1-RR
R2SC2-LR
R2N2-LR
R3N2-500
R3N-250
R3N2-250
R3N-150
R3N2-150
R3N2-50
R3N1-LR
R3S1-CP
R3S2-LR
R3S3-SG
R3S-50
R3S-150
R3SC1-CP
R3SC3-SG
R3SC2-LR

Port of Miami Current and Volume Flow Map (USACE 2006)	
Potential Sedimentation Effect Area Delineation Report	
Scale: 1 inch = 400 meters	Drawn By: MR
Date: July 2015	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J13-1269
	Figure 2

METHODS

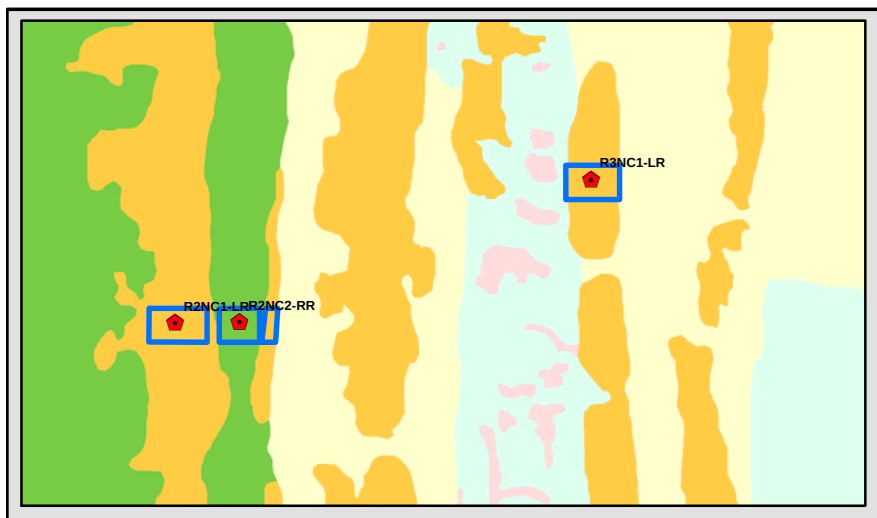
A tiered survey approach was developed to investigate the condition of benthic resources of middle and outer reef habitats and identify areas where permanent impacts to benthic resources have potentially occurred as an effect of project activities between April 26, 2015 and May 22, 2015. Initial survey work included the quantitative and qualitative assessment of reference and channel-side sites, since a month or more had passed since the last surveys at these sites (March 2015) (DCA 2015). In this way, scientific divers familiarized themselves with current conditions of benthic resources (more than a month after final offshore dredging, but more than four months after heavily concentrated dredging ceased) at reference and channel-side sites. Figure 3 depicts all qualitative and quantitative survey locations. All site summaries are reported in Appendix A. Photos presented in this report may include a 12 inch ruler or a black and white scale bar. Black and white blocks within the scale bars are 5 cm in length.

Qualitative Assessment Survey

Qualitative methods were used as a preliminary assessment tool to document conditions at locations within middle and outer reefs between reference and channel-side sites. Scientific divers began by surveying conditions at reference sites. Once conditions at the reference sites had been revisited, divers proceeded toward the channel from the reference sites and conducted bounce dives to qualitatively estimate zones of influence (impacted v. un-impacted). In the case of the southern outer reef, because reference sites were similar to channel-side sites in terms of partial mortality and turf presence, qualitative surveys were conducted from near the channel-side edge, south towards the reference area. During each qualitative survey divers recorded observations on landscape, community and individual benthic organisms, as well as representative photographs of the sites. Qualitative notes were collected for each dive location and included:

- Presence of benthic organisms and distribution of sizes
- Qualitative characteristics of benthic sediment
- Presence or absence of clay-like material
- Presence and appearance of turf algae
- Presence and appearance macroalgae
- Presence of sedimentation in the water column
- Depth of sediment
- Presence of partial mortality consistent with channel-side sites on hard corals
- Presence of disease on benthic fauna

Due to the variability of all of these parameters across sites, the presence of partial mortality on scleractinian corals was most heavily relied upon to determine whether a location was defined as a potential impact site or area. Coral partial mortality was differentiated from coral disease partial mortality because in most cases, coral mortality associated with disease was directional, affected a majority of the colony and not just sediment affected areas. White plague was present on corals regardless of relief of habitat, whereas partial mortality occurred in areas that were low lying, or depressions. Scientific observations over the course of the compliance monitoring time period at channel-side sites documented partial mortality of hard coral colonies, but did not document partial mortality, or other measureable deleterious effects of sedimentation on sponges, octocorals or zoanthids. Macroalgae and turfs were not considered as a proxy for impact due to their ephemeral nature. Functional groups of interest (scleractinians, octocorals, and sponges) were low in abundance and patchy in their spatial distribution. Therefore, percent cover values obtained from video transects data analysis were low and highly variable, making percent cover of these groups an impractical indicator for potential impact (DCA 2010 and DCA 2015). Therefore, this impact assessment relied upon partial mortality of coral colonies to document the potentially affected area.



Inset: North control sites located approximately 5 miles north.

R2NC2-2.5 miles

R3N2-North of Anchoage

R2NC2-3.5 miles

Legend

- Miami Sediment Stress Investigation Sites
- POM Anchorage Area Boundary
- Miami Harbor Monitoring Station Location (Oct-2013)

Dade County Habitats (Final SEPT09)

- Artificial
- Colonized Pavement
- Linear Reef
- Patch Reef
- Ridge
- Scattered Coral/Rock in Sand
- Spur and Groove
- Sand Borrow Area
- Sand
- Inlet Channel

0 0.25 0.5 0.75 1 Miles

R2N1-1000
R2N1-950
R2N1-850
R2N1-750
R2N1-650
R2N1-550
R2N1-450
R2N1-350
R2N1-250
R2N1-150
R2N2-LR
R2N1-RR
R2S2-LR
R2S1-RR
R2S1-100
R2S1-200
R2S1-300
R2S1-400
R2S1-1025
R2SC1-RR
R2SC2-LR

R3N2-500
R3N-250
R3N2-250
R3N-150
R3N2-150
R3N2-50
R3N1-LR
R3S1-CP
R3S2-LR
R3S3-SG
R3S-50
R3S-150
R3SC1-CP
R3SC3-SG
R3SC2-LR

Potential Sedimentation Effect Study Sites	
Potential Sedimentation Effect Area Delineation Report	
Scale: 1 inch = 0.25 miles	Drawn By: MR
Date: July 2015	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J13-1269
	Figure 3

Quantitative Assessment and Scleractininan Condition Surveys

Quantitative assessment of coral condition for the middle and outer reef delineation of potential impact assessment were conducted at all FDEP required monitoring stations in the middle and outer reef habitat. Temporary sites that represent un-impacted, and potentially impacted areas that were identified during the qualitative middle and outer reef surveys were also surveyed in a manner consistent with FDEP required compliance monitoring.

Temporary sites were chosen based on qualitative surveys as described above. To the greatest extent practical three temporary transects, 20 m in length and approximately 5 m apart were placed in a north to south direction to be consistent with compliance monitoring site methods. See Appendix B for site maps for all surveyed sites.

Video transect data were collected following compliance monitoring methods, 40 cm above the bottom at a pace of ~5m/minute. Video was collected for the record and colony counts for octocorals and hard corals were performed in the laboratory. Upright octocorals were counted by the presence of a holdfast. Encrusting octocorals were identified by the mat and polyps if visible or by the lack of polyp structure when compared to *Palythoa* mats. Living hard corals were counted if corallite structure was visible, generally corals identified were 3 cm or greater. Appendix C includes the octocoral and hard coral count data from video transects, as well as calculated density values based on the video transect length and width (0.40 m X 20 m) X 3 transects for a total of 24 m^2 per site.

Surveys were completed between April 25, 2015 and May 22, 2015. Video documentation of the transects at the FDEP required project monitoring stations and temporary transects were collected, but not analyzed. The following language from the FDEP permit describes the method for surveys for coral health (SC 32.(a).(i)):

> A) Construction surveys shall be conducted at each transect within each monitoring station by qualified biologists and involve:
>
> 1) Evaluating benthic organisms (scleractinian corals, octocorals, sponges, etc.) for standing sediment that is not removed by normal currents or wave action;
>
> 2) Evaluating scleractinian corals along each transect for additional indications of sedimentation stress such as excessive mucus, extruded polyps, and color changes (bleaching or paling). All scleractinian corals on each transect will be assessed for each of the health parameters and assigned a health level of "0" or "1" for each parameter (A score of "0" would indicate no observed bleaching, excess mucus production, polyp extension, or disease, while a "1" would be indicated for each observed parameter – please see example below). These data will be collected for each project area transect and each control area transect.

Permanently marked (tagged) corals and corals on temporary transects were evaluated by qualified marine biologists during monitoring events for indications of stress and/or standing sediment not moved by normal waves or current action. During underwater surveys (*in situ*), corals are assigned a "0" (normal or non-stressed) or "1" (stressed), and photographed. If a "1" is assigned to a coral, a code or description is recorded on the data sheet. Descriptions of possible conditions and observations are provided in Table 1. Comparisons are made between reference and channel-side sites for a side (north or south). For example all southern channel-side sites are compared to their reference within the same monitoring period, (e.g. R2SC1 v. R2S1). In addition, temporary transects were compared to their closest control for significance testing.

Table 1 Possible stress indicators for permanently marked scleractinians receiving a "1" during *in situ* surveys.

Condition	Cause	Appearance
Polyp Extension	Stress and feeding	Tentacles are extended on 100% of polyps on the colony.
Mucus	Sediment stress/Lunar cycle	Excessive mucus production results in a mucus film, strands of mucus, and/or sediment balled up in mucus.
Paling	Stress/Elevated Irradiance/Temperature	Live tissue with some loss of color.
Partial Bleaching	Stress/Elevated Irradiance/Temperature	Patches of fully bleached or white tissue.
Bleaching	Stress/Elevated Irradiance/Temperature	Live tissue with complete loss of color across the entire colony.
Black Band Disease	Stress	Black band surrounds dead patch.
White Band Disease	Stress	White lines or bands of recently dead coral tissue found in species of the genus *Acropora*.
White Plague Disease	Stress	White lines or bands of recently dead coral tissue affecting non-*Acroporid* corals.
Yellow Band	Stress	Yellow band surrounds dead patch.
Dark spot	Stress	Dark spots on otherwise normal *Siderastrea* spp.
Fish bites	Grazing	Bites of live tissue removed.
Unknown *Solenastrea* Disease	Stress	Patchy discoloration of living tissue resulting in a mottled bleached appearance. Only noted for *Solenastrea* spp.
Unknown Condition	Stress	Discoloration of living tissue from an unknown cause. Not related to known bleaching or disease indicators.
Cliona delitrix	Competition	Red boring sponge present on colony. Typcially accompanied by tissue mortality radiating outward from the point of sponge emergence.
Physical Disturbance	Abrasion	Abrasion or physical disturbance such as a gouge or a nick, not in a discernable pattern like fish bites.
Sediment Accumulation	Sedimentation	Moderate sediment accumulation on top of colony (more than dusting). Accumulation in grooves and/or between polyps.
Partial Burial	Sedimentation	Portion(s) of the colony buried by sediment.
Burial	Sedimentation	Entire colony buried by sediment.
Recent Partial Mortality	Sedimentation	Partial mortality of coral colony appears white with no live polyps visible. Generally, occurs around the margin of the colony. Visible when sediment recedes.
Unknown Partial Mortality	Stress	Tissue mortality from an unknown cause.
Competitive Mortality	Competition	Recent partial mortality from a competition event. Typically the result of sponge or zoanthid overgrowth.
Complete Mortality	Any	Death of the entire colony; no live tissue remaining on the skeleton.

Sediment Stress

Of the coral stress indicators evaluated during compliance monitoring several were specifically targeted to evaluate the effect of sedimentation of corals. Sediment dusting (SED) was not considered a "stress" indicator and was given a condition score of zero. SED was a low amount, a "dusting", of sediment on top of the coral. Sediment accumulation (SA), was an accumulation of sediment ontop of the coral, between polyps, or within grooves and was qualitatively more than a dusting of sediment. Partial burial (PBUR) was the accumulation of sediment around the base of the coral, sometimes in the form of a berm, and burial (BUR) was the complete burial of the coral colony by sediment. Recent partial mortality (PM) was the observation of dead coral skeleton where sediment had previously accumulated around a coral colony. Of these sediment stress indicators, sediment dusting, sediment accumulation, partial burial, and complete burial by sediment were ephemeral indicators of coral stress that could be alleviated by water movement and/or physical removal of sediment by the coral. Partial mortality (PM) however was an indicator of permanent impacts of sediment stress to coral colonies. Due to the ephemeral nature of sediment dusting, sediment accumulation, partial burial, and burial on the health of coral colonies, only partial mortality due to sediment is used here to quantify potential permanent impacts of sedimentation to coral colonies. However, the quantitative evaluation of sediment dusting, sediment accumulation, partial burial and burial indicators at quantitatively sampled sites is provided in Appendix D. For the purpose of evaluating the permanent impact of sediment stress on middle and outer reef resources our results focus on the extent and degree of partial mortality due to sedimentation found on middle and outer reef resources.

Photo 8a. Example of coral partial mortality due to sedimentation prior to sedimentation, during, and with sand removed.

Photo 8b. Example of coral partial mortality due to sediment as documented on temporary transect during impact assessment surveys. (Note there is no definitive way to differentiate source of sedimentation – natural v. project).

At compliance monitoring sites, two types of sediment related partial mortality have been identified; rings of mortality near the base of the colony, and small patches of mortality near topographical depressions (Photo 8). The ring of partial mortality due to sediment accumulation is the most common type of sediment-related mortality found at channel-side sites. Formed by the accumulation of sediment at the base of the coral colony due to active processes of sediment removal, these rings were often found on flat to mounding coral colonies during periods of heavy sediment accumulation which most often resulted in partial burial or burial. A second example of sediment related partial mortality was noted for corals located within topographical depressions. In this case, sediment accumulated within a natural depression in the reef structure and surrounded a portion of the colony base with sediment that was not moved by the colony or water flow. If the sediment remained in the depression for an extended period of time it caused small patches of sediment related partial mortality. Sediment related partial mortality is present at both channel-side and control sites within the project area, as sediment is a natural part of the system. The two types of coral partial mortality were visually distinguishable from white plague related mortality that was often directional and covered most if not all of the coral skeleton (Photo 9).

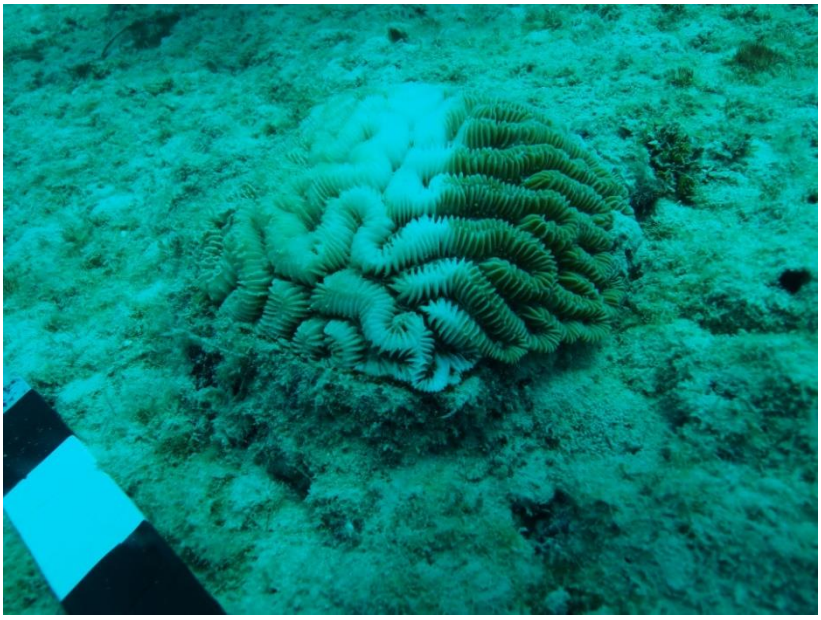


Photo 9. *Meandrina meandrites* affected by white plague disease.

The collection of data on partial mortality caused by sedimentation and other coral stress conditions were assigned in the field during data collection. QA/QC was conducted on photos for all coral conditions in the laboratory. Data were entered into an Excel spreadsheet for analysis.

For the purposes of the impact assessment, partial mortality was evaluated at temporary locations between middle and outer reef compliance monitoring sites. Sediment-related partial mortality was assessed as any partial mortality observed by divers that resembled the ring or patch descriptions of sediment related impacts at compliance monitoring sites. Corals with existing sediment accumulation on the coral surface were fanned to view the health of the underlying skeleton. If partial mortality was documented with crustose coralline algae or other benthic organisms growing from previously living coral skeleton, this mortality was determined to be of greater age than that produced from project related activities and were not assigned sediment-related partial mortality stress code.

At permanent compliance monitoring sites, partial mortality due to sediment was established using permanently marked coral data collected during compliance and impact assessment monitoring periods. As a result, any partial mortality due to sedimentation observed by a diver during the 70 weeks of compliance monitoring or during the impact assesssment period was included in the evaluation of partial mortality by sediment at compliance monitoring sites. The combined data ensured that all measures of sediment related partial mortality were included in the evaluation of the impact assessment.

Impact Determination

Based upon the qualitative and quantitative surveys a potential impact area was estimated for each reef and side on middle and outer reefs. For the purposes of this report an area or location was designated as potentially impacted if:

> Qualitative or quantitative surveys documented overall benthic community characteristics and coral partial mortality consistent with that caused by sedimentation found at channel-side sites.

A location or area was designated as un-impacted if:

> Qualitative or quantitative surveys documented overall benthic community characteristics and coral partial mortality consistent with that at compliance monitoring reference sites.

RESULTS

Delineation of potential impact area

A total of 51 surveys were conducted between April 25, 2015 and May 22, 2015 at sites across middle and outer reefs (Table 2, Figure 3). Environmental conditions during surveys varied from excellent visibility (40 feet) to poor visibility (5 feet), currents also varied, from no current to current of approximately 1 knot. Current movements were always to the north, with the exception of one day on the outer reef, when a south-flowing current was present. Table 2 shows the list of survey sites visited and their chronological order. Temporary sites are named according to their linear distance from the channel, or in the case of R2NC2-2.5 miles and R2NC2-3.5 miles, their distance south of the named control site. Quantitative surveys were performed at all compliance monitoring sites and at the following temporary transects: R2S1-200, R2S1-400, R2N1-550, R2N1-850, R3S-50, R3S-150, R3N2-150, R3N2-250.

Table 2 Site name, date and data collected at each site for impact assessment surveys.

Site	Date Surveyed	Data Collected	Status
R3SC3	April 25, 2015	Quantitative and Qualitative	Compliance Reference
R3SC2	April 25, 2015	Quantitative and Qualitative	Compliance Reference
R3SC1	April 25, 2015	Quantitative and Qualitative	Compliance Reference
R3S3	April 25, 2015	Quantitative and Qualitative	Compliance Channel-side
R3S2	April 25, 2015	Quantitative and Qualitative	Compliance Channel-side
R3S1	April 26, 2015	Quantitative and Qualitative	Compliance Channel-side
R3S2-200m line	April 26, 2015	Quantitative and Qualitative	Delineation only
R3S1-200m line	April 26, 2015	Quantitative and Qualitative	Delineation only
R3NC1	April 26, 2015	Quantitative and Qualitative	Compliance Reference
R3N1	April 26, 2015	Quantitative and Qualitative	Compliance Channel-side
R3N2-500	April 27, 2015	Qualitative	Delineation only

Site	Date Surveyed	Data Collected	Status
R3N2-north of anchorage	April 27, 2015	Qualitative	Delineation only
R3N2-250	April 27, 2015	Qualitative	Delineation only
R3N2-150	April 27, 2015	Qualitative	Potentially Impacted
R3N2-50	April 27, 2015	Qualitative	Potentially Impacted
R2NC2	May 11, 2015	Quantitative and Qualitative	Compliance Reference
R2NC2-2.5 miles	May 11, 2015	Qualitative	Delineation only
R2N1-1000	May 11, 2015	Qualitative	Delineation only
R2N1-950	May 11, 2015	Qualitative	Delineation only
R2NC2-3.5 miles	May 11, 2015	Qualitative	Delineation only
R2N1-750	May 11, 2015	Qualitative	Delineation only
R3S-50	May 13, 2015	Quantitative and Qualitative	Un-impacted
R3S-150	May 13, 2015	Quantitative and Qualitative	Un-impacted
R3N-150	May 14, 2015	Quantitative and Qualitative	Potentially Impacted
R3N-250	May 14, 2015	Quantitative and Qualitative	Un-impacted
R2N1-650	May 14, 2015	Qualitative	Delineation Only
R2NC1	May 19, 2015	Quantitative and Qualitative	Compliance Reference
R2NC2	May 19, 2015	Quantitative and Qualitative	Compliance Reference
R2N1	May 19, 2015	Quantitative and Qualitative	Compliance Channel-side
R2N2	May 19, 2015	Quantitative and Qualitative	Compliance Channel-side
R2SC1	May 19, 2015	Quantitative and Qualitative	Compliance Reference
R2SC2	May 19, 2015	Quantitative and Qualitative	Compliance Reference
R2S1	May 20, 2015	Quantitative and Qualitative	Compliance Channel-side
R2S2	May 20, 2015	Quantitative and Qualitative	Compliance Channel-side
R2SC1-1025m	May 20, 2015	Qualitative	Delineation only
R2SC1	May 20, 2015	Qualitative	Compliance Reference
R2S1-400	May 20, 2015	Qualitative	Delineation only
R2S1-200	May 20, 2015	Qualitative	Delineation only
R2S1-300	May 20, 2015	Qualitative	Delineation only
R2S1-400	May 21, 2015	Quantitative	Un-impacted
R2S1-200	May 21, 2015	Quantitative	Potentially Impacted
R2N1-750	May 21, 2015	Qualitative	Un-impacted
R2N1-650	May 21, 2015	Qualitative	Potentially Impacted
R2N1-550	May 21, 2015	Qualitative	Potentially Impacted
R2N1-450	May 21, 2015	Qualitative	Potentially Impacted
R2N1-350	May 22, 2015	Qualitative	Potentially Impacted
R2N1-250	May 22, 2015	Qualitative	Potentially Impacted
R2N1-150	May 22, 2015	Qualitative	Potentially Impacted
R2N1-550	May 22, 2015	Quantitative and Qualitative	Potentially Impacted
R2N1-950	May 22, 2015	Qualitative	Delineation only
R2N1-850	May 22, 2015	Quantitative and Qualitative	Un-impacted

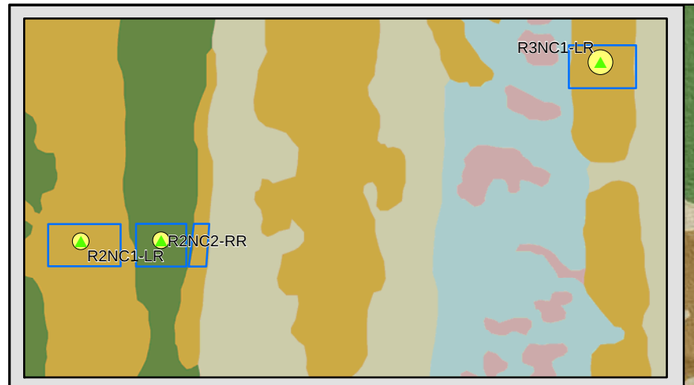
Quantification of Impact Acreage

Based on the surveys conducted between April 25, 2015 and May 22, 2015 the area of potential impact has been estimated as 213.7 acres across middle and outer reef habitats (Figure 4; Table 3). The potentially impacted area was not equally distributed across reef type or side. More than 60% of the potential impact area was located on the north side of the middle reef (130.3 acres Table 3), whereas the south side of the outer reef constituted less than 1% of the potential impacted area (1.6 acres, Table 3). It should be noted, as with hardbottom habitat, not all habitat on each reef is consistent with habitat described by Walker et al. 2008. For example, on the north side of the middle reef R2N1-1000 was sand habitat, with no signs of hard corals or octocorals, but according to Walker et al. 2008, this area is depicted as reef habitat. This finding underlines a basic misconception on the resolution of the Walker et al. (2008) maps. The map is a large scale map developed for a regional perspective, but cannot be used as a definitive presentation of the presence or absence of hardbottom and reef structure within smaller scales (i.e. the vicinity of the Miami Harbor Channel). In addition, the amount of partial mortality due to sedimentation was variable across the potentially impacted area (see section on partial mortality due to sedimentation). The estimates of partial mortality due to sedimentation were variable based on their distance from the channel and the amount of low-lying habitat within the surveyed site. Since there is no quantification of low-lying areas within the middle and outer reef where permanent sedimentation impacts were most likely to occur, the above acreage estimates are an overestimation of the actual impact to benthic habitat and hard corals. Thus a more thorough understanding of the relief and characteristics of these habitats is needed in order to more accurately define the area of potential effect.

In May 2015, the Florida Department of Environmental Protection conducted surveys within the potential impact area on the outer and middle reef using different metrics than those employed by DCA. Based upon FDEP survey results, an additional buffer from 250 m to 500 m has been added to the potential sedimentation effect area north of the channel along the outer reef as a precautionary measure. This will insure that permanent impacts following the project, pursuant to State permit condition requirements, are documented and addressed (Table 3) if they are present.

Table 3 Quantification of potentially impacted area by reef and side.

Site	Potential Impact Area (ac)
R3S	1.6
R3N	8.3
R3N FDEP	9.1
R2S	64.4
R2N	130.3
Total	213.7



Inset: North control sites located approximately 5 miles north.

Legend

- Potential Sediment Stress Investigation Site
- Miami Harbor Monitoring Station Location (Oct-2013)

Partial Mortality Proportional Value

- 0.00 - 0.15
- 0.16 - 0.30
- 0.31 - 0.45
- 0.46 - 0.60
- 0.61 - 0.75
- 0.76 - 0.90

Potential Effect Gradient

Less Effect — Greater Effect

Dade County Habitats (Walker et al. 2008)

- Artificial
- Colonized Pavement
- Linear Reef
- Patch Reef
- Ridge
- Scattered Coral/Rock in Sand
- Spur and Groove
- Sand Borrow Area
- Sand
- Inlet Channel

- POM Anchorage Area Boundary
- Project Layout
- Potential Sediment Affected Area (Aug-2015)
- FDEP Additional Study Area (Aug-2015)

0 125 250 500 750 Meters

R2N1-1000
R2N1-950
R2N1-850
R2N1-750
R2N1-650
R2N1-550
R2N1-450
R2N1-350
R2N1-250
R2N1-150
R2N2-LR
R2N1-RR
R2S2-LR
R2S1-RR
R2S1-100
R2S1-200
R2S1-300
R2S1-400
R2S1-1025
R2SC1-RR
R2SC2-LR
R3N2-500
R3N2-250
R3N-250
R3N2-150
R3N-150
R3N2-50
R3N1-LR
R3S1-CP
R3S3-SG
R3S2-LR
R3S-50
R3S-150
R3SC1-CP
R3SC3-SG
R3SC2-LR

Potential Sediment Affected Area and Partial Mortality of Permanently Marked Coral Colonies	
Scale: 1 inch = 300 meters	Drawn By: MR
Date: July 2015	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J13-1269
	Figure 4

Impact Delineation Survey Results

Potential impacts were greatest on the northern side of the middle reef, followed by the southern side of the middle reef, the north side of the outer reef, and finally, the south side of the outer reef. Due to the volume of information for all sites, sites presented below were the sites most critical in making a determination of potential impact or no impact for a reef and side. All site summaries have been included in their temporal order within Appendix A. A map of the potentially impacted areas within the middle and outer reef habitat are shown in Figure 4.

Southern Outer Reef Impact Delineation

After surveying southern outer reef reference sites and channel-side sites, two 200m temporary transects were surveyed to delineate potential permanent impacts at the southern outer reef. R3S2-200 line and R3S1-200 line began at channel-side site and extended 50 m and 35 m, respectively. From the qualitative surveys at R3S2-200 and R3S1-200 scientific divers determined there was no qualitative difference between reference sites and up to 50 m away from the channel edge (R3S2-200) or 35 m away from the channel edge (R3S1-200). At these distances away from the channel the community was similar to the reference site in terms of coral condition, presence of octocorals, sponges, sediment characteristics, sediment depth, and presence of turf and macroalgae. As a result, the channel-side site was determined to be potentially impacted, the area between the channel and 50 m (R3S-50) away on the southern outer reef was defined as the edge of the potentially impacted area and 50m and beyond was characterized as un-impacted (Figure 4). Quantitative transects were then performed at R3S-50 (un-impacted) and R3S-150 (un-impacted) for comparison with compliance monitoring sites.

The southern outer reef was the least potentially impacted area, when compared to northern outer reef and middle reef habitat, again presumably due to the northward current in the area. On the south side of the outer reef, no signs of obvious impact occurred beyond channel-side sites. Channel-side sites were most heavily affected as expected (USACE 2006), as they were directly adjacent to dredging, impacts were greatest channel-side and diminish with distance from the channel. As a result, impacts diminish to the south away from outer reef channel-side sites, to approximately 50 m (Figure 4). Complete descriptions of the qualitative site surveys at R3S2-200 line, R3S1-200 line, and the quantitative temporary sites R3S-50, and R3S-150 are provided below and in Appendix A.

R3S2 – 200m line

R3S2-200 line was set at the channel-edge in the vicinity of R3S3-SG Transect 3 to identify a transition from potentially impacted site (R3S3) in a direction, moving away from the channel. Visibility was 50 feet and a moderate north current was present throughout the dive. The line was laid out to the south and crossed spurs and grooves that were positioned in an east to west direction (see photos), thus the depth along the line varied from 40 ft. at the start of the transect to 46 ft. at the bottoms of the grooves and up to 36 feet at the tops of the spurs out to 50 m distance from the channel. Divers surveyed the line for hard coral condition, presence of octocorals and sponges, sediment characteristics, and depth within 1m of the line (50 cm on either side). Data and photos for corals were collected along the entire transect up to 50m. Photographs were collected every 10m to document habitat landscape and hard corals assessed for condition.

Turf and macroalgae were evident along the entire transect, as they had been at channel-side sites. Recruits and small corals (less than 5 cm) were abundant along the transect. Sponges, including *Xestospongia* were present, as were octocorals of all sizes. A *Diploria strigosa* off the line was noted to have white plague, at 44 m distance, as compliance monitoring results have shown this disease is widespread throughout the region (DCA 2015). Sediment depth ranged from 0-1 cm along the transect, except for sand grooves which were 2-3 cm in depth. Sediment characteristics were coarse with a fine element at the start of the transect and transitioned to only coarse texture by 50m. No silty sediment pockets were documented in low areas. Data collection ceased at 50 m away from the channel as the community was similar to the reference site in terms of coral condition, presence of octocorals, sponges, sediment characteristics, depth, and presence of turf and macroalgae. The survey along this line documented a transition from impact at channel-side sites to undetectable impacts at 50m away from the channel (Photos 10-12).

Photo 10. Landscape of R3S2-200 m line at 10m mark looking south. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

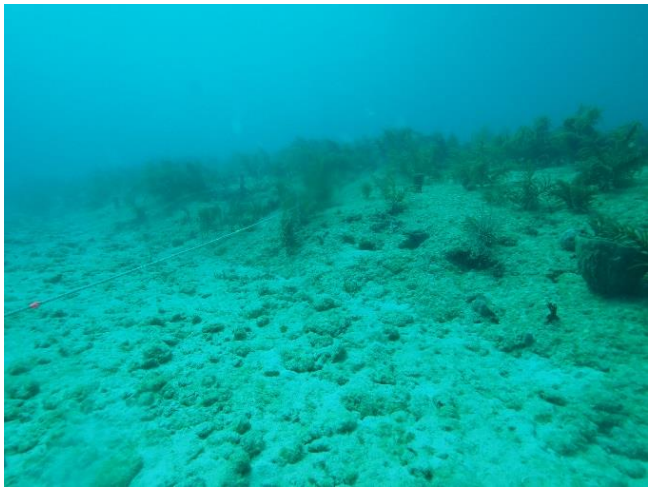


Photo 11. Variable relief along R3S2-200 m line. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

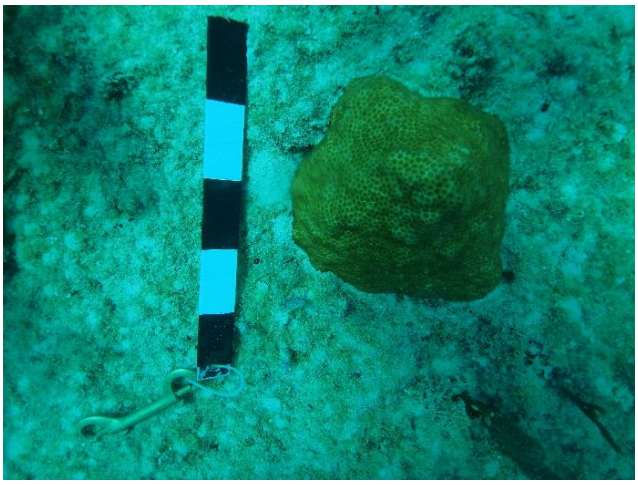


Photo 12. *Solenastrea bournoni* along R3S2-200 m line. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

R3S1 – 200m line

R3S1-200 m line was laid out in the vicinity of R3S1-CP Transect 3 to determine whether or not a visual transition could be documented moving away from the channel. The transect originated 5 m south of the channel edge and extended to the south. Visibility was 50 feet and a moderate north current was present throughout the dive. The line was laid out to the south and crossed low relief spurs and grooves that were positioned in an east to west direction, thus the depth along the southern line varied from 38 feet at the start of the transect to 39 feet at the bottoms of the grooves and up to 36 feet at the top of the spurs out to 35 m distance from the channel. Divers surveyed the line for hard coral condition, presence of octocorals and sponges, sediment characteristics, and depth. Data and photos for corals were collected along the entire transect up to 35m. Photographs were collected every 10m to document habitat landscape and hard corals assessed for condition.

Turf and macroalgae were evident along the entire transect. Recruits and small corals (less than 5 cm) were abundant along the transect. Sponges, including *Xestospongia* were present, as were octocorals of all sizes. Sediment depth ranged from 0-5 cm along the transect, with deepest depths being in sand pockets or grooves between more elevated hardbottom features. Sediment characteristics were coarse with a fine element at the start of the transect and transitioned to coarse material by 35m. No silty sediment pockets were documented in low areas. Data collection ceased at 35 m away from the channel as the community was similar to the reference site in terms of coral condition, presence and condition of octocorals and sponges, sediment characteristics, depth, and presence of turf algae and macroalgae (Photos 13-15).

At approximately 50 m (35 m to 50 m depending on longitude within reef) from the channel-edge, based on qualitative surveys coarse sediment was dominant, benthic community characteristics and partial mortality of corals was consistent with reference sites.

Photo 13. Landscape view of R3S1-200 m line transect looking south from R3S1 (within 35 m of channel edge looking south). Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

Photo 14. Landscape view looking south from 50 m south of channel. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

Photo 15. Rubble area with sand, sponge and small *Siderastrea siderea* colony (<5 cm) and scale (black and white bars are 5 cm each). Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

Southern Outer Reef Quantitative Surveys of Temporary Transects

R3S-50

R3S-50 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document occurrence of partial mortality that would be consistent with partial mortality found at channel-side sites on May 13, 2015. The 50 m location was chosen because the qualitative surveys suggested this area was beyond the area of impact based on sediment characteristics (see R3S2-200 above). The site was in 29-33 feet of water and horizontal visibility was 20 feet. The habitat was defined as linear reef by Walker et al. 2008. Scientific divers documented an octocoral dominated community with sponges and hard corals. Hard coral recruits were evident (*Siderastrea siderea*, *S. radians,* and *Montastrea cavernosa*), but generally hard corals were the least represented among the three groups. The site transects crossed grooves filled with sand as well as spurs that were raised above these sand areas. Sediment depth ranged from 0-3 cm, but was most commonly less than 0.5 cm in areas of hardbottom (Photos 16-18).

R3S-50 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality values were consistent with reference sites.

Photo 16. Landscape view of transect at temporary site R3S-50. Photo was taken on May 13, 2015 during the middle and outer reef impact assessment survey.

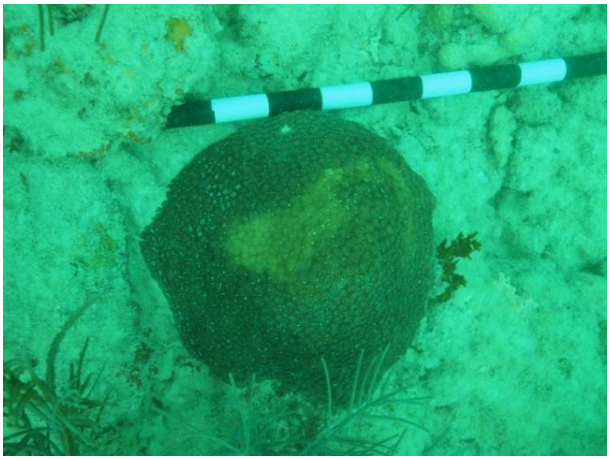


Photo 17. *M. cavernosa* at R3S-50 with partial paling of the colony. Photo was taken on May 13, 2015 during the middle and outer reef impact assessment survey.

Photo 18*. D. strigosa* at R3S-50 (coral condition score of PM). Photo was taken on May 13, 2015 during the middle and outer reef impact assessment survey.

R3S1-150

R3S1-150 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document occurrence of partial mortality that would be consistent with partial mortality found at channel-side sites on May 13, 2015. The site was in 26-30 feet of water and horizontal visibility was 20 feet. The habitat was defined as linear reef by Walker et al. 2008. Observers documented an octocoral dominated community with sponges and hard corals also present. The site transects crossed grooves filled with sand as well as spurs that were raised above these sand areas. Sediment depth ranged from 0-3 cm, but was most commonly less than 0.5cm in areas of hardbottom. Hard coral recruits were evident (*Siderastrea siderea*, *S. radians,* and *Montastrea cavernosa*), but generally hard corals were the least represented among the three groups. Turf algae were evident and macroalgae, including *Halimeda* and *Dictyota* were present. Corals with the appearance of white plague disease were documented at the site.

R3S1-150 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality values were consistent with reference sites.

Northern Outer Reef Impact Delineation

After surveying the northern outer reef reference and channel-side sites, bounce dives at R3N2-250 and R3N2-150 were used to outline the potentially impacted and un-impacted areas to the north of the channel in the outer reef habitat. R3N2-250 was designated as un-impacted based on the lack of partial mortality around the bases of hard corals. In addition, no clay-like material was documented at 250m from the channel. R3N2-150 was designated as potentially impacted based on the presence and extent of partial mortality of hard corals found in low lying areas and the presence of pockets of clay-like material found within the site during the qualitative survey on April 27, 2015. As a result, the potential impact area was defined from the area of greatest impact channel-side to no impact at 250m away from the channel edge (Figure 4). Channel-side sites were most heavily affected (as expected in USACE 2006), as they were directly adjacent to dredging, so impacts are greatest channel-side (USACE 2006) and diminish with distance from the channel to 250m.

Impacts extended further on the north side of the outer reef, compared to the southern side, presumably due to the predominantly north current in the area. Quantitative transects were then performed at R3N-150m (potentially impacted) and R3N-250 (un-impacted) for comparison with compliance monitoring sites. Complete descriptions of the qualitative site surveys at R3N2-250, R3N2-150, and quantitative temporary sites R3N-150, and R3N-250 are provided below and in Appendix A. In May 2015, the Florida Department of Environmental Protection conducted surveys within the potential impact area on the outer and middle reef using different metrics than those employed by DCA. Based upon FDEP survey results, an additional buffer from 250m to 500m has been added to the potential sedimentation effect area north of the channel along the outer reef as a precautionary measure. This will insure that permanent impacts following the project, pursuant to State permit condition requirements, are documented and addressed (Table 3) if they are present.

R3N2- 250

R3N2-250 was visited to qualitatively survey the area on April 27, 2015. This site was characterized by high relief spur and groove habitat. Maximum water depth was 45 feet in the grooves and 39 feet on the tops of the spurs (Photo 19 and 20). Horizontal visibility was 50 feet. Turf algae were visible, and sediment depth was 0-0.5 cm in depth on areas of hardbottom, but deeper (2-3 cm) in grooves. Sediment on top of hardbottom areas was coarse with some fine texture. No pockets of clay-like material were documented at this site. Octocorals, hard corals and sponges, and *Lyngbya* were present. Turf algae and macroalgae were also present. Corals

with the appearance of white plague disease were documented on *Meandrina meandrites* (Photo 21) and *Solenastrea bournoni*. No partial mortality at the base of hard corals was observed at this site (Photos 19 and 20).

R3N2-250 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photo 19. Landscape view of R3N2-250. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

Photo 20. *Solenastrea bournoni* at R3N2-250 with the appearance of white plague disease. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

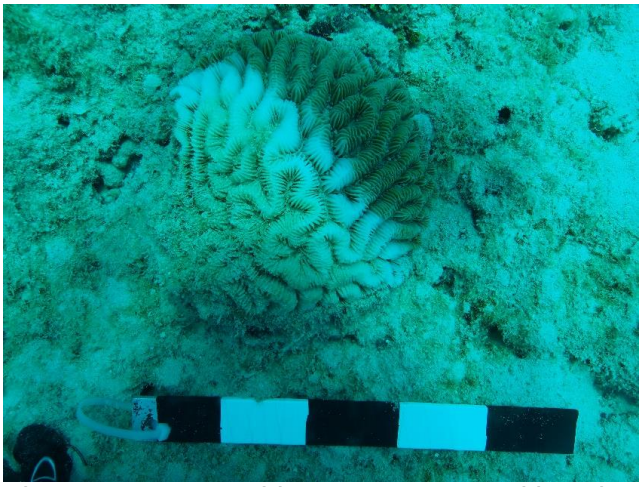


Photo 21. *M. meandrites* at R3N2-250 with active white plague disease. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

R3N2-150

R3N2-150 was visited to qualitatively survey the area on April 27, 2015. This site was characterized by low relief spur and groove habitat. Maximum water depth was 44 feet in the grooves and 42 feet on the tops of the spurs. Horizontal visibility was 50 feet. Turf algae were visible, and sediment depth was 0-0.5 cm in depth on areas of hardbottom, but deeper in grooves. Sediment on top of hardbottom areas was coarse with some fine texture. Pockets of clay-like material were documented at this site. Octocorals, hard corals and sponges, and *Lyngbya* were present. *Solenastrea bournoni* corals with the appearance of white plague disease were documented at the site. This was the first location on the north side of the outer reef (traveling from north to south) where a number of coral colonies in low lying areas had partial mortality around their bases, consistent with channel-side sites (Photos 22-24).

R3N2-150 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 22. Landscape view of R3N2-150. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

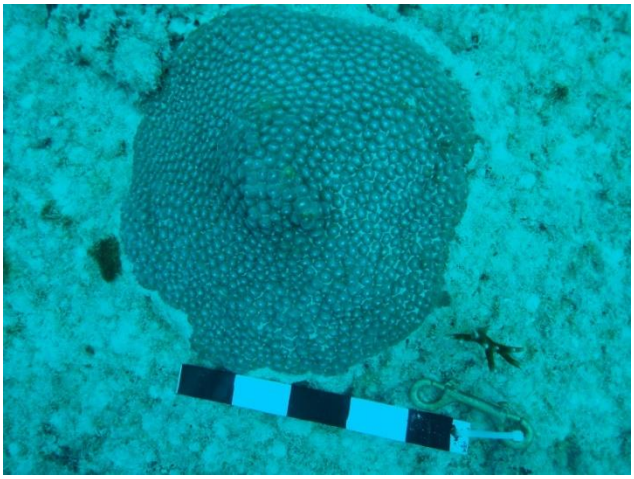


Photo 23. *M. cavernosa* at R3N2-150. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey. Partial mortality is apparent at the base of the coral.

Photo 24. *S. bournonii* at R3N2-150 with the appearance of white plague disease. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

Northern Outer Reef Quantitative Temporary Sites

R3N-150

R3N-150 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document occurrence of partial mortality that would be consistent with partial mortality found at channel-side sites on May 14, 2015. The site was in 37-44 feet of water and horizontal visibility was 30 feet (Photo 25). Observers documented an octocoral dominated community with sponges and hard corals. Transects were positioned in a north to south direction and spanned across spurs (37 feet) and grooves (44 feet). The grooves between spurs were sand bottom and were generally 3-4 cm in depth. Sediment characteristics were a mix of coarse and fine material. On hardbottom areas, sediment depth was 0.5 cm or less. Recruits (corals smaller than 3 cm) were documented. Small silty pockets of clay-like material were observed on the north side of spurs.

R3N-150 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality values were consistent with those documented at channel-side sites.

Photo 25. Landscape view of R3N-150. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

R3N-250

R3N-250 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document coral condition on May 14, 2015. The site was in 37-41 feet of water and horizontal visibility was 25 feet (Photos 26-28). Horizontal visibility was 25 feet during the dive and the prevailing current was northbound. Turf algae were visible and binding coarse sediment. Observers documented an octocoral dominated community with sponges and hard corals. Transects were positioned in a north to south direction and spanned across spurs (37 feet) and grooves (41 feet). The grooves between spurs were sand bottom and were generally 3-4 cm in depth. Sediments were mixed coarse and fine grains. On hardbottom areas, sediment depth was 0.5 cm or less. No pockets of clay-like material were documented at R3N-250.

Photo 26. Landscape view of R3N-250. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

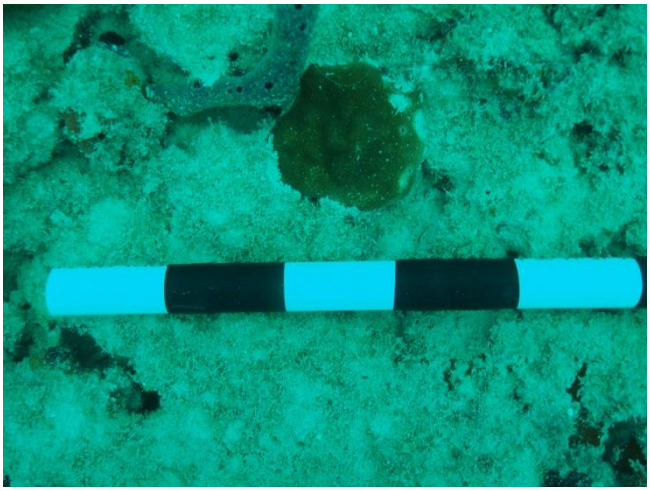


Photo 27. *P. astreoides* and benthic organisms at R3N-250. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

Photo 28. Landscape view of R3N-250. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

R3N-250 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality values were consistent with reference sites.

Southern Middle Reef Impact Delineation

After surveying the southern middle reef reference and channel-side sites, bounce dives at R2S1-400, R2S1-200, and R2S1-300 were used to delineate the potentially impacted and un-impacted areas to the south of the channel within the middle reef habitat. R2S1-400 was designated as an un-impacted site because coral partial mortality, turf algae, and sand were not qualitatively different when compared to the southern reference site. R2S1-200m was determined to be a potentially impacted site due to the presence and degree of partial mortality documented on *Diploria clivosa* colonies and the presence of clay-like material found in pockets during the qualitative assessment. R2S1-300 was documented as potentially impacted, but to a lesser extent than R2S1-200. At R2S1-300 there were fewer instances of partial mortality on *Diploria clivosa* colonies, as well as lesser extent of partial mortality on individual colonies and there was no clay-like material documented at this site. R2S1-400 was defined as un-impacted because no partial

mortality consistent with channel-side sites was documented, and clay-like material was absent. As a result, the potentially impacted area is defined from 0-400 m from the southern middle reef channel with impacts diminishing away from the channel edge out to 400 m where no apparent impacts were documented during the survey period.

Impacts extended further on the north side of the middle reef, compared to the southern side, presumably due to the predominantly north current in the area. As a result of the qualitative assessment, quantitative transects were then performed at R2S1-400m (un-impacted) and R2S1-200m (potentially impacted) for comparison with compliance monitoring sites. Complete descriptions of the qualitative site surveys at R2S1-400, R2S1-200, R2S1-300 and the quantitative temporary sites R2S1-200 and R2S1-400 are provided below.

R2S1-400

R2S1-400 was visited to qualitatively assess the location for signs of potential impact on May 20, 2015. The habitat was characterized as ridge habitat by Walker et al. 2008. Maximum depth at R2S1-400 was 24 feet and visibility was horizontally 40 feet. The habitat was dominated by patchy distribution of octocorals, and relief was relatively flat (6-12 inches of relief) with large rubble incorporated into the hardbottom (Photos 29-30). In areas of hardbottom, the depth of sediment was 0.5 cm and numerous sand patches were 3 cm in depth. Small isolated pockets of clay like material were documented at this location, but overall, the sediment was a mix of coarse and fine sand. No partial mortality of hard corals was documented at R2S1-400.

R2S1-400 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photo 29. Landscape view of R2S1-400. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Photo 30. *S. bournoni* and vertical scale at R2S1-400. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

R2S1 – 200

R2S1-200 was visited on May 20, 2015 to qualitatively assess the site for potential sedimentation effects. The depth at this site was 25 feet and visibility was 40 horizontal feet. R2S1-200 was almost flat and had very little relief (0-6 inches), sand patches were present with a mix of fine and coarse sand, and fewer sand pockets were present when compared to R2S1-400 (Photos 31 and 32). Sediment depth on hardbottom was 0-2cm, and on average 1cm or less. Sand pockets were 2-3 cm and pockets of clay-like material were noted. *Diploria clivosa* colonies were abundant at this site and several colonies exhibited partial mortality consistent with partial mortality described at channel-side sites.

Photo 31. Landscape view of R2S1-200. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

R2S1-200 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

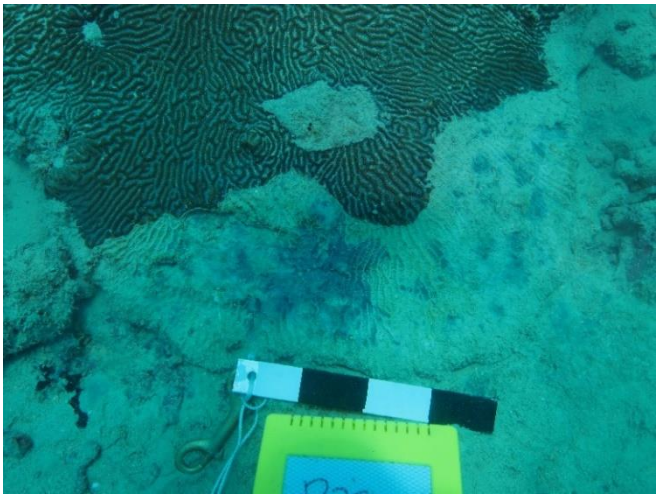


Photo 32. Partial mortality of *Diploria clivosa* at R2S1-200, consistent with partial mortality documented at channel-side sites. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

R2S1-300

R2S1-300 was visited to qualitatively assess the location for signs of impact on May 20, 2015. Depth was 24 feet and horizontal visibility was 40 feet. Observers documented almost flat (0-6 inches) hardbottom at this site, similar to R2S1-200 (Photos 33 and 34). Sediment depth on hardbottom was 0-2cm, and on average 1cm or less. Sand pockets were deeper, but pockets of clay-like material were not documented. *Diploria clivosa* colonies were abundant but fewer signs of partial mortality were observed, when compared with R2S1-200.

R2S1-300 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites, although to a lesser extent when compared to R2S1-200.

Photo 33. Landscape view of R2S-300. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Photo 34. *Diploria clivosa* with partial mortality consistent with channel-side sites at R2S1-300. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Southern Middle Reef Quantitative Temporary Sites

R2S1-400

Quantitative surveys were conducted at R2S1-400 to document coral condition, including partial mortality following methods used at compliance channel side sites on May 21, 2015. The site depth was 25 feet of water and visibility was 20 feet. The site had very little relief (6-12 inches) and was mostly bare with octocoral and hard corals (Photo 35-37). The site was dominated by open space, and octocorals were the most abundant benthic organism. Sediment depth ranged from 0 to 2 cm and was most commonly 1 cm or less on hardbottom.

R2S1-400 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality values were consistent with reference sites.

Photo 35. Landscape view of R2S1-400. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 36. *S. bournoni* colony at R2S-400. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

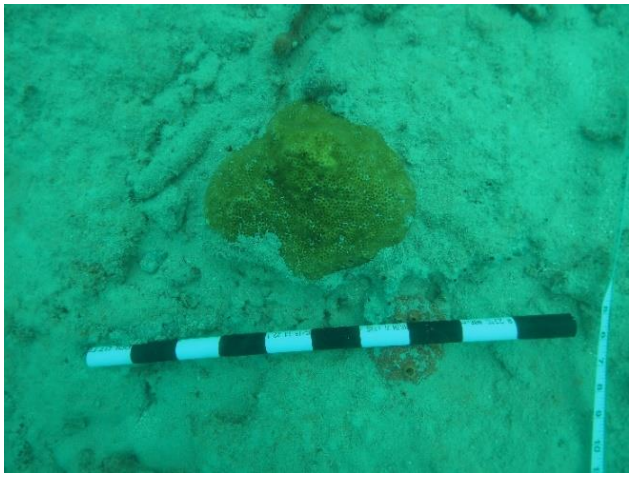


Photo 37. *S. bournoni* colony at R2S-400. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2S1-200

Quantitative surveys were conducted at R2S1-200m to document coral condition, including partial mortality following methods used at compliance channel side sites on May 21, 2015. The site depth was 26 feet, and visibility was 40 feet. The site had very little relief (0-6 inches). The site was dominated by open space, and octocorals were the most abundant benthic organism. Sediment depth ranged from 0 cm to 2 cm and was most commonly 1 cm or less in depth (Photos 38-40).

Photo 38. Landscape at R2S1-200. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 39. *S. bournoni* at R2S1-200. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 40. *M. cavernosa* at R2S1-200 with white plague disease. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2S-200 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality values were consistent with those documented at channel-side sites.

Northern Middle Reef Impact Delineation

After surveying the northern middle reef reference and channel-side sites, bounce dives at R2N1-750, R2N1-650, R2N1-550, and R2N1-450 were used to delineate the potentially impacted and un-impacted areas to the north side of the channel within the middle reef habitat. R2N1-750 was designated as un-impacted because partial mortality of corals was not observed during qualitative surveys, and no pockets of clay-like material were found at the site. In addition, several healthy colonies of *Acropora cervicornis* were found at R2N1-750. R2N1-650 was designated as potentially impacted because partial mortality on corals in low lying areas was observed and pockets of clay-like material were present at the site. R2N1-550 was designated as a potentially impacted site due to the occurrence and degrees of partial mortality of hard corals in low lying areas, as well as the presence of pockets of clay-like material at the site. At R2N1-450 partial mortality was also noted on hard corals in low lying areas but the site had fewer pockets of clay-like material than R2N1-550 and R2N1-650. Channel-side sites were most heavily affected, as they were directly adjacent to dredging, so impacts are greatest channel-side and diminish with distance from the channel to 750 m, where potential impacts were not documented.

Potential impacts extended further on the north side of the middle reef, compared to the southern side, presumably due to the predominant north current in the area. As a result of the qualitative assessment, quantitative transects were then performed at R2N1-550 (potentially impacted) and R2N1-850 (un-impacted) for comparison with compliance monitoring sites. Complete descriptions of the qualitative site surveys at R2N1-750, R2N1-650, R2N1-550, and R2N1-450, and at the quantitative site locations R2N1-550 and R2N1-850 are provided below and in Appendix A.

The northern middle reef may be subject to higher background sedimentation levels than the outer reef or the south sides of the middle and outer reefs based on hydrodynamics. Leading up to and during the course of impact assessment surveys (April and May 2015), numerous dives on the north side of the middle reef were in 5 feet of visibility (or less). A fine layer of freshly deposited brown silt was commonly found away from the channel on the north side of the middle reef leading up to and during the impact assessment surveys. This suggests a background source of

deposition that contributes to the condition of these benthic resources. The documented sedimentation encountered during the impact assessment survey confound any potentially documented sedimentation effects from the project, as it was not possible to separate sources of sediment that led to partial mortality of corals, the primary indicator of "effect" within this study. Unfortunately, without comparable data for this region of the middle reef, there is no way to separate the effect of the natural deposition from material that may have been associated with the project.

R2N1-750

R2N1-750 was visited on May 11, 2015, when underwater surge conditions were present along with relatively low visibility (horizontal 6 feet) (Photo 41), so the site was revisited on May 21, 2015, when horizontal visibility was 40 feet. The second visit revealed the site was high in relief, with depth ranging from 23-30 feet (Photos 42-44). The benthic habitat was dominated by octocorals. Numerous fish used the relatively high relief for habitat, including parrotfish, grunts, snappers and angelfish. *Acropora cervicornis* were abundant in the area, more than twenty colonies that ranged in size from 25 cm to 1.5 m in size were observed. Sediment depth ranged from 0-1 cm and was most frequently less than 0.5 cm in depth. Sediment was fine to coarse and bound in turf algae. *Montastrea cavernosa* and *Dichocoenia stokesii corals* with the appearance of white plague disease were noted at the site. Two *A. cervicornis* colonies with the appearance of white band disease were also noted.

R2N1-750 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photo 41. *Acropora cervicornis* photographed at R2N1-750 on May 11, 2015 in relatively low visibility conditions, scale is 12 inch ruler.

Photo 42. Landscape view of R2N1-750. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 43. Landscape view of R2N1-750. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 44. *Acropora cervicornis* at R2N1-750. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1-650

R2N1-650 was visited on May 14, 2015, but visibility was low, so the site was revisited on May 21, 2015, when horizontal visibility was 40 feet. The second visit revealed the site was relatively high in relief, with depth ranging from 24-30 feet. The benthic habitat at this site was dominated by octocorals. Fish were documented, including parrotfish, grunts, snappers and angelfish. No *Acropora cervicornis* colonies were documented. Sediment depth ranged from 0-4 cm and was most frequently less than 1 cm in depth. Sediment was fine to coarse and bound in turf algae, but turf algae color was not distinguishable. Pockets of clay-like material were documented. Coral colonies of *Montastrea cavernosa* were observed with the appearance of white plague disease. Some partial mortality was documented on low lying hard corals (Photos 45-47). Coral recruits (corals less than 3 cm) were documented.

R2N1-650 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 45. Landscape view of R2N1-650. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 46. White plague disease on *M. cavernosa*. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 47. *M. cavernosa* with a portion of the colony paled at R2N1-650. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1-550

R2N1-550 was visited to qualitatively assess the location for effects of sedimentation on May 21, 2015. The observed habitat was relatively high in relief, with a low point in the middle of surrounding higher relief habitat, forming a bowl. R2N1-550 was lower in relief than R2N1-750 and R2N1-650, depth ranged from 24-29 feet. Octocorals dominated the benthic community. An apparently healthy *Acropora cervicornis* colony was documented at the site along with *Montastrea cavernosa* colonies with white plague disease. Observers noted fewer incidents of white plague than at R2N1-650. Sediment depth ranged from 0-5 cm, with 1 cm or less being the most common depth. Fine sand was bound by turf algae across the site, but turf color was not apparent. Pockets of clay-like material were documented in low areas. Partial mortality was observed on corals in low lying areas (Photos 48-50).

R2N1-550 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 48. Landscape view of R2N1-550. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 49. *M. cavernosa* at R2N1-550 with the appearance of white plague disease. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 50. *Acropora cervicornis* at R2N1-550. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1 – 450

R2N1-450 was visited to qualitatively assess the location for effects of sedimentation on May 21, 2015. The observed habitat was relatively high in relief, and depth ranged from 19-26 feet. Octocorals dominated the landscape (Photo 51). A single *Acropora cervicornis* colony was documented at the site (Photo 52). Corals with the active white plague disease were documented on colonies of *Montastrea cavernosa* (Photo 53). Sediment depth ranged from 0-3 cm in depth with the most common depth being 0.5 cm or less, except in pockets of sand. A layer of fine sediment was present across the site and octocorals were noted to be shedding mucus laden sediment. Fewer pockets of clay-like material were documented when compared to R2N1-550. Partial mortality was noted on hard corals in low lying areas.

Photo 51. Landscape view of R2N1-450. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 52. *Acropora cervicornis* at R2N1-450. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 53. *M. cavernosa* with recent partial mortality and white plague disease. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1-450 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Northern Middle Reef Quantitative Temporary Sites

R2N1-550

R2N1-550 was quantitatively surveyed on May 22, 2015 to document coral condition using methods consistent with those at channel-side sites for compliance monitoring. Visibility was 10-15 feet during the survey and the maximum depth was 30 feet (Photo 54). Two out of three

transects that sampled habitat in low relief areas at R2N1-550 had partial mortality consistent with partial mortality documented at channel-side sites. Corals on the same transect, in areas of higher relief, did not exhibit partial mortality consistent with channel-side sites (see Appendix D for coral stress and partial mortality analysis). No *A. cervicornis* were documented during the survey on May 22. 2015.

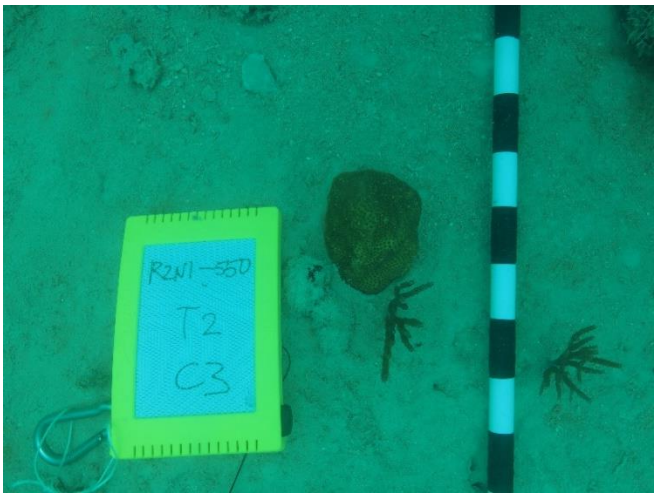


Photo 54. *S. bournoni* surveyed at R2N1-550. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

R2N1-550 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality values were consistent with those documented at channel-side sites.

R2N1-850

R2N1-850 was quantitatively surveyed on May 22, 2015. This site was characterized by Walker et al. 2008 as linear reef. However, observers documented low relief (0-6 inches) hardbottom with numerous large sand patches and large octocorals (>1m), more typical of hardbottom habitat (Photo 54). Few hard corals were present. Hard coral species included, *Solenastrea bournoni*, *Siderastrea siderea*, *Dichocoenia stokesi*, *Stephanocoenia intersepta*, and *Montastraea cavernosa*. Many of the corals larger than 10cm in diameter were located in large sand patches. Sediment was 0-4 cm deep across the site, but most commonly 1 cm or less on areas of hardbottom. R2N1-850 results demonstrated that more detailed benthic mapping is needed to accurately characterize the habitat witihin the potential impact area.

R2N1-850 was designated as an un-impacted site because hard corals present exhibited partial mortality hard corals present exhibited partial mortality consistent with reference sites.

Photo 54. Landscape view of R2N1-850. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

Quantitative Impact Delineation Results

Partial Mortality Due to Sediment Stress

Scleractinian partial mortality (PM) due to sediment stress data were collected *in situ* for all temporary impact assessment monitoring sites and by compiling partial mortality data from compliance and impact asessment monitoring periods at all compliance monitoring sites. Partial mortality due to sediment was documented throughout the middle and outer reef habitats including reference sites where natural sedimentation has caused partial mortality. Rates of partial mortality due to sediment were patchy throughout the middle and outer reef habitats with the highest rates being document channel-side on the northern side of the middle reef whereas the lowest rates of channel-side partial mortality were located on the southern side of the outer reef habitat. Figure 4 details measured rates of partial mortality due to sediment throughout the middle and outer reef habitats.

At the middle reef, the proportion of corals noted with partial mortality due to sediment ranged from 0.07 at R2NC1 and R2NC2 to 0.93 at R2N1 (Table 4). All middle reef channel-side sites and R2N1-550m had rates of sediment related partial mortality that were significantly higher than their respective control sites (Table 4). All other temporary transects along the middle reef (R2S1-400, R2S1-200, R2N1-850) had rates of partial mortality due to sediment that were not significantly different than their respective control sites.

In general, the proportion of corals with partial mortality due to sediment was highest at middle reef channel-side sites with a documented reduction in frequency as distance from the channel increased (Figure 4). On the north side of the channel, rates of partial mortality were highest at R2N1 (0.93) but dropped to 0.33 at 550 m from the edge of the channel. Although R2N1-550 m was still considered inside the area of impact, the proportion of corals with partial mortality due to sediment stress was significantly lower than channel-side. At R2N1-850 the proportion of corals with sediment-related partial mortality was 0.19 which was even lower than at 550 m (Table 4, Figure 4). At the southern middle reef sites partial mortality due to sediment was highest at R2S2 (0.63). 200 m from the channel (R2S1-200) (potentially impacted site) the proportion of partial mortality had dropped to 0.28 and by 400 m (R2S1-400 m) (un-impacted site) the proportion was 0.11 (Table 4, Figure 4). The fact that similar rates of partial mortality due to sediment were

documented at 550 m from the north end of the channel but only 200 m from the southern side of the channel suggests that sediment related impact extend further on the northern side of the channel in the middle reef habitat. These results are consistent with those documented in the qualitative impact delineation surveys and show that partial mortality due to sediment stress is highest on the north side of the middle reef and that the proportion of corals exhibiting permanent impacts due to sedimentation is highest channel-side and diminishes from the channel to the un-impacted areas in the middle reef habitat. Transport of suspended sediment to the north along the middle reef is supported by the hydrologic modeling of the study area described earlier in the report.

At the outer reef the proportion of corals noted with partial mortality due to sediment at channel-side sites was less than the values documented at middle reef sites. Sediment-related partial mortality ranged from 0.00 at R3SC2 to 0.71 at R3N1 (Table 4). The proportion of corals with sediment related partial mortality at outer reef channel-side sites were significantly different than their respective controls with the exception of R3S2 where levels were nearly equal that of the reference (R3SC2) (Table 4). None of the temporary transect locations, either inside or outside the impact area, had partial mortality due to sediment values that were significantly different than those documented at outer reef control sites (Table 4).

At the outer reef, the highest values of sediment-related partial mortality were documented at channel-side sites with values dropping off as the distance from the channel increased (Figure 4). On the north side of the channel rates of partial mortality were highest at R3N1 (0.71) but dropped to 0.08 at 150 m from the edge of the channel (R3N2-150). The proportion of corals with sediment related partial mortality remained low at 250 m from the channel (0.11 at R3N1-250) (Table 4, Figure 4). Although R3N2-150 was still considered inside the area of impact, the proportion of corals with partial mortality due to sediment stress was much less than the channel-side site and were not significantly different from control values (Table 4). At the southern outer reef channel-side sites partial mortality due to sediment was highest at R3S1 (0.42) but by 50 m from the channel (R3S-50) the proportion of partial mortality had dropped to 0.25 and by 150 m (R3S-150) the proportion was 0.21 (Table 4, Figure 4). The values of partial mortality for both R3S-50 and R3S-150 were not significantly different than their respective outer reef control (Table 4).

Within the outer reef habitat, sediment impacts were more pronounced on the northern side of the channel but dropped off significantly by 150m from the channel. On the southern side of the channel the partial mortality impacts that were documented near the channel were not documented to the same degree at the 50 m site. These results are consistent with those documented in the qualitative impact delineation surveys and show that partial mortality due to sediment stress is highest on the north side of the outer reef and that the proportion of corals exhibiting potentially permanent impacts due to sedimentation is highest channel-side and diminishes from the channel to the un-impacted area in the outer reef habitat.

Due to the high rates of white plague disease-related mortality documented at middle and outer reef sites (DCA 2015) all sediment-related partial mortality data is presented in Table 4 in two formats: one that includes all tagged corals at compliance monitoring sites, and again with all dead corals removed from the total number of corals sampled. The removal of dead corals from the sediment-related partial mortality values did change the numbers of corals documented with partial mortality due to sediment and the total number of corals sampled at some compliance monitoring sites. However, the relative proportions of sediment-related mortality and results of significance testing did not change significantly when dead corals were removed. All proportions of partial mortality due to sediment and the results of significance testing are presented in both formats in Table 4.

Table 4 Proportions of sediment related partial mortality as measured during compliance and impact assessment monitoring. Scleractinians at compliance and temporary impact monitoring sites were assigned a "0" or "1" depending on the presence/absence of sediment- related partial mortality. Corals with no evidence of sediment-related partial mortality were assigned a "0", while corals exhibiting sediment-related partial mortality (PM) were assigned a "1". Data is presented both for the total number of corals marked at a given site "All corals" and with dead corals removed "without dead corals". Sites that were significantly different than respective control sites are designated with a "*". Partial mortality on an individual coral colony is defined as any portion of a coral colony with mortality consistent in appearance with sedimentation related partial mortality, previously documented at channel-side sites. Partial mortality exist naturally within the system, affecting hard corals close to and away from the channel.

Survey Zone	Area	Site	Partial Mortality Due to Sediment Stress							
			All Corals				Without Dead Corals			
			#PM	N	Prop. Of PM	SD	#PM	N	Prop. Of PM	SD
Middle Reef	South	R2SC1-RR	9	30	0.30	0.47	9	23	0.39	0.50
		R2SC2-LR	2	25	0.08	0.28	2	12	0.17	0.39
		R2S1-400	2	18	0.11	0.32	2	18	0.11	0.32
		R2S1-200	8	29	0.28	0.45	8	29	0.28	0.45
		R2S1-RR	16	26	0.62*	0.50	14	20	0.68*	0.48
		R2S2-LR	15	24	0.63*	0.49	8	15	0.53*	0.52
	North	R2NC2-RR	2	30	0.07	0.25	2	30	0.07	0.25
		R2NC1-LR	2	28	0.07	0.26	2	28	0.07	0.26
		R2N1-850	3	16	0.19	0.40	3	16	0.19	0.40
		R2N1-550	10	30	0.33*	0.48	10	30	0.33*	0.48
		R2N1-RR	28	30	0.93*	0.25	17	18	0.94*	0.24
		R2N2-LR	16	24	0.67*	0.48	12	20	0.60*	0.50
Outer Reef	South	R3SC1-CP	4	24	0.17	0.38	3	20	0.15	0.37
		R3SC2-LR	0	20	0.00	0.00	0	13	0.00	0.00
		R3SC3-SG	3	24	0.13	0.34	2	18	0.11	0.32
		R3S-150	4	19	0.21	0.42	4	19	0.21	0.42
		R3S-50	6	24	0.25	0.44	6	24	0.25	0.44
		R3S1-CP	8	19	0.42*	0.51	7	18	0.39*	0.50
		R3S2-LR	1	25	0.04	0.20	0	21	0.00	0.00
		R3S3-SG	9	25	0.36*	0.49	8	21	0.38*	0.50
	North	R3NC1-LR	6	24	0.25	0.44	5	20	0.25	0.44
		R3N2-250	2	18	0.11	0.32	2	18	0.11	0.32
		R3N2-150	2	26	0.08	0.27	2	26	0.08	0.27
		R3N1-LR	15	21	0.71*	0.48	15	19	0.75*	0.42

White Plague Disease

In mid-November 2015 (Compliance Week 52), a number of permanently marked corals at southern reference sites on the middle reef were reported with white plague coral disease. During the middle and outer reef impact assessment surveys (April-May 2015) corals with active white plague disease were documented at several of the temporay transects both inside and outside the potentially impacted area. Temporary sites with corals exhibiting symptoms characteristic of white plague disease included: R2N1-550, R2S1-200, R2S1-400, R3N1-150, R3N1-250, R3S-50, and R3S-150. In addition, white plague mortality and active white plague disease continued to be documented at compliance monitoring sites. The numbers of corals that have died from white plague disease and any active infection at compliance monitoring sites are noted in Table 5. Because there is no way to definitively assign causation to standing dead corals without previous information on coral health, no counts of coral mortality due to white plague disease were assessed at the temporary transect locations.

Table 5 Total Scleractinan mortality from baseline through the Middle and Outer reef impact assessment as measured at each compliance monitoring site. Mortality has been broken into categories based on cause of coral mortality and include: sediment, disease and bleaching (white plague not included), and white plague disease. The white plague disease category includes colonies photographed with definitive signs of white plague disease and those consistent with white plague due to the resulting mortality patterns, timing, location, and species involved. Corals showing active white plague have also been included.

Survey Zone	Area	Site	Scleractinian Mortality (Baseline through Middle and Outer Reef Impact Assessment)								
			N	Sediment	Bleaching / Disease	WP Mortality	WP Active	% Sediment Mortality	% WP Mortality	Total Mortality	% of Tagged Dead
Middle Reef	South	R2S1	27	0	0	7	0	0.00	25.93	7	25.93
		R2SC1	30	0	1	6	4	0.00	20.00	7	23.33
		R2S2	24	0	0	9	4	0.00	37.50	9	37.50
		R2SC2	25	0	2	11	0	0.00	44.00	13	52.00
	North	R2N1	30	0	0	12	0	0.00	40.00	12	40.00
		R2NC2	30	0	0	0	2	0.00	0.00	0	0.00
		R2N2	24	2	0	2	1	8.33	8.33	4	16.67
		R2NC1	28	0	0	0	1	0.00	0.00	0	0.00

Survey Zone	Area	Site	Scleractinian Mortality (Baseline through Middle and Outer Reef Impact Assessment)								
			N	Sediment	Bleaching / Disease	WP Mortality	WP Active	% Sediment Mortality	% WP Mortality	Total Mortality	% of Tagged Dead
Outer Reef	South	R3S1	19	1	0	0	0	5.26	0.00	1	5.26
		R3SC1	24	0	2	2	0	0.00	8.33	4	16.67
		R3S2	25	0	1	3	0	0.00	12.00	4	16.00
		R3SC2	20	0	0	7	2	0.00	35.00	7	35.00
		R3S3	25	0	0	4	4	0.00	16.00	4	16.00
		R3SC3	24	0	0	6	2	0.00	25.00	6	25.00
	North	R3N1	21	2	0	0	0	9.52	0.00	2	9.52
		R3NC1	24	0	0	4	1	0.00	16.67	4	16.67
Totals			400	5	6	73	21	1.25	18.25	84	21.00

All three types of white plague disease (WPL I, II, and III), are characterized by a sharp line between apparently healthy coral tissue and recently dead coral skeleton (Sutherland et al. 2004). The migrating disease line associated with white plague diseases can progress rapidly, as fast as 2cm/day, and often results in total colony mortality (Richardson et al. 1998). Thirty two Caribbean coral species are susceptible to white plague disease (Weil et al. 2002), and outbreaks following summer bleaching events have caused significant declines in total coral cover (Brandt & McManus 2009; Miller et al. 2009).

White Plague Disease at Compliance Monitoring Sites

Between Compliance Week 52, when the mortality of several corals with white plague disease was first reported within the project study area, and the current middle and outer reef impact assessment survey, white plague disease has spread from primarily affecting middle reef sites, to both the outer reef and hardbottom habitats. Information on the numbers of corals affected by white plague disease at each compliance monitoring site of the middle and outer reef is found in Table 5. All compliance sites in the middle and outer reef habitat were surveyed between April 25, 2015 and May 22, 2015 during the middle and outer reef impact assessment survey.

To date, white plague disease has caused the total mortality of 18.5% (73 out of 400 marked corals) and has affected (either killed or is actively causing mortality) 23.5% of marked corals throughout the middle and outer reef sites (Table 5). In contrast, total mortality due to sediment (natural and potentially dredge related) has only affected 1.25% of marked corals at middle and outer reef compliance monitoring sites (5 out of 400 corals) (Table 5). Despite the relatively recent

occurrence of white plague disease within compliance monitoring sites, white plague related mortality represents over 86% of all scleractinian mortality documented at middle and outer reef compliance monitoring sites since baseline surveys (Table 5). Similar observations have been made throughout Miami-Dade County, both near and far from the Port Miami project by William Precht of DCA from November 2014 through present (June 2015).

Middle Reef

White plague disease has been noted within the tagged colonies at all middle reef compliance monitoring sites. The highest levels of coral mortality due to white plague was noted at the control site R2SC2 (44.0% of tagged corals). This level of coral mortlaity due to white plague is the highest of any compliance monitoring site (Table 5). On the south side of the channel coral moratlity due to white plague ranges from 20.00% (R2SC1) to 44.0% (R2SC2) of tagged coral colonies (Table 5). On the north side of the channel, coral mortality due to white plague is typically much lower and ranges from 0.00% (R2NC1, and R2NC2) to 40.00% (R2N1). As a result, the geographical distribution of white plague disease does not follow the same pattern as sediment-related partial mortality. The proportion of corals that have died as a result of white plauge disease are higher on the southern side of the channel with similar rates of mortality found at both channel-side and middle reef southern control sites.

Outer Reef

In contrast to the middle reef where corals at all compliance monitoring sites have been affected by white plague, no tagged corals have yet to be affected by white plague at either R3S1 or R3N1 of the outer reef monitoring sites (Table 5). Levels of coral mortality due to white plague disease on the outer reef range from 0.00% (R3S1) to 35.00% (R3SC2 – a control site). On the north side of the channel, coral mortality due to white plague is much lower and ranges from 0.00% (R3N1) to 20.00% (R3NC1). As a result, the geographical distribution of white plague disease at outer reef sites does not follow the same pattern as sediment-related partial mortality. At the outer reef the percentage of corals that have died as a result of white plague disease is higher at the outer reef controls when compared with channel-side sites. The opposite pattern is true for sediment-related partial mortality at the outer reef (Table 4)

The effect of the white plague disease event, continues to be high disease-related coral mortality at several middle and outer reef sites (channel-side and reference). The present outbreak has affected both channel-side and reference sites, with *Meandrina meandrites* and *Dichocoenia stokesi* being the most affected species. Total colony mortality of *Diploria strigosa, Diploria clivosa, Solenastrea bournoni, Montastrea cavernosa* and *Colpophyllia natans* have also been documented as a result of white plague disease.

CONCLUSIONS

This potential sedimentation effect survey report presents the data collected from April 25 to May 22, 2015 within middle (Reef 2) and outer reef (Reef 3) areas north and south of the Miami Harbor Channel, one month after the completion of offshore dredging activities. 213.7 acres of potential impact area were estimated to be present within the middle and outer reefs, both north and south of the channel. The potentially impacted area on the middle and outer reefs were proportional to the influence of hydrodynamics acting in the area of the Miami Harbor Channel. Potential impact areas were estimated to be greatest north of the middle reef and lowest on the southern portion of the outer reef (Figure 4). This distribution of potential impact area is consistent with the present knowledge of current, tidal and eddy patterns (USACE 2006). For areas outside of the channel-side monitoring sites, potential impacts include both potential project related and natural occurrence of sedimentation effects. The lack of during project data away from the established

monitoring stations makes assignment of sediment source and the effects of that sediment on the benthic community impossible to determine.

Methods employed during the potential impact assessment surveys relied on qualitative and quantitative techniques to estimate potential impacts based on known impacts at channel-side sites. Without comparative pre-construction data of impacted areas, surveys cannot separate background sedimentation (natural) and potential project related effects, therefore the estimations presented here are a combination of natural and potential project related effects.

In the summer of 2014, a NOAA coral watch bleaching alert was issued for the south Florida region. Regional bleaching was documented in south Florida during the summer of 2014 by a number of observers in the Florida Keys (NOAA 2014a; 2014b; NOAA 2015), the event was described for hard corals in the Florida Keys and Miami-Dade County.

Shortly after the bleaching event, corals with symptoms consistent with white plague coral disease were documented at southern compliance reference sites. White plague disease spread from south to north after the bleaching event and is currently ongoing as far north as Broward County. The spread of white plague disease across the region has affected hard coral populations of all size classes and across species. Within the middle and outer reef Miami Harbor Project sites, 23% of marked and monitored corals (channel-side and control) have died or have active white plague infections, in contrast only 1.25% of colonies at monitoring sites have suffered total mortality due to sedimentation, all of these colonies were located at channel-side sites, no total mortality from sedimentation was documented at reference sites.

The potential affected area is variable in time and space, as currents, wind, waves, as well as material variables influence how far material may have traveled during dredging. Since no during dredging data were collected at locations away from channel-side or reference sites, a post-hoc study was done to estimate impacts to benthic habitats. Based on known conditions at channel-side sites, where impacts are well known because of the monitoring effort, permanent impacts were defined as partial mortality due to sedimentation. During the April-May 2015 outline of the potential sedimentation effect area, the clay-like material was documented only in pockets in low lying areas on the middle and outer reefs. This was not surprising, since hydrodynamic forces would be expected to disperse and mix this material into the existing sediment matrix. Partial mortality consistent with sedimentation impact was documented to the highest degree at channel-side sites. At channel-side sites and at greater distances, partial mortality was only documented in low lying areas where corals would not be able to easily shed sediment. Even at channel-side sites, corals that were in areas of higher relief were typically not permanently impacted by sedimentation. White plague disease on the other hand, has had a dramatic effect on coral populations throughout Miami-Dade County (DCA 2015 and this report). This disease outbreak has caused mortality of large and small corals, within reference and channel-side sites, as well as further afield in Sunny Isles and as far south as northern Monroe County. Recently infected colonies have been documented in Broward County to the north (Personal communication William F. Precht).

Follow up surveys of the potentially impacted area are required by permit specifications one month after construction and two times in the following year (FDEP SC 32.ii.d). If additional mitigation is required, a mapped and quantified acreage of actual low and high relief habitat, differentiated from sand should be used to assess potential additional mitigation responsibilities in combination with impact data (partial mortality of hard corals (1 year post-construction surveys)). Specifically the following additional data are warranted:

1. Detailed quantification and delineation of middle and outer reef high and low relief habitat within the area of potential effect.
2. Quantification of scleractinian coral densities within the potential effect area.

In addition, the linear regression methods followed in the 2010 Quantitative Study may be implemented to document areas between channel-side and reference sites using the regression model. A comparison of scleractinian and octocoral size class and density values with those data from 2010, may reveal additional relevant information. However, monitoring sites established in 2013 for construction monitoring (channel-side and reference stations) should continue to be monitored, as these are the sites where the effect of sedimentation has been best characterized and where recovery would be best documented.

Since there are no baseline data for areas outside of the channel-side compliance and reference sites that are quantitatively comparable it is not possible to definitively tie a cause of mortality or partial mortality (permanent impact) of any benthic organisms to any particular cause (dredging or otherwise) post-hoc. This is a lesson learned for future projects, detailed maps of the project surroundings and an appropriate study design are critical to assessing project effects in a during-project or post-project period. Rather than conducting channel-side and reference site comparisons, a regression based design would better address potential effects across an area, both during and after construction.

RECOMMENDATIONS

The potentially impacted area is variable in time and space, as currents, wind, waves, as well as material characteristics influenced the distribution of material during dredging activities. During the April-May 2015 delineation of the potential sedimentation effect area, clay-like material that had been present at channel-side sites was dispersed or integrated into existing sediment, pockets of clay-like material were documented away from the navigation channel in areas of sand.

In May 2015, the Florida Department of Environmental Protection (FDEP) conducted surveys within the potential impact area on the outer and middle reef using different metrics than those employed by DCA. Based upon FDEP survey results, an additional buffer from 250 m to 500 m has been added to the potential sedimentation effect area as a precautionary measure. This will insure that any potential permanent impacts following the project, pursuant to State permit condition requirements, are fully addressed.

If additional mitigation is required, a mapped and quantified acreage of actual high and low relief hardbottom habitat should be used to assess potential additional mitigation in combination with permanent impact data (partial mortality of permanently marked corals) from the channel-side compliance sites (post-construction surveys). Specifically the following additional data are warranted:

1. Detailed quantification and delineation of middle and outer reef habitat within the area of potential effect. Areas of low relief and flat or low lying areas were observed to be most be affected, these areas could be the focus of future delineation efforts, with the understanding that these studies will not be able to differentiate between potentially dredge related sedimentation effects and naturally occurring sedimentation effects.

2. Quantification of middle and outer reef resources including scleractinian coral, octocoral, sponge and zoanthids within the area of potential effect based on a linear regression model.

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APPENDIX A

Qualitative and Quantitative Site Surveys Descriptions

APPENDIX A – IMPACT ASSESSMENT SURVEY SUMMARIES FOR ALL SITES

Impact Assessment Surveys April 25, 2015

Compliance Monitoring Site R3SC3

R3SC3 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on April 25, 2015 (Photos 1-3). The low relief spur and groove habitat included hardbottom, rubble and sand areas. Maximum water depth was 36 feet. Horizontal visibility was 50 feet. Green turf algae were visible and were binding coarse sand. The material found in sand pockets was coarse and generally 2-3 cm in depth. Sediment depth on the hardbottom was generally 0.5 cm or less. Hard corals, octocorals, sponges and *Lyngbya* were present. Coral disease and disease on *Xestospongia muta* were noted.

R3SC1 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.

Photo 1 and 2. Photo 1 (left) shows the R3SC3 landscape with disease on *Xestospongia*. Photo 2 (right) depicts the low relief hardbottom of R3SC3 with scale. Macroalgal turfs are present in both images. Photos were taken on April 25, 2015 during the middle and outer reef impact assessment survey.

Photo 3. White plague on marked *Diploria strigosa* at R3SC3. Photo was taken on April 25, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R3SC2

R3SC2 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms (Photos 4-6). The low relief linear reef habitat included hardbottom, rubble and sand areas. Maximum water depth was 25 feet. Horizontal visibility was 50 feet. Green and brown turf algae were visible and bound coarse sediment. Material in sand pockets was mostly coarse and generally 2-3 cm in depth. Sediment depth on hardbottom was generally 0.5 cm or less. Hard corals, octocorals, sponges and *Lyngbya* were present. Coral disease, specifically white plague was documented on hard coral species.

R3SC2 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.

Photos 4 and 5. Photo 4 (left) shows a landscape view of R3SC2. Photo 5 (right) depicts the turf algae and sediment visible at R3SC2. Photos 4 and 5 were taken on April 25, 2015 during the middle and outer reef impact assessment survey.

Photo 6. White plague affecting a tagged colony of *Diploria strigosa* at R3SC2. Photo was taken on April 25, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R3SC1

R3SC1 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms (Photos 7-9). The low relief colonized pavement habitat included hardbottom, rubble and sand areas, with more sand patches when compared to R3SC2 and R3SC3. Maximum water depth was 35 feet. Horizontal visibility was 50 feet. Green and brown turf algae were visible and bound coarse sediment. Material in sand pockets was mostly coarse with some fine texture, and generally 2-3 cm in depth. Sediment depth on hardbottom was generally 0.5 cm or less. Hard corals, octocorals, sponges and *Lyngbya* were present. Coral disease, specifically white plague was noted on hard corals.

R3SC1 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.

Photos 7 and 8. Photo 7 (left) shows a landscape view of R3SC1. Photo 8 (right) depicts the turf algae and sediment visible at R3SC1. Photos 7 and 8 were taken on April 25, 2015 during the middle and outer reef impact assessment survey.

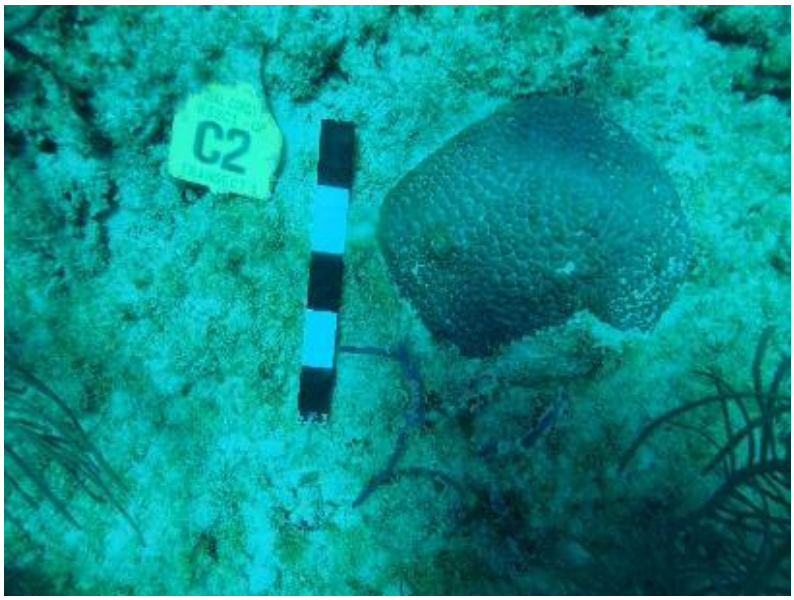


Photo 9. Recent mortality associated with white plague disease in a tagged colony of *Montastrea cavernosa*. Photo was taken on April 25, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R3S3

R3S3 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms (Photos 10-12). The low relief spur and groove habitat included hardbottom and sand areas. Maximum water depth was 46 feet. Horizontal visibility was 40 feet. Green and brown turf algae were visible and bound coarse sediment. Turf algae were shorter (less than 1 cm) in length when compared to southern control R3SC1, 2, and 3. Material in sand pockets was mostly coarse with more fines than control sites, and generally 2-3 cm in depth. No pockets of clay-like material were documented. Sediment depth on hardbottom was generally 0.5 cm or less. Hard corals, octocorals, sponges and *Lyngbya* were present. Coral disease, specifically white plague was noted on hard corals.

R3S3 was designated as an impacted site because compliance monitoring results documented partial mortality associated with sedimentation during construction activities at this site.

Photos 10 and 11. Photo 10 (left) shows a landscape view of R3S3. Photo 11 (right) depicts the turf algae and sediment visible at R3S3. Photos 10 and 11 were taken on April 25, 2015 during the middle and outer reef impact assessment survey.

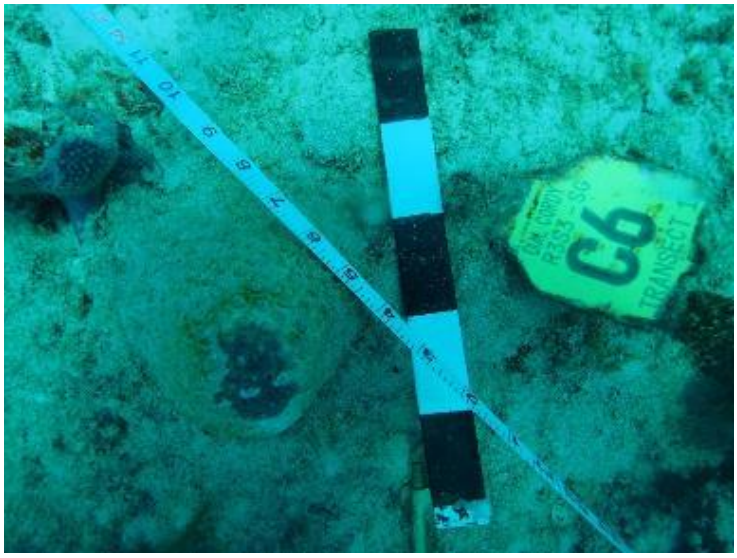


Photo 12. Recent mortality associated with white plague disease of a tagged colony of *Montastrea cavernosa*.

Compliance Monitoring Site R3S2

R3S2 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms (Photos 13-15). The low relief linear reef habitat included hardbottom, rubble and sand areas. Maximum water depth was 44 feet. Horizontal visibility was 40 feet. Green and brown turf algae were visible and bound coarse sediment, turf algae were shorter (less than 1 cm) in length when compared to southern control R3SC1, 2, and 3. Material in sand pockets was mostly coarse with some fine texture and was finer in texture when compared to control sites, but was generally 2-3 cm in depth. Sediment depth on hardbottom was generally 0.5 cm or less. Hard corals, octocorals, sponges and *Lyngbya* were present. Coral disease, specifically white plague was noted on hard corals.

R3S2 was designated as an un-impacted site due to the documentation of sediment related coral partial mortality closer to reference values than adjacent channel-side sites R3S1 and R3S3. Possible explanations for this are depth and proximity to the channel. R3S2 (33 feet) is shallower than both R3S1 (38 feet) and R3S3 (35 feet), so currents may move material away from the site more quickly than the adjacent deeper sites. Also, R3S2 transects begin slightly further south (~3 m) than R3S1 and R3S3 transects. However, due to proximity this site is included within the potential sedimentation affected area.

Photos 13 and 14. Photo 13 (left) shows a landscape view of R3S2. Photo 14 (right) depicts the turf algae and sediment visible at R3S2. Photos 13 and 14 were taken on April 25, 2015 during the middle and outer reef impact assessment survey.

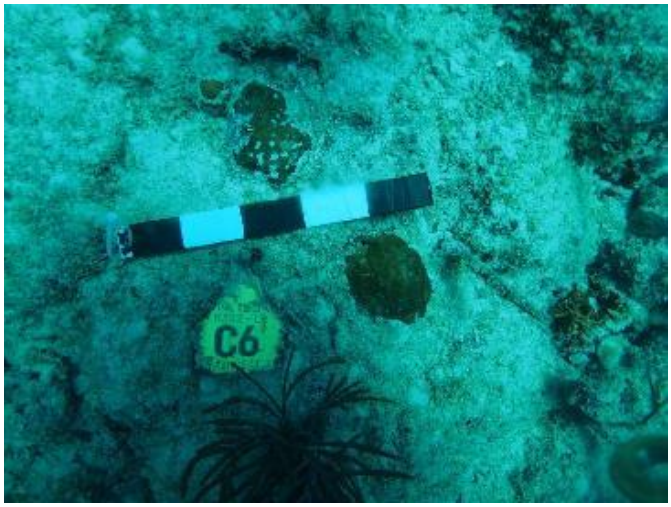


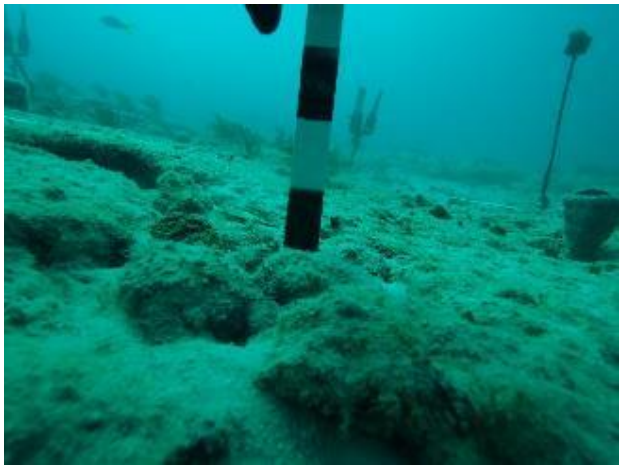
Photo 15. A permanently marked *Porites astreoides* colony at R3S2. Photo 15 was taken on April 25, 2015 during the middle and outer reef impact assessment survey.

Impact Assessment Surveys April 26, 2015

Compliance Monitoring Site R3S1

R3S1 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms (Photos 16-18). The low relief linear reef habitat included hardbottom, rubble and sand areas. Maximum water depth was 44 feet. Horizontal visibility was 40 feet. Green and brown turf algae were visible and bound coarse sediment, turf algae were shorter (less than 1 cm) in length when compared to southern control R3SC1, 2, and 3. Material in sand pockets was coarse, no fine texture was noted, and sediment depth in sand pockets was 2-3 cm. Sediment depth on hardbottom was generally 0.5 cm or less. Hard corals, including coral recruits, octocorals, sponges and *Lyngbya* were present. Coral disease, specifically white plague was noted on hard corals.

R3S1 was designated as an impacted site because compliance monitoring results documented partial mortality associated with sedimentation during construction activities at this site.



Photos 16 and 17. Photo 16 (left) shows a landscape view of R3S1. Photo 17 (right) depicts the turf algae and sediment visible at R3S1. Photos 16 and 17 were taken on April 26, 2015 during the middle and outer reef impact assessment survey.

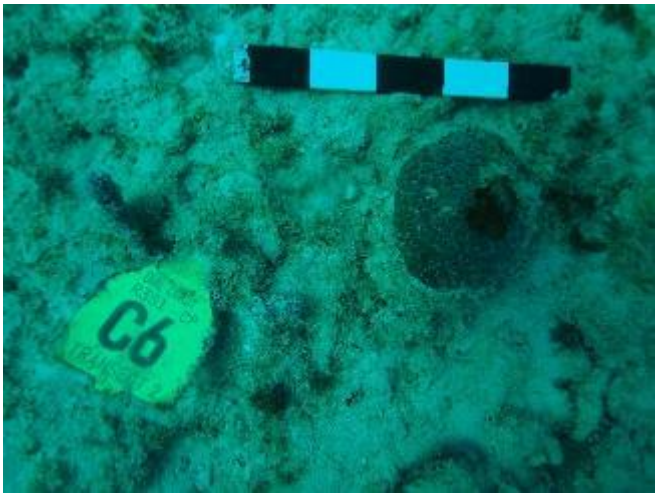


Photo 18. Permanently marked coral *M. cavernosa* with a tuft of cyanobacteria in the middle. Photo 18 was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

R3S2 – 200m line

R3S2-200 line was set at the channel-edge in the vicinity of R3S3-SG Transect 3 to identify a transition from potentially impacted site (R3S3) in a direction, moving away from the channel. Visibility was 50 feet and a moderate north current was present throughout the dive. The line was laid out to the south and crossed spurs and grooves that were positioned in an east to west direction, thus the depth along the line varied from 40 ft. at the start of the transect to 46 ft. at the bottom of the grooves and up to 36 feet at the top of the spurs out to 50 m distance from the channel. Divers surveyed the line for hard coral condition, presence of octocorals and sponges, sediment characteristics, and depth within 1m of the line (50 cm on either side). Data and photos for corals were collected along the entire transect to 50m. Photographs were collected every 10m to document habitat landscape and hard corals were assessed for condition.

Turf and macroalgae were evident along the entire transect, consistent with the observations at channel-side sites, where they had been evident. Recruits and small corals (less than 5 cm) were abundant along the transect. Sponges, including *Xestospongia* were present, as were octocorals of all sizes. A *Diploria strigosa* off the line was noted to have white plague, at 44 m distance, as compliance monitoring results have shown this disease is widespread throughout the region (DCA 2015). Sediment depth ranged from 0-1 cm along the transect, except for sand grooves which were 2-3 cm in depth. Sediment characteristics were coarse with a fine element at the start of the transect and transitioned to only coarse texture by 50m. No silty sediment pockets were documented in low areas. Data collection ceased at 50 m away from the channel as the community was similar to the reference site in terms of coral condition, presence of octocorals, sponges, sediment characteristics, depth, and presence of turf and macroalgae. The survey along this line documented a transition from impact at channel-side sites to undetectable impacts at 50m away from the channel (Photos 19-21).

Photo 19. Landscape of R3S2-200 m line at 10m mark looking south. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

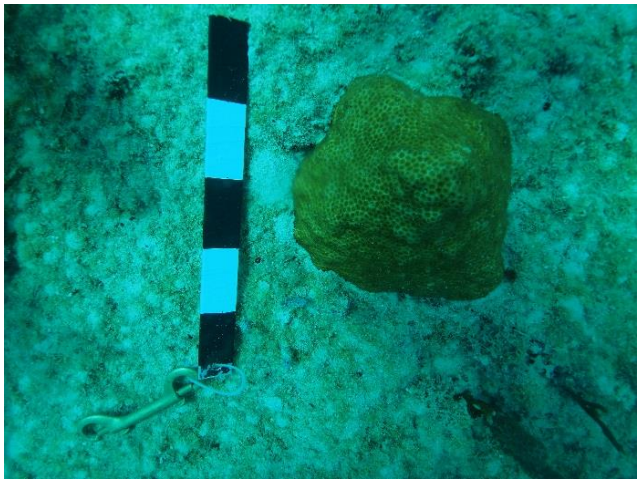


Photo 20. *Solenastrea bournoni* along R3S2-200 m line. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

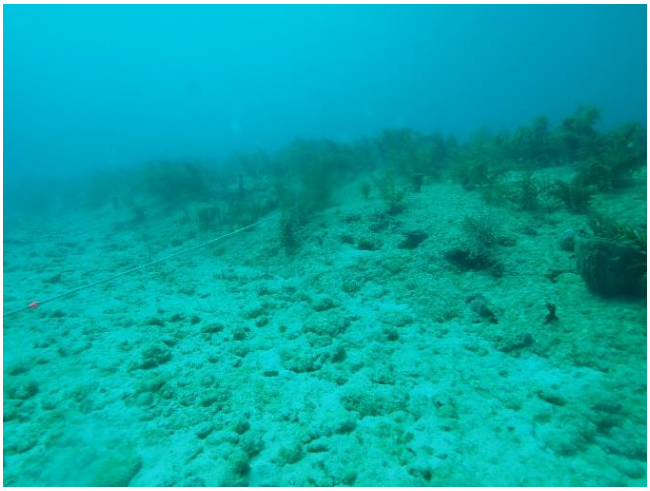


Photo 21. Variable relief along R3S2-200 m line. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

R3S1 – 200m line

R3S1-200 m line was laid out in the vicinity of R3S1-CP Transect 3 to determine whether or not a visual transition could be documented moving away from the channel. The transect originated 5 m south of the channel edge and extended to the south. Visibility was 50 feet and a moderate north current was present throughout the dive. The line was laid out to the south and crossed low relief spurs and grooves that were positioned in an east to west direction, thus the depth along the southern line varied from 38 feet at the start of the transect to 39 feet at the bottoms of the grooves and up to 36 feet at the top of the spurs out to 35 m distance from the channel. Divers surveyed the line for hard coral condition, presence of octocorals and sponges, sediment characteristics, and depth. Data and photos for corals were collected along the entire transect up to 35m. Photographs were collected every 10m to document habitat landscape and hard corals were assessed for condition.

Turf and macroalgae were evident along the entire transect. Recruits and small corals (less than 5 cm) were abundant along the transect. Sponges, including *Xestospongia* were present, as were octocorals of all sizes. Sediment depth ranged from 0-5 cm along the transect, with deepest depths being in sand pockets or grooves between more elevated hardbottom features. Sediment characteristics were coarse with a fine element at the start of the transect and transitioned to coarse material by 35m. No silty sediment pockets were documented in low areas. Data collection ceased at 35 m away from the channel as the community was similar to the reference site in terms of coral condition, presence and condition of octocorals and sponges, sediment characteristics, depth, and presence of turf algae and macroalgae (Photos 22-24).

At approximately 50 m (35 m to 50 m depending on longitude within reef) from the channel-edge, coarse sediment was dominant based on qualitative surveys, benthic community characteristics and partial mortality of corals was consistent with reference sites.

Photo 22. Landscape view of R3S1-200 m line transect looking south from R3S1 (within 35 m of channel edge looking south). Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

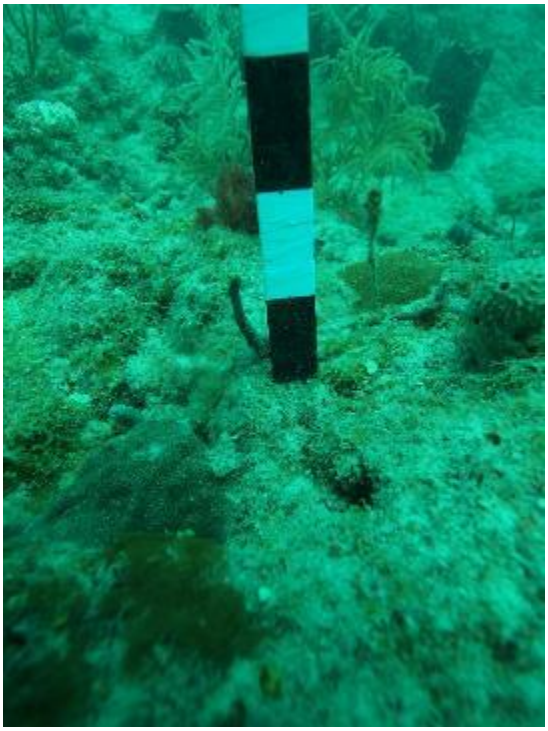
Photo 23. Landscape view looking south from 50 m south of channel. Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

Photo 24. Rubble area with sand, sponge and small *Siderastrea siderea* colony (<5 cm) and scale (black and white bars are 5 cm each). Photo was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R3NC1

R3NC1 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on April 26, 2015 (Photos 25-27). The low relief linear reef habitat included hardbottom, rubble and sand areas. Maximum water depth was 45 feet. Horizontal visibility was 30 feet. Green and brown turf algae were abundant and thick (2-3cm), *Dictyota* and *Halimeda* were present, turf and macroalgae bound coarse sediment. Material in sand pockets was coarse, no fine texture was noted, and depth in sand pockets was 2-3 cm, sediment depth on hardbottom areas was generally less than 0.5 cm in depth. Few hard coral recruits were observed, possibly due to the thick turf algae present at this site. Larger hard corals, octocorals, sponges and *Lyngbya* were present. Coral disease, specifically white plague was noted on hard corals.

R3NC1 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.



Photos 25 and 26. Photo 25 (left) shows a landscape view of R3NC1. Photo 26 (right) depicts the turf algae and sediment visible at R3NC1. Photos 25 and 26 were taken on April 26, 2015 during the middle and outer reef impact assessment survey.

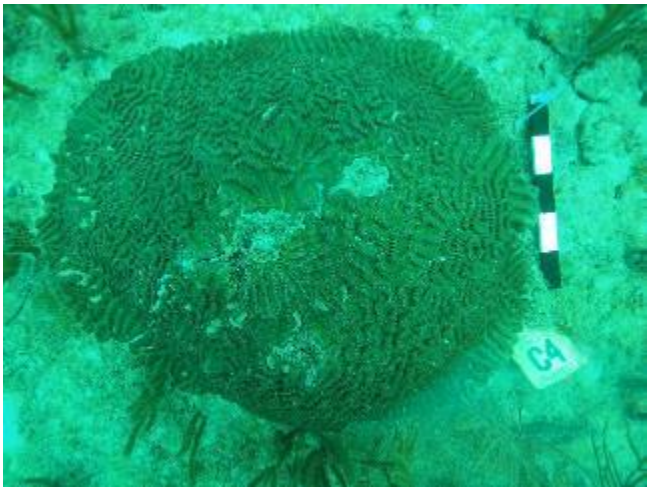


Photo 27. Permanently marked *Colpophyllia natans* at R3NC1. Photo 27 was taken on April 26, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R3N1

R3N1 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on April 26, 2015 (Photos 28-30). The low relief linear reef habitat included hardbottom, rubble and sand areas. Maximum water depth was 44 feet. Horizontal visibility was 50 feet. Turf algae were not visible, but their texture was present under a layer of fine white sand that spanned the channel-side site. Sediment on hardbottom areas was 0.5-1cm in depth, while sand pockets were 2-3 cm in depth. Fine white sand was prevalent across the site, and pockets of clay-like material were documented. No macroalgae were documented, while *Lyngbya* and short cyanobacteria were present in some areas. Octocorals, sponges and hard corals were present. Coral disease, specifically white plague was noted on hard corals.

R3N1 was designated as an impacted site because compliance monitoring results documented partial mortality associated with sedimentation during construction activities at this site.

Photos 28 and 29. Photo 28 (left) shows a landscape view of R3N1. Photo 29 (right) depicts the substrate at R3N1. Photos 28 and 29 were taken on April 26, 2015 during the middle and outer reef impact assessment survey.

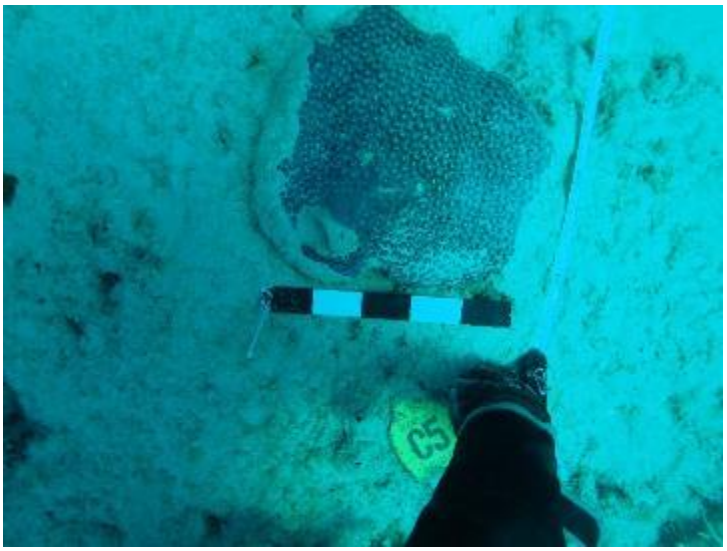


Photo 30. Permanently marked *Montastrea cavernosa*. was taken on April 26, 2015 during the middle and outer reef impact assessment survey. This coral was marked as a "1" and received PM (partial mortality and SA (sediment accumulation) as scores during surveys.

Impact Assessment Surveys April 27, 2015

R3N2-500

R3N2-500 was visited to qualitatively survey the area on April 27, 2015. R3N2-500 was characterized by high relief spur and groove habitat. Maximum water depth was 45 feet in the grooves and 37 feet on top of the spurs. Horizontal visibility was 50 feet. Turf algae were visible, and sediment depth was 0-0.5 cm in areas of hardbottom, but deeper in grooves. Isolated pockets of clay-like material were present in sand grooves, and fell on the north side (lee) of the spurs, along the hardbottom sand interface in the groove feature. Overall, sediment within groove formation was coarse sand. Octocorals, hard corals and sponges, and *Lyngbya* were present (Photos 31-33). No signs of partial mortality consistent with channel-side sites on hard corals were documented.

R3N2-500 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photos 31 and 32. Photo 31 (left) shows a landscape view of R3N2-500. Photo 32 (right) depicts the sand groove at the base of the spur and a lionfish at R3N2-500. Photos 31 and 32 were taken on April 27, 2015 during the middle and outer reef impact assessment survey.

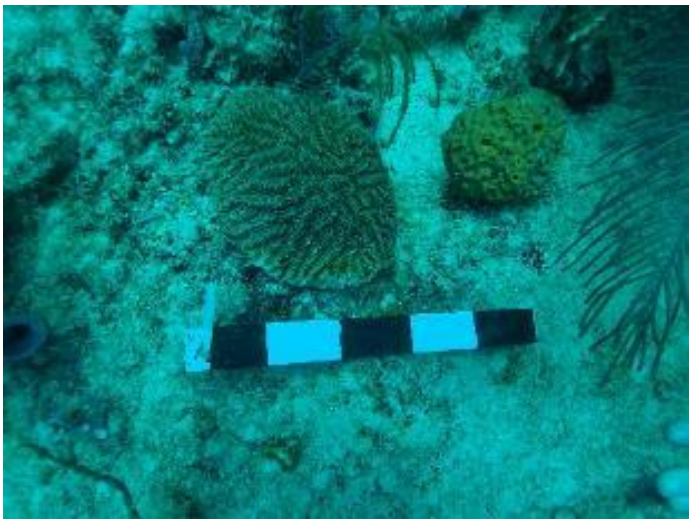


Photo 33. *Meandrina meandrites* at R3N2-500. Photo 33 was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

R3N2-north of anchorage

The north edge of the anchorage on Reef 3 was visited to qualitatively survey the area on April 27, 2015. This site was characterized by low relief spur and groove habitat. Maximum water depth was 44 feet in the grooves and 40 feet on the tops of the spurs. Horizontal visibility was 50 feet. Turf algae were visible, and sediment depth was 0-0.5 cm in depth on areas of hardbottom, but deeper in grooves. Sediment was coarse sand within grooves, and no clay-like material was documented at this site. Octocorals, hard corals and sponges, and *Lyngbya* were present (Photos 34-36).

R3N2-north of anchorage was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

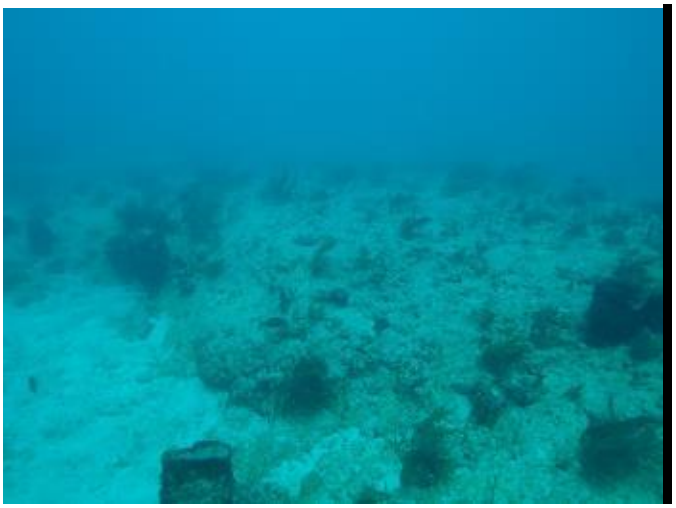


Photo 34 and 35. Photo 34 (left) shows a landscape view of R3N2-north of anchorage showing sand groove and adjacent spur. Photo 35 (right) depicts a landscape view of the hardbottom habitat at R3N2-north of the anchorage. Photos 34 and 35 were taken on April 27, 2015 during the middle and outer reef impact assessment survey.

Photo 36. Sponge on edge of hardbottom, over sand groove at R3N2-north of anchorage. Photo 36 was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

R3N2- 250

R3N2-250 was visited to qualitatively survey the area on April 27, 2015. This site was characterized by high relief spur and groove habitat. Maximum water depth was 45 feet in the grooves and 39 feet on the tops of the spurs (Photo 37). Horizontal visibility was 50 feet. Turf algae were visible, and sediment depth was 0-0.5 cm in depth on areas of hardbottom, but deeper (2-3 cm) in grooves. Sediment on top of hardbottom areas was coarse with some fine texture. No pockets of clay-like material were documented at this site. Octocorals, hard corals and sponges, and *Lyngbya* were present. Turf algae and macroalgae were also present. Corals with the appearance of white plague disease were documented on *Solenastrea bournoni* and *Meandrina meandrites* (Photo 38 and 39). No partial mortality at the base of hard corals was observed at this site.

R3N2-250 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photo 37. Landscape view of R3N2-250. Photo 37 was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

Photo 38. *Solenastrea bournoni* at R3N2-250 with the appearance of white plague disease. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

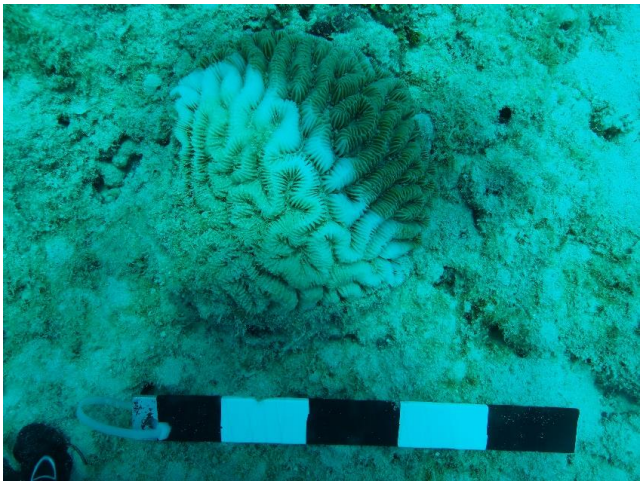


Photo 39. *M. meandrites* at R3N2-250 with active white plague disease. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

R3N2-150

R3N2-150 was visited to qualitatively survey the area on April 27, 2015. This site was characterized by low relief spur and groove habitat. Maximum water depth was 44 feet in the grooves and 42 feet on the top of the spurs. Horizontal visibility was 50 feet. Turf algae were visible, and sediment depth was 0-0.5 cm in depth on areas of hardbottom, but deeper in grooves. Sediment on top of hardbottom areas was coarse with some fine texture. Pockets of clay-like material were documented at this site. Octocorals, hard corals and sponges, and *Lyngbya* were present. *Solenastrea bournoni* corals with the appearance of white plague disease were documented at the site. This was the first location on the north side of the outer reef (traveling from north to south) where a number of coral colonies in low lying areas had partial mortality around their bases, consistent with channel-side sites (Photos 40-42).

R3N2-150 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 40. Landscape view of R3N2-150. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

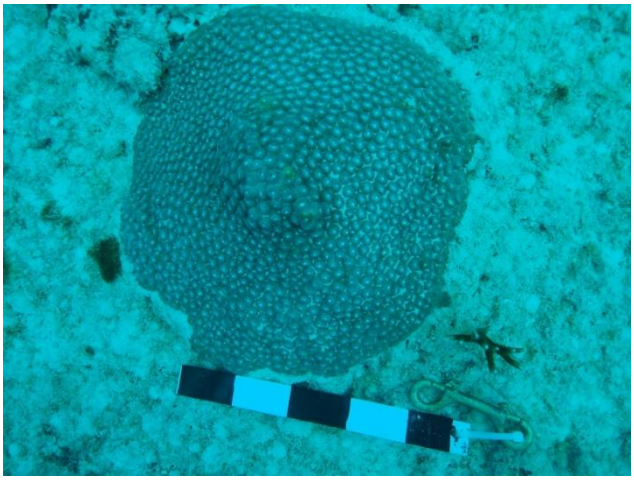


Photo 41. *M. cavernosa* at R3N2-150. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey. Partial mortality is apparent at the base of the coral.

Photo 42. *S. bournonii* at R3N2-150 with the appearance of white plague disease. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

R3N2-50

R3N2-50 was visited to qualitatively survey the area on April 27, 2015. This site was characterized by low relief spur and groove habitat. Maximum water depth was 44 feet in the low areas and 42 feet in higher areas. Horizontal visibility was 50 feet. Turf algae were visible, and sediment depth was 0-0.5 cm in depth on areas of hardbottom, but deeper in low areas (2-3 cm). Sediment in hardbottom areas was coarse with some fine texture. Pockets of clay-like material were documented at this site. Octocorals, hard corals and sponges, and *Lyngbya* were present. The presence of white plague was documented on *Solenastrea bournoni* and *Montastrea cavernosa*. A number of coral colonies in low lying areas had partial mortality around their bases, consistent with channel-side site partial mortality (Photos 43-45).

R3N2-50 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photos 43 and 44. Photo 43 (left) shows a landscape view of R3N2-50. Photo 44 (right) shows a pocket of clay-like material at R3N2-50. Photos 43 and 44 were taken on April 27, 2015 during the middle and outer reef impact assessment survey.

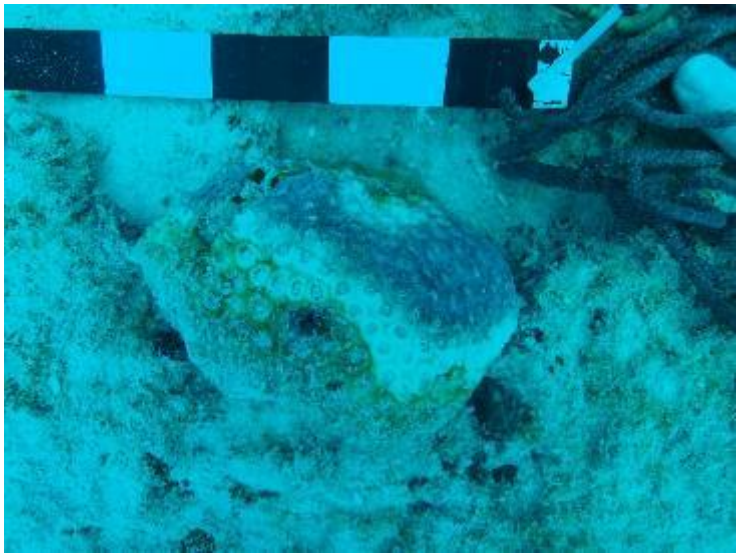


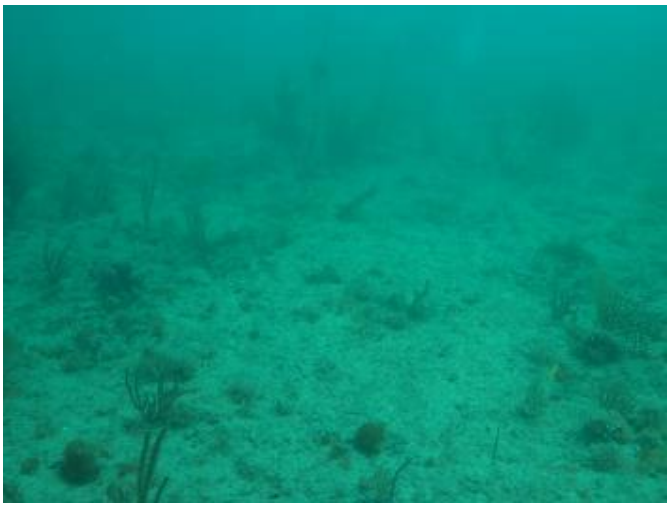
Photo 45. White plague disease on *Montastrea cavernosa* at R3N2-50. Photo was taken on April 27, 2015 during the middle and outer reef impact assessment survey.

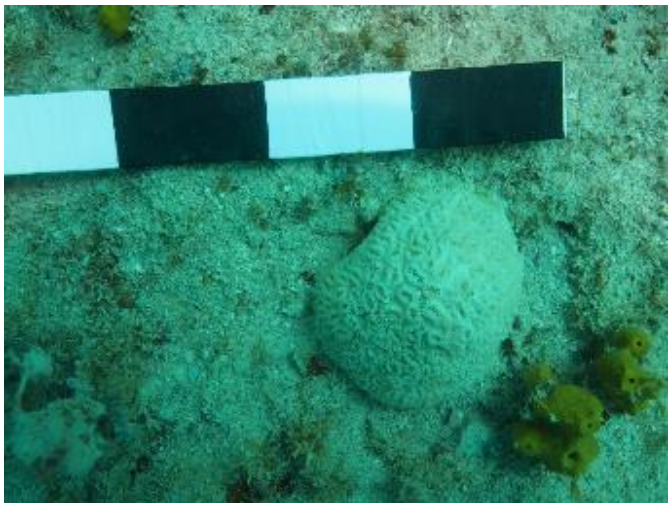
Impact Assessment Surveys May 11, 2015

Compliance Monitoring Site R2NC2

R2NC2 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 11, 2015. The low relief ridge habitat included hardbottom and sand areas. Maximum water depth was 24 feet. Horizontal visibility was 15 feet. A thin layer of sediment was present across the site, perhaps due to recent windy weather conditions. The dusting was a coarse material, consistent with sand found in pockets within the site. Sediment depth on hardbottom areas were less than 0.5 cm, and sand pockets were 2-3 cm in depth. Green and brown turf algae were visible and bound coarse sediment. Hard corals, including recruits, octocorals, sponges, *Lyngbya*, red calcareous algae, and *Dictyota* were present (Photos 46-48). Coral disease, specifically white plague was noted on hard corals, as well as presumably disease-related recent mortality of entire colonies (*Dichocoenia stokesii* see Photo 47).

R2NC2 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.





Photos 46 and 47. Photo 46 (left) shows a landscape view of R2NC2. Photo 47 (right) is a recently dead *Dichocoenia stokesii*. The mortality pattern shown in Photo 47 is consistent with documented mortality associated with white plague disease. Photos 46 and 47 were taken on May 11, 2015 during the middle and outer reef impact assessment survey.

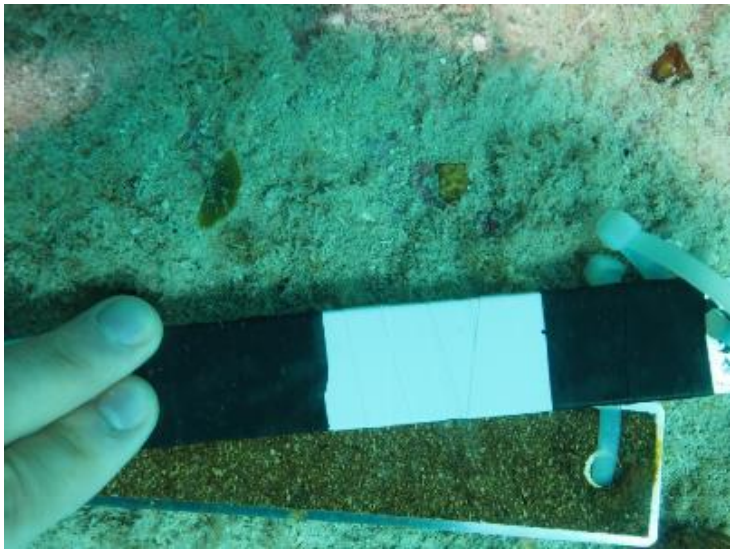


Photo 48. Small coral recruits documented at R2NC2. Photo 48 was taken on May 11, 2015 during the middle and outer reef impact assessment survey.

R2NC2-2.5 miles

R2NC2-2.5 miles was visited to qualitatively survey the area on May 11, 2015 (Photos 49-51). This site was characterized by low relief hardbottom and described as ridge habitat by Walker et al. 2008. The habitat was low relief hardbottom with many octocorals in a range of sizes, from small to large (greater than 1m). Few hard corals were present, however a number of smaller coral recruits were documented, many less than 2 cm. Whitish cyanobacteria covered the abundant macroalgae present at the site. All macroalgal groups were represented, including phaeophytes, rhodophytes, and chlorophytes. In general, there was less than 0.5 cm of sediment depth on the site, but pockets of sediment were deeper (2-3 cm).

R2NC2-2.5 miles was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photos 49 and 50. Photo 49 (left) is a landscape view of R2NC2-2.5miles. Photo 50 is a view of the macroalgae dominated substrate found at R2NC2-2.5 miles, note the heavy cyanobacterial mat. Photos 49 and 50 were taken on May 11, 2015 during the middle and outer reef impact assessment survey.

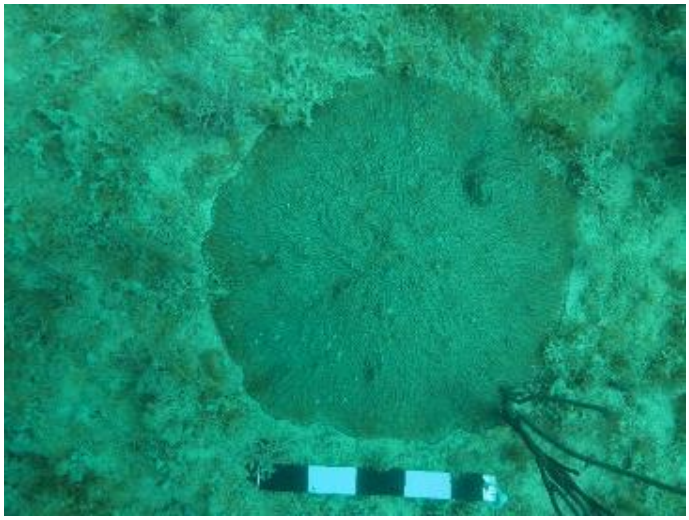


Photo 51 is a large *Diploria clivosa* colony at R2NC2-2.5 miles. Photo 51 was taken on May 11, 2015 during the middle and outer reef impact assessment survey.

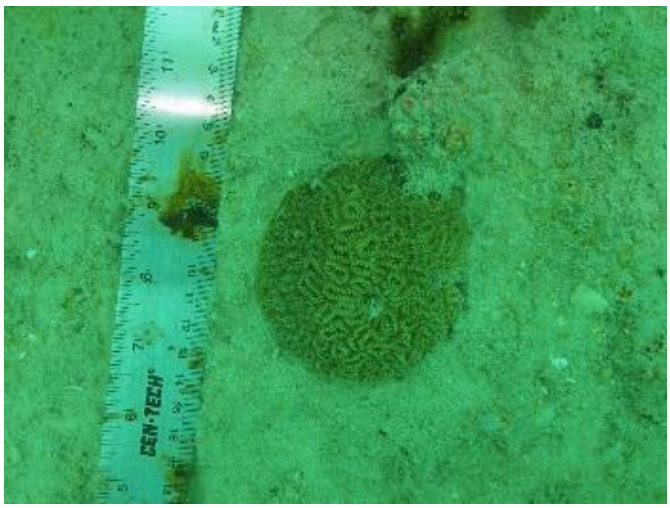
R2N1-1000

R2N1-1000 was visited to qualitatively survey the area on May 11, 2015. This site was sand only, so no assessment was conducted and no photographs were collected. Depth at this location was 24 feet and visibility was 15 feet.

R2N1-950

R2N1-950 was visited to qualitatively survey the area on May 11, 2015. R2N1-950 was in 27 feet of water and horizontal visibility was 6 feet (Photos 52 and 53). The site was characterized by Walker et al. 2008 as ridge habitat, observations documented the habitat was low relief hardbottom, with low hard coral cover, abundant octocorals, including recruits and large colonies (>1m). Sponges and hard corals were also present, colonies of *Siderastrea siderea* and *Montastrea cavernosa* were documented with white plague disease. The sediment at the site was coarse with some fine texture and sediment depth was 0.5 cm to 1 cm in depth. Macroalgae species included *Halimeda*.

R2N1-950 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.



Photos 52 and 53. Photo 52 (left) is a close up of small octocorals and sponge with vertical scale at R2N1-950. Photo 53 (right) is a *Dichocoenia stokesii* at R2N1-950. Photos 52 and 53 were taken on May 11, 2015 during the middle and outer reef impact assessment survey.

R2NC2 – 3.5 miles

R2NC2-3.5 miles was visited to qualitatively survey the area on May 11, 2015. R2N1-3.5 miles was in 28 feet of water, and horizontal visibility was 6 feet (Photos 54-56). The habitat at this site was described by Walker et al. 2008 as ridge habitat, observations documented hardbottom with some relief (1-2m) with octocorals in a range of sizes from small to large (>1m) present. Hard corals were higher in abundance than other middle reef sites visited on the same day, and sponges were present. A colony of *Acropora cervicornis* was documented. Sediment depth was 0.5 cm or less in depth on the hardbottom. Sand pockets were coarse and 2-3 cm in depth. Turf and macroalgae were abundant and covered in a fine layer of silty sediment.

R2NC2-3.5 miles was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photos 54 and 55. Photo 54 (left) is a landscape view of R2NC2-3.5 miles. Photo 55 (right) is a view of the substrate near a *M. cavernosa* colony at R2NC2-3.5 miles, note turf and cyanobacterial mix. Photos 54 and 55 were taken on May 11, 2015 during the middle and outer reef impact assessment survey.

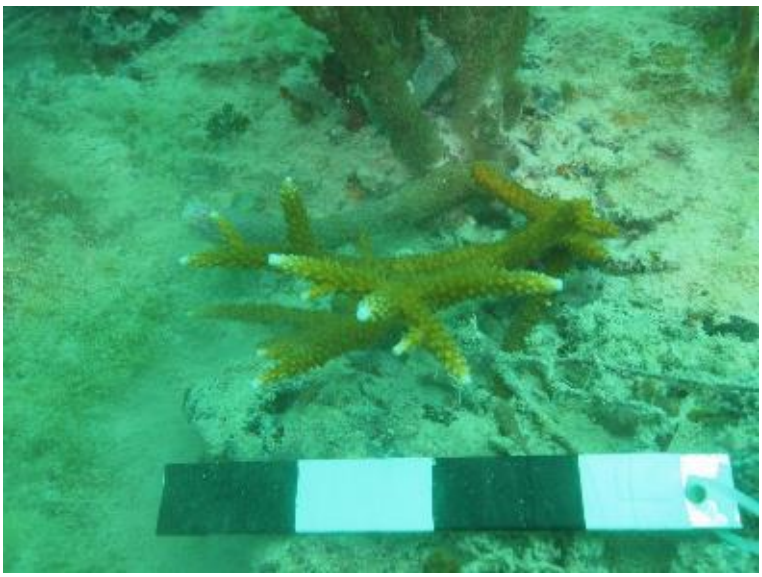


Photo 56 is a colony of healthy *A. cervicornis* at R2NC2-3.5 miles. Photo 56 was taken on May 11, 2015 during the middle and outer reef impact assessment survey.

R2N1-750

R2N1-750 was visited to qualitatively survey the area on May 11, 2015. The depth at R2N1-750 was 25 feet and horizontal visibility was 6 feet. A fine layer of freshly deposited brown silty sediment was present across the site. The habitat at R2N1-750 was described as ridge habitat by Walker et al. 2008. Observations documented octocorals, hard corals, and sponges of various sizes. Some turf algae were present, but turf color was obscured by recent deposition. Corals greater than 10cm were *Montastrea cavernosa* and *Siderastrea siderea*. Some recruits were documented in low areas, near sand. *A. cervicornis* colony was identified and appeared normal (Photo 57). White plague disease was present at the site (Photo 58).

R2N1-750 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photos 57 and 58. Photo 57 (left) is a healthy *A. cervicornis* colony found at R2N1-750. Photo 58 (right) is a large *M. cavernosa* colony with white plague disease at R2N1-750. Photos 57 and 58 were taken on May 11, 2015 during the middle and outer reef impact assessment survey.

Impact Assessment Surveys May 13, 2015

R3S-50

R3S-50 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document occurrence of partial mortality that would be consistent with partial mortality found at channel-side sites on May 13, 2015 (Photos 59-61). The 50 m location was chosen because the qualitative surveys suggested this area was beyond the area of impact based on sediment characteristics (see R3S2-200 above). The site was in 29-33 feet of water and horizontal visibility was 20 feet. The habitat was defined as linear reef by Walker et al. 2008. Scientific divers documented an octocoral dominated community with sponges and hard corals. Hard coral recruits were evident (*Siderastrea siderea*, *S. radians,* and *Montastrea cavernosa*), but generally hard corals were the least represented among the three groups. The site transects crossed grooves filled with sand as well as spurs that were raised above these sand areas. Sediment depth ranged from 0-3 cm, but was most commonly less than 0.5 cm in areas of hardbottom.

R3S-50 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality values were consistent with reference sites.

Photo 59. Landscape view of transect at temporary site R3S-50. Photo was taken on May 13, 2015 during the middle and outer reef impact assessment survey.

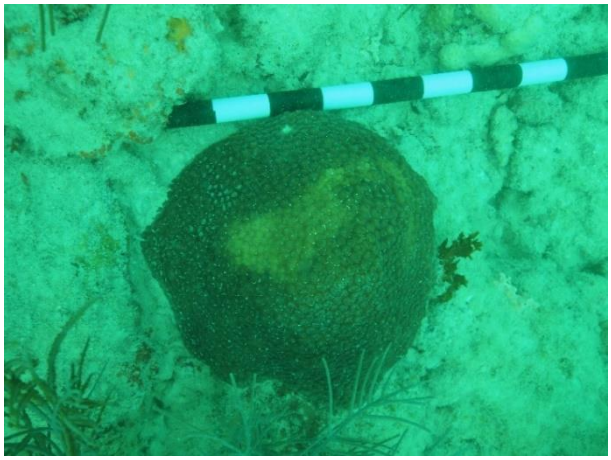


Photo 60. *M. cavernosa* at R3S-50 with partial paling of the colony. Photo was taken on May 13, 2015 during the middle and outer reef impact assessment survey.

Photo 61. *D. strigosa* at R3S-50 (coral condition score of PM). Photo was taken on May 13, 2015 during the middle and outer reef impact assessment survey.

R3S1-150

R3S1-150 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document occurrence of partial mortality that would be consistent with partial mortality found at channel-side sites on May 13, 2015 (Photos 62 and 63). The site was in 26-30 feet of water and horizontal visibility was 20 feet. The habitat was defined as linear reef by Walker et al. 2008. Observers documented an octocoral dominated community with sponges and hard corals also present. The site transects crossed grooves filled with sand as

well as spurs that were raised above these sand areas. Sediment depth ranged from 0-3 cm, but was most commonly less than 0.5cm in areas of hardbottom. Hard coral recruits were evident (*Siderastrea siderea*, *S. radians,* and *Montastrea cavernosa*), but generally hard corals were the least represented among the three groups. Turf algae were evident and macroalgae, including *Halimeda* and *Dictyota* were present. Corals with white plague disease were documented at the site.

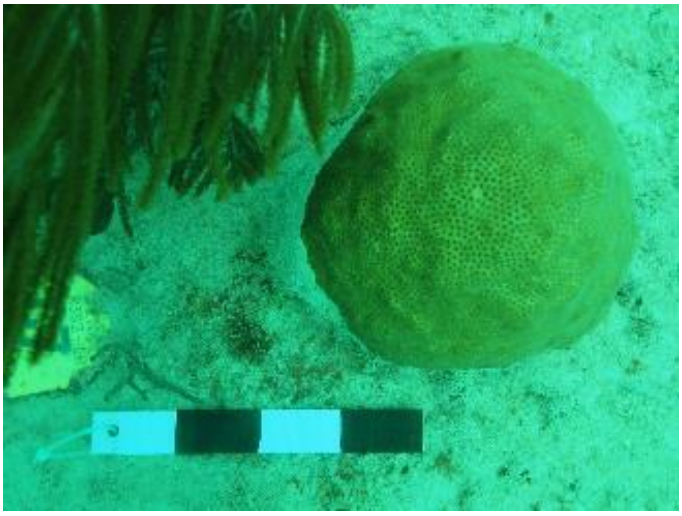
R3S1-150 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality values were consistent with reference sites.

Photos 62 and 63. Photo 62 (left) is a *Mycetophyllia aliciae* from R3S1-150 with mortality consistent with white plague disease. Photo 63 (right) is a large *M. cavernosa* colony with white plague disease at R3S1-150. Photos 62 and 63 were taken on May 13, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R3S2

R3S2 was visited in order to provide DEP with an opportunity to observe communities at an outer reef channel-side site on May 13, 2015 (Photos 64-66). No data were collected during the dive, since data were previously collected at this location, but photos are shown below. Maximum depth was 35 feet and visibility was 5 feet.

R3S2 was designated as an un-impacted site due to the documentation of sediment related coral partial mortality closer to reference values than adjacent channel-side sites R3S1 and R3S3. Possible explanations for this are depth and proximity to the channel. R3S2 (33 feet) is shallower than both R3S1 (38 feet) and R3S3 (35 feet), so currents may move material away from the site more quickly than the adjacent deeper sites. Also, R3S2 transects begin slightly further south (~3 m) than R3S1 and R3S3 transects. However, due to proximity this site is included within the potential sedimentation affected area.



Photos 64 and 65. Photo 64 (left) is a landscape view of R3S2. Photo 65 (right) is a permanently marked *S. bournoni* colony at R3S2. Photos 64 and 65 were taken on May 13, 2015 during the middle and outer reef impact assessment survey.

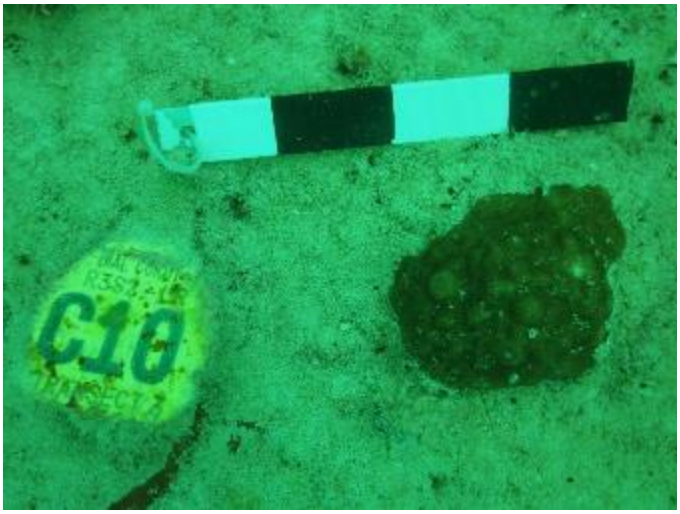


Photo 66. Permanently marked *P. astreoides* at R3S2. Photo 66 was taken on May 13, 2015 during the middle and outer reef impact assessment survey.

Impact Assessment Surveys May 14, 2015

R3N-150

R3N-150 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document occurrence of partial mortality that would be consistent with partial mortality found at channel-side sites on May 14, 2015. The site was in 37-44 feet of water and horizontal visibility was 30 feet (Photo 67). Observers documented an octocoral dominated community with sponges and hard corals. Transects were positioned in a north to south direction and spanned across spurs (37 feet) and grooves (44 feet). The grooves between spurs were sand bottom with generally 3-4 cm of sediment depth. Sediment characteristics were a mix of coarse and fine material. On hardbottom areas, sediment depth was 0.5 cm or less. Recruits (corals smaller than 3 cm) were documented. Small silty pockets of clay-like material were observed on the north side of spurs.

R3N-150 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality values were consistent with those documented at channel-side sites.

Photo 67. Landscape view of R3N-150. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

R3N-250

R3N-250 was surveyed using the quantitative survey protocol proscribed for compliance monitoring in order to document coral condition on May 14, 2015. The site was in 37-41 feet of water and horizontal visibility was 25 feet (Photos 68-70). Horizontal visibility was 25 feet during the dive and the prevailing current was northbound. Turf algae were visible and binding coarse sediment. Observers documented an octocoral dominated community with sponges and hard corals. Transects were positioned in a north to south direction and spanned across spurs (37 feet) and grooves (41 feet). The grooves between spurs were sand bottom and were generally 3-4 cm in depth. Sediments were mixed coarse and fine grains. On hardbottom areas, sediment depth was 0.5 cm or less. No pockets of clay-like material were documented at R3N-250.

R3N-250 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photo 68. Landscape view of R3N-250. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

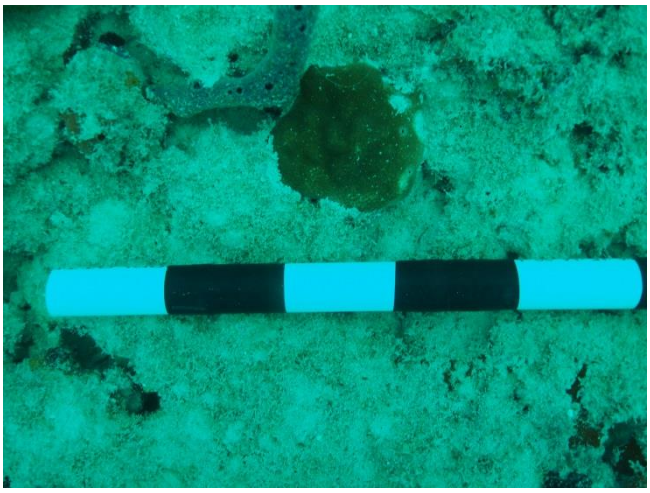


Photo 69. *P. astreoides* and benthic organisms at R3N-250. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

Photo 70. Landscape view of R3N-250. Photo was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

R2N1-650 bounce dive with DEP

R2N1-650 was visited to qualitatively survey the area on May 14, 2015. The depth at R2N1-650 was 28 feet and horizontal visibility was 7 feet (Photo 71). A fresh fine layer of silty fine sediment that was brown to gray in color was present across the site. The habitat at R2N1-650 was described as ridge habitat by Walker et al. 2008. Observations documented octocorals, hard corals, and sponges. Colonies of *Montastrea cavernosa* exhibited signs of white plague disease and recent partial mortality presumably associated with the disease. Turf algae were not visible, as they were freshly covered in silty material. Sand in pockets was coarse.

R2N1-650 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

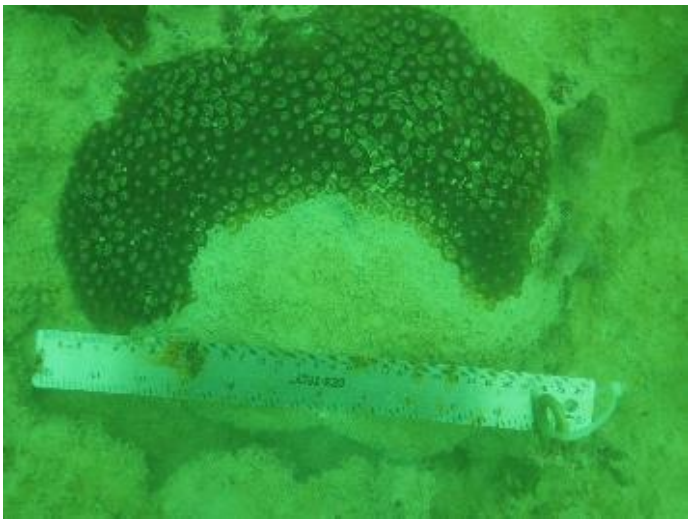


Photo 71. A *M. cavernosa* colony with white plague disease at R2N1-650. Photo 71 was taken on May 14, 2015 during the middle and outer reef impact assessment survey.

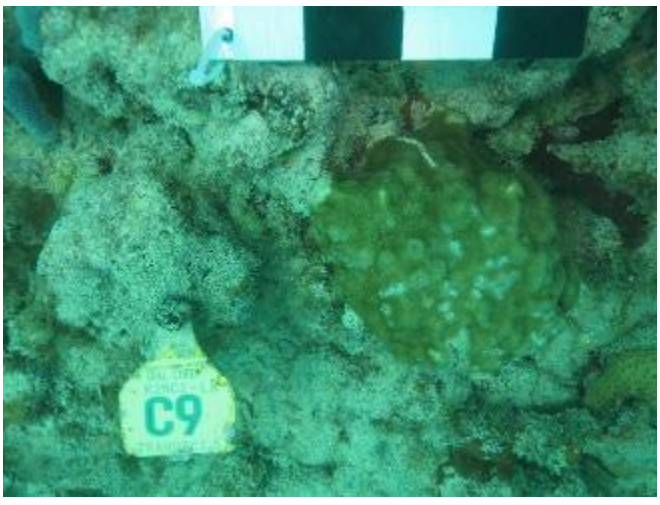
May 15 through May 17 was forecasted as a period of high winds (15 knots or greater), so impact surveys were temporarily suspended. Surveys resumed on May 19, 2015.

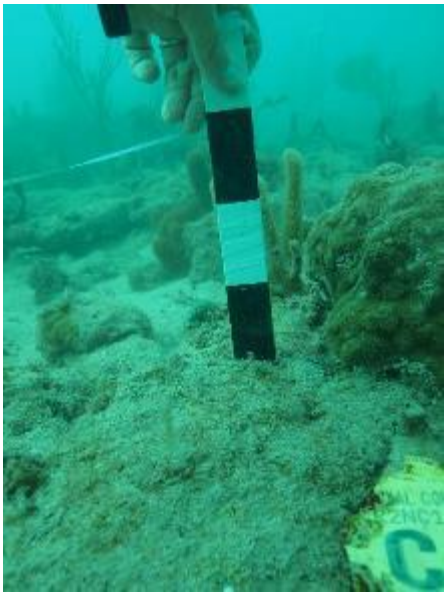
Impact Assessment Surveys May 19, 2015

Compliance Monitoring Site R2NC1

R2NC1 was visited and monitoring protocol methods were used to collect data on benthic organisms on May 19, 2015 (Photos 72 and 73). The low relief linear reef habitat included hardbottom and some large sand areas (Walker et al. 2008). Maximum water depth was 19 feet. Horizontal visibility was 15 feet. Sediment depth on hardbottom areas were less than 0.5 cm, and sand pockets were 2-4 cm in depth. Turf algae were visible and bound coarse sediment. A number of coral colony margins were partially buried, likely due to weather in the preceding days before the survey.

R2NC1 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.





Photos 72 and 73. Photo 72 (left) is a permanently marked *P. astreoides* at R2NC1. Photo 72 (right) is a close up of benthos at R2NC1 with vertical scale. Photos 72 and 73 were taken on May 19, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R2NC2

R2NC2 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 19, 2015 (Photos 74-76). Sediment depth was less than 0.5 cm. Turfs were previously abundant at this site, but were not present on this visit or were covered by sediment. Many coral margins were covered. Macroalgae including *Dictyota*, and *Halimeda* were present. Mostly coarse sediment was observed at the site with some fine material present.

R2NC2 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.

Photos 74 and 75. Photo 74 (left) is a permanently marked *D. stokesii* colony at R2NC2. Photo 75 (right) is a close up of the benthos and *M. cavernosa* with vertical scale. Photos 74 and 75 were taken on May 19, 2015 during the middle and outer reef impact assessment survey.

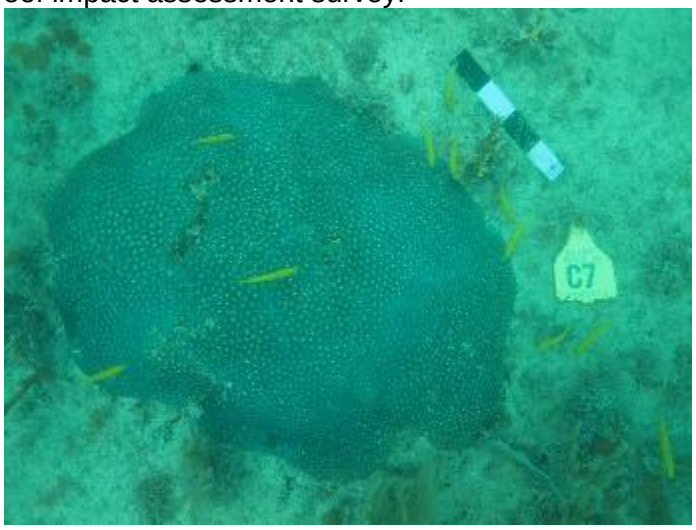


Photo 76. *M. cavernosa* colony at R2NC2. Photo 76 was taken on May 19, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R2N1

R2N1 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 19, 2015 (Photos 77-78). NOAA divers shadowed scientific divers while conducting surveys. R2N1 habitat was described as ridge habitat by Walker et al. 2008. The maximum depth was 28 feet

and visibility was 50 feet. The sediment at this site was a fine white sand, depth of sediment was generally 0.5 to 1 cm in depth. Sand pockets were between 2 and 5 cm in depth. No pockets of clay-like material were documented.

The dominant group at this site was octocorals, followed by sponges and hard corals. Benthic organisms color was visible, and contrasted with the surrounding white fine sand that was present across the site.

R2N1 was designated as an impacted site because compliance monitoring results documented partial mortality associated with sedimentation during construction activities at this site.

Photo 77. Close up of the benthos and sponge at R2N1. Photo 77 was taken on May 19, 2015 during the middle and outer reef impact assessment survey.

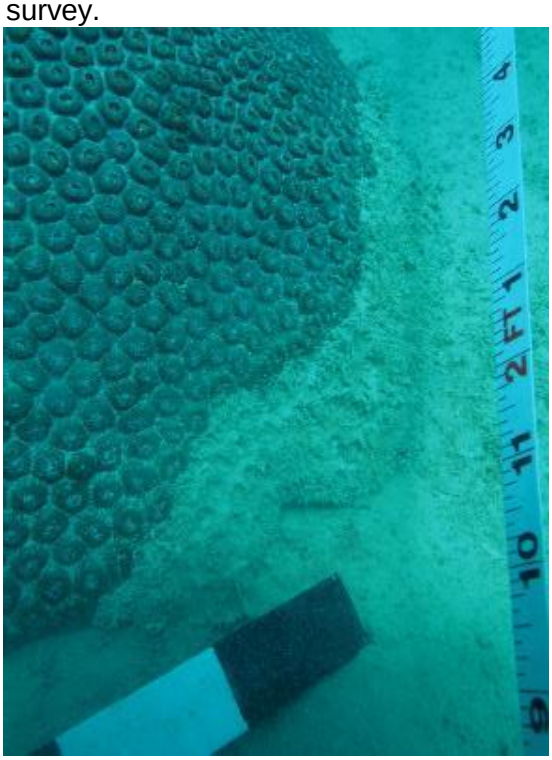


Photo 78. Close up of partial mortality on *M. cavernosa* colony at R2N1. Photo 78 was taken on May 19, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R2N2

R2N2 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 19, 2015 (Photos 79 and 80). NOAA divers shadowed the scientific diver team while conducting surveys. R2N2 was described as linear reef habitat by Walker et al. 2008. The site is characterized by hardbottom surrounding a large sand flat with islands of hardbottom within it. Octocorals and sponges are the predominant benthic fauna at this site, with fewer hard corals. More silty material was present compared to R2N1. Sediment depth was 0.5 to 1cm in depth. Depressions in the hardbottom had pockets of sediment between 2 and 4 cm in depth. Octocorals and sponges were observed to be healthy and unaffected. Sediment bound in and on turf algae was documented, and benthic texture indicated the presence of sediment covered turf algae. Visibility was greater than 50 feet.

R2N2 was designated as an impacted site because compliance monitoring results documented partial mortality associated with sedimentation during construction activities at this site.

Photo 79. Landscape view of R2N2. Photo 79 was taken on May 19, 2015 during the middle and outer reef impact assessment survey.

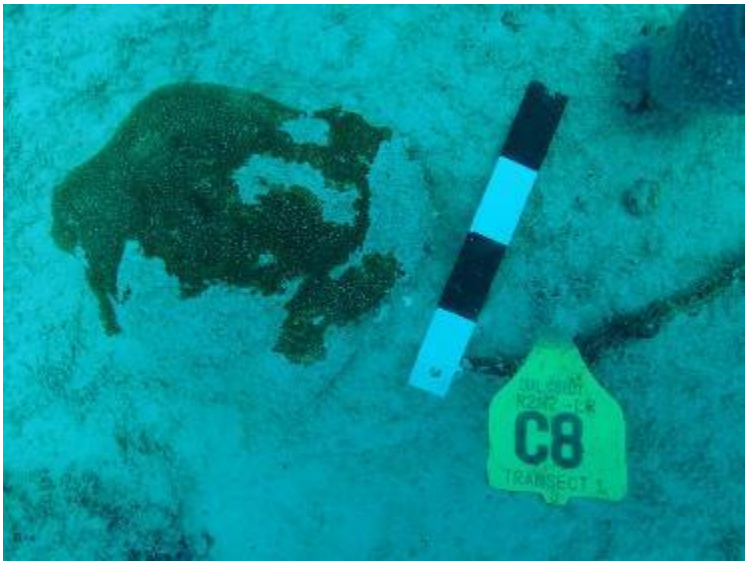


Photo 80. Tagged colony of *S. bournoni* at R2N2 with evidence of recent patchy mortality. Photo 80 was taken on May 19, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R2SC1

R2SC1 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 19, 2015 (Photos 81-83). R2SC1 was characterized as ridge habitat by Walker et al. 2008. Maximum depth was 22 feet and horizontal visibility was 40 feet. Turf algae were evident, but their color

was obscured and the site appeared as though it had recently been dusted with sediment, likely from recent weather conditions. Sediment was generally less than 0.5 cm on areas of hardbottom, with occasional deeper pockets of 2-3 cm. White plague disease was active at the site, affecting *Diploria strigosa* and *Montastrea cavernosa*. Most marked and many unmarked corals at this site are dead, due to white plague disease that began causing mortality of several corals in the area in November 2014.

R2SC1 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.

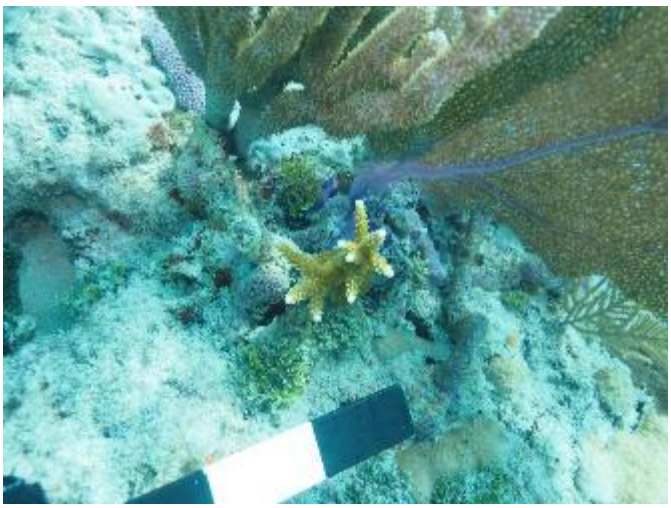
Photos 81 and 82. Photo 81 (left) is a landscape view of R2SC1. Photo 82 (right) is a tagged colony of *A. cervicornis* at R2SC1. Photos 81 and 82 were taken on May 19, 2015 during the middle and outer reef impact assessment survey.

Photo 83. Tagged colony of *Diploria strigosa* with signs of active white plague disease. Photo 83 was taken on May 19, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R2SC2

R2SC2 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 19, 2015 (Photos 84-86). R2SC2 was characterized as linear reef habitat by Walker et al. 2008. Maximum depth was 20 feet and horizontal visibility was 35 feet. Turf algae were evident and their color showed through a dusting of sediment, similar to R2SC1. Macroalgae, including *Halimeda* and *Dictyota* were documented. Most marked and unmarked corals were dead at this site, due to the white plague disease event that began causing coral mortality in November 2014. A small *A. cervicornis* colony (<5 cm) was documented near Transect 3. *Aspergillosis* was noted affecting at least one colony of *Gorgonia ventillata*.

R2SC2 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.



Photos 84 and 85. Photo 84 (left) is a landscape view of R2SC2. Photo 85 (right) is a small un-tagged colony of *A. cervicornis* at R2SC2. Photos 84 and 85 were taken on May 19, 2015 during the middle and outer reef impact assessment survey.

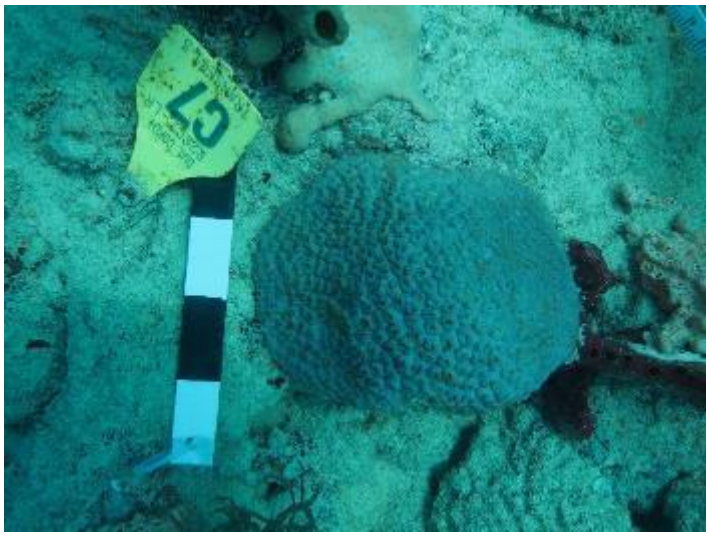


Photo 86. A tagged colony of *M. cavernosa* at R2SC2. Photo 86 was taken on May 19, 2015 during the middle and outer reef impact assessment survey.

Impact Assessment Surveys May 20, 2015

Compliance Monitoring Site R2S1

R2S1 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 20, 2015 (Photos 87 and 88). R2S1 was characterized as ridge reef habitat by Walker et al. 2008. Maximum depth was 26 feet and horizontal visibility was 40 feet. The site is depauperate of benthic organisms when compared to reference areas, but the dominant group at this site is octocorals, followed by sponges and then by hard corals. Benthic organisms color was visible, and contrasted with the surrounding white fine sand that was present across the site. In areas of hardbottom, sand depth was 0.5 to 1 cm. Turf algae were covered in 0.5 cm of fine sand. Pockets of clay-like material were identified, and sand pockets were 2-3 cm in depth. White plague coral disease was observed on an unmarked *Diploria strigosa* colony at R2S1.

R2S1 was designated as an impacted site because compliance monitoring results documented partial mortality associated with sedimentation during construction activities at this site.

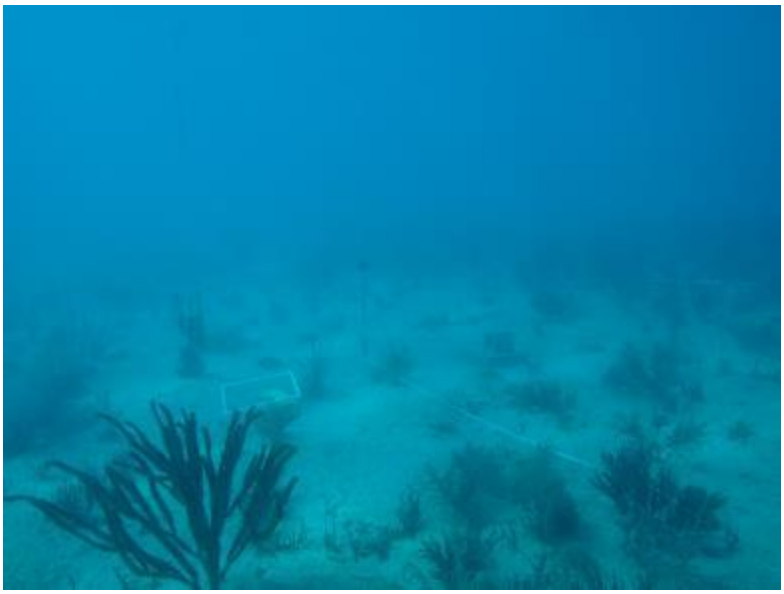
Photo 87. Landscape view of R2S1. Photo 87 was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Photo 88. Unmarked colony of *D. strigosa* colony with white plague disease at R2S1. Photo 88 was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R2S2

R2S2 was visited and FDEP mandated construction monitoring protocol methods were used to collect data on benthic organisms on May 20, 2015 (Photos 89-91). R2S2 was characterized as linear reef habitat by Walker et al. 2008. Maximum depth was 30 feet and horizontal visibility was 40 feet. Octocorals are the predominant benthic organisms followed by sponges and lastly hard corals. A dusting of sediment was present across the site, in general sediment depth was 0.5-1 cm in areas of hardbottom. Sediment pockets were deeper, generally 2-4 cm. Sediment at this site was a fine to silty white sand. When compared to R2S1 the sediment was finer, as observed through tactile sampling. White plague coral disease was active at R2S2, colonies affected included marked corals of *Colpophyllia natans* and *Montastrea cavernosa.*

R2S2 was designated as an impacted site because compliance monitoring results documented partial mortality associated with sedimentation during construction activities at this site.



Photos 89 and 90. Photo 89 (left) is a landscape view of R2S2. Photo 90 (right) is a view of the benthos at R2S2 near a tagged colony of *S. bournoni* with recent disease-related patchy mortality. Photos 89 and 90 were taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Photo 91. Tagged *Colpophyllia natans* colony with active white plague disease at R2S2. Photo 91 was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

R2SC1- 1025

R2SC1-1025 was visited to qualitatively assess the area for impact on May 20, 2015 (Photos 92-94). The site was characterized by Walker et al. 2008 as ridge habitat and was dominated by octocorals, followed by sponges and hard corals represented a minor constituent of benthic organisms. Overall, the area was low relief (less than 1 m). Maximum depth at the site was 25 feet and the horizontal visibility was 40 feet. White plague disease was documented on *Montastrea cavernosa* and *Diploria strigosa*. Turf algae were present and binding fine sand which was 0.5 cm in depth on hardbottom areas. Pockets of sand were coarse, and 2-3 cm in depth.

R2SC1-1025 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.


Photos 92 and 93. Photo 92 (left) is a landscape view of R2SC1-1025. Photo 93 (right) a close-up of a *M. cavernosa* colony with patchy mortality consistent with white plague disease. Photos 92 and 93 were taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Photo 94. *D. strigosa* colony with active white plague disease at R2SC1-1025. Photo 94 was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Compliance Monitoring Site R2SC1

R2SC1 was visited to qualitatively assess sedimentation levels at the reference site (Photo 95). On May 20, 2015 at R2SC1 horizontal visibility was 40 feet, and maximum depth was 25 feet. Observers recorded sediment depth on areas of hardbottom were 0.5 cm and deeper in sand pockets. Turfs were visible and bound coarse sediment.

R2SC1 was a compliance monitoring reference site and was used to define the un-impacted condition as it was away from any potentially project related sedimentation effects.

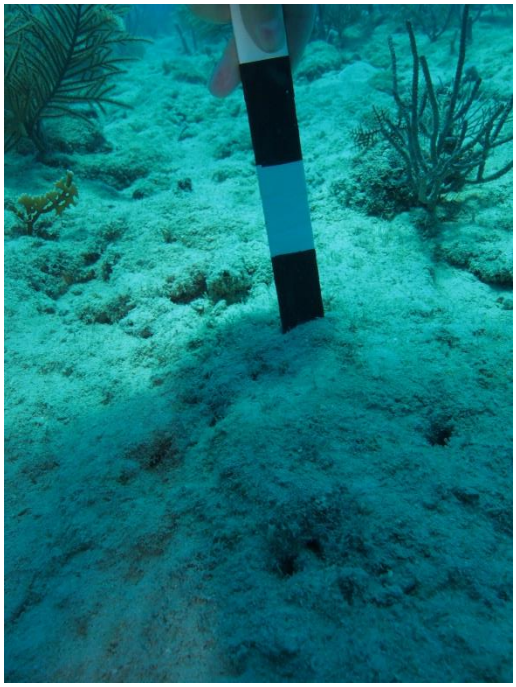


Photo 95. Close up of the benthos at R2SC1. Photo 95 was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

R2S1-400

R2S1-400 was visited to qualitatively assess the location for signs of potential impact on May 20, 2015. The habitat was characterized as ridge habitat by Walker et al. 2008. Maximum depth at R2S1-400 was 24 feet and visibility was horizontally 40 feet. The habitat was dominated by patchy distribution of octocorals, and relief was relatively flat (6-12 inches of relief) with large rubble incorporated into the hardbottom (Photos 96 and 97). In areas of hardbottom, the depth of sediment was 0.5 cm and numerous sand patches were 3 cm in depth. Small isolated pockets of clay like material were documented at this location, but overall, the sediment was a mix of coarse and fine sand. No partial mortality of hard corals was documented at R2S1-400.

R2S1-400 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

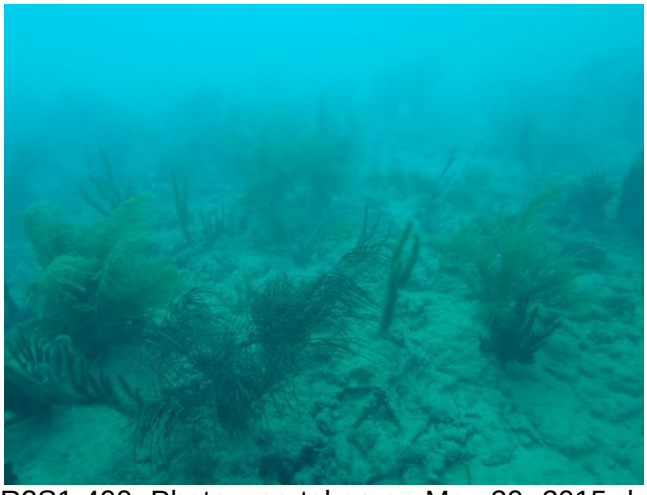


Photo 96. Landscape view of R2S1-400. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Photo 97. *S. bournoni* and vertical scale at R2S1-400. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

R2S1 – 200

R2S1-200 was visited on May 20, 2015 to qualitatively assess the site for potential sedimentation effects. The depth at this site was 25 feet and visibility was 40 horizontal feet. R2S1-200 was almost flat and had very little relief (0-6 inches), sand patches were present with a mix of fine and coarse sand, and fewer sand pockets were present when compared to R2S1-400 (Photos 98 and 99). Sediment depth on hardbottom was 0-2 cm, and on average 1 cm or less. Sand pockets were 2-3 cm and pockets of clay-like material were noted. *Diploria clivosa* colonies were abundant at this site and several colonies exhibited partial mortality consistent with that described at channel-side sites.

R2S1-200 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 98. Landscape view of R2S1-200. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

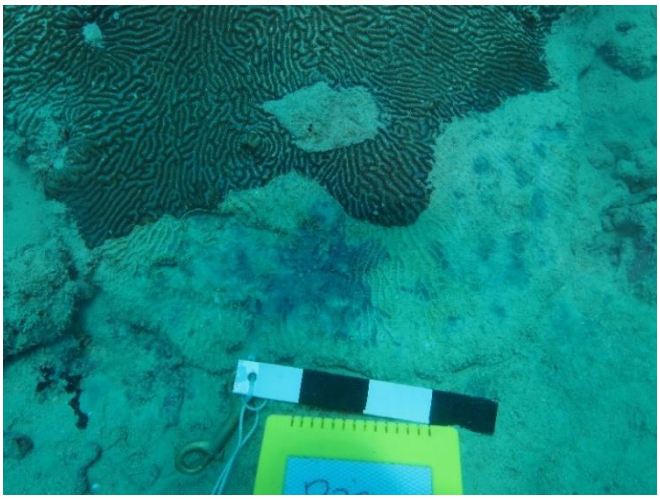


Photo 99. Partial mortality of *Diploria clivosa* at R2S1-200, consistent with partial mortality documented at channel-side sites. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

R2S1-300

R2S1-300 was visited to qualitatively assess the location for signs of impact on May 20, 2015. Depth was 24 feet and horizontal visibility was 40 feet. Observers documented almost flat (0-6 inches) hardbottom at this site, similar to R2S1-200 (Photos 100 and 101). Sediment depth on hardbottom was 0-2 cm, and on average 1 cm or less. Sand pockets were deeper, but pockets of clay-like material were not documented. *Diploria clivosa* colonies were abundant but fewer signs of partial mortality were observed, when compared with R2S1-200.

R2S1-300 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites, although to a lesser extent when compared to R2S1-200.

Photo 100. Landscape view of R2S-300. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Photo 101. *Diploria clivosa* with partial mortality consistent with channel-side sites at R2S1-300. Photo was taken on May 20, 2015 during the middle and outer reef impact assessment survey.

Impact Assessment Surveys May 21, 2015

R2S1-400

Quantitative surveys were conducted at R2S1-400 to document coral condition, including partial mortality following methods used at compliance channel side sites on May 21, 2015. The site depth was 25 feet of water and visibility was 20 feet. The site had very little relief (6-12 inches) and was mostly bare, with octocoral and hard corals (Photos 102-104). The site was dominated by open space, and octocorals were the most abundant benthic organism. Sediment depth ranged from 0 to 2 cm and was most commonly 1 cm or less on hardbottom.

R2S1-400 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality values were consistent with reference sites.

Photo 102. Landscape view of R2S1-400. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 103. *S. bournoni* colony at R2S-400. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

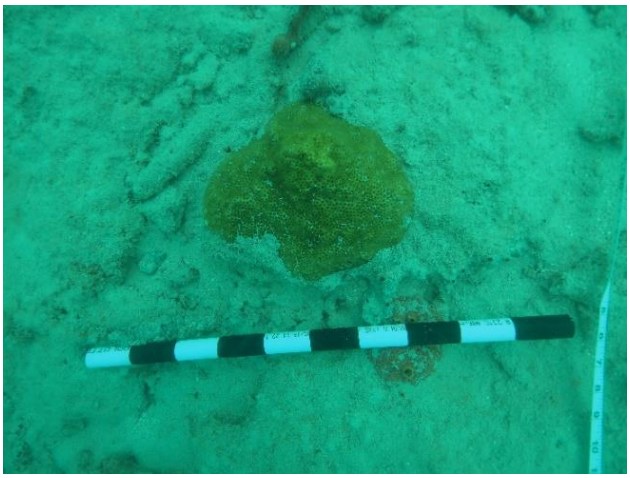


Photo 104. *S. bournoni* colony at R2S-400. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2S1-200

Quantitative surveys were conducted at R2S1-200m to document coral condition, including partial mortality following methods used at compliance channel side sites on May 21, 2015. The site depth was 26 feet, and visibility was 40 feet. The site had very little relief (0-6 inches). The site was dominated by open space, and octocorals were the most abundant benthic organism. Sediment depth ranged from 0 cm to 2 cm and was most commonly 1 cm or less in depth (Photos 105-107).

R2S-200 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality values were consistent with those documented at channel-side sites.

Photo 105. Landscape at R2S1-200. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 106. *S. bournoni* at R2S1-200. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 107. *M. cavernosa* at R2S1-200 with white plague disease. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1-750

R2N1-750 was revisited visited on May 21, 2015, with horizontal visibility of 40 feet. The second visit revealed the site was high in relief, with depth ranging from 23-30 feet (Photos 108-111). The benthic habitat was dominated by octocorals. Numerous fish used the relatively high relief for habitat, including parrotfish, grunts,

snappers and angelfish. *Acropora cervicornis* were abundant in the area, more than twenty colonies that ranged in size from 25 cm to 1.5 m in size were observed. Sediment depth ranged from 0-1 cm and was most frequently less than 0.5 cm in depth. Sediment was fine to coarse and bound in turf algae. *Montastrea cavernosa* and *Dichocoenia stokesii* corals with the appearance of white plague disease were noted at the site. Two *A. cervicornis* colonies with the appearance of white band disease were also noted.

R2N1-750 was designated as an un-impacted site because overall benthic community characteristics and coral partial mortality was qualitatively consistent with reference sites.

Photo 108. *Acropora cervicornis* photographed at R2N1-750 on May 21, 2015.

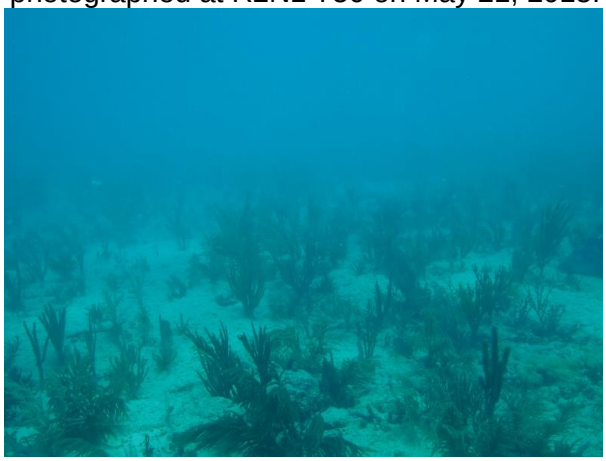


Photo 109. Landscape view of R2N1-750. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 110. Landscape view of R2N1-750. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 111. *Acropora cervicornis* at R2N1-750. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1-650

R2N1-650 was visited on May 14, 2015, but visibility was low, so the site was revisited on May 21, 2015, when horizontal visibility was 40 feet. The second visit revealed the site was relatively high in relief, with depth ranging from 24-30 feet. The benthic habitat at this site was dominated by octocorals. Fish were documented, including parrotfish, grunts, snappers and angelfish. No *Acropora cervicornis* colonies were documented. Sediment depth ranged from 0-4 cm and was most frequently less than 1 cm in depth. Sediment was fine to coarse and bound in turf algae, but turf algae color was not distinguishable. Pockets of clay-like material were documented. Coral colonies of *Montastrea cavernosa* were observed with the appearance of white plague disease. Some partial mortality was documented on low lying hard corals (Photos 112-114). Coral recruits (corals less than 3 cm) were documented).

R2N1-650 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 112. Landscape view of R2N1-650. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 113. White plague disease on *M. cavernosa*. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 114. *M. cavernosa* with a portion of the colony paled at R2N1-650. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1-550

R2N1-550 was visited to qualitatively assess the location for effects of sedimentation on May 21, 2015. The observed habitat was relatively high in relief, with a low point in the middle of surrounding higher relief habitat, forming a bowl. R2N1-550 was lower in relief than R2N1-750 and R2N1-650, depth ranged from 24-29 feet. Octocorals dominated the benthic community. An apparently healthy *Acropora cervicornis* colony was documented at the site along with *Montastrea cavernosa* colonies with white plague disease. Observers noted fewer incidents of white plague than at R2N1-650. Sediment depth ranged from 0-5 cm, with 1 cm or less being the most common depth. Fine sand was bound by turf algae across the site, but turf color was not apparent. Pockets of clay-like material were documented in low areas. Partial mortality was observed on corals in low lying areas (Photos 115-117).

R2N1-550 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 115. Landscape view of R2N1-550. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 116. *M. cavernosa* at R2N1-550 with the appearance of white plague disease. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 117. *Acropora cervicornis* at R2N1-550. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

R2N1 – 450

R2N1-450 was visited to qualitatively assess the location for effects of sedimentation on May 21, 2015. The observed habitat was relatively high in relief, and depth ranged from 19-26 feet. Octocorals dominated the landscape (Photo 118). A single *Acropora cervicornis* colony was documented at the site (Photo 119). Corals with the active white plague disease were documented on colonies of *Montastrea cavernosa* (Photo 120). Sediment depth ranged from 0-3 cm in depth with the most common depth being 0.5 cm or less, except in pockets of sand. A layer of fine sediment was present across the site and octocorals were noted to be shedding mucus laden sediment. Fewer pockets of clay-like material were documented when compared to R2N1-550. Partial mortality was noted on hard corals in low lying areas.

R2N1-450 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photo 118. Landscape view of R2N1-450. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 119. *Acropora cervicornis* at R2N1-450. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Photo 120. *M. cavernosa* with white plague disease. Photo was taken on May 21, 2015 during the middle and outer reef impact assessment survey.

Impact Assessment Surveys May 22, 2015

R2N1 -350

R2N1-350 was visited to qualitatively assess the location for effects of sedimentation on May 22, 2015. The habitat was characterized as ridge habitat by Walker et al. 2008. The observed habitat was lower in relief when compared to R2N1-450, but was still relatively high in relief, depth ranged from 25-28 feet. Horizontal visibility was 10 feet. Octocorals dominated the landscape, with large octocorals (>1 m) being common. White plague was documented affecting *Montastrea cavernosa*. Sediment depth ranged from 0-3 cm with 0.5 cm or less being the most common measurement (Photos 121–122). Partial mortality consistent with channel-side site partial mortality was documented.

R2N1-350 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

Photos 121 and 122. Photo 121 (left) is a colony of *M. cavernosa* with recent mortality and active white plague disease. Photo 122 (right) is a close-up of a *M. cavernosa* colony with recent mortality and active white plague disease. Photos were taken on May 22, 2015 during the middle and outer reef impact assessment survey.

R2N1-250

R2N1-250 was visited to qualitatively assess the location for effects of sedimentation on May 22, 2015. The habitat was characterized as ridge habitat by Walker et al. 2008. The observed habitat was relatively high in relief, depth ranged from 26-29 feet. Horizontal visibility was 10 feet during the survey and a fine layer of sediment was documented over the site. Sediment depth ranged from 0—2 cm in depth and was most commonly 0.5 cm or less in depth. Pockets of clay-like material were observed. White plague was present and documented affecting *M. cavernosa*. Patterns of mortality consistent with partial mortality associated with sedimentation were observed.

R2N1-250 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.

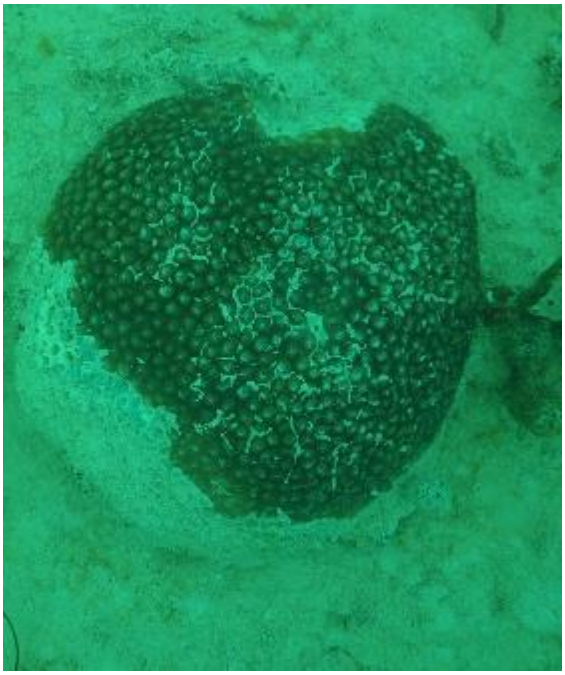
Photo 123. Landscape view of R2N1-250. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

Photo 124. *M. cavernosa* colony with partial mortality consistent with that noted at channel-side sites due to sedimentation. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

R2N1-150

R2N1-150 was visited to qualitatively assess the location for effects of sedimentation on May 22, 2015. The habitat was characterized as ridge habitat by Walker et al. 2008. The observed habitat was relatively high in relief, depth ranged from 27-30 feet. Horizontal visibility was 10 feet. A fine layer of sediment covered the benthic habitat. Large octocorals and large areas of open space dominated the site, many octocorals were larger than 1 m in height. Sediment depth ranged from 0-2 cm in depth and was most frequently 0.5 cm or less in depth. Pockets of clay like material were observed. White plague was observed on *M. cavernosa* colonies (Photos 126-127). Partial mortality consistent with channel-side site partial mortality was documented.

R2N1-150 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality was qualitatively consistent with those documented at channel-side sites.



Photos 125 and 126. Photo 125 (left) is a landscape view of R2N1-150. Photo 126 (right) is a close-up of a *M. cavernosa* colony with sediment accumulation on the top of the colony and recent mortality due to active white plague disease on the sides. Photos were taken on May 22, 2015 during the middle and outer reef impact assessment survey.

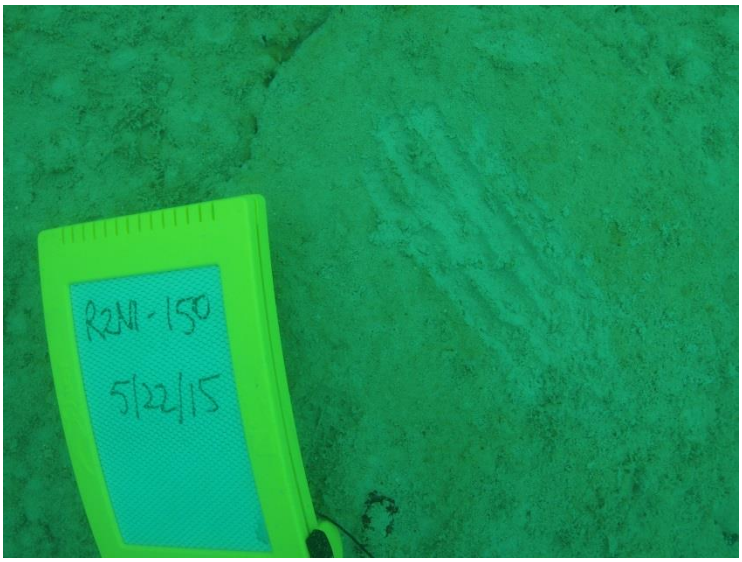


Photo 127. Close-up of benthos and sediment present at R2N1-150. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

R2N1-550

R2N1-550 was quantitatively surveyed on May 22, 2015 to document coral condition using methods consistent with those at channel-side sites for compliance monitoring. Visibility was 10-15 feet during the survey and the maximum depth was 30 feet. Two out of three transects that sampled habitat in low relief areas at R2N1-550 had partial mortality consistent with partial mortality documented at channel-side sites. Corals on the same transect, in areas of higher relief, did not exhibit partial mortality consistent with channel-side sites (see Appendix D for coral stress and partial mortality analysis). No *A. cervicornis* were documented during the survey on May 22. 2015.

R2N1-550 was designated as a potentially impacted site because benthic community characteristics and coral partial mortality values were consistent with those documented at channel-side sites.

Photo 128. *S. bournoni* surveyed at R2N1-550. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

R2N1-950

Attempted quantitative surveys at R2N1-950, but sufficient numbers of hard corals were not available to survey on a single transect. This habitat is dominated by large sand patches, with rare hard corals and octocorals (Photo 129). Due to the inability to complete quantitative surveys at this location, the team moved to R2N1-850.


Photo 129. Sponge and octocorals present at R2N1-950. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

R2N1-850

R2N1-850 was quantitatively surveyed on May 22, 2015. Visibility was horizontally 15 feet and maximum depth was 30 feet. This site was characterized by Walker et al. 2008 as linear reef. However, observers documented low relief (0-6 inches) hardbottom with numerous large sand patches and large octocorals (>1 m), more typical of hardbottom habitat (Photo 130). Few hard corals were present. Hard coral species included, *Solenastrea bournoni*, *Siderastrea siderea*, *Dichocoenia stokesi*i, *Stephanocoenia intersepta*, *and Montastrea cavernosa*. Many of the corals larger than 10 cm in diameter were located in large sand patches. Sediment was 0-4 cm deep

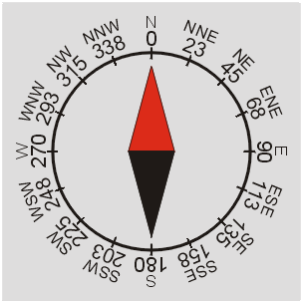
across the site, but most commonly 1 cm or less on areas of hardbottom. The habitat resembled that of nearshore hardbottom / rubble areas as opposed to a true reef community. R2N1-850 results demonstrated that more detailed benthic mapping is needed to accurately characterize the habitat witihin the potential impact area.

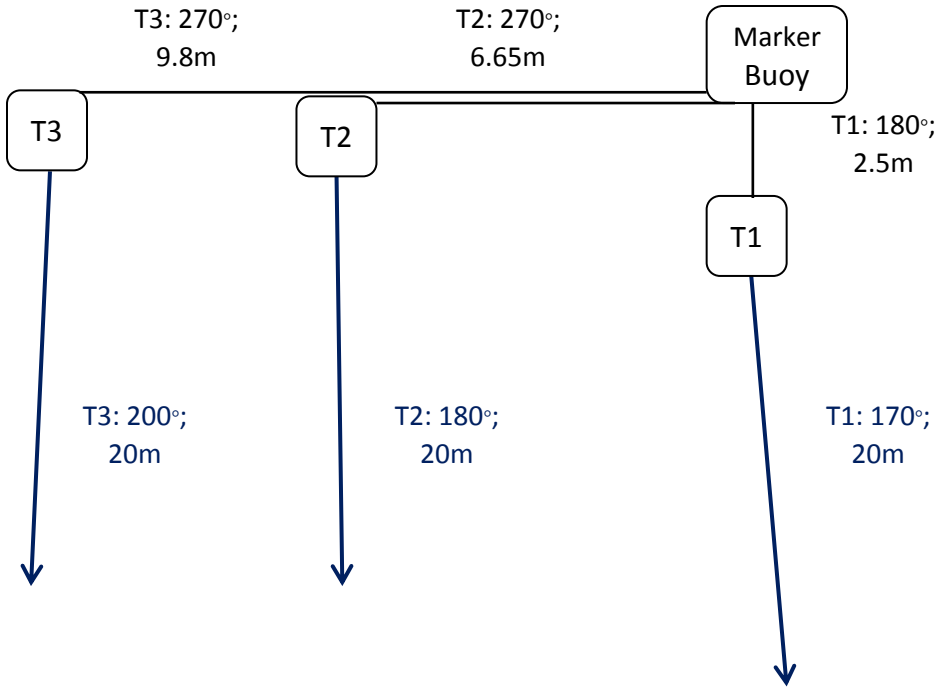
R2N1-850 was designated as an un-impacted site because hard corals present exhibited partial mortality consistent with reference sites.

Photo 130. Landscape view of R2N1-850. Photo was taken on May 22, 2015 during the middle and outer reef impact assessment survey.

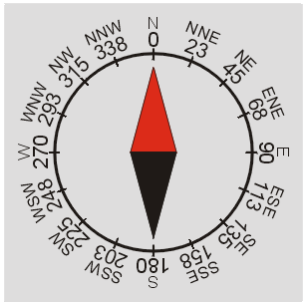
APPENDIX B

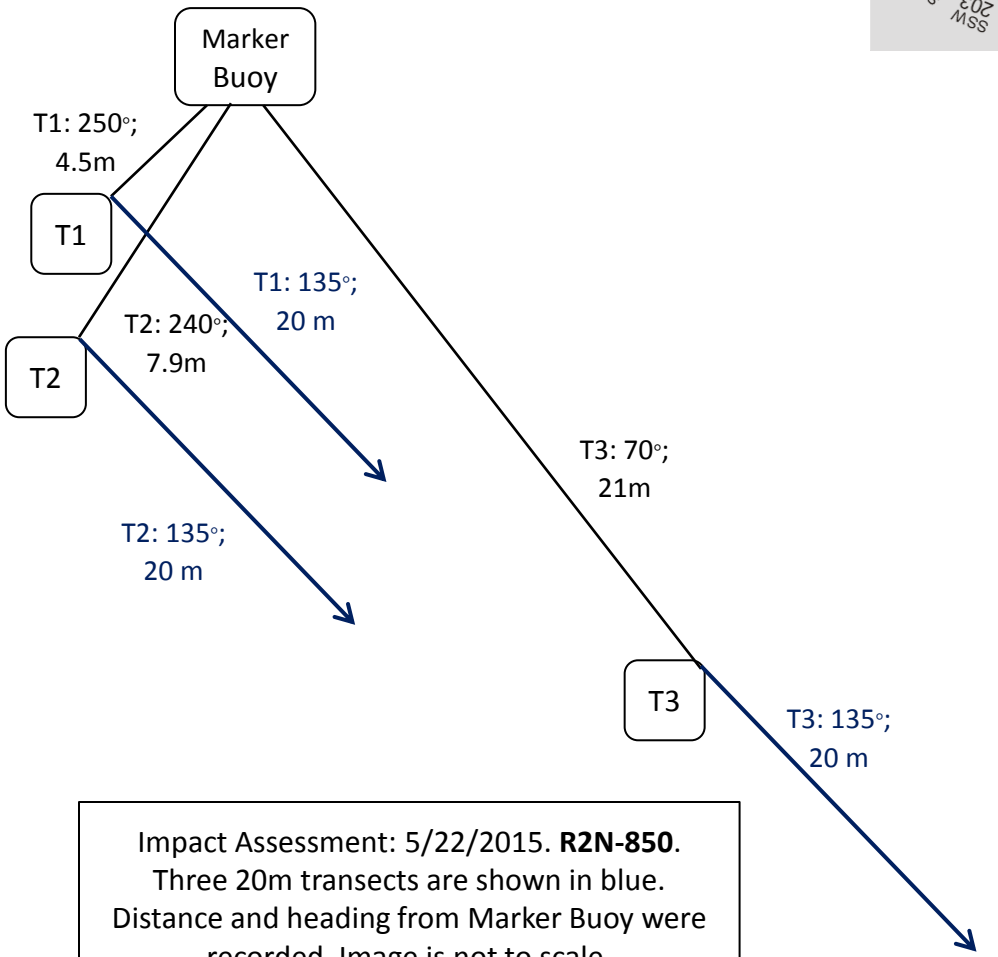
Map of All Temporary Sites Transect Locations



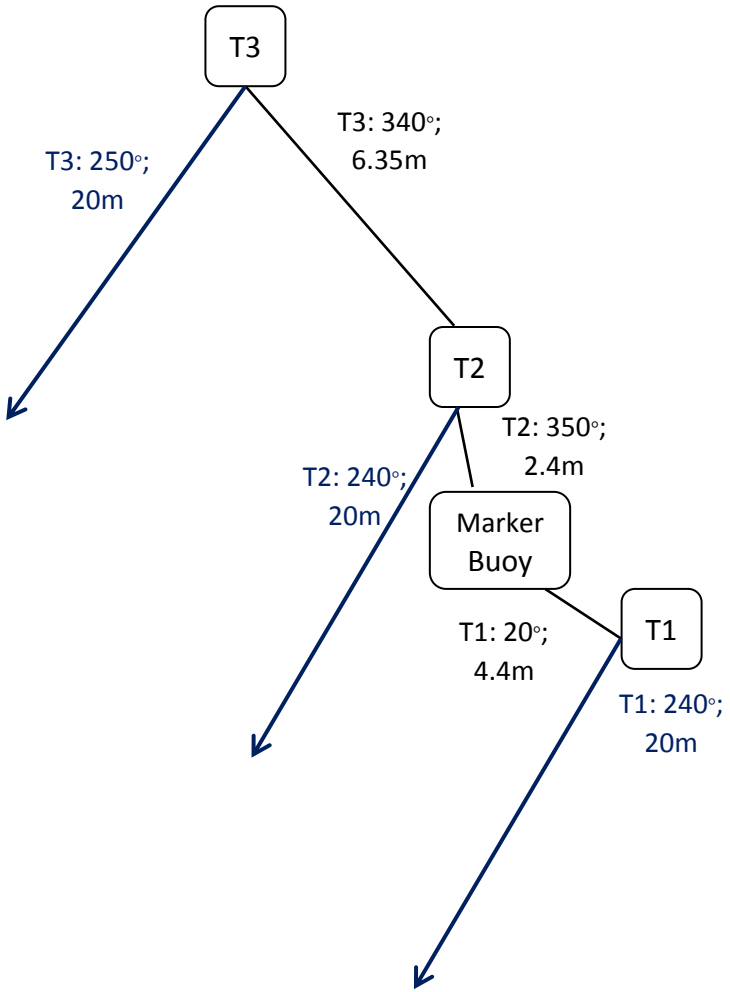


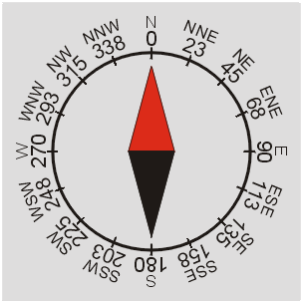
Impact Assessment: 5/22/2015. **R2N-550**. Three 20m transects (in blue) were run in a north to south direction. Distance and heading from Marker Buoy were recorded. Image is not to scale.



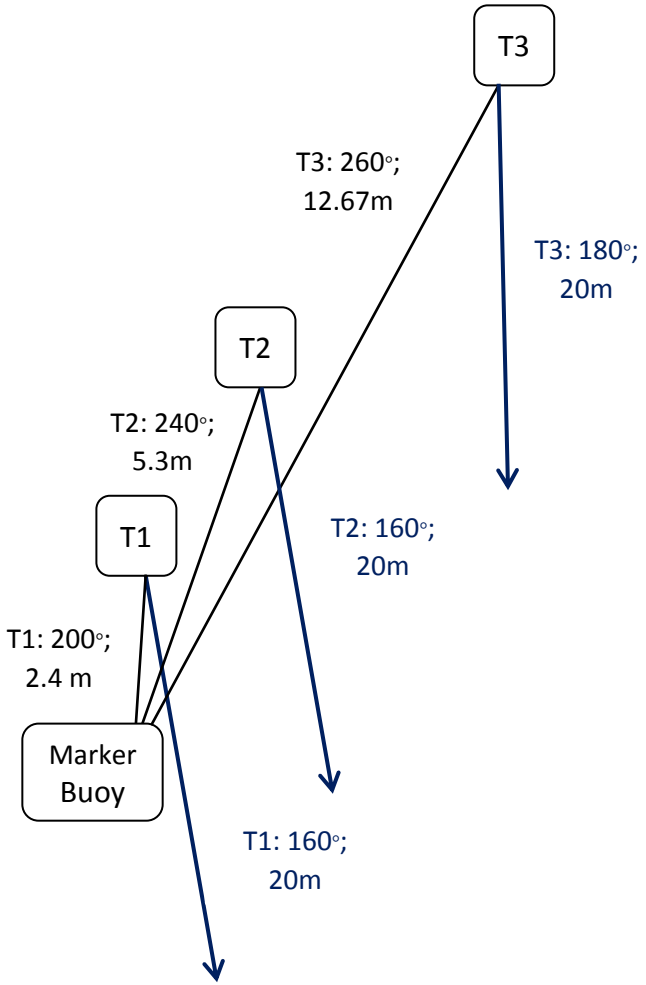


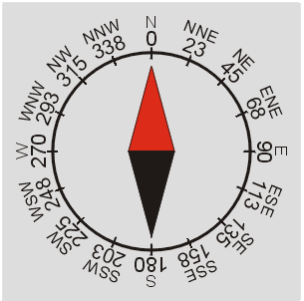
Impact Assessment: 5/22/2015. **R2N-850**. Three 20m transects are shown in blue. Distance and heading from Marker Buoy were recorded. Image is not to scale.



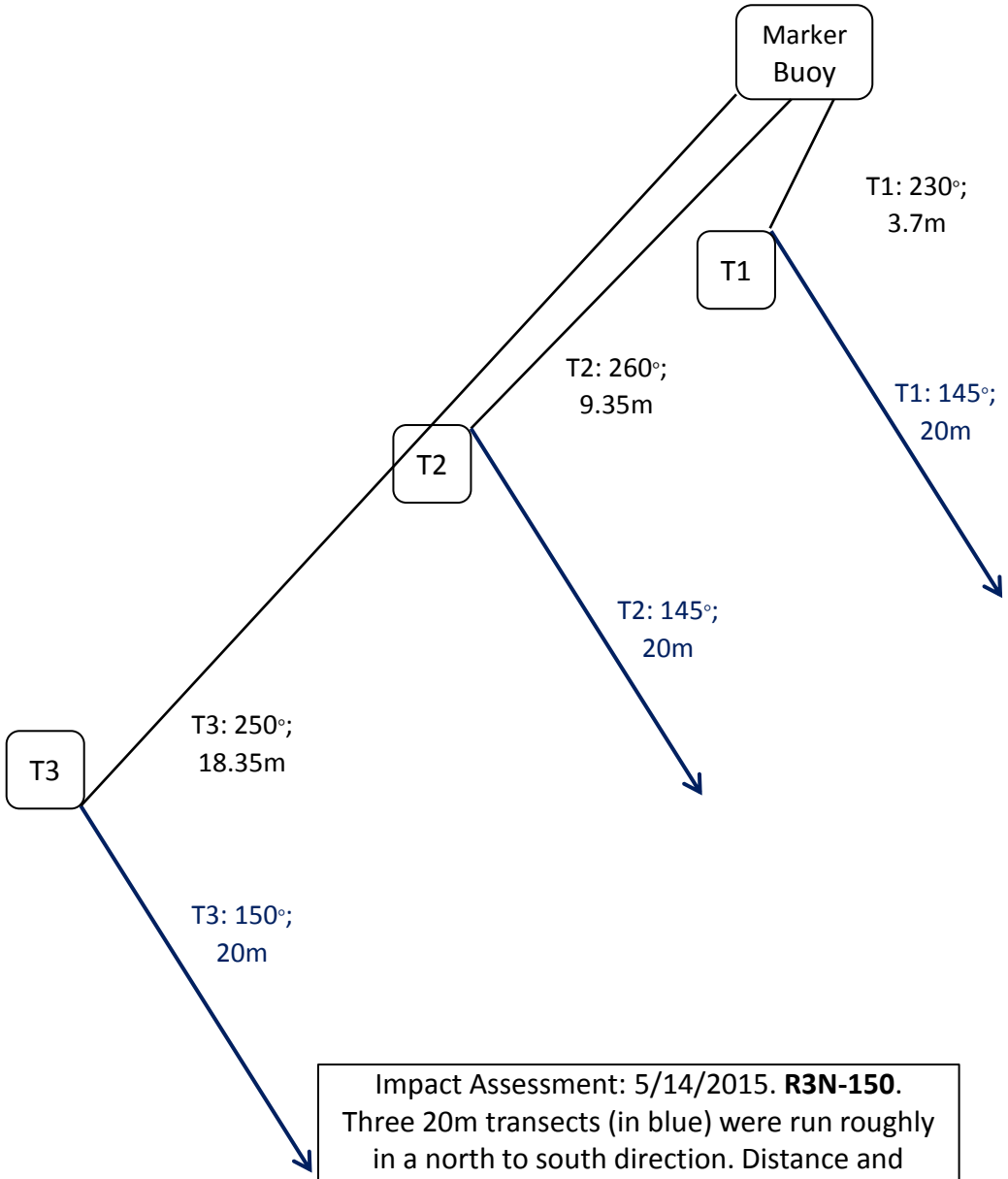


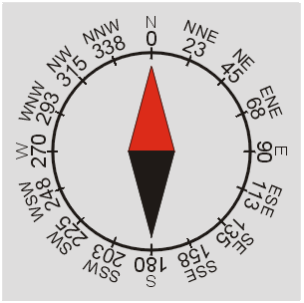
Impact Assessment: 5/21/2015. **R2S-400**. Three 20m transects (in blue) were run in roughly a north to south direction. Distance and heading from Marker Buoy were recorded. Image is not to scale.



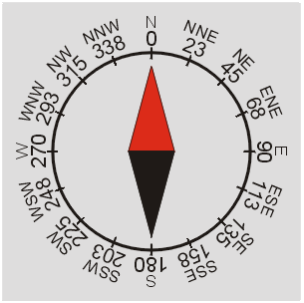


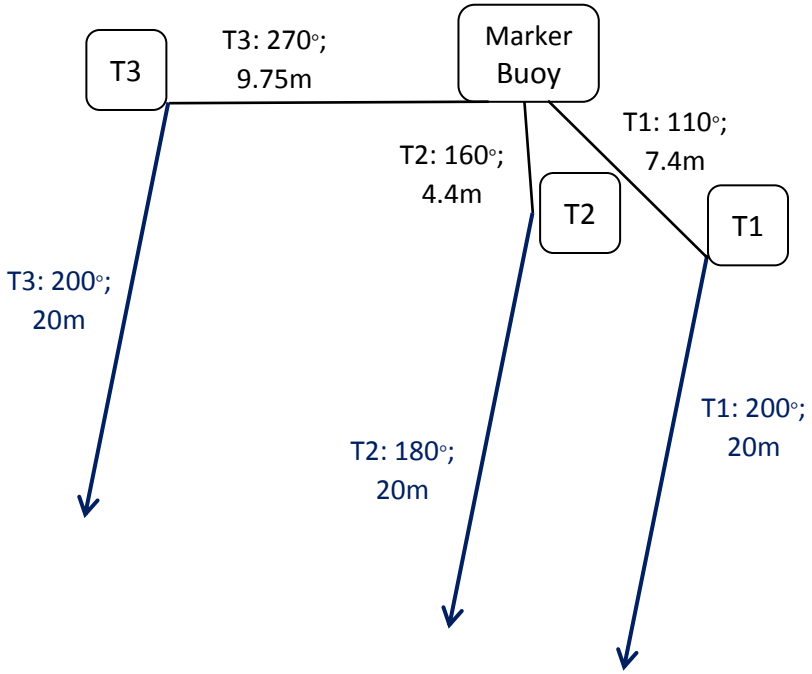
Impact Assessment: 5/22/2015. **R2S-200**. Three 20m transects (in blue) were run in a north to south direction. Distance and heading from Marker Buoy were recorded. Image is not to scale.



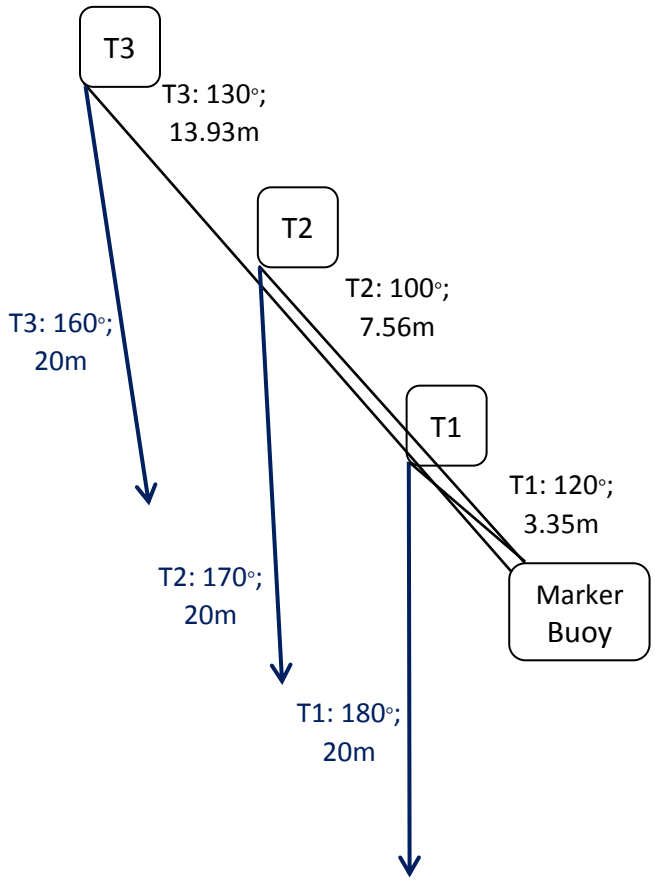


Impact Assessment: 5/14/2015. **R3N-150**. Three 20m transects (in blue) were run roughly in a north to south direction. Distance and heading from Marker Buoy were recorded. Image is not to scale.

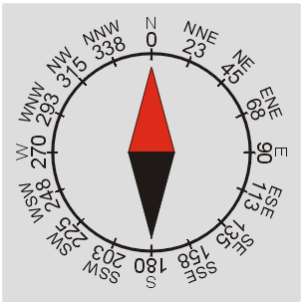


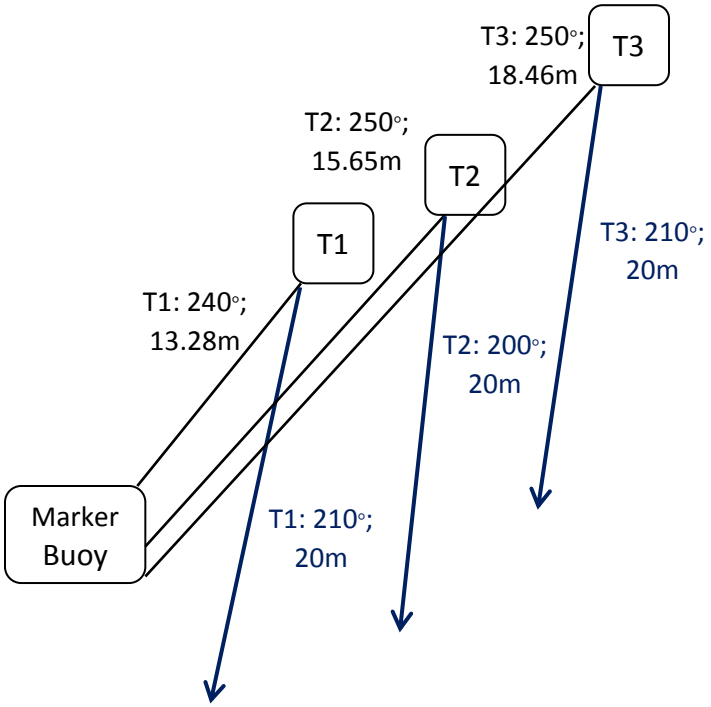


Impact Assessment: 5/14/2015. **R3N-250**. Three 20m transects (in blue) were run in a north to south direction. Distance and heading from Marker Buoy were recorded. Image is not to scale.



Impact Assessment: 5/13/2015. **R3S-50**. Three 20m transects (in blue) were run in a north to south direction. Distance and heading from Marker Buoy were recorded. Image is not to scale.





Impact Assessment: 5/13/2015. **R3S-150**. Three 20m transects (in blue) were run in a north to south direction. Distance and heading from Marker Buoy were recorded. Image is not to scale.

APPENDIX C

Video Transect Octocoral and Hard Coral Count Data

Appendix C - Video Transect Octocoral and Hard Coral Count Data

Site	N of Octocorals	N of Corals	Octocoral Density (N/m^2)	Coral Density (N/m^2)
R2S1-RR	96	25	4.00	1.04
R2S2-LR	294	22	12.25	0.92
R2S1-200M	285	30	11.88	1.25
R2S1-400M	106	24	4.42	1.00
R2SC1-RR	346	106	14.42	4.42
R2SC2-LR	312	18	13.00	0.75
R2N1-RR	403	33	16.79	1.38
R2N2-LR	68	35	2.83	1.46
R2N1-550M	473	43	19.71	1.79
R2N1-850M	303	21	12.63	0.88
R2NC1-LR	299	98	12.46	4.08
R2NC2-RR	873	55	36.38	2.29
R3S1-CP	41	34	1.71	1.42
R3S2-LR	131	54	5.46	2.25
R3S3-SG	115	45	4.79	1.88
R3S-50M	265	65	11.04	2.71
R3S-150M	294	40	12.25	1.67
R3SC1-CP	137	72	5.71	3.00
R3SC2-LR	166	71	6.92	2.96
R3SC3-SG	241	76	10.04	3.17
R3N1-LR	55	24	2.29	1.00
R3N-150M	71	32	2.96	1.33
R3N-250M	96	39	4.00	1.63
R3NC1-LR	294	29	12.25	1.21

Video transects were $8m^2$ each, for a total of $24m^2$ per site.

APPENDIX D

Sedimentation Stress Data for All Sites Surveyed

APPENDIX D

INTRODUCTION AND BACKGROUND

Great Lakes Dredge and Dock (GLDD) began dredging operations associated with the Port of Miami Phase III Federal Channel Expansion Project in November 2013 under USACE contract W912EP-13-C-0015. Offshore compliance monitoring was required under FDEP permit number 0305721-001-BI any time a dredge was within 750 meters of a channel-side site (Figure 1). Compliance monitoring at middle and outer reef monitoring sites was conducted between November 2013 and December 2014, when dredging was concentrated in offshore areas, and intermittently from January through March 2015, when a dredge was infrequently offshore, and when weather permitted safe diving operations. Monitoring results were reported to the Corps and FDEP through Compliance Week 69/70, when final offshore dredging was completed (March 22, 2015) (Figure 1).

After months of implementing adaptive management strategies for the dredging operations, corals at channel-side sites were still exhibiting "stress above normal" as defined by the FDEP permit. In April 2015, GLDD initiated additional surveys in consultation with the FDEP and Corps per permit language provided in FDEP Permit Specification 32 (a).(ii).(d). The FDEP permit Specific Condition 32.(a).(ii).d required additional surveys to outline the area(s) of impact:

> Any change of 5% or more in cover by any functional group evaluated in quadrats in two or more adjacent transects, or on average for the zone of monitoring on one side of the channel, or **stress expressed above normal by corals and/or octocorals within transects** (stress scale used for Broward County Segment III project) **will require an additional survey to outline the area(s) of impact.** Impacted areas shall continue to be **monitored monthly** during the construction, one month post-construction, and two times during next year in order to document results of the impact. Final monitoring results shall document permanent impacts, if any, to be used for estimates of additional mitigation using UMAM.

METHODS

As part of the FDEP permit required delineation surveys, Dial Cordy and Associates (DCA) conducted compliance monitoring surveys at all middle and outer reef reference and channel-side sites during the delineation of potential sedimentation effect area surveys between April 25 and May 22, 2015. This survey method was also conducted at temporary sites within potentially impacted and un-impacted areas defined by qualitative surveys (see Methods in Delineation of Potential Sedimentation Effect Area Middle and Outer Reef Habitats). Methods below have previously been presented in Compliance Monitoring weekly reports. The results reported here include the coral condition data for all sites surveyed during the delineation of potential sedimentation effect survey period.

Quantitative Assessment and Scleractininan Condition Surveys

Quantitative assessment of scleractinian coral condition for the middle and outer reef delineation of potential impact assessment were conducted at all FDEP required monitoring stations in the middle and outer reef habitat (channel-side and reference sites). In addition sites were selected that represented areas within the area of impact and outside the area of impact and quantitative assessments of scleractinian coral condition were conducted at these temporary transects on

both the middle and outer reefs. Quantitative data collection was conducted at the following temporary transects: R2S1-200m, R2S1-400m, R2N1-550m, R2N1-850m, R3S-50m, R3S-150m, R3N1-150m, R3N1-250m. Surveys were completed between April 25, 2015 and May 22, 2015. Video documentation of the transects at the FDEP required project monitoring stations were collected and analyzed for octocoral and scleractinian density (see Appendix C for results). The following language from the FDEP permit describes the method for surveys for coral health (SC 32.(a).(i)):

A) Construction surveys shall be conducted at each transect within each monitoring station by qualified biologists and involve:

1) Evaluating benthic organisms (scleractinian corals, octocorals, sponges, etc.) for standing sediment that is not removed by normal currents or wave action;

2) Evaluating scleractinian corals along each transect for additional indications of sedimentation stress such as excessive mucus, extruded polyps, and color changes (bleaching or paling). All scleractinian corals on each transect will be assessed for each of the health parameters and assigned a health level of "0" or "1" for each parameter (A score of "0" would indicate no observed bleaching, excess mucus production, polyp extension, or disease, while a "1" would be indicated for each observed parameter – please see example below). These data will be collected for each project area transect and each control area transect.

Permanently marked (tagged) corals and corals on temporary transects were evaluated by qualified marine biologists during monitoring events for indications of stress and/or standing sediment not moved by normal waves or current action. During underwater surveys (*in situ*), corals are assigned a "0" (normal or non-stressed) or "1" (stressed), and photographed. If a "1" is assigned to a coral, a code or description is recorded on the data sheet. Descriptions of possible conditions and observations are provided in Table 1. Comparisons are made between reference and channel sites for a side (north or south). For example all southern channel-side sites are compared to their reference within the same compliance monitoring week, (e.g. R2SC1 v. R2S1). In addition, temporary transects were compared to their closest control for significance testing. Statistical comparisons for all condition data are presented in Table 2.

Table 1: Possible stress indicators for permanently marked scleractinians receiving a "1" during *in situ* surveys.

Condition	Cause	Appearance
Polyp Extension	Stress and feeding	Tentacles are extended on 100% of polyps on the colony.
Mucus	Sediment stress/Lunar cycle	Excessive mucus production results in a mucus film and/or sediment balled up in mucus.
Paling	Stress/Elevated Irradiance/Temperature	Live tissue with some loss of color.
Partial Bleaching	Stress/Elevated Irradiance/Temperature	Patches of fully bleached or white tissue.
Bleaching	Stress/Elevated Irradiance/Temperature	Live tissue with complete loss of color across the entire colony.

Condition	Cause	Appearance
Black Band Disease	Stress	Black band surrounds dead patch.
White Band Disease	Stress	White lines or bands of recently dead coral tissue found in species of the genus *Acropora*.
White Plague Disease	Stress	White lines or bands of recently dead coral tissue affecting non-*Acroporid* corals.
Yellow Band	Stress	Yellow band surrounds dead patch.
Dark spot	Stress	Dark spots on otherwise normal *Siderastrea* spp.
Fish bites	Grazing	Bites of live tissue removed.
Unknown *Solenastrea* Disease	Stress	Patchy discoloration of living tissue resulting in a mottled bleached appearance. Only noted for *Solenastrea* spp.
Unknown Condition	Stress	Discoloration of living tissue from an unknown cause. Not related to known bleaching or disease indicators.
Cliona delitrix	Competition	Red boring sponge present on colony. Typcially accompanied by tissue mortality radiating outward from the point of sponge emergence.
Physical Disturbance	Abrasion	Abrasion or physical disturbance such as a gouge or a nick, not in a discernable pattern like fish bites.
Sediment Accumulation	Sedimentation	Moderate sediment accumulation on top of colony (more than dusting). Accumulation in grooves and/or between polyps.
Partial Burial	Sedimentation	Portion(s) of the colony buried by sediment.
Burial	Sedimentation	Entire colony buried by sediment.
Recent Partial Mortality	Sedimentation	Partial mortality of coral colony appears white with no live polyps visible. Generally, occurs around the margin of the colony. Visible when sediment recedes.
Unknown Partial Mortality	Stress	Tissue mortality from an unknown cause.
Competitive Mortality	Competition	Recent partial mortality from a competition event. Typically the result of sponge or zoanthid overgrowth.
Complete Mortality	Any	Death of the entire colony; no live tissue remaining on the skeleton.

Sediment Stress

Sedimentation stress data are qualitative estimations of sediment related stress that are observed on permanently marked hard corals. *In situ* data on sediment stress and other conditions are assigned in the field during data collection. QA/QC is conducted on photos for all coral conditions in the laboratory. Data are entered into an Excel spreadsheet for analysis each week. Sediment dusting (SED) is not considered a “stress” indicator and is given a score of zero. SED is a low amount, a “dusting”, of sediment on top of the coral. Sediment accumulation (SA), is an accumulation of sediment on top of the coral, between polyps, or within grooves and is qualitatively more than a dusting of sediment. Partial burial (PBUR) is the accumulation of sediment around the base of the coral, sometimes in the form of a berm, and burial (BUR) is the

complete burial of the coral colony by sediment. SA, PBUR, and BUR are given scores of a "1". A single coral may exhibit one or more conditions, including one or more sediment stress codes. For example, a coral may have sediment accumulation (SA) and partial burial (PBUR). The score for such a coral would be a "1", code data are collected for all applicable conditions. Sediment stress data are reported in Table 3.

RESULTS

Scleractinian Stress

The recently high levels of scleractinian coral mortality at FDEP required offshore monitoring sites attributed to the white plague disease event have created a confounding factor when examining total coral stress and sediment stress data from compliance monitoring sites. As part of field surveys, tagged colonies which have documented total colony mortality are scored as a "1" to indicate coral stress (Table 1). As a result, sites with high coral mortality continue to have high stress values, regardless of other stressors acting on living corals (i.e. sediment stress, disease). In order to clearly present these data, total scleractinian stress is presented here in two forms, first with dead colonies given a stress score of "1" (Table 2) and then with dead colonies removed from total scleractinian stress results (Table 2).

Coral stress remains high at all middle reef sites. When dead corals are included in the analysis, coral stress ranges from 0.57 (R2NC2) to 0.96 (R2S1) at all middle reef monitoring sites. When dead corals were removed from the analysis, coral stress declined only slightly at compliance monitoring sites and ranged from 0.57 (R2NC2) to 0.95 (Table 2). Since no standing dead corals were surveyed at temporary impact monitoring sites, the levels of coral stress at these sites did not change when dead corals were removed. When comparing coral stress levels at channel-side and temporary monitoring sites to middle reef controls only R2N1 (0.90) was found to have significantly higher levels of coral stress than its respective control (R2NC2, 0.57). These results are likely due to the elevated stress levels observed throughout the middle reef habitat including high values at middle reef controls. High stress at all middle reef sites is not attributed to a single cause rather the combined result of sediment stress, the presence of white plague and other diseases, coral paling and several other stressors acting on middle reef corals.

At the outer reef coral stress levels were slightly lower than at the middle reef monitoring sites. When dead corals are included in the analysis, coral stress ranged from 0.42 (R3S-50) to 0.90 (R3SC2) at all outer reef monitoring sites (Table 2). When dead corals were removed from the analysis, coral stress declined only slightly at compliance monitoring sites and ranged from 0.42 (R3S-50m) to 0.95 (R3SC2) (Table 2). Since no standing dead corals were surveyed at temporary impact monitoring sites, the levels of coral stress at these sites did not change when dead corals were removed. Coral stress levels at channel-side and temporary monitoring sites were not significantly different than outer reef controls. High stress at all outer reef sites is not attributed to a single cause rather the combined result of sediment stress, the presence of white plague and other diseases, coral paling and several other stressors acting on outer reef corals.

Table 2: Mean scleractinian stress levels as measured during middle and outer reef impact assessment surveys. Scleractinians at permanent compliance monitoring sites and temporary impact assessment monitoring sites were assigned a "1" or "0" depending on the presence/absence of stress indicators. Data is presented with all corals counted in the survey (except missing corals) and again without missing and dead corals. See Table 1 for a complete list of stress indicators.

Survey Zone	Area	Site	Scleractinian Stress					
			All Corals			Without Dead Corals		
			Mean	SD	N	Mean	SD	N
Middle Reef	South	R2SC1-RR	0.83	0.38	30	0.78	0.42	23
		R2SC2-LR	0.96	0.20	25	0.92	0.29	12
		R2S1-400M	0.72	0.46	18	0.72	0.46	18
		R2S1-200M	0.93	0.26	29	0.93	0.26	29
		R2S1-RR	0.96	0.19	27	0.95	0.22	20
		R2S2-LR	0.88	0.34	24	0.80	0.41	15
	North	R2NC2-RR	0.57	0.50	30	0.57	0.50	30
		R2NC1-LR	0.61	0.50	28	0.59	0.50	28
		R2N1-850M	0.69	0.48	16	0.69	0.48	16
		R2N1-550M	0.73	0.45	30	0.73	0.45	30
		R2N1-RR	0.90*	0.31	30	0.83*	0.38	18
		R2N2-LR	0.75	0.44	24	0.70	0.47	20
Outer Reef	South	R3SC1-CP	0.58	0.50	24	0.50	0.51	20
		R3SC2-LR	0.90	0.31	20	0.85	0.38	13
		R3SC3-SG	0.71	0.46	24	0.61	0.50	18
		R3S-150M	0.63	0.50	19	0.63	0.50	19
		R3S-50M	0.42	0.50	24	0.42	0.50	24
		R3S1-CP	0.74	0.45	19	0.67	0.49	18
		R3S2-LR	0.72	0.46	25	0.67	0.48	21
		R3S3-SG	0.68	0.48	25	0.62	0.50	21
	North	R3NC1-LR	0.67	0.48	24	0.60	0.50	20
		R3N1-250M	0.67	0.49	18	0.67	0.49	18
		R3N1-150M	0.50	0.51	26	0.50	0.51	26
		R3N1-LR	0.62	0.50	21	0.58	0.51	19

***N*:** **Number of corals sampled to calculate the mean.**
SD: **The standard deviation of the mean.**
***:** **Denotes a statistically significant difference (P≤0.05) between the channel-side site and reference site using a two sample t-test.**

Sediment Stress

At the middle reef, sediment stress was highest on the south side of the channel where both sediment accumulation (SA) and partial burial by sediment (PBUR) were higher than middle reef southern control sites (Table 3). Sediment accumulation ranged from 0.08-0.13 at middle reef southern controls and ranged from 0.22 to 0.48 at southern middle reef channel-side and

temporary transects (Table 3). No corals were documented with partial burial by sediment at southern middle reef controls but levels ranged from 0.08-0.21 at middle reef channel-side and temporary transects (Table 3). Levels of sediment accumulation and partial burial by sediment were very similar for R2S1 and R2S1-200 but dropped by half at R2S1-400 (Table 3). No corals were documented as being buried at any southern middle reef site. During the impact assessment survey, coral stress due to sedimentation was limited to moderate levels of sediment accumulation channel-side that decreased with increasing distance from the channel and some partial burial by sediment at channel-side and temporary transect locations.

On the northern side of the middle reef, partial burial was rare and sediment accumulation declined with increased distance from the channel. Partial burial by sediment was only noted at the northern middle reef control sites (R2NC1 and R2NC2) and at middle reef channel-side sites (R2N1 and R2N2). The proportion of corals experiencing partial burial by sediment was lower than 0.07 at all northern middle reef sites and values were similar for channel-side and control sites (Table 3). Sediment accumulation was highest at R2N1 (0.33) and declined to 0.23 at R2N1-550 and 0.19 at R2N1-850 with levels at the middle reef controls being less than 0.11. No corals were documented as being buried at any northern middle reef site. During the impact assessment survey coral stress due to sedimentation was limited to low to moderate levels of sediment accumulation at northern middle reef channel-side sites.

At the southern side of the outer reef, partial burial by sediment was only documented at R3S-150M and sediment acumulation was highest at channel-side sites. The proportion of corals with partial burial by sediment (PBUR) was 0.05 at R3S-150 and was not documented at any other southern outer reef sites. Sediment accumulation was low at southern outer reef sites and ranged from 0.12 to 0.28 at channel-side sites and dropped to 0.00-0.05 at temporary southern outer reef transects (Table 3). Sediment accumulation at the outer reef controls ranged from 0.08 to 0.13 (Table 3). No corals were documented as being buried at any southern outer reef site. As a result, coral stress due to sedimentation was limited to low levels of sediment accumulation at channel-side sites at southern outer reef sites.

At northern outer reef sites rare events of burial and partial burial were noted at channel-side and temporary impact assessment transects and sediment accumulation decreased with increased distance from the channel. The proportion of corals experiencing burial by sediment (BUR) was 0.05 at R3N1 and was not documented at any other northern outer reef sites (Table 3). Partial burial by sediment was only noted at temporary northern outer reef transects and levels were below 0.08 for both sites (Table 3). Sediment accumulation was highest at R3N1 (0.38) and declined to 0.23 at R3N1-150 and 0.17 at R3N1-250 with levels at the northern outer reef control being 0.04 (Table 3). During the impact assessment survey at northern outer reef sites, coral stress due to sedimentation was limited to very low levels of burial and partial burial by sediment at individual sites and low to moderate levels of sediment accumulation that declined with increasing distance from the channel.

Overall, coral stress due to sedimentation was low across all middle and outer reef sites. Moderate levels of sediment accumulation and partial burial by sediment were only noted at the channel-side and temporary transects of the southern middle reef habitat. Sediment accumulation was in general heavier at channel-side sites but diminished as distance from the channel increased. The low levels of partial burial and burial by sediment indicate that sediment stress conditions have abated. The removal of dead corals from the evaluation of coral stess did cause changes in the values of various sediment stress indicators but the patterns remained consistent.

Table 3: Proportions of sediment stress indicators as measured during the middle and outer reef delineation of potential sedimentation effect surveys. Scleractinians at compliance monitoring sites and temporary transects were assigned a "0" "1" depending on the presence/absence of sediment stress indicators. Corals with sediment dusting (SED) or no sediment accumulation were assigned a "0", while corals exhibiting sediment accumulation (SA), partial burial (PBUR), and/or burial (BUR) were assigned a "1". Data on sediment stress indicators is presented here with all corals except missing corals used to evaluate the total number sampled (All corals) and also with dead corals removed from the total number sampled (without dead corals).

Zone	Area	Site	Sediment Stress									
			All Corals					Without Dead Corals				
			SED	SA	PBUR	BUR	N	SED	SA	PBUR	BUR	N
Middle Reef	South	R2SC1-RR	0.23	0.13	0.00	0.00	30	0.30	0.17	0.00	0.00	23
		R2SC2-LR	0.12	0.08	0.00	0.00	25	0.25	0.17	0.00	0.00	12
		R2S1-400M	0.50	0.22	0.11	0.00	18	0.50	0.22	0.11	0.00	18
		R2S1-200M	0.31	0.48	0.21	0.00	29	0.31	0.48	0.21	0.00	29
		R2S1-RR	0.22	0.41	0.22	0.00	26	0.30	0.55	0.30	0.00	20
		R2S2-LR	0.25	0.25	0.08	0.00	24	0.40	0.40	0.13	0.00	15
	North	R2NC2-RR	0.43	0.10	0.07	0.00	30	0.43	0.10	0.07	0.00	30
		R2NC1-LR	0.25	0.11	0.04	0.00	28	0.25	0.11	0.04	0.00	28
		R2N1-850M	0.44	0.19	0.00	0.00	16	0.44	0.19	0.00	0.00	16
		R2N1-550M	0.53	0.23	0.00	0.00	30	0.53	0.23	0.00	0.00	30
		R2N1-RR	0.23	0.33	0.07	0.00	30	0.39	0.56	0.11	0.00	18
		R2N2-LR	0.46	0.29	0.04	0.00	24	0.55	0.35	0.05	0.00	20
Outer Reef	South	R3SC1-CP	0.33	0.13	0.00	0.00	24	0.40	0.15	0.00	0.00	20
		R3SC2-LR	0.20	0.10	0.00	0.00	20	0.31	0.15	0.00	0.00	13
		R3SC3-SG	0.38	0.08	0.00	0.00	24	0.50	0.11	0.00	0.00	18
		R3S-150M	0.00	0.05	0.05	0.00	19	0.00	0.05	0.05	0.00	19
		R3S-50M	0.04	0.00	0.00	0.00	24	0.04	0.00	0.00	0.00	24
		R3S1-CP	0.42	0.21	0.00	0.00	19	0.44	0.22	0.00	0.00	18
		R3S2-LR	0.52	0.28	0.00	0.00	25	0.62	0.33	0.00	0.00	21
		R3S3-SG	0.52	0.12	0.00	0.00	25	0.62	0.14	0.00	0.00	21
	North	R3NC1-LR	0.63	0.04	0.00	0.00	24	0.75	0.05	0.00	0.00	20
		R3N-250M	0.06	0.17	0.06	0.00	18	0.06	0.17	0.06	0.00	18
		R3N1-150M	0.00	0.23	0.08	0.00	26	0.00	0.23	0.08	0.00	26
		R3N1-LR	0.33	0.38	0.00	0.05	21	0.37	0.42	0.00	0.05	19

***N*: Number of corals sampled to calculate the mean.**