BIOLOGICAL ASSESSMENT: SEA TURTLES IN THE NEW YORK DISTRICT

1.0 Introduction

The Endangered Species Act of 1973 mandates the protection from extinction, of uncommon or threatened wildlife and plant species. Section 7(a) of this act requires federal agencies to evaluate their proposed actions with respect to any species that is listed as endangered or threatened, and with respect to the species' critical habitat, if any has been designated. section 7(a) (2) requires that federal agencies ensure that any activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or to destroy or adversely modify its critical habitat. If a federal action may effect a listed species, or its critical habitat, the responsible federal agency must enter into a formal consultation with the National Marine Fisheries Service (NMFS). The five species of marine turtles that occur in the northwestern Atlantic are the Kemp's ridley, Lepidochelys kempii, the green turtle, Chelonia mvdas, the .loggerhead turtle, Caretta caretta, the leatherback turtle, Dermochelys coriacea, and the hawksbill turtle, Eretmochelys imbricata. All are listed as endangered or threatened under the Endangered Species Act. An endangered species is one that faces imminent extinction throughout all or a significant portion of its range; a threatened species is one that is likely to become endangered in the foreseeable future. The leatherback and the hawksbill turtles were listed on June 2, 1970 as endangered throughout their range. The Kemp's ridley was listed on December 2, 1970 as endangered throughout its range. The green turtle was listed on July 28, 1978 as endangered in its breeding populations in Florida and on the Pacific coast of Mexico, and as threatened -throughout the rest of its range. On the same date, the loggerhead turtle was listed as threatened throughout its range. Of these five species of endangered and threatened marine turtles, three (the Kemp's ridley, green and loggerhead) are known to seasonally occur in near shore and estuarine waters in the New York area (Morreale and Standora 1989, 1990, 1991a, 1992).

In a letter dated 26 January 1993, the New York District Army Corps of Engineers (NYDACE) requested the initiation of a formal consultation with NMFS as required under section 7(2) (a) of the Endangered Species Act. In a reply dated 1 June 1993, NMFS complied with the request and directed NYDACE to prepare a biological assessment concerning the work and its potential impacts on sea turtles. The following document, which represents NYDACE compliance with that request, is a generic assessment of the potential impacts to the three species of concern within the marine waters of the NYD. It was considered that any review of project specific impacts to sea turtles necessitates discussing the turtles' life histories and their distribution in general. The following biological assessment summarizes the occurrence, activities, and status of sea turtles, and includes an analysis of the potential risks of dredging operations both to sea turtles in general and, more specifically, to those in the New York region.

2.0 General Data Collection, Survey Methods, and Sea Turtle Distribution in the Eastern U.S.

Understanding the ecology, abundances, and distribution of sea turtles is very difficult. Sea turtles occur in habitats that are inaccessible to observers, spend much of their time submerged, and are wide-ranging throughout entire oceans. Therefore, reported information on sea turtles must be cautiously interpreted. Data on sea turtle abundance and distribution have been collected via several methods, including aerial surveys, reports from fishermen, stranding network surveys, and nesting surveys. Although all of these techniques can be useful, all have their associated weaknesses. Beginning in 1978, the Cetacean and Turtle Assessment Program (CETAP) surveyed the Atlantic coast utilizing aerial methods (Shoop and Kenney, 1992). The results of this thorough research form one of the bases for current sea turtle distribution theory. The inherent problems associated with aerial surveys, however, are usually problems of omission of individuals. Since observers can only see turtles on the surface, the proportion that are submerged can only be estimated. Likewise, the smaller species such as the Kemp's ridley often go unseen, as do most juveniles of all species. In addition, physical conditions such as waves and glare also interfere with the observers' abilities to conduct an accurate count. Hence, aerial surveys underestimate numbers of turtles.

A recent development in the collection of sea turtle data has been the formation of the Sea Turtle Stranding and Salvage Network (STSSN), which records the occurrence of moribund, dead, and cold-stunned turtles that wash up along the eastern and Gulf coasts. Information from the STSSN is extremely useful in detecting localized trends in distribution and mortality, but is also very limited in its uses. Cold-stunned and dead animals can float great distances, making identification of origin difficult. Also, marshy and difficult-to-reach shorelines are seldom surveyed, often leaving large areas unchecked.

Other survey techniques that have proven useful in turtle research include nesting beach surveys and participation with and observation of commercial fishing activities. Both techniques are useful for quantifying certain demographic trends~ Long-term monitoring of nesting beaches can be used to observe trends in the adult female portion of a population, while fishing surveys can yield information on distribution and seasonal occurrence. Given the difficulties involved and the inherent limitations of most of the survey techniques, any account of turtle distribution must incorporate several data sets. For turtles along the u.s. Atlantic coast, the range of distribution for leatherbacks, loggerheads, Kemp's ridleys, and green turtles extends from Florida to the Gulf of Maine (Thompson 1984, Morreale et ale 1992, Shoop and Kenney 1992}, while hawksbills generally extend only as far as North Carolina (Anon. 1992). Aerial surveys have indicated that the larger sea turtles extend from nearshore waters out to the continental slope, and in the South tend to be more abundant in mid-shelf waters in the warmer months. cooperative research with commercial fishermen has shown that smaller turtles occur in inshore waters, and especially in major estuaries, such as Chesapeake Bay (Lutcavage and Musick 1985) Pamlico Sound (Epperly and Veishlow 1990), and Long Island Sound (Morreale and Standora 1992). Furthermore, small juveniles are most frequently observed at depths of 50 m or less. The combination of these two techniques in conjunction with stranding surveys has clearly demonstrated that the occurrence and abundance of all sea turtles from Cape Hatteras to New England is seasonally dependent. The majority of sea turtle activity in the northeastern U.S~ occurs from June through October every year.

3.0 Species Accounts and site Specific-usage

This section includes a discussion of the life histories of the Kemp's ridley, green and, loggerhead turtles as well as a summary of their occurrence and distribution in the N.Y. Bight region. The leatherback turtle also occurs in NYD marine waters, but is considered to occur mainly in pelagic waters of the Northeast (Shoop and Kenny 1992, Morreale et al. 1992) and is not likely to be impacted by typical nearshore dredging activities. Therefore, this species is only briefly discussed.

Since the Kemp's ridley is the most endangered sea turtle and is abundant in N.Y. waters, it has been the subject of intensive study in recent years (Morreale and Standora 1992). Although many of the behavioral data from this research were derived from detailed studies of the juvenile Kemp's ridleys, the general principles can be applied directly to juvenile loggerheads and, to a slightly lesser extent, green turtles that are summer residents in the Northeast.

3.1 Kemp's ridley turtle

The Kemp's ridley turtle is considered to be in imminent danger of extinction (NRC 1990). The general reproductive scheme of the Kemp's ridley, which differs from all other sea turtles, except for the closely related olive ridley, has contributed in part to its overexploitation and current endangered status. With only minor exceptions, the entire world's population nests on a single beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963, Pritchard 1969, Woody 1986). After gathering in waters off the nesting beach, the females come ashore en masse over a period of several hours during the day in what is termed an "arribada" (Woody 1986, Plotkin et al. 1991). In 1947, such an arribada at Rancho Nuevo was captured on film by an amateur photographer. Upon later analysis, it was estimated that more than 40,000 females emerged to next in that single event. Estimates from more recent years indicate that there are only about 1000 nesting females remaining worldwide.

The nesting season for Kemp's ridleys lasts from April to July (Woody 1986, NRC 1990). Individual nesting females remain on land for about an hour and can return to deposit new clutches from 2 to 10 times in a single season (Rostal et al. 1992). Each clutch contains an average of approximately 100 eggs, which incubate for 50 to 70 days. Sex determination is temperature-dependent in this species, as it is for all species of sea turtles (Morreale et al. 1982, Standora and Spotila 1985, Girondot and Pieau 1990). Because of the precarious status of the Kemp's ridley and the heavy predation pressure on nest sites, virtually all eggs are now transferred to a protected beach hatchery to maximize survival.

It .is believed that once the eggs are deposited in the nest, the developmental stages over the next few years are similar among all cheloniid turtles (there is no substantive information on early stages of leatherbacks). After hatching, the turtles dig there way out of the nest and head for the surf, guided mainly by light cues. The hatchling turtles swim offshore into the Gulf of Mexico in what has been described as the "swimming frenzy" common to all hatchling sea turtles (Carr, 1967). This period of exertion can last for several days. From the beginning of this swim, until they reach a size of greater than 20 cm, little is known about their development or behavior. During the intervening period, which has been termed the "lost year", it is assumed that these young turtles spend from one to several years as part of the plankton community, floating as pelagic surface drifters (Carr, 1986). This biological community, which often consists of large rafts of floating vegetation, harbors rich patches of macroplankton upon which the turtles can feed. Although the details of this early life stage remain sketchy, many inferences have been made from the available information. During this passive pelagic stage, major ocean currents may transport the young turtles to far distant Points., or the hatchlings may get caught up in repeating circular currents consisting of local eddies (Carr 1980). For Kemp's ridley hatchlings, which all emerge from a single nesting beach, their "lost year" dispersal patterns may take one of several qoutes. Some of the hatchlings may become entrained in the gyre-like currents and eddies of the Gull of Mexico and remain in that vicinity for their entire lives. Others may be carried via the northward trending Loop Current, through the Florida straits, and northward along the Atlantic coast within the Gulf Stream (Witham 1980, Carr 1980). The latter scenario is among many possible mechanisms by which juvenile turtles may ultimately be transported to inshore waters along the east coast.

In an early report, Pritchard and Marquez (1973) hypothesized that the Gulf Stream transport of young turtles affords an environment of rapid development, as well as implementing their dispersal. .Thus, by passively migrating, turtles would be carried to waters as far north as New York and New England, where they would move into inshore waters and begin a new developmental stage. Carr (1986) later pointed out that if post-hatchling turtles were transported in such a passive manor, they would appear in northeastern waters at much smaller sizes than are observed. He proposed that the turtles might first travel around in the Gulf stream for up to several years before being swept into inshore waters by occasional eddies. However, the exact circumstances which would deposit the young turtles in a specific area is unknown. The frequency and direction of Gulf stream eddies, which would facilitate such transport, are well documented, but, since the integrity of these Gulf stream rings is lost as the water mass approaches the continental shelf, the deposition of young turtles into the littoral zone would necessitate another mechanism, possibly onshore Ekman transport (directed currents driven by wind and the rotational forces of the earth) as well as active swimming (Ingham 1979). Shoop and Kenney (1992) speculated that the migration of juvenile turtles into estuarine waters may be controlled via such factors as chemical gradients, changes in salinity, high nutrient inputs, differences in sedimentary environment, and high concentrations of benthic prey.

From the long-term mark-recapture and the telemetric studies of Morreale and Standora (1989, 1990, 1991, 1992), it is now becoming evident that after turtles spend their first life stage in a pelagic surface-feeding mode, they undergo a transition and purposefully swim into inshore waters. In this new life stage, juvenile turtles are undoubtedly large enough to actively swim into inshore waters without any influence from sporadic eddies or current anomalies (S. Morreale pers. comm.). Once in inshore waters, they shift foraging tactics and become benthic feeders. In addition to being proficient foragers (Morreale and Standora 1992b), their high degree of mobility (Standora and Morreale 1991) and their regular pattern of occurrence in the Northeast each year (Morreale et ale 1992) strongly indicates that their inshore shift is deliberate.

At one time it was thought that the presence of sea turtles in northern waters was incidental, and this belief persisted until recently (Morreale et ale 1992). However, reliable records exist from as far back as the mid-1800's documenting the occurrence of sea turtles as far north as the Gulf of Maine (Dekay 1842,.Bleakney 1965, Lazell 1980,' Morreale et ale 1989). That there are seasonal abundances of sea turtle's along the northeastern coast is now an accepted fact. It has been demonstrated that New York waters are likely an important part of the developmental range for juvenile turtles (Morreale and Standora 1989, 1990, 1991), and it even has been speculated that the shelf waters of New. England may be "critical habitat" for Kemp's ridleys and loggerheads (Lazell 1980). Despite this information, however, neither of these areas has been declared as such by NMFS.

Since most sea turtles nesting in the western Atlantic do so south of Virginia, the annual appearance of many individuals in the coastal waters of New England and New York signifies that this region is being used primarily as foraging grounds. There appear to be at least five such areas (New England, New York, Chesapeake, N. Carolina, and Central Florida) along the East Coast that serve as developmental habitats for juvenile and sub-adult Kemp's ridleys, loggerheads and green turtles. Observations among these regions have indicated a gradient in mean turtle size which increases with decreasing latitude. The pattern show~ that while there are almost exclusively small, and presumably young, turtles in Northeastern inshore waters the number of larger turtles increases as one moves to Southern regions (Ehrart 1980, Bellmund et al. 1986; for review, see Morreale et al. 1992).

In New York' waters, young turtles usually begin arriving inshore in late June (Morreale and Standora 1989). At that time, individuals move into shallow coastal waters and embayments and begin exhibiting benthic foraging behavior. Most observations of these juveniles place them in water of 50 m or less, and studies of diving behavior have shown that an individual can spend less than a total of 1/2 hour a day at the surface (Byles 1989, Morreale and Standora 1992).

It has been documented that juvenile, sub-adult, and adult Kemp's ridleys feed on various species of crabs and invertebrates (Dobie et al. 1961, NRC 1990, Burke et al. in press), with the smallest turtles usually foraging in the shallowest depths (Ogren 1989). Although the diets of juveniles and adults in the Gulf of Mexico and in Chesapeake Bay consist primarily of the portunid crabs Callinectes sapidus (blue crab) and Ovalipes stephesoni (Spotted Lady Crab), in the New York region their-diet consists mainly of the genera Libinia (>60%), Cancer, and Ovalipes (Morreale and Standora 1992, Burke et ale in press). other less important dietary items include the blue mussel, Mvtilus edulis, the bay scallop, Argopectin irradians. and fragments of algae and debris. Feeding behavior and growth studies have indicated that such a diet for New York's turtles contributes to their very high growth rates (Morreale and Standora 1991). ,

During the months of July through September, the sea turtles in N.Y. waters display localized movements, perhaps influenced by prey availability. Radio-telemetered Kemp's ridleys characteristically resided at depths of 5-15 meters. Even while swimming in water of depths of up to 50 meters, individuals seldom descended beyond 12 meters. This limitation may be related to low visibility, due to turbidity and resulting light attenuation (Morreale and Standora 1990). Monitored turtles also exhibited diving cycles consistent with the crepuscular activity patterns of their crustacean prey (Morreale arid Standora 1991). At night the turtles appear to be sleeping or resting on the bottom, with only infrequent trips to the surface.

By the end of September, the warm inshore waters, which give rise to long residence times and localized movements of the young sea turtles, begin to cool down with the approach of winter. With these declining temperatures, turtles must begin to move out of shallow inshore waters or face potential cold-stunning. Along the East Coast, to avoid cold water, a turtle would have to continue moving out of the estuarine habitats, into the ocean, and then southward, following the receding warmer water. The growing body of data collected via radio and satellite telemetry, along with information from the long-term mark recapture study, indicates that most of New York's summer resident turtles follow such a scenario each year (Morreale and Standora 1992). These telemetry studies have confirmed that the initiation of emigration in the fall is the result of thermal cues (the rapid decline in water temperature occurring in the fall) and that temperature also strongly influences the direction in which the turtles swim once in the ocean. Long-distance movement data also show that juvenile turtles that leave the New York area can reach waters warm enough (above 15 degrees C) in which to overwinter in about a month of seemingly unhurried travel.

In some instances, sea turtles have been observed entering a state of torpor in response to lower temperatures (Carr 1980). This behavioral response has been implicated as a means by which turtles can overwinter without migrating long distances. Such a state of dormancy has been reported for sea turtles in Baja California (Felger et al. 1976) and at Cape Canaveral, Florida (Ogren and McVea 1982). Mud-covered, lethargic turtles also have been reported in a state of hibernation by fishermen in the Gulf of Mexico and at Cedar Key, Florida. Although superficially this response resembles the overwintering behavior observed in freshwater turtles, the temperatures at which many freshwater and terrestrial species can survive are from 5 to 10 Clower than the lethal minimum for sea turtles (for review, see Morreale et al. 1992). Hence, sea turtles tend to migrate to warmer offshore water or to deeper waters as temperatures decline below 15 C. However, if a suitable refuge is too distant, or the route is blocked by physical or thermal barriers, individuals may attempt to remain and hibernate. In many cases, such a response has been attributed to the cold-stunning and subsequent death of green, loggerhead and Kemp's ridley turtles (Witherington and Ehrhart 1989b, Burke et al. 1991). In New York, given the severe winter conditions, it is highly unlikely that a sea turtle could successfully overwinter in the estuarine or nearshore waters (Morreale et al. 1992). Such an attempt would almost certainly "result in cold-stunning. Thus, there is a window of opportunity each year during which turtles can benefit greatly from foraging in inshore waters of the Northeast. Beyond this window these northern waters are unsuitable for sea turtles

3.2 Loggerhead turtle

Adult and sub-adult loggerhead turtles have a reddish-brown carapace and yellowish plastron. Adults can be larger than 122 cm SCL, and can weigh in excess of 150 kg. The species' distribution is world-wide in tropical and subtropical regions with populations occurring along the continental shelves and in estuarine environments along the coasts of the Atlantic, Pacific and Indian Oceans. *One* of the largest aggregations occurs on in the Gulf of Oman (Ross and Barwani 1982). In the western Atlantic, loggerheads range from the temperate waters of Argentina to the Gulf of Maine. This population of loggerheads that utilizes the western Atlantic coast may make up 30% (28,000) of the world's population (NRC 1990). Nesting areas are confined to warmer regions within this range including the Caribbean, the Gulf of Mexico and the southeastern U.S. coasts. In the U.S., Florida contains the highest number of nesting turtles, but beaches in Georgia, and South and North Carolina are also utilized. The loggerhead currently is listed as a federally threatened species and recent surveys of adult females suggest that the population is declining due, in part, to increased mortality (Witherington and Ehrhart 1989a).

It is estimated that the loggerhead attains sexual maturity between 20 to 30 years of age. (Frazer and Ehrhart 1985). Each year in the southeastern U.S. sexually active adults migrate to the shallow waters adjacent to their nesting beaches, where mating occurs from March to June (Fritts et al. 1983). The peak nesting season occurs from June through August and an individual may re-nest 1~7 times in a single season (Richardson and Richardson 1982). Nesting females haul out individually, at night, onto high energy beaches of the mainland coastal barrier islands where they usually deposit from 100 to 125 eggs. Incubation lasts from 55 to 75 days depending on nest temperature; hatching success can range from 55 to 75 % (Witherington 1986). Upon emergence from the nest, hatchlings swim immediately offshore to become associated with sargassum and pelagic drift lines, which usually are related to current convergences (Carr 1987, Fletemeyer 1978). There they remain, much as was described for Kemp's ridleys, until they begin appearing inshore along the East Coast at sizes from 30-50 cm (Carr 1986).

After juvenile loggerheads move into inshore waters, they frequently are observed in sheltered, semi-enclosed estuarine habitats of the continental margins along the eastern U.S., Bahamas, and Gulf of Mexico. Included among several such habitats are pamlico Sound, Chesapeake Bay and Long Island Sound, all of which have been documented as foraging habitat for these juveniles. The juvenile feeding grounds often are distinct from adult foraging and mating areas, which may be hundreds of kilometers away. In the case of New York waters, juveniles can be more than 1000 km removed from the adult population (pers comm. Steve Morreale). In general, the loggerhead appears to exhibit a less specific diet than other turtles, including as food such diverse groups as crustaceans, mollusks, and coelenterates (Van Nierop and den Hartog 1984) and, in rare cases, fish (Burke et ale 1993). The diets of New York's loggerhead turtles, although differing from those of other regions, were found to be highly similar to those of Kemp's ridleys in the same waters (Burke et ale in press). Loggerheads in this region were found to feed mainly upon crabs, with the most abundant prey item being spider crabs (genus Libinia).

The loggerhead is likely the most commonly occurring sea turtle in Northeastern waters. The timing of occurrence of and their distribution in the New York area is nearly identical to that of the Kemp's ridley (Morreale and Standora 1992). As temperatures decline in the fall, most of these turtles emigrate, following virtually identical routes to the South as do the Kemp's ridleys (S. Morreale pers. comm). Although some individuals wash ashore cold-stunned, they are much less common each winter than the Kemp's ridley (Morreale et ale 1992).

3.3 Green turtle

The adult green turtle has a smooth, olive-green to brown carapace, often showing bold streaks and spots. The plastron is yellowish-white. Adults are comparable in size to adult loggerheads but, because of the number of distinct populations worldwide, can differ greatly from each other, both in physical and behavioral attributes. The green turtle has a global distribution throughout tropical and subtropical oceans. In U.S. waters, this species occurs around the U.S. Virgin Islands and Puerto Rico and along the Gulf and. East Coasts from Texas to Massachusetts.

Throughout most of its range Green turtle populations have been depleted because of human demand for its meat and eggs. For 300 years these turtles provided seafarers with meat for long voyages. Entire breeding populations were exterpated such as those formally nesting on the Cayman

Islands. Its body fat which is green and hence the turtles name, was rendered into oil for cooking, lamps and lubrication (Parsons 1962). A European market developed that eventually was responsible for shipping 15,000 turtles a year to England alone. "Turtling" was still and active industry in the Florida Keys until the turn of the century (Rebel 1974).

Adult females nest on high energy beaches, in a similar fashion to loggerheads, however their is little overlap in their nesting range within the U.S. Along the East Coast, green turtles nest only in small numbers in Florida (NRC 1990). Until recently it was thought that nesting group represented a unique and endangered population. More recent evidence, however, has indicated that Florida green turtles are not genetically distinct from those nesting in Costa Rica (Meylan et al. 1990) .Green turtles are unique among marine turtles in being herbivorous as adults. Green turtles are known to have very slow growth rates which is thought to be related to their diet. The age of maturity is estimated at 15 to 30 years (Witham 1983).

Adult green turtles generally forage in shallow, well protected sea grass meadows (Carr 1986). Pelagic stage juveniles are assumed to be omnivorous, feeding on available invertebrates and plant material in the drift of convergence zones. When they end their pelagic existence they switch to a benthic feeding behavior feeding on sea grasses and macro-algae. Presumably because of the lack of such habitat in the Northeast, green turtles are considered to be somewhat rare in that region. In New York waters, they are the least frequently observed of the four species, but there has been a general increase in the incidence of capture over the past five summers (Morreale and Standora 1992). Only juvenile green turtles have been observed in New York's inshore waters; mean sizes each year are nearly identical to those of the Kemp's ridleys. Lower numbers notwithstanding, timing of occurrence and distribution of green turtles throughout the region appear to be similar to those observed for both the Kemp's ridley and the loggerhead. The only obvious distinctive trait among New York's green turtles is their herbivorous diet, which is composed mostly of algae and sea grass (Burke et ale 1992). Becaus7 of ~uch c: diet, green turtles in the Northeast may ~end to 1nhab1t sl1ghtly shallower areas than the other spec1es of sea turtles.

3.4 Leatherback turtle

The leatherback turtle is the single extant member of the family Dermochelyidae. It is the largest of the sea turtles, commonly reaching lengths greater than 150 cm SCL and weighing in excess of 400 kg (NRC 1990). Its carapace and plastron are covered with a continuous layer of skin instead of horny scutes, and both are raised into a series of longitudinal ridges. Leatherbacks appear in coastal areas but are essentially pelagic animals that travel great distances as they migrate between feeding grounds and nesting areas (Bleakney 1965). This turtle is often encountered outside the tropics, even at latitudes approaching polar regions (Shoop and Kenney 1992), and is frequently observed in the offshore waters of the Northeast, including New York (Morreale et al. 1992). Most descriptive accounts on this turtle indicate that it may feed exclusively on jellyfish in the water column. Because of the leatherback's mostly pelagic nature and its unique feeding habits, it is not a frequent visitor to inshore waters. Thus, it would not be impacted readily by any activities that were conducted in the littoral zone, especially those confined to shallow water. In support of this view, a letter dated 4/12/93 by Richard Roe, director of the N.E. Regional NMFS office, stated that any impact to leatherback turtles due to the dredging activities associated with beach nourishment projects is unlikely.

4.0 Mortality

Marine turtles potentially are susceptible to several different biotic and abiotic sources of mortality, including many that are either directly or indirectly anthropogenic in nature. Among the natural sources of mortality are those that effect turtles in very early stages. Impacts to nests and hatchlings include predation by mammals, crabs, birds, and insects (Marquez et al. 1989, Dodd 1988). Nests can also be destroyed by invading plant roots (Raymond 1984) or by fungal and bacterial infections. Abiotic sources such as heavy rains, erosion, accretion, or tidal inundation can also cause nest destruction (Horikoshi 1989).

Once in the water, hatchlings are consumed by predatory fish and birds of many species. Although sea turtles are most at risk to natural mortality as eggs and hatchlings, they may succumb to disease and parasites (Wolke et al. 1982) or be attacked by large predators such as sharks, at all stages of their lives. In temperate regions, turtles also must contend with severe annual declines in temperatures. In the South, extreme cold can result in the cold-stunning of hundreds of juvenile turtles, many of which die (Witherington and Ehrhart 1989). In the Northeast, any sea turtle that remains beyond November is likely to become cold-stunned and die (Morreale et al. 1992).

During the relatively long lives of sea turtles, there is a high probability that they will experience one of a variety of diverse, potentially lethal, interactions with humans. Negative impacts may include hunting, habitat modification or destruction, incidental capture or entanglement in fishing gear, injuries from contact with boats or dredges, or entrainment in power plant and dredge intakes (NRC 1990). With such activities as beach renourishment nests can be buried and compacted, accompanied by a change in the nature of sediments, all of which can affect incubation temperature, gas exchange, and moisture content. Changes in these factors can directly influence emergence success (Nelson 1986, Mortimer 1982, Ackerman 1980). The extent of the impact of some factors can be harder to assess because of their potential indirect effects upon turtles. In addition, some factors, such as waterfront development may exert both direct and indirect effects. Artificial beachfront lighting from buildings, streets, and parks can cause disorientation of hatchling turtles, resulting in increased exposure to desiccation and to predators (Dickerson and Nelson 1989). Development related activities also frequently result in moderate to severe habitat degradation. Although the loss of foraging or nesting habitat may not directly induce death, sea turtles forced to utilize sub-optimal habitats may suffer a reduction in reproductive output or an increase in incidence of disease.

Until the recent mandatory regulations that were imposed on commercial fishermen by NMFS, the single largest human-associated source of mortality to adult and sub-adult loggerheads, Kemp's ridleys, and green turtles in the U.s. was reported to be their capture and accidental drowning in shrimp trawls (Henwood and Stuntz 1987, Murphy 1989)'. Tests revealed that turtle mortality was directly related to the duration of the tow. Death rates are minimal until tow times exceed 60 minutes, and as they exceed 200 minutes, the mortality rate approaches 50 %. Along the coast of the southeastern U.S., where shrimping was intense near the nesting beaches, loggerhead numbers were declining. The populations were stable, however, where shrimping was low or absent. Estimates based on various information sources concluded that the Atlantic and Gulf of Mexico shrimp fishery may have been responsible for the annual capture of 47,000 turtles, resulting in 11,000 deaths per year (Henwood and Stuntz 1987). With the mandatory installation of Turtle Excluder Devices (TED's) on shrimp trawls and mandatory reduction in trawl duration, however, mortality due to this source has been greatly reduced. Some modes of fishing, however, remain a great source of mortality to sea turtles (O'Hara et al. 1986).

As a direct result of high human densities along the Eastern Seaboard, a frequent cause of injury and mortality to sea turtles is collision with boats. In the Northeast the tremendous number of high-speed recreational boats that congest the shallow coastal embayments each summer probably represents a much larger source of mortality to juvenile sea turtles than all of the fishing mortalities in that area combined. In New York waters, during a recent summer's research, a phenomenal 40% of all turtles found dead had been struck by boats (Morreale and Standora 1991). The apparently high incidence of boat collisions with turtles is supported by data from their stranding and mark-recapture studies as well as other independent stranding network data. Although it is often difficult to determine whether such injuries occurred before or after death, over the past 8 years of studies there were many clear cut cases of injuries and fatalities resulting from boats (pers. comm. Steve Morreale).

Less direct pressures associated with heavy human usage of these coastal areas are the increase in floatable garbage and debris during the summer months. Ingestion of plastics and debris by sea turtles in New York is well documented (Morreale and Standora 1991, Burke et al. 1993 in press), however, the numbers of turtles effected will never be known (NRC 1990). Turtles swallow a variety of drift items including plastic bags, balloons, plastic beads, and monofilament line. Ingestion of these materials can cause intestinal blockage, reduced nutrient absorption, and release of toxic chemicals (NRC 90), all of which can ultimately lead to death.

4.1 Dredging Impacts on Sea Turtles

Among the several possible causes of death to sea turtles is the potential entrainment of individuals in dredging apparatus. Incidental mortality of sea turtles due to channel maintenance with hopper dredges became evident as a result of dredging in 'Port Canaveral Channel, Florida in 1980. This sheltered, low energy area is prone to shoaling and requires regular dredging to maintain the channel depth (Studt 1987). Initial investigations revealed an unusually high concentration of loggerhead turtles in the channel, possibly due to the physical characteristics of the channel (soft bottom, low energy, deeper water). These factors may make the ship channel an ideal resting area for adult and sub-adult turtles and as a refuge from predators and an overwintering site for smaller turtles (Byles and Dodd 1989, Meylan et al. 1983, Carr et al. 1980). At the same time, however, the characteristics that make the Canaveral area favorable to sea turtles, also make it a high maintenance area in terms of dredging. Thus, the potential for turtle/dredge interactions is high.

As a result of trawling surveys within the Cape Canaveral Channel, large seasonal variations were observed in sea turtle population structure. During the coldest months, the highest number of turtles were captured (Butler et al. 1987). This result may be due to lower activity levels related to colder water temperatures. In addition, to changes in densities, three distinct groups of loggerheads were observed in the channel at different times of the year (Henwood 1987). Adult males were most common in April, adult females were most common in May and June and for the remainder of the year subadults made up 80% of the population.

Although the Canaveral Channel is thought to contain unusually high densities of turtles, especially during winter (Standora et al. 1992), mortality from hopper dredges has been observed in other shipping channels in southern Florida and in Kings Bay shipping channels in Georgia (Dickerson 1991). In general these southern latitudes offer more hospitable temperatures all year, and sea turtles are relatively common in nearshore and inshore waters. Nevertheless, the higher number of dredge-related mortalities in Florida than in Georgia, is probably indicative of a trend of decreasing turtle densities in more northerly waters.

5.0 Site Specific Usage: ~ YORK DISTRICT MARINE WATERS

Between June and October, large numbers of juvenile loggerheads, Kemp's ridleys and green turtles immigrate into New York's estuarine waters, where they remain for up to several weeks (Morreale and Standora 1989, 1990, 1991, 1992). This pattern, which has been observed over the past six years, strongly indicates that there is an annual cyclicity to the occurrence and distribution of sea turtles throughout New York waters. Turtles are most abundant when the water temperature is ...highest (usually August through September), with large scale meteorological events potentially influencing variations in overall numbers, species composition, and strandings (Morreale and Standora 1992). Over the course of this long-term research project, 228 individual turtles were tagged and released in New York waters (S. Morreale pers. comm.). For the 336 total captures and recaptures, most of the sampling was confined to the eastern end of Long Island, with only minimal representation from western portions. Observations, however, indicate that turtles would be expected to occur throughout New York waters in habitats that are similar to those where they are observed in the eastern L.I. bays.

Because most of the turtles that occur in New York waters are sexually immature (typically 3-6 years of age), their primary emphasis would be expected to be on survival and growth. As a result, turtles entering the area each summer would exhibit high residency rates in areas that provide suitable temperatures (15 C or higher), an abundance of food resources, and do not require much energy expenditure, such as enclosed estuaries and embayments (S. Morreale pers. comm.).

The young turtles observed preference for waters shallower than 15 m (Morreale and Standora 1990) may be influenced by physiological limitations or by turbidity and light penetration to the bottom. In general turbidity is relatively high and shallow areas provide more ambient light at the bottom resulting in better visibility there. Increased light facilitates algal growth supporting a more diverse benthic population. These shallow areas usually lack a thermocline thus providing warm water throughout the water column. Any such shallow area that provides similar conditions in the New York area should also host relatively equal concentrations of sea turtles. Conversely, it is assumed that turtles occurring in waters deeper than 20 m are not likely to remain long in those areas.

Spider crabs Libinia emarqinata appear to be the preferred prey species for the juvenile Kemp's ridley and loggerhead turtles in NY District marine waters. In summer these crabs are abundant in nearshore relatively shallow waters and estuarine embayments especially in areas that offer heterogeneous substrates. The local species of spider crabs possess relatively weak claws and are largely detritus feeders and they would be expected to be found in areas which offer good cover as well as the capacity to entrap the debris on which they forage (Dr. Peter Lawton, Dept of Fisheries and Oceans, Biological Station, St Andrews New Brunswick, Canada). This correlates well with what is known of the foraging habitats of juvenile sea turtles in the north east. L. emarqinata would not be found in abundance in large grained sandy bottomed (high energy) environments which offer little if any cover, and reduced capacity to trap detritus (pers. Comm. Dr. Peter Auster, National Undersea Research Council, University of CT., Avery Pt.
CT.). Results from (20) benthic monitoring trawls (CENAN-PL-ES 30' trawl width, 20 minute duration) conducted at the

Coney Island N.Y borrow site in August 1992 revealed that of 1055 total crabs captured, spider and rock crabs combined (known turtle prey species) constituted only 11% of the sampled population. The most abundant species, about 90% was Ovalipes. Benthic" trawls were also conducted at the Long Beach N.Y. borrow area with very similar results (6% spidercrabs/spidercrabs 6/93.). In a letter to the NYDCOE dated 4/27/93, Nancy J. Haley of the Protected Species Program of NMFS, stated that lack of suitable prey abundance likely precludes turtles from occurring in a specific area (Upper N.Y. Harbor). Based on this criteria further consultation was not required.

Young sea turtles may feed primarily on slow moving species due to their inexperience in capturing faster moving portunid (swimming) crabs, which are reported to be a significant portion of the diet of adult Kemp's ridleys. The generally turbid, low visibility regional waters of the N.Y. District and the" quickness of the swimming portunid crabs may also help explain prey selection. Another factor which may affect prey selection is the burying behavior of the portunid "crabs which can make them very difficult to detect.

5.1 Effects of Dredging (Borrow sites) in the New York District

Dredging of off shore borrow areas of New York and New Jersey should not have an effect on sea turtles. Although no specific data on turtle usage are available for most of these sites, the characteristics of these areas to be dredged make them unlikely to be a special, unique, or critical habitat for sea turtles. At a typical borrow site, there is not an abundant population of the spider crabs (or rock crabs), which comprise the bulk of the diet for loggerheads and Kemp's ridleys in the region (Burke et. al 1992), and there are no eel grass beds. The coarse-grained sandy substrate, is a result of strong tidal currents and in some cases may also be under the influence of strong riverine flow. Thus, within a typical borrow area, the physical oceanographic regime and its related lack of abundant food resources, makes it highly unlikely that juvenile turtles would remain any longer than it takes for them to travel through the area. .This situation is probably also true for any of federally maintained inlets which possess strong tidal flows and characteristic sandy bottoms (Shinnecock, Fire Island, Jones Beach, and Rockaway etc.)

Despite the water depth of less than 20 m at many of the N.Y. District borrow sites (and similarly the inlets), it is the opinion of NYDACE that these habitats are not important or critical to sea turtles. This conclusion is supported by results from similar beach renourishment projects elsewhere along the East Coast. In recent USACE beach nourishment projects in West Hampton N.Y. completed 10/93, Cape May, New Jersey and in Bethany, Delaware (both completed in 1992), direct observations of hopper dredge operations revealed no evidence of interactions with turtles. In a similar dredging operation at Myrtle Beach, South Carolina, it was also the opinion of NMFS SE Region (4/23/1992 Charles Oravetz) that sea turtles would not be concentrated in areas of offshore borrow pits and would not likely suffer any adverse effects from hopper dredge operations. Given the lack of turtle/dredge interactions at these more southern sites, where densities of turtles presumably are higher, the chance for any significant negative impacts on turtles in N.Y District (offshore) borrow areas seems minimal. Furthermore, if the operations at the borrow sites (or inlets) will not involve hopper dredges, the chance of any direct interaction between the dredge and a turtle should be considered negligible.

6.0 Summary

The best available scientific knowledge indicates that several factors strongly influence the probability of sea turtles residing in the New York District's marine waters. Seasonal climate appears to be the most important single factor, and a definite window exists from June to November, during which time sea turtles are present in this region. Superimposed on the turtles' temperature requirement are the interdependent elements of water depth, food availability, and energy regime (tides and currents). These may combine to create a habitat that is either conducive to, or unsatisfactory for extended residency on the part of juvenile sea turtles.

By mid-summer sea turtles begin to utilize the warm shallow embayments such as those in eastern Long Island, and likely any in the New York area, that fulfill the turtles' requirements for the above environmental parameters. Similar areas such as portions of the lower New York Bay, Jamaica Bay, Raritan Bay, and Sandy Hook Bay may also provide suitable habitat for juvenile sea turtles. However, because of the dearth of information for western Long Island and northern New Jersey, we only can make inferences about sea turtle activity in these habitats.

There remain several questions pertaining to the probability of encountering a turtle while dredging in offshore borrow areas or during normal maintenance dredging operations inside a channel. To date, the use of hopper dredges in southern channels has been implicated as the main source of mortality to sea turtles during dredging. It remains unclear, however, whether all other types of dredging should be exonerated. The lack of observations of direct impacts to sea turtles during recent uses of hopper dredges in offshore borrow areas also raises the question of whether the threat to turtles exists primarily in specific channel dredging situations.

It is obvious that adult and sub-adult sea turtles frequent the benthos in and around several ship channels in the Southeast, and that maintenance operations have led to incidental mortality via hopper dredges. The undesirable consequences to sea turtles in southern channels as a result of hopper dredge activities has led to the conservative assumption that the similar precautionary measures that have been implemented in the South might also apply for dredging operations in the Northeast.

The USACE North Atlantic Division is concerned over the possible negative impacts that dredging may exert on threatened and endangered populations of sea turtles both in the South and in the Northeast. We also recognize the need to monitor those activities which may present a genuine threat to those species of concern. We also are concerned that a monitoring program based on the investigations and observations within southern shipping channels, however, may not be the most judicious approach to conserving sea turtles in the Northeast. It is our further opinion that monitoring in soft-bottomed Northeastern shipping channels (less than 20 m in depth) is warranted and that any program implemented for observation or mitigation should remain somewhat flexible pending results of such procedures.

7.0 Rockaway to East Rockaway and Jamaica Bay New York

Dredging of the borrow areas off of the Rockaways should not have any impact on sea turtles. Although there is no data on turtle usage of these sites their similarity to other (nearby) borrow areas characterize them as unlikely sites for turtle impacts. In general at the borrow site there would not be an abundant population of spidercrabs (and rockcrabs) which tend to reside in large numbers in shallow, inshore, highly productive benthic habitats during the summer. This is evident from our trawling data from comparable sites. Also, there are no eel grass beds in the borrow areas. The sandy substrate which makes the site desirable for beach nourishment is typically a result of strong tidal currents. Thus within the borrow area, the combination of the physical oceanography and lack of abundant food resources makes it unlikely that sea turtles would remain any longer then it takes for them to swim through the site.

From the information contained within this biological assessment, it is the conclusion of the NYDACE that the borrow sites chosen to be used for the Rockaway to East Rockaway and Jamaica Bay project will not pose a threat to sea turtles, even with the use of a hopper dredge. It is also the judgement of the NYDACE that a seasonal window need not be observed and that during dredging operations onboard monitoring should not be required. However the occasional presence of turtles in these areas is well known and the NYDACE understands the need to ascertain the actual threat to these endangered marine reptiles via monitoring procedures. However, should such monitoring support our initial conclusion of no impact, a mechanism should be developed to reduce and eventually eliminate monitoring for this and similar projects. In the interim, the following protocols which were received from NMFS (letter dated April 12, 1993, Richard B. Roe) will be instituted. A NMFS- approved observer with demonstrated abilities to identify sea turtle species and turtle parts will be placed on board the dredge being used for the beach nourishment project (6/15 -11/15). An observer will be onboard for the first week of dredging and subsequent shifts will proceed one week on and one week off. While on board observations will proceed 6 hours on and 6 hours off with combined monitoring periods representing 50% of the time and total dredging monitoring time equaling 25%. .Observation sheets and major incident reports shall be prepared by the observer using approved NMFS formats and a final report will be submitted to NMFS. If any parts or whole turtles are taken incidental to the project the appropriate NMFS personnel will be notified within 24 hours.

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DEPARTMENT OF THE **ARMY**
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REPl. Y TO
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February 13 1995

Environmental Analysis Branch
Special Projects Section

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Dear Mr. Montzaris,

This is in reference to your letter of November 10, 1994 concerning the New York District Army Corps of Engineers' (NYD) biological assessment of endangered sea turtles. As was reiterated in your letter, the blological assessment was initiated specifically for the East Rockaway beach nourishment project. The report also contained a comprehensive review of historical and current ecological data on sea turtles in marine waters under the jurisdiction of the NYD as well as a general assessment of impacts and monitoring activities along the Atlantic coast. Both agencies agreed to this approach because the number of consultations potentially required by future projects made the comprehensive "generic" approach the most expedient method of completing each agency's tasks. The purpose of the generic format of the biolo9ical assessment was to provide an accurate scientific foundatlon of sea turtle information applicable to similar beach nourishment and inlet projects throughout the district.

The rendering of a broad biological opinion was to have provided a means for establishing protection to other, on- going projects for which a determination is still needed. According to your (NMFS) letter of June 1, 1993 "without a formal biological opinion in place for these (East Rockaway, West Hampton etc.) and other similar beach nourishment projects the Corps of Engineers is not protected from Endangered Species Act section 9 prohibitions on taking endangered species".

The biological opinion was to have prevented time consuming, repetitious consultations for these and future projects. The NYD must stress the fact that the projected biological opinion was never intended to replace all future consultations.. Instead, by providing" a thorough review and assessment of dredging and beach nourishment impacts, future consultations could be conducted in a more expeditious manner. By laying out and coming to agreement on the need for protective measures and monitoring plans and what they entail, future projects could benefit from already established protocol and greatly reduce review times and negotiation between our agencies.

As the future projects evolved to the point where plans were available those would be transmitted to your agency and a 9Uick determination made regarding how well they fit into the "generic" characterization. For those projects similar to the generic model described in the biological assessment (and we believe that most projects will fall into this category) the appropriate monitoring and related protective measures would be suitable. The ensuing consultation would be brief, essentially referring to the biological assessment's conclusions and the recommendations already established in the biological opinion.

Since the completion of the biological assessment (October 1993) Mr. Howard Ruben made numerous attempts (by phone, through written correspondence and by initiating informal conversations) to assess the status of the NYD's biological opinion. Contrary to the gist of your letter Mr. Ruben had received information on several occasions from various NMFS staff members that the rendering of a biological opinion was imminent, and would be sent to the district upon its completion. When the biological opinion was not forthcoming he was informed that the substantial delays were due to personnel changes and internal review, and not to an incomplete biological assessment.

During the 16 August 1994 meeting held at Corps headquarters in Washington D.C. Mr. Ruben met informally with NMFS personnel. The topic of additional information from the NYD was discussed at that time. Mr. Ruben requested that he be sent the specifics in writing. They were first received in your letter dated 10 November. The questions are addressed in our attached response (enclosures 1 and 2). It must be emphasized that some projects are too early in their planning stage to provide all the detailed answers (quantities dredged at which locations etc.) you are requesting. When this data becomes available it will be supplied to you within the general design memorandums that are routinely sent to you as the first step of inter-agency coordination. Prior to November 10, 1994 this information was supplied for all NYD beach nourishment projects for which these measurements were known.

Another subject that was discussed at the meeting in Washington was the necessity of standardizing and defining the requirements of the "NMFS" qualified" observer program. With so many ongoing and future projects in the NYD that could require observers, this program is a genuine concern. As Planning Coordinator for sea turtles Mr. Ruben made a personal request to members of your staff to be kept abreast of the changes/progress in the program, especially in regards to the subject matter and status of the proposed observer manual.

We are not expecting your agency to provide us with a blanket biological opinion covering all planned or proposed beach nourishment projects within the District. We do expect that the biological assessment prepared by Mr. Ruben will be sufficient in breadth and scope to facilitate the consultation process for all future projects that fall within its parameters, namely beach nourishment projects along the south shore of L.I. and the northern portion of the N. J. coast, Sand¥ Hook to Manasquan. Again, as each project is evaluated With respect to the generic model, conclusions, assessments and recommendations will reflect those agreements already established between the biological assessment and the biological opinion and the consultation process should not require detailed analysis nor extensive review times.

The comprehensive nature of the NY district's biological assessment describes in detail what is known of the relationships between sea turtles and the biological and physical characteristics of the habitats they frequent in the district's marine waters. This information was compiled using the best and most recent available information. This includes analysis of these relationships with specific types of areas common to the majority of on-going and proposed projects.

Although the NY district's biological assessment was written to characterize beach nourishment projects, much of the information within the document may be applicable to other types of dredging projects occurring in similar habitats. These however, would have to be determined on a case-by-case basis with the biological assessment used as a starting point to summarize turtle usage and behavior. It may not be as appropriate a model for predicting impacts and protective measures for these other projects.

The NY district believes that the probability of impacts to sea turtles from hopper dredges will be limited to predictable very specific habitats such as shallow embayments. The probability of impacting sea turtles within the NY District (ocean) borrow sites is expected to be very low and is supported by several seasons of monitoring without incidence. It is also the contention of the NY district that the ecology (habitats, behavior and numbers) of these turtles in NY district marine waters is significantly different than sea turtles in the south east Atlantic. The threat of entrainment of sea turtles by hopper dredges in specific southern shipping channels should not be applied to the NY district's jurisdiction. Mr. Ruben has had several discussions with members of your staff, and there was agreement for the need to recognize each region of the north east (New England, New York, Delaware) as a unique situation. The NY District believes that continued vigilant monitoring and mitigation without evidence of impacts to sea turtles should lead to a greatly reduced monitoring schedule and eventual eliminat1on of monitors should impacts be nonexistent.

According to your letter of 10 November 1994, the East Rockaway (turtle) issue was resolved in a letter dated 24 November 1993. Neither Plan Formulation Branch nor the Environmental Assessment branch has a record of this document and they would li,ke to request a copy for their files.

Should you have any questions concerning this reply or require additional information please call Mr. Ruben at 212- 264-1275.

Sincerely,

Stuart Piken, P.E.
Chief, Planning Division

Enclosures
(3)

Enclosure 1

1. The types of projects that the biological assessment will cover include beach nourishment borrow sites (Atlantic Ocean) and large federally maintained inlets with coarse sand bottoms.

2. Approximate quantities of sand to be dredged for on-going and future projects (where it is known) are provided below (enclosure 2). As plans are developed or modified information will be sent to you as it becomes available.

For purposes of analysis of potential impacts and improving the NY district's ability to provide accurate future environmental assessments, staff biologists would like to know the nature of the relationship between the quantity of material dredged and potential impacts to turtle.

3. Beach nourishment material requires that it be 90% or greater suitable sand. The physical attributes of these sediments is such that it effectively eliminates potential problems associated with contamination. Most contaminants of concern are strongly associated with the organic components of the sediment. Beach nourishment sand and the heavily scoured sediments of the inlets have very low levels of organics. Likewise re-suspension will be short term and not widespread. These subjects were covered in the biological assessment pages 17-19.

Potential borrow areas are tested (pre-construction) for contamination and sampled for benthic populations, to ensure that no critically productive, or contaminated areas will be disturbed. Borrow sites typically have little structure (cover) and few prey items during the height of the turtle season.

4. A typical dredge site (as described above) would be similar to that described for East Rockaway in the original biological assessment.

5. Designated and potential borrow site locations are supplied as part of the initial coordination procedures. The locations of known borrow sites and their corresponding projects have been supplied with the associated cubic yardage.

6. The numbers of projects, the inherent difficulties and dangers of working offshore during the winter, and the (lack of) availability of dredging contractors during the colder months make it unlikely that the dredging required for these projects can consistently avoid the seasonal window of June through November.

working offshore during the winter, and the availability of dredging contractors during the colder months make it unlikely that the dredging required for these projects can avoid, the seasonal window of June through November.

7. It is the NY district's understanding through conversations with Doug Beach (3/3/94), and Colleen Coogan (8/8/94) as well as written documentation (Richard Roe, 6/1/93) that only projects requiring hopper dredges have been implicated in turtle impacts. Thus the NY district assumes that the use of a hopper dredge is the defining criteria for consultation with NMFS concerning turtles.

8. Mitigation measures which the NY district may utilize can include but are not limited to the following: More detailed studies of the borrow areas during the pre- construction phase to minimize the possibility of any impact to turtles; Application of the new (excluder) draghead; When possible adherence to avoidance windows; The use of on-board observers and inflow screening.

Enclosure 3

Beach Nourishment Parameters
And Maps

PROJECT	Long Beach 1998	W. Hampton 1996	Rockaway 199	Sea Bright 1995	Asbury 1996
INITIAL NOURISHMENT	**8.6M cy**	**4.5M cy**	3M cy	16M cy	1M cy
CYCLE TIME	5 yrs	3 yrs	3 yrs	6 yrs	6 yrs
RE- NOURISMENT	**2.1M cy**	1.2M cy	1.8 M cy	3.5M cy	2.6M cy

** Duration of initial nourishment is dependent on many factors. Once contracts are finalized specific sites and quantities to be dredged can be estimated. However, duration (# seasons) will be dependent on when initial dredging actually begins (May/August etc.). During an effective dredging season about 4M cubic yards can be pumped.

Potential Beach Nourishment Projects

1. Fire Island Interim Beach Contigency Plan. Slated to begin in 1998. General location of borrow sites have been designated. Quantity to be dredged unkown at this time.
2. West Shinnecock. Slated to Slated to begin 1999. Same as above.
3. West of Morriches. Slated to begin 1999. Same as above.

Inlet Dredging Schedules. These quantities were calculated for annual dredging needs. However due to differing conditions year to year at each individual inlet, these amounts are not necessarily removed annually and are probably worse case scenarios. Due to other endangered species regulations, inlets are dregded only during winter (and are relatively short term).

1. Rockaway 60k cy/yr
2. East Rockaway 180k cy/yr Jones
3. 250k-500k cy for 1996 Fire
4. Island 250k-1M cy/yr
5. Shinnecock 250k cy/yr

Enclosure 2

Beach Nourishment Parameters

And Maps

PROJECT	Long Beach 1998	W. Hampton 1996	Rockaway ?	Sea Bright 1995	Asbury 1996
INITIAL NOURISHMENT	8.6M cy	4.5M cy	3M cy	16M cy	1M cy
CYCLE **TIME**	5 yrs	3 yrs	3 yrs	6 yrs	6 yrs
RE-NOURISMENT	**2.1M cy**	**102M cy**	**1.8** M cy	3.5M cy	2.6M cy

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