PROTECTED MARINE SPECIES WATCH PROGRAM
MIAMI HARBOR DEEPENING PROJECT

FINAL REPORT
US ARMY CORPS OF ENGINEERS CONTRACT
W912EP-05-C-0012

Submitted to:
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CONTENTS

LIST OF FIGURES

LIST OF TABLES

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1.0 Summary

A protected species watch program was put into effect for blasting activities conducted within the Port of Miami, Fl between 25 June and 12 August 2005. Blasting presents potential risks to marine species protected under the Endangered Species Act and the Marine Mammal Protection Act. As such, the watch program was required for federal permitting of the project and was carried out by ECOES Consulting, Inc, an independent contractor for the project. During the course of blasting, 185 sightings of protected marine species occurred. These sightings were comprised of three species: the bottlenose dolphin (*Tursiops truncatus*), the Florida manatee (*Trichechus manatus*), and the loggerhead turtle (*Caretta caretta*). No protected species were injured during blasting activities and all blasting was conducted within full compliance of the approved watch plan. The crew of the drill boat apache and all support vessels were extremely helpful in supporting the watch plan and assisting observers.

2.0 Introduction

The Port of Miami is a major marine terminal in southeast Florida. The Port accommodates both commercial and cruise ship industries. In 2004, it was the only port in Florida to surpass 1 million TEUs (20 ft Equivalent Unit, i.e. 20ft container) in cargo volume and over 3 million passengers transited its terminals (http://www.miamidade.gov/portofmiami/director_message.asp). Due to the expanding nature of the Port's capabilities, there was a request to modify and deepen the turning basin at Lummus Island. Expanding and deepening the Turning Basin would eliminate the need for vessels docked at Lummus Island to back to or from the Fisher Island Turning Basin (Department of Commerce, 2005). In order to complete this project, rock needed to be removed from the basin. Past deepening projects and recent test cores indicated that the rock would require blasting prior to standard removal (T. Jordon, pers comm., 2005). Underwater blasting has the potential to have adverse impacts on several protected marine species in the area; therefore a watch plan was constructed and implemented during all blasting events to insure the safety of these species.

Miami Harbor is located in southeast Florida along Lummus Island, which contains all port facilities (Figure 1). There is an abundance of unique shallow marine environments surrounding the Port, including Biscayne Bay Aquatic Preserve. The area supports marine and estuarine communities including protected seagrasses, mangroves, and a variety of hard and soft bottom habitats.

This region supports a large number of state and federally listed species as well as commercially and recreationally important species. Any work conducted within the harbor is likely to have some influence on these sensitive environments and species. A watch plan was required for completion of the project. The watch plan was designed to address the issues regarding only marine mammal and marine turtle species likely to be directly affected by blasting.

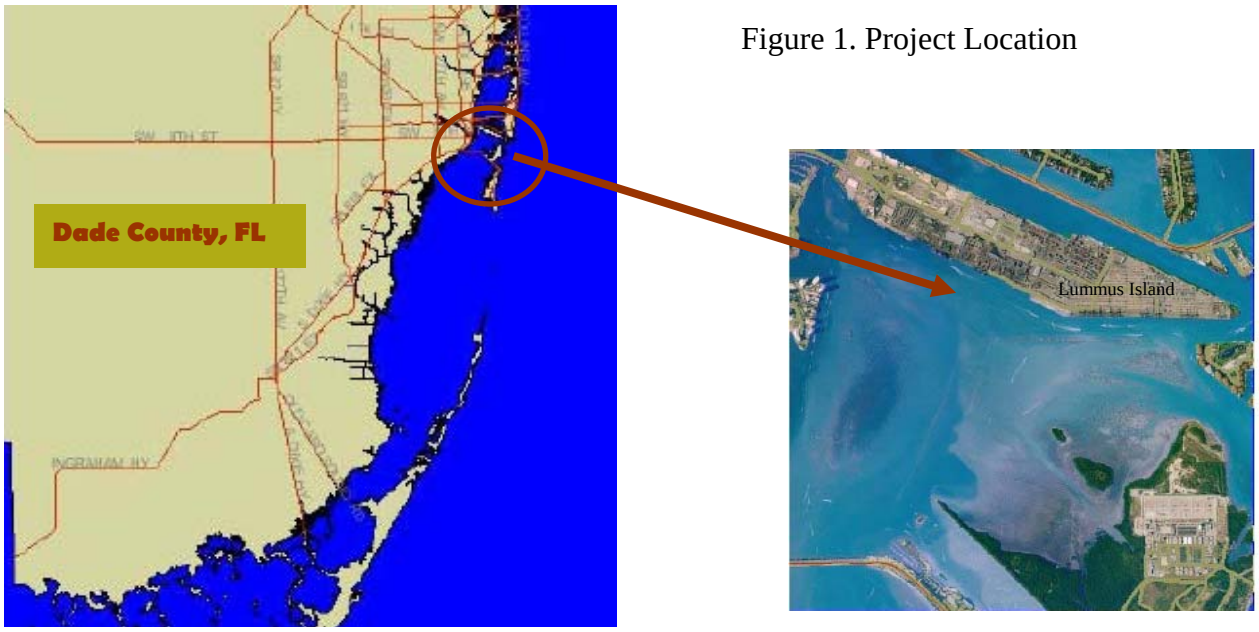

Figure 1. Project Location

2.1 Species Accounts

Marine Turtles

Four species of marine turtle commonly occupy the waters surrounding Miami-Dade County; however, only two are likely to occur in the area around Miami Harbor. The two common species of marine turtle for the Miami Harbor area are the Atlantic Green (Chelonia mydas), and the Loggerhead (Caretta caretta). The Hawksbill turtle (Eretmochelys imbracata) also occurs in Biscayne Bay; and may be more common than nesting and stranding records suggest; although the likelihood of occurrence within the Harbor for this species is less than either the loggerhead or green. One additional species, the leatherback (Dermochelys coriacea) is recorded in nesting records for Dade County; however, this is an exclusively offshore species that does not occur in inshore waters (Table 1). In Florida, the Green turtle is federally listed as endangered under the Endangered Species Act (ESA) of 1973 while the loggerhead is federally listed as threatened under the ESA. Marine turtles are protected by two federal agencies. In general, the USFWS has jurisdiction over marine turtles that are nesting along the coast while National Marine Fisheries Service (NMFS) has jurisdiction over turtles in the water; therefore, the turtle protection regimes for this blasting operation are under the NMFS.

Table 1. Marine turtle stranding and nesting data for Dade County, FL 2001-2003

Marine turtle stranding* and nesting** data for Dade County, FL 2001-2003	Strandings 2003	Nesting 2003	Strandings 2002	Nesting 2002	Strandings 2001	Nesting 2001
Loggerhead (C. caretta)	35	489	24	374	32	496
Green (C. mydas)	29	0	21	15	24	0
Hawksbill (E. imbricata)	8	***	5	***	2	***
Leatherback (D. coriacea)	0	3	0	4	0	9

* Strandings indicate the number of individuals of each species found dead or injured

** Nesting indicates the number of confirmed nests laid on Dade County monitored beaches For each species

*** Data not available for this species from data source

(Data source: Florida Game and Freshwater Fish Commission)

Blasting impacts are not well documented for marine turtle species but range from auditory detection and discomfort to lethal injuries. Caging studies done during explosive removal of offshore structures showed that the effects on marine turtles were dependent upon the size, type and depth of the explosive charge as well as the size and depth of the turtle in the water column (MMS 2003, Gitschlag and Herczeg, 1994). Some caged turtles were found to be unconscious within 1,200ft and 3,000ft of an offshore removal explosion detonating 50lb of explosives inside the jacket legs of a platform, 15ft below the mud line. (Keevin and Hempen, 1997). Other turtles suffered cloacal damage and dilation, or widening, of blood vessels (Keevin and Hempen, 1997). Turtles rendered unconscious would drown under non-caged conditions. Such sub-lethal injuries may be of greater concern for mortality to marine turtle species than direct mortality. Actual mortality from blasting may be underestimated due to this delayed mortality; however no information is available correlating underwater explosive pressures to injury or mortality in sea turtles (Keevin and Hempen, 1997).

LOGGERHEAD (*Caretta caretta*)

The loggerhead is our most common turtle throughout Florida waters. Florida's beaches represent the highest nesting activity for loggerheads that nest along the Atlantic coast (FWC 2005). Loggerheads are the most common nesting turtle in Miami-Dade with annual nests counts normally hovering around 400/yr and represent the highest number of sea turtle strandings (Table 1). In 2004, there were a little over 40,000 loggerhead nests with 289 reported from Miami-Dade monitored beaches. Nest numbers from 2004 represented the lowest nest number for loggerheads since 1989. Loggerheads can be found in a wide variety of habitats from well offshore to far up estuaries where they will feed on crustaceans and benthic invertebrates. Loggerheads will be equally at home in harbors as in seagrass flats or in the open ocean. The loggerhead is the most frequently taken sea turtle during dredging operations. A total of 151

confirmed loggerheads were taken by hopper dredges between 1980 and 2004 within the Jacksonville district; representing 60% of all turtle takes by dredges in the southeast Atlantic (USCOE 2005).

GREEN TURTLE (*Chelonia mydas*)

The green sea turtle is a year round resident of Florida waters. Nesting is concentrated on the central East coast; with highest numbers of nests and emergences in Brevard County (FWC 2005). In 2004, 3,353 green turtle nests were documented in Southeast Florida between Brevard and Miami-Dade Counties; however, only 2 of these nests were documented in Miami-Dade. Although their nesting numbers are low, the green turtle represents the second highest stranding numbers for marine turtles in Miami-Dade County (Table 1). They are typically herbivores thus use of coastal waters, such as seagrass beds, is vitally important to this species. They are also found nearshore during nesting season (spring-summer). They will opportunistically feed on benthic fauna such as crabs and mollusks. Green turtles have both pelagic and coastal phases making them equally susceptible to offshore and nearshore activities, including work within harbor waters. Impacts to this species from dredging are well documented (Dickerson et al 2004). Between 1980 and 2004 green turtles were the second most abundant take species by hopper dredging in the USCOE, Jacksonville District. There were 83 dredging projects on the east coast which resulted in takes of 36 greens out of 250 total turtle takes (14%) (USCOE 2005).

HAWKSBILL (*Eretmochelys imbricata*)

Hawksbills are the most tropical of the sea turtles found in Florida. They are frequently spotted by divers off the Florida Keys. Most nesting is restricted to the southeastern coast of Florida, and has been reported from Broward, Miami-Dade, Martin, Monroe, Palm Beach, and Volusia counties (Meylan et al 1995). There are regular stranding reports for hawksbills in Miami-Dade although their numbers are very low (Table 1). Nesting for this species in Miami-Dade is infrequent but has been reported in some isolated locations of Biscayne Bay.

LEATHERBACK (*Dermochelys coriacea*)

The giant leatherback turtle is a resident species in the Atlantic and listed as endangered by the USFWS. They are highly pelagic and migratory and are rarely seen nearshore outside of nesting (Wynne and Schwartz 1999). Leatherbacks feed mainly on jellyfish and are capable of deep dives. They are wide-ranging species with extensive migrations between nesting grounds, feeding grounds and the open ocean (USFWS 1999). A female leatherback satellite tagged in Juno Beach, FL on April 2, 2005, has, as of November 2, 2005, traveled 9,486 km between Florida, Nova Scotia and the last tracked point near the center of the North Atlantic near the mid-Atlantic ridge (Marinelife Center of Juno Beach, 2005). In the continental United States, small nesting populations occur on the Florida east coast (approximately 35 females/year) (USFWS 1999). Leatherbacks in Florida nest mainly in the southeast coast, with highest densities from Palm Beach to St. Lucie Counties (FWC 2005). Miami-Dade showed no stranding records for Leatherbacks between 2001 and 2003; but did have 9,4, and 3 nests reported in the same years, respectively.

Marine Mammals

Two marine mammals are of concern for blasting within Miami Harbor: the bottlenose dolphin (*Tursiops truncatus*) and the Florida manatee (*Trichechus manatus*). The dolphin is protected under the Marine Mammal Protection Act (MMPA) and is under the jurisdiction of the NMFS. The manatee is listed as endangered under the ESA and is under the jurisdiction of the USFWS. The Florida Fish and Wildlife Commission (FWC) Bureau of Protected Species also has jurisdiction over manatees with respect to speed zones, protected areas, and standard conditions for in-water activities.

Blasting effects on marine mammals can range from harassment to direct injury. Dolphins are a highly auditory species dependent upon vocalization and audition for nearly all aspects of their behavior and survival. Temporary threshold shifts (TTS) and direct injury to ear structures could have long-term negative consequences for individual dolphins as well as to group dynamics and behavior. TTS is well documented in the literature for dolphins (Ketten, 1998) as are some of the physical injuries to auditory structures (Ketten, 1998; Kevin and Hempen, 1997). Both dolphins and manatees are highly susceptible to lethal and sub-lethal injuries by the reaction of air cavities within the body to the pressure waves produced from the blast. In particular, organs such as the lungs and intestines can be severely compromised even though outward injury may not noticeable.

Under the MMPA, it is illegal to take or harass marine mammals without a special authorization from the NMFS. The ACOE received an incidental harassment authorization from the NMFS in 2005 (Department of Commerce, 2005) with the knowledge that dolphins frequent the turning basin area and are likely to incur some harassment as defined in the MMPA as a result of blasting activities. The authorization was given as NMFS concluded that

"NMFS has determined that the Corps' proposed action, including mitigation measures to protect marine mammals, should result, at worst, in the temporary modification in behavior by small numbers of bottlenose dolphins, including temporarily vacating the area to avoid the blasting activities and the potential for minor visual and acoustic disturbance from the detonations. This action is expected to have a negligible impact on the affected species or stocks of marine mammals. In addition, no take by injury and/or death is anticipated, and harassment takes will be at the lowest level practicable due to incorporation of the mitigation measures described in this document."

Unlike the MMPA, the USFWS, does not allow any take authorization for manatees under the ESA. The ACOE underwent a Section 7 Consultation with USFWS to insure proper protection measures were implemented for manatees during blasting within Miami Harbor.

BOTTLENOSE DOLPHIN (*Tursiops truncatus*)
Dolphins have a wide spread distribution throughout the southeast and can be found in nearshore, shallow waters as well as open ocean environments. Dolphins have a wide range of prey items which can vary regionally. In south Florida, bottlenose dolphins typically feed on schooling fish and squid, although a wide variety of prey items will be taken. Bottlenose dolphin

groups in Biscayne Bay consist of both permanent residents and nearshore migrants. National Oceanic and Atmospheric Administration (NOAA) Fisheries has conducted a photo identification program in Biscayne Bay aimed at distinguishing residents from migrants. This study included areas outside the Miami Harbor area but serves as a good indicator of dolphin numbers likely to occur within the project location. Since 1990, a total of 193 distinctive individuals have been identified from the Bay (NOAA Fisheries SEFSC 2005). Of the 51 individuals identified during the 1990-91 survey period 33 (64.7%), were re-sighted in 1994 (NOAA Fisheries SEFSC 2005). Data from these surveys show that dolphins regularly are sighted within and around the Miami Harbor Channel (OBIS, 2005). Previous aerial surveys conducted in and around Lummus channel reported dolphins at some point in all the watch programs.

MANATEE (Trichechus manatus)

Manatees occur throughout Biscayne Bay on a year-round basis, but are most consistently observed in tributaries and seagrass beds. The bay provides important feeding areas for manatees in southeast Florida, particularly the northern area of the bay (north of Rickenbacker Causeway). (Browder et al 2003). The Port of Miami region also appears to be a major thoroughfare for manatees moving between the winter aggregation sites from Port Everglades to Coral Gables (Browder et al 2003). Radio telemetry studies documented a high use of the seagrass beds by tagged manatees during the night (Browder et al 2003). There was a general trend in movement for the manatees to move up the rivers and canals during the day then out of the canals to feed in the bay at dark, perhaps when boat traffic was reduced (Browder et al 2003, C. Knox, pers comm., 2003). Due to these nocturnal habits, aerial surveys in this region may underestimate the use of Biscayne Bay (Browder et al 2003). Previous watch programs in the Miami Harbor area documented extensive use by manatees throughout the day (Barkaszi, pers comm. 2005).

A synopsis done of manatee and seagrass concerns at major ports in Florida by the Florida Fish and Wildlife Commission (http://www.floridaconservation.org/psm/habitat/portfac.htm) identified two manatee issues at the Port of Miami that should be addressed whenever developing a protected species watch plan for that area. Specifically, the two critical functions or areas of the port as they relate to manatees are:

Feeding habitat: Manatees feed on the extensive seagrass meadows located immediately south of the Port of Miami. Other feeding locations are found in Biscayne Bay.

Travel corridors: Manatees move from feeding locations in Biscayne Bay into the Miami River and the Little River throughout the year. They also travel through Government Cut.

Manatee deaths are highly associated with human activities throughout Florida with vessel interactions being leading cause of manatee deaths. In Dade county there is a high mortality rate in water control structures as well from vessel collisions. In Dade County, human caused mortality represented 63% of the total known deaths between 1974 and 2001 (FWC, FMRI, 2002).

3.0 METHODS

3.1 Blast Plan

A blast plan was developed between the ACOE and the blasting/dredging contractor to maximize the efficiency of the rock removal while minimizing the impacts to the surrounding environment and species. Through agency coordination, the blast plan that was accepted utilized confined blasting techniques, where a borehole containing explosives is capped with an inert material thus decreasing the strength of the pressure wave generated upon detonation. All blasting was done from the Great Lakes Dredge and Dock Company's Drill Barge, *Apache* (Figure 2).

Figure 2. Drill Barge Apache set up in Miami Harbor.

3.2 Safety Zones

As part of the blast plan, a safety radius for marine mammals and turtles had to be calculated to determine the distance from the blast at which harassment or injury to marine mammals is likely to occur. This safety radius is determined by the amount of explosives used within each borehole. These calculations are based on human impacts when exposed to a detonation suspended in the water column. Due to the nature of the confined blast and the probable sensitivity differences between humans and marine mammals, it is believed that this radius is a conservative, but prudent, approach to the protection of marine wildlife species. The zone calculations are done in a tiered approach based on level of impact and mitigative procedures. The calculations are as follows:

1) Danger Zone: The radius whose outer limit represents the minimum distance for no expected mortality. The danger zone (ft) = 260 (the cube root of weight of explosives in lbs per delay)

2) The Exclusion zone is a larger radius to insure species are beyond the minimum distance whereby Level A harassment may occur, typically beyond the 180db isopleths. The exclusion zone (ft) = 520 (cube root of weight of explosives in lbs per delay)

3) The Safety Zone is the radius of the exclusion zone plus a 300ft buffer to insure animals entering or traveling close to the safety zone (zone of Level A harassment) are spotted and appropriate actions can be implemented before or as they enter any impact areas. Animals in the safety zone are closely monitored to insure they do not enter the exclusion zone.

The calculations used in this project were more stringent than the calculations outlined in the DRAFT MANATEE BLASTING PROTOCOL set forth by the FWC in: Appendix D: Draft Interagency Manatee Task Force Protocols. Service ICU Planning Aid Report 7. February 27, 2004. In these protocols, a danger zone of 260 (cube root of explosives) plus a 300 ft is used for the exclusion zone.

The poundage of explosives used for this project was not expected to exceed 375 lbs per delay. Using this explosive weight, the three radii would be:

Danger zone = 1875 ft

Exclusion zone = 3750 ft

Safety zone = 4050 ft

Explosive weights ranged from 17 lbs to 376 lbs with the average explosive weight 119lbs giving the typical zone distances of:

Danger zone =1278

Exclusion zone = 2556

Safety zone = 2856

The above distances were used for conducting the watch program during all blasts unless the watch coordinator was informed that the blast weight was over 120lbs (Figure 2).

3.3 Watch Plan

A watch plan was formulated based on the required safety zones and optimal observation locations. The watch plan consisted of 6 observers which included at least 1 aerial observer, 2 boat-based observers, and 2 observers stationed on the drill barge. The 6th observer was placed in the most optimal observation location (boat, barge or aircraft) on a day by day basis depending on the location of the blast and the placement of dredging equipment. This process helped to insure complete coverage of the safety zone and critical areas. The watch began at least 1 hour prior to blast and continued for one-half hour after the blast.

The aerial observer flew in a turbine engine helicopter (bell jet ranger) with doors removed. This provided maximum visibility of the safety zone as well as exceptional maneuverability and the needed flexibility for continual surveillance without fuel stops or down time, minimization of delays due to weather or visibility and the ability to deliver post-blast assistance. The survey radius for the aerial crew was roughly three times the safety zone as required by standard observation conditions set by FWC.

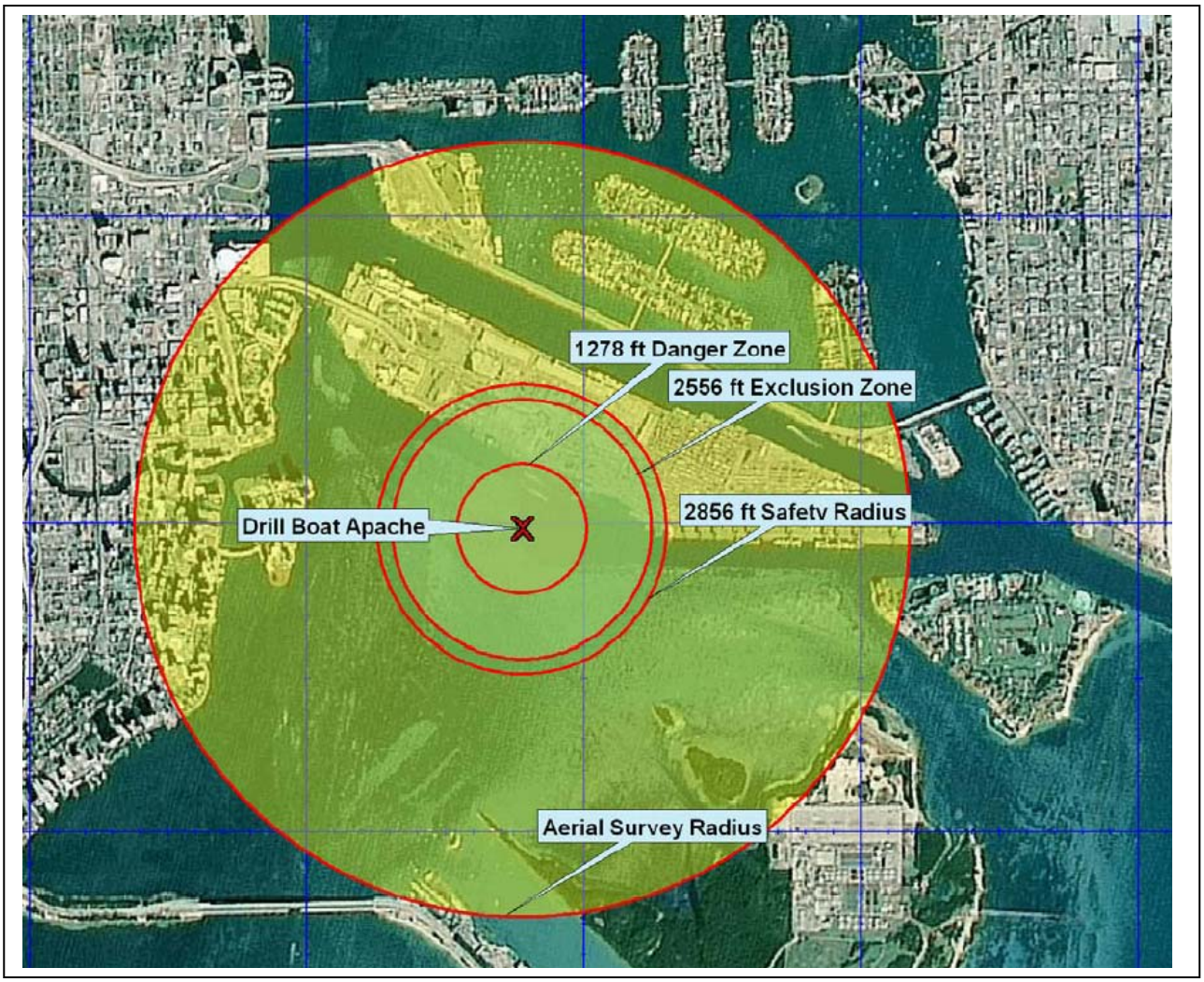

Figure 3. Sample layout of all watch zones using an average explosive weight of 119 lbs.

Boat-based observers were placed on one of two vessels, both of which had attached platforms that place the observers at least 3 meters above the water surface enabling optimal visibility of the water from the vessels (Figure 5,6). The boat observers covered the safety zone where waters were deep enough to safely operate the boats without any impacts to seagrass resources. The shallow grass beds south of the project site relegated the observer boats mainly to the channel east and west of the blast zone (Figure 4). The pontoon boat was able to move up the small pipe channel to the north of the site and in some of the deeper portions of the grass beds. At no time were any of the observer boats allowed in shallow areas where props could impact the seagrass.

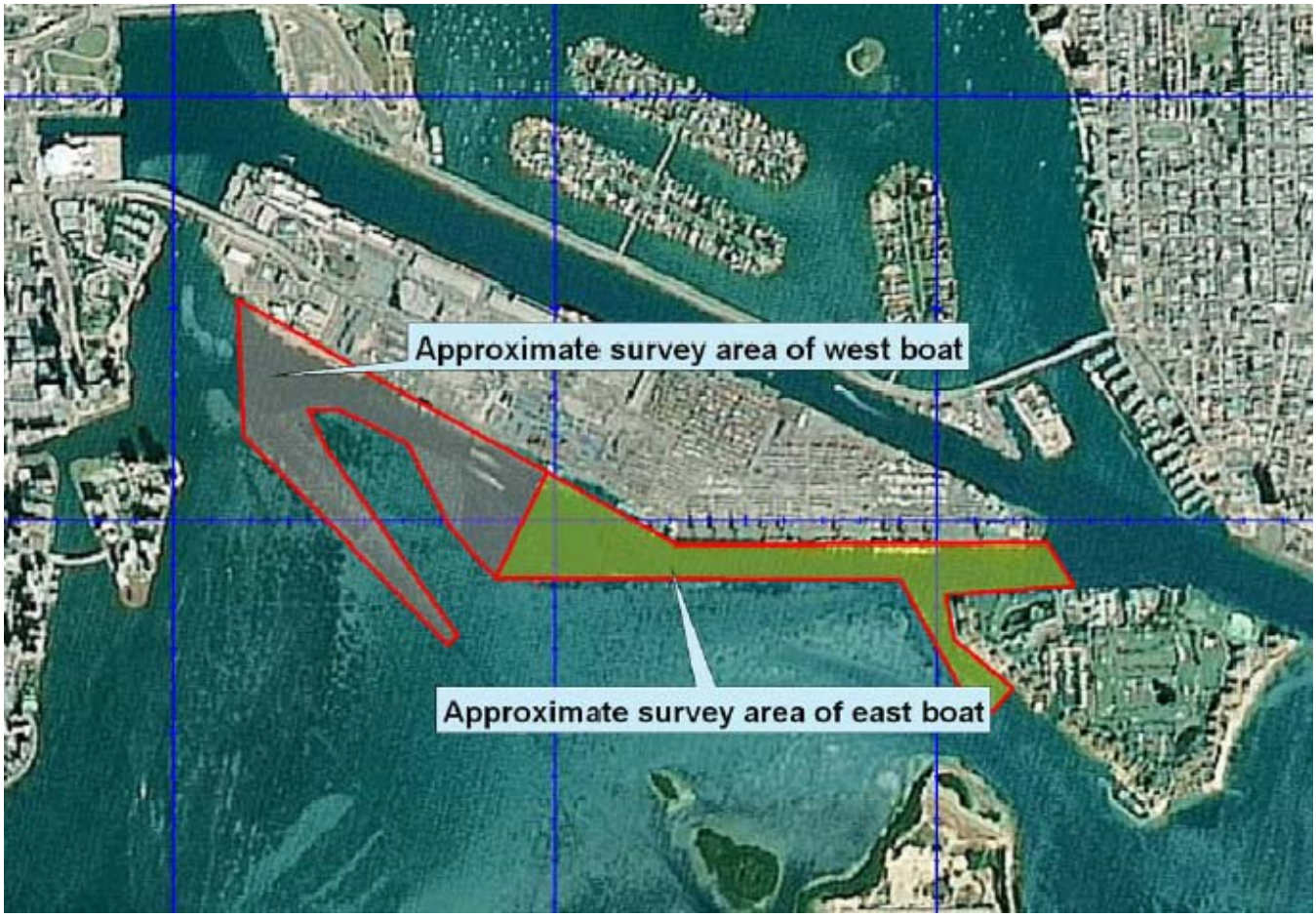

Figure 4. Approximate survey areas for the two observer boats.

The restricted access of the boats did not impact the watch program because the visibility through the water column in these shallow areas was excellent from the air and under normal conditions, the bottom could be seen. Therefore, the important areas for boat coverage was within the channel where animals were not as easily tracked from the air and thus boats could provide additional coverage. The only times this restrictive area became a concern was when the dredge Texas was operating and the tide was either flooding or switching from flood to ebb. At these times, the turbidity in the water was high and visibility of the aerial observer and the boat observers was compromised.

Figure 5. Observer in position on platform of the security boat, Sea-Me

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Figure 6. Observer on platform of pontoon boat

The drill barge observers were in place on the catwalk of the control tower approximately 30 ft above the water (Figure 7). One observer faced the blast array while the other faced away from the blast. This site is a critical site for observers as it not only gives an excellent view of the most critical impact zone, it also serves as back up communications between the aerial observer and the blaster in charge.

Figure 7. View of observer on drill barge looking south at one boat observer and the aerial observer

All observers were equipped with marine-band VHF radios, maps of the blast zone, polarized sunglasses, and appropriate data sheets. In addition to this observation gear, all required personal protective equipment (hard hat, steel toed boots, life vest) was worn by observers at all times with the exception of the aerial observer. In addition to this standard equipment, one of the barge observers was equipped with an aviation band radio for communications back up to the aerial observer. A passive acoustic monitoring (PAM) system using a single omni-directional hydrophone with shielded cable (Cetacean Research Technology Model C54XR) and laptop with signal conditioning and detection software was on board the pontoon observer boat to collect mammal vocalizations and blast sound data when possible.

Communications among observers and with the blaster was of critical importance to the success of the watch plan. The aerial observer was in contact with the observers and the drill barge with regular 15-minute radio checks throughout the watch period. Constant tracking of animals spotted by any observer was possible due to the amount and type of observer coverage and the good communications plan.

Watch hours were restricted to two hours after sunrise and one hour before sunset. The watch began at least one hour prior to the scheduled blast and was continuous throughout the blast. Watch continued for at least 30 minutes post blast at which time any animals that were seen prior to the blast were re-located whenever possible and all observers in boats and in the aircraft assistant in cleaning up any blast debris.

3.4 Blast Protocol

The typical watch protocol for a single blast went as follows:

Basic Protocol of a typical protected species watch for Port of Miami

Time ("T-minus-blast time)	*Activities*
T-2 hours	Blasting supervisor notifies all safety, fire, transportation etc contacts and the watch coordinator. Watch coordinator contacts all observers, boat operators, aircraft etc required for the watch program and all personnel mobilizes to the appropriate locations around the blast site
T-1hour 15 minutes	Watch coordinator contacts blasting supervisor and confirms that drilling and loading is ready to go to the 1 hour notification. All observer personnel are in place and observing at this point in time. Once confirmation that the operations are ready to go to the one hour, the watch proceeds
T-1hour	Aerial observer is in air and on location. Watch coordinator conducts a radio check to each observer to confirm communications. At that time the watch coordinator and blaster in charge give the official earliest time to blast and the watch clock begins
T-30 minutes	Blaster in charge contacts watch coordinator and confirms the all clear to go to 30 minutes. This is typically done when the drill barge is ready to move off the blast array. At this point the blast is "committed". Watch coordinator gives the all clear. At this point the boat observers should concentrate on clearing from the outermost exclusion zone inward to ward the blast.
T-15 minutes	Blaster in charge checks in with the watch coordinator to be given the all clear to go to the 15 minute. At this time, the watch coordinator should inform the blaster in charge of any possible delays that will occur at the 5 minute for any sighting holds to expire. The watch coordinator will then give the all clear to go to the 15 minute

T-5 minutes	Blaster in charge checks in with the watch coordinator to be given the all clear to go to the 5 minute. At this time, the watch coordinator will either inform the blaster in charge that he must hold on the 5 minute for a designated period of time or will give the all clear. Before the all clear is given, there should be no animals in the exclusion zone, entering the exclusion zone and all 30 minute "loss of contact" holds for previous sightings should have expired.
T-5 minutes after the "all clear' given	Fish scare charge - Warning siren is sounded
T-1 minute	Blaster in charge asks for all clear for the 1 minute. Watch coordinator calls in to each observer to confirm they are all clear to go to the one minute. Watch coordinator gives the all clear. Warning siren is sounded
T- 30 seconds	Blaster in charge requests and all clear to go to 15 seconds. Watch coordinator gives the all clear. Blaster announces
T-10 seconds	Blaster in charge announces 10 seconds to blast and begins count down, 10, 9 , 8, 7, 6, 5 ,4
T-3 seconds	Blaster continues countdown but radio silence is given so that anyone can stop the blast at the last minute.
T-0	Blast is detonated
T+5 minutes	Blaster in charge confirms all detonations have fired and there were no misfires. Once determined, blaster announces all clear in the blast zone and protected species watch begins the 30 minutes post blast survey. Watch coordinator checks in with each observer to confirm that they are all clear immediately after the blast.
T+15 minutes	Watch coordinator checks in with observers and maintains all clear status
T+30 minutes	Watch coordinator checks in with each observer to confirm all clear status. Watch coordinator releases the observers from duty. Observers demobilize.

If any protected species were spotted during the watch, the observer notified the aerial observer and/or the other observers via radio. The animal was located by the aerial observer to determine its range and bearing from the blast array. Initial locations and all subsequent re-acquisitions, were plotted on maps. Animals within or approaching the safety zone were tracked by the aerial and boat based observers until they exited the safety zone. Anytime animals were spotted near the safety zone, the drill barge was alerted as to the animal's proximity and some indication of any delays it might cause.

If an animal was spotted inside the exclusion zone and not re-acquired, no blasting was authorized until at least 30 minutes had elapsed since the last sighting of that animal. If manatees were spotted near any of the operations, all crew boats, tugs and other vessels were notified to go to slow speed. The watch continued its countdown up until the T minus 5 minute point. At this time, the aerial observer confirmed that all animals are outside the safety zone and that all holds have expired prior to clearing the drill barge for the 5 minute notice. This insured that the fish scare charge was not detonated while any protected species might be in the area.

4.0 RESULTS

Between 25 June and 12 August, a total of 38 blasts were completed within the watch program. On a single day, (19 July) two blasts were competed; however, all other days consisted of single blasts. All watches and blast protocols were conducted within full compliance of all regulations.

During observations, there were the expected two species of marine mammals spotted, manatees (*T. manatus*) and bottlenose dolphin (*T. truncatus*), as well as loggerhead turtles (*C. caretta*) and other unidentified sea turtles. A total of 180- 185 individual animals were spotted, with approximately 60% of these observations being manatees (Figure 8). The variability in the number of individuals is due to probable repeated sightings. Protected species were spotted during watches for 36 of the blasts or 95% of the watches. Dolphins were spotted inside the exclusion zone 12 times with a total of 30 individuals; turtles were spotted inside the exclusion 6 times for a total of 7 individuals; and manatees were spotted inside the exclusion zone 5 times with a total of 14 individuals.

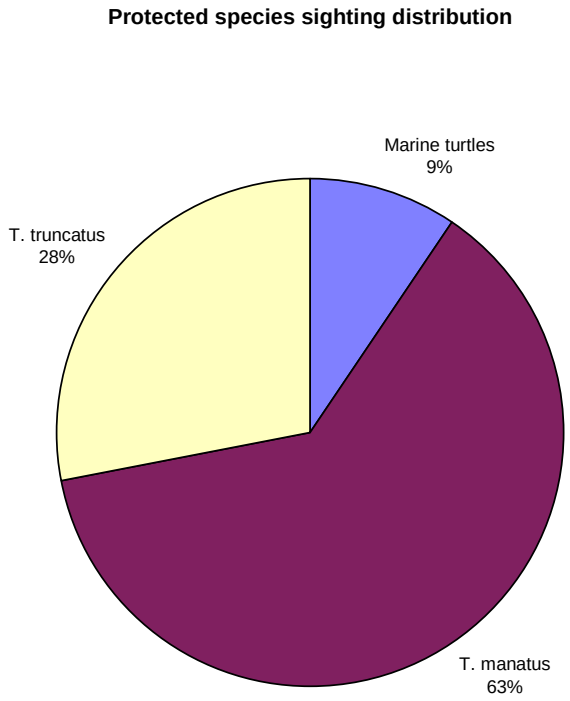

Figure 8. Species distribution of all protected species sighting during blast watch programs in Miami Harbor.

A delay in blasting only occurs when a protected species enters the exclusion zone; therefore, the distance from the blast array is an important note (Figure 9). On average, manatees were observed farthest from the source, at approximately 3500 feet; however, manatees were also the species that represented the closest approach to the drill barge and blast array (50 ft) during any of the watches. On average, sea turtles averaged the closest overall distance to the array.

Total observation hours for the 38 blasts were 71 hours and 55 minutes. There were 13 occasions that the blast was delayed for protected species within the exclusion zone. The delays were caused 5 times for marine turtles, 4 times for dolphins, and 4 times for manatees. The longest delays resulted from turtle sightings, in particular the sightings that occurred on 1 and 2 July 2005. On both days, the blast was delayed multiple times for the same turtle resulting in nearly 2hrs and 30 minutes of delay per day. The turtle(s) observed during these days were spotted multiple times, each time nearly at the end of each mandatory 30-minute hold period initiated from the previous sighting. While these sightings may have caused a significant delay in the blast, it also indicates that the 30-minute hold from previous sightings is effective in detecting relatively stationary marine turtles in these situations. All other delays for protected species were less than 30 minutes, and most were less than 15 minutes, with much of that time used to confirm that the animal was fully out of the safety zone. There were approximately 6 occurrences where blasting was delayed for boat traffic or misfires.

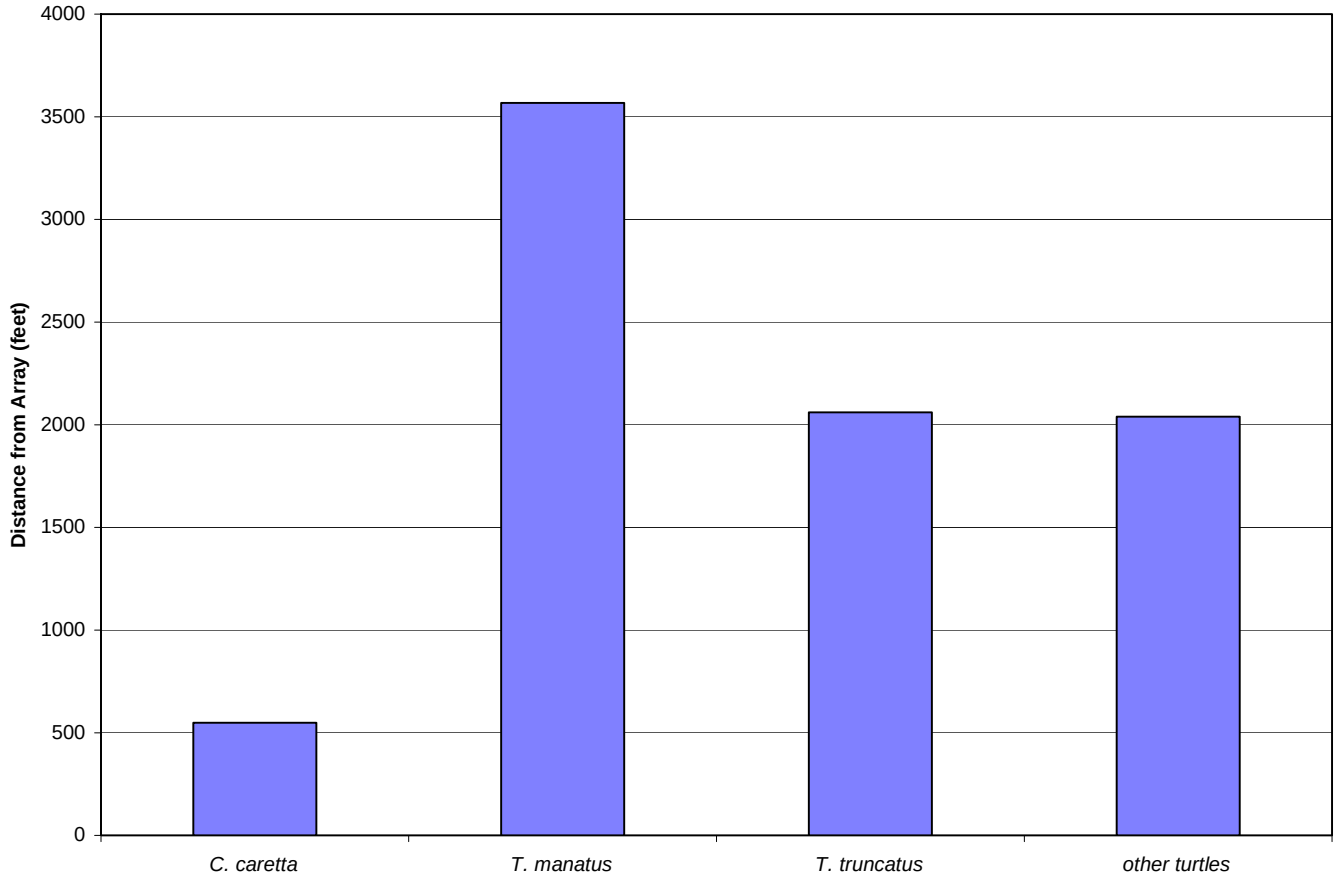

Figure 9. Average distance of protected species from blast array.

Most manatee sightings (57%) occurred in or around the Virginia Key water treatment plant basin at the east end of the pipe channel, southeast of the project site (Table 2). Manatees here were observed bottom resting and feeding. Manatees feeding were within the Critical Wildlife Area. Most traveling was within or along the pipe channel in the SE/NW direction. Manatees were observed moving along the pipe channel from the treatment plant basin all the way to the mouth of the Miami River.

Table 2. Number of sightings based on location of animals and location of observers

# of sightings (# animals)	Basin/Pipe Channel	Miami River Intersection	Fisher Island	Exclusion Zone (Lummus Channel)	Other	1st observed by			Additional observation by		
						Helo	Boats	Drill Barge	Helo	Boats	Drill barge
Manatees	27 (66)	10 (20)	4 (9)	4 (13)	2 (6)	46	0	1	1	8	2
Dolphins	2 (3)	2 (4)	8 (12)	11 (30)	1 (2)	20	4	0	4	18	2
Turtles	2 (2)	0 (0)	1 (1)	9 (11)	1 (1)	5	1	7	2	0	0

Some animals left the treatment plant basin and moved north near Fisher Island where they entered Lummus channel. On one occasion, manatees were first spotted in the ocean approximately 200 yards from the shoreline of Fisher Island, then moved into the boat basins on the island. Manatees were also regularly spotted feeding on the crescent shaped grass bed located at the intersection of the Miami River, the ICW, and Lummus channel. Most movement within the project site occurred just south of the channel along the transition between the very shallow grass beds and the drop off of the channel. This is probably a particularly dangerous place as the water is shallow but smaller boats still regularly move at high speeds along this area or cross over into the shallows. On one occasion, (See 8 July 2005 PSO report) a Coast Guard vessel drove at high speed across this area (going from the channel to the grass flats) over the top of 3 manatees feeding within this corridor. This was not the only problem encountered with a law enforcement vessel. On 23 July 05, a police boat went around the security boats and ran over the shot lines truncating a main line. This caused nearly a one-hour delay in the blast operations.

Manatees and dolphins were first spotted by the aerial observer 92% of the time; mainly due to the amount of area covered by the aerial observer and high concentration areas (such as the treatment basin) that were outside of the boat survey area. Turtles were first spotted by the drill barge observers 58% of the time with the remaining sightings first made by the aerial observer with the exception of one sighting made by a boat observer.

When assessing the initial sightings for animals actually inside the safety zone, the percentages even out slightly. Manatees that were spotted inside the safety zone or near Lummus channel were first spotted by the aerial observer 3 out of 4 times with a single initial observation made by the drill barge observer. Similarly, dolphins that were spotted inside the safety zone were first

spotted by the aerial observer 63% of the time with the remaining initial sightings coming from the boat observers. By contrast, 66% of turtle sightings within the safety zone were first made by the drill barge observers. This is important to note, as often these were single sightings with no re-acquisition of the turtle after the initial sighting. 100% of manatees and dolphins that were first spotted by the aerial observer near the safety zone were subsequently re-acquired by the boat observers who often tracked them out of the safety zone. These data indicate the high effectiveness of the observer program and its locations. While boats are sometimes at a disadvantage in observer programs due to their reduced height off the water, the mobility of the vessels in conjunction with the intense aerial survey certainly compensates for any lowered visibility. The importance of the drill barge observers, particularly for spotting marine turtles, cannot be underestimated; however, it also illustrates the drawbacks of only using stationary observers in that the initial sightings and re-acquisitions of some species are much lower than the mobile observers. Overall the combination of three observation techniques was highly effective.

Any animals near the exclusion were watched carefully during the blast for any changes in behavior or noticeable reaction to the blast. The only observation that showed signs of a reaction to blast was on 27 July when two dolphins were in the channel west of the blast. The dolphins were stationary at approximately 2400' feeding and generally cavorting. Due to the proximity of the dolphins, the drill barge was contacted prior to blast to confirm that the exclusion zone calculation was 1600' for the lower weight of explosives used that day. The topography of the bottom in that area is very shallow (~1m) to the south, then an exceptionally steep drop off into the channel at 40+ ft ending at the bulkhead wall to the north. Westward, the channel continues and has a more gradual upward slope. At the time of the blast, one of the dolphins was at the surface in the shallows, while the other dolphin was underwater within the channel. The dolphin that was underwater showed a strong reaction to the blast. The animal jumped fully out of the water in a "breaching" fashion; behavior that had not been exhibited prior to the blast. The animal was observed jumping out of the water immediately before the observers heard the blast suggesting that the animal reacted to the blast and not some other stimulus. It is probable that, because this animal was located in the channel, the sound and pressure of the blast traveled either farther or was more focused through the channeling and the reflection from the bulkhead, thus causing the animal to react even though it was well outside the safety radius. These two dolphins were tracked for the entire 30-minute post blast period and no obvious signs of distress or behavior changes were observed. Other animals observed near the safety radius during blast were all to the south of the array, well up on the grass beds or in the pipe channel that runs through the grass beds. None of these animals showed any reaction to blast. This observation may be important to consider when formulating blast / watch plans for marine mammals in the future. It may be prudent to extend or contract the exclusion zone based on the bathymetry of the project site.

All data summary sheets and maps from the watch program can be found in Appendix A. Additional project photos can be found in Appendix B.

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