

## **Bogue Inlet Channel Erosion Response Project Draft Environmental Impact Statement**

Compatibility with Project Objectives. The inlet fill material would improve the recreational opportunities associated with the town's ocean shoreline while the restoration of the inlet shoreline access would offer a wide range of recreational outlets for visitors to Emerald Isle.

### **5.13 NAVIGATION**

Alternatives A, B, and C would have the same impacts on navigation as described below.

Direct and Indirect Impacts. Alternatives A, B, and C would not have any impact on existing navigation conditions in Bogue Inlet. Under these alternatives, the USACE Navigation Branch would continue to maintain the inlet bar channel using U.S. Government sidecast dredges and possibly a mini-hopper dredge. The USACE Navigation Branch removed an average of 151,500 cubic yards from the channel each year between 1984 and 1999 at an average cost of \$432,000/year. Recently, the dredging amounts and associated costs have increased dramatically with an average of 514,200 cubic yards/year being removed from the channel between 2000 and 2002 at an average cost of \$1,132,000/year. In spite of this rather substantial dredging effort, controlling depths in the channel remain shallower than the authorized depth of 8 feet below mean low water (MLW). This has had a major impact on commercial boating and fishing activity in Bogue Inlet. The rapidly shifting channel requires frequent shifting of the navigation aids by the U.S. Coast Guard. Due to the time required to move the navigation aids, the deepwater channel is often located outside the marked channel corridor requiring local knowledge by the most experienced captain and user of the inlet to be able to navigate the inlet safely.

Cumulative Effects. Controlling depths in Bogue Inlet will continue to be shallower than the authorized depth of 8 feet below MLW and the channel will continue to shift locations making it unreliable for commercial fishing interest operating out of Swansboro and other nearby ports. The variability of the channel depth and location will also have a continuing negative effect on the recreational use of the inlet.

Compatibility with Project Objectives. None of the goals and objectives for the project address problems and needs associated with navigation in and through Bogue Inlet. However, any action taken to respond to erosion of the Emerald Isle inlet shoreline should not negatively impact navigation in the inlet. Since Alternatives A, B, and C do not involve any changes in the current operation of the inlet by the USACE Navigation Branch, Alternatives A, B, and C would not affect navigation either positively or negatively.

Alternative E – Channel Relocation without Beach Nourishment

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Direct and Indirect Impacts. The dimensions of the centrally located channel, which would have a depth of 13.5 feet below NGVD (15 feet below MLW) and a maximum width of 500 feet across a large portion of the ebb tide delta, would greatly exceed the authorized dimensions of the navigation channel. As a result, the new channel would provide a relatively deep channel for some period of time following its construction. However, even this positive impact is expected to be relatively short lived as estimates of shoaling of the new channel for the case in which the existing channel is artificially filled indicates that controlling depths will again approach 8 feet MLW within 9.5 months after construction. On the positive side, the USACE Navigation Branch could suspend maintenance dredging in the inlet during the channel construction period and for the 9 to 10 months following completion of the channel. Based on recent dredging costs in Bogue Inlet, this could save the USACE Navigation Branch approximately \$1.0 million.

Navigation in the inlet would be impacted for a brief period during the construction of the new channel primarily during the time the sand dike is being constructed across the existing channel. Construction of the sand dike is expected to take less than 10 days, however, once the new channel is completed, new navigation aids would have to be installed along the new channel alignment. The total amount of time Bogue Inlet would likely be closed to navigation would be approximately 30 days. Since construction of the new channel is scheduled for November 2004 to March 2005, closure of the inlet to navigation would occur during a period when navigation activity in the inlet is normally low.

Cumulative Effects. After about 9 to 10 months following the relocation of the inlet channel, maintenance dredging by the USACE Navigation Branch would resume. With the resumption of the normal maintenance activities, future channel conditions would not differ substantially from past conditions, i.e., controlling depths will continue to be less than 8 feet MLW most of the time and the position of the channel would continue to change.

Compatibility with Project Objectives. The channel relocation would negatively impact navigation in Bogue Inlet for approximately 30 days during the winter or early spring. Following this brief interruption, navigation through the inlet would return to normal and could actually be improved for 9 to 10 months after completion of the new channel.

### **Alternative F – Channel Relocation with Beach Nourishment**

Direct and Indirect Impacts. The dimensions of the new channel would be the same as under Alternative E, however, since the existing channel would not be completely closed, the existing channel would capture some of the littoral material moving into the inlet from Emerald Isle. This would slow the rate of shoaling of the

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new channel, increasing the period of time in which controlling depths remain at or below 8 feet MLW to around 12 months following completion of the new channel. The suspension of maintenance dredging by the USACE Navigation Branch during the channel construction period and for 12 months following channel completion could save the USACE over \$1.4 million in dredging costs.

Alternative F also involves the construction of a sand dike across the existing channel which, like Alternative E, would close the channel to navigation for a total period of about 30 days. Again, this closure would occur in the winter or early spring and would not impact commercial and recreational boating interests who normally use the inlet.

Cumulative Effects. The new channel should maintain depths equal to or greater than 8 feet MLW for at least 12 months following construction after which normal maintenance dredging by the USACE Navigation Branch would resume. Accordingly, there would not be any long lasting impacts of the project on navigation.

Compatibility with Project Objectives. The channel relocation would negatively impact navigation in Bogue Inlet for approximately 30 days during the winter or early spring. Following this brief interruption, navigation through the inlet would return to normal and could actually be improved for 12 months after completion of the new channel.

#### **5.14 HISTORIC PROPERTIES AND CULTURAL RESOURCES**

Cultural resources investigations of Bogue Inlet include magnetometer and side-scan sonar surveys. Three magnetic anomalies were detected, one on the east side of the existing channel at a point approximately 1,600 feet north of Inlet Drive, or in the general vicinity of the sand dike proposed for Alternatives E and F, and two in the central portions of the ebb tide delta in the area of the proposed channel under Alternatives E and F. The only anomaly thought to be of historic significance was located near the proposed dike. Since this area will be filled, no impact on the potential historic artifact would occur. The two anomalies in the channel area were relatively small and believed to be modern debris such as a crab trap, anchor, or pipe and are not historically significant. The study concluded that no further investigations are needed. A copy of these investigations (Appendix H) was sent to the USACE, Wilmington District office on July 25, 2003 for distribution to the State Historic Preservation Officer for review.

Alternatives A, B, and C would have the same impact on historic properties and cultural resources as described below.

Direct and Indirect Impacts. No direct or indirect impacts to historic properties or

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cultural resources are expected from implementation of Alternatives A, B, and C. An anomaly of potential historic origin is located within the current navigational channel of Bogue Inlet. If channel migration to the east persists, maintenance dredging by the USACE Navigation Branch could possibly unearth or damage the object, but this seems highly unlikely. Cultural resource investigations have been conducted on the offshore borrow sites identified for use in the Phase 3 beach nourishment and no impact to submerged cultural is expected to result from the use of the borrow sites.

Cumulative Effects. In the event that the object identified within the existing channel is unearthed by the USACE Navigation Branch channel maintenance activities, there would be a cumulative effect in the loss or damage of cultural or historically significant resources.

Compatibility with Project Objectives. Alternatives A, B, and C are not compatible with the project objectives.

Alternatives E and F would have the same impact on historic properties and cultural resources as described below.

Direct and Indirect Impacts. No direct or indirect impacts to historic properties or cultural resources are expected from implementation of the channel relocation without beach nourishment alternative. The only anomaly thought to be of potential historic significance in the project area is located near the proposed dike. Since this area will be filled, no direct or indirect impact on historic resources will result other than burial of the object which may have been exposed as a result of channel migration, or is of recent origin and not culturally or historically significant. Cultural resource investigations have been conducted on the offshore borrow sites identified for use in the Phase 3 beach nourishment and no impact to submerged cultural is expected to result from the use of the borrow sites.

Cumulative Effects. None.

Compatibility with Project Objectives. Alternative E is compatible with the project objectives, but does not provide for the use of the high quality inlet material to be used for nourishment of the Phase 3 project shoreline. Alternative F is compatible with all project objectives.

## **5.15 SOCIO-ECONOMIC**

### **Alternative A – No Action**

Direct and Indirect Impacts. Under the no action alternative, losses in revenue to Emerald Isle and Carteret County will occur due to the immediate loss of seven

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threatened homes and land along western Emerald Isle. The tax value of real property located within the area that would be impacted by continued inlet shoreline erosion over the 10-year period totals almost \$11.0 million. Households displaced by the inlet erosion would have a direct impact on the economy of the area due to reduced spending. A summary of the economic impact of Alternative A is provided in Section 5.23.

Cumulative Effects. Nourishment of the beach along Emerald Isle using offshore borrow sites should provide a reduction in impacts from hurricanes and storms within the project area. However, if erosion of the Emerald Isle inlet shoreline is allowed to continue, additional structures, including roads and utilities, may be threatened and there will be incidental repercussions to tourism and the local economy. The loss of tax revenue and household spending would accumulate over a period of at least 10 years or as long as the inlet shoreline continued to migrate to the east.

Compatibility with Project Objectives. This alternative does not support the project objectives.

### **Alternative B – Without Project – Relocate Homes**

Direct and Indirect Impacts. Under this alternative, the tax revenue for the relocated structures would be preserved, however, the overall tax base for Emerald Isle and Carteret County would be reduced with the loss of the abandoned lots in the Pointe subdivision. The continued erosion of the Emerald Isle inlet shoreline may affect roads and utilities in the area, which would lead to incidental repercussions to the local economy. A summary of the economic impact of Alternative B is provided in Section 5.23.

Cumulative Effects. If erosion is allowed to continue, the cumulative effects for the relocate homes alternative will include the cumulative effect of lost tax revenue for lots lost or abandoned in the Pointe subdivision.

Compatibility with Project Objectives. This alternative does not support the project objectives.

### **Alternative C – Without Project - Sand Bag Revetments**

Direct and Indirect Impacts. Sand bag revetments would only provide temporary protection from the erosion occurring on the western edge of The Pointe. Since the sandbags are only permitted for a limited amount of time, erosion of the Pointe would continue but at a reduced rate. The erosion would result in the permanent loss of the tax value of structures and lots as well as result in a reduction of household spending. A summary of the economic impact of Alternative C is

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provided in Section 5.23.

Cumulative Effects. State rules only allow sand bags protecting homes to be in place for a period of two years and those protecting roads to be in place for five. Installation of sand bags would slow the rate of inlet shoreline erosion to the east but eventually homes, roads, and utilities would be lost by continued erosion. Loss of these structures would result in losses in revenue to Emerald Isle and Carteret County and could possibly negatively affect tourism to the area. Nourishment of Emerald beach would still occur under this alternative, therefore, the cumulative effects concerning nourishment will be comparable to those listed for the no action alternative.

Compatibility with Project Objectives. This alternative does not support the project objectives.

**Alternative E – Channel Relocation without Beach Nourishment**

Direct and Indirect Impacts. The relocation of the channel and filling of the existing channel will eliminate the immediate erosion threat to structures and infrastructure in the Pointe subdivision for at least 15 years and possibly 35 years depending on the stability of the relocated channel. This would preserve the tax base of Emerald Isle and Carteret County and would maintain household spending. Since Alternative E would deplete the funds presently available for nourishing Phase 3 of the beach nourishment project, the Town of Emerald Isle would probably have to delay construction of Phase 3 for 2 years while it develops the financial capability to accomplish the work. A summary of the economic impact of Alternative E is provided in Section 5.23.

Cumulative Effects. The channel relocation should provide long-term protection of 31 to 51 homes and Town infrastructure over the next ten years by reducing erosion rates along The Pointe shoreline. Protection of these structures will maintain the Town's tax base. The eventual construction of Phase 3 would provide an improved recreational beach and an increased level of storm damage protection.

Compatibility with Project Objectives. This alternative is compatible with the project objectives.

**Alternative F – Channel Relocation with Beach Nourishment**

Direct and Indirect Impacts. The relocation of the channel will eliminate the immediate erosion threat to structures and infrastructure in the Pointe subdivision for at least 15 years and possibly 35 years depending on the stability of the relocated channel. This would preserve the tax base of Emerald Isle and Carteret

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County and would maintain household spending. Alternative F would allow the Town of Emerald Isle to immediately complete the construction of the Phase 3 beach fill without having to arrange for additional financing. A summary of the economic impact of Alternative F is provided in Section 5.23.

Cumulative Effects. Effects on the Pointe subdivision are anticipated to be the same as the cumulative effects described for the channel relocation without beach nourishment alternative. The Town of Emerald Isle would not have to arrange additional financing to accomplish Phase 3 of its nourishment project.

Compatibility with Project Objectives. This alternative is completely compatible with the project objectives.

### 5.16 LAND USE

Alternatives A, B, and C would have similar impacts on land use as described below.

Direct and Indirect Impacts. Erosion of the inlet shoreline over the next 10 years would affect land use within the Town of Emerald Isle in general and the Pointe subdivision specifically. Once properties are lost to erosion, the land use opportunities associated with those areas will change to reflect the owner's inability to develop them for residential use. Further development or reclamation of the property will likely be limited or prohibited by local, state, and Federal regulations.

Cumulative Effects. The cumulative effects will result in the loss of residential and public recreational land uses within the Town of Emerald Isle. The economics and related impacts from implementation of the no action alternative are addressed in Section 5.23.

Compatibility with Project Objectives. Alternatives A, B, and C do not support the project objectives.

Alternatives E and F will have similar impacts on land use as described below.

Direct and Indirect Impacts. Channel relocation without beach nourishment will result in an increase in recreational opportunities and a preservation of the at risk homes by altering the erosion patterns currently impacting the eastern shoreline of Bogue Inlet. Upon completion of the sand dike and infilling of the existing channel either directly under Alternative E or indirectly under Alternative E, additional recreational land uses will be available to the residents and visitors of Emerald Isle.

Ownership of any new land that accretes on the west end of Emerald Isle would

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revert to the adjacent upland property owners according to an Advisory Opinion rendered by NC Attorney General's office.

Cumulative Effects. Under both Alternative E and F, a considerable amount of new land is expected to accrete off the west end of Emerald Isle. Ownership of this new land would vest with the adjacent upland property owners. The State of North Carolina owns a portion of the existing Emerald Isle sand spit, so any land that accretes to that section of the spit would revert to the State. Land that accretes to other areas, particularly around Bogue Court and Inlet Drive, would become the property of the individual owners.

Compatibility with Project Objectives. Alternatives E and E are compatible with the project objectives as they relate to land use.

## **5.17 HYDRODYNAMICS**

### **5.17.1 Tides and Tidal Flow**

Alternatives A, B, and C would not have any significant direct, indirect, or cumulative impacts on existing tides and tidal flow in Bogue Inlet.

Alternatives E and F would have the same impacts on tides and tidal flow as described below.

Direct and Indirect Impacts. Construction of the new channel and closure of the existing channel with the construction of the sand dike could briefly impact flows in Bogue Inlet during the adjustment period of the new channel. Model tests conducted for the channel relocation alternatives (see Appendix B) indicated a 17% reduction in tidal flow through the inlet immediately following channel construction and closure of the existing channel. Over a relative short period of time (perhaps 4 to 6 weeks) the new channel will undergo scour as it adjust to the new flow regime. The scour of the new channel will restore the cross-sectional area of Bogue Inlet to its equilibrium value resulting in a return of the normal tidal exchange or tidal prism of the inlet.

Cumulative Effects. Following the 4 to 6 week adjustment period, the new channel will take on natural characteristics and tidal flow through Bogue Inlet will return to normal. The resumption of the normal tidal exchange would maintain existing tide levels and tide ranges in the sound.

Compatibility with Project Objectives. The tides and associated tidal flow through Bogue Inlet would return to normal following a brief period of adjustment and would serve to maintain the habitat of the inlet adjacent sound areas.

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**5.17.2 Waves**

Alternatives A, B, and C would have similar impacts on waves as described below.

Direct and Indirect Impacts. The eastward migration of the inlet channel would continue to push the east side of the inlet's ebb tide delta toward Emerald Isle with the resulting wave refraction patterns around the east portion of the ebb tide delta contributing to the continued accretion of the ocean shoreline along the west end of Emerald Isle. Some of the positive impacts along the ocean shoreline would be offset as the eastward migration of the channel would eventually begin to impact properties along the ocean front.

Cumulative Effects. The eastward migration of the inlet channel and the associated eastward movement of the ebb tide delta would result in the inlet impacting sections of Emerald Isle farther to the east as wave refract and diffract around the ebb tide delta. The zone of influence of the wave refraction patterns around the ebb tide delta directly impacts approximately 3,000 feet of shoreline immediately east of Bogue Inlet with secondary impacts, in the form of accretion, reaching 7,500 feet east of the inlet.

Compatibility with Project Objectives. The wave refraction pattern around the existing ebb tide delta has resulted in the formation of the distinct bulge in the shoreline immediately east of the inlet. This bulge will migrate east as the inlet channel continues to migrate to the east. While the impacts would be positive for the sections of the shoreline within the direct wave shadow zone of the delta and for some distance east of the shadow zone, the erosion associated with the eastward movement of the channel would begin to directly impact properties located along the ocean shoreline. This would have a negative impact on the town and county tax bases.

Alternatives E and F would have similar impacts on waves as described below.

Direct and Indirect Impacts. The relocation of the inlet channel would result in a restructuring of the ebb tide delta of the inlet with the east side of the delta shifting approximately 3,000 to 3,500 feet to the west. This would move the impacts of wave refraction around the ebb tide delta a comparable distance to the west exposing the west end of Emerald Isle to the direct wave attack. The 3,000-foot to 3,500-foot westward shift of the delta would position the west side of the ebb tide delta immediately off the east end of Bear Island and should result in wave sheltering along that section of the island. The accompanying wave refraction pattern around the newly positioned ebb tide delta will eventually cause the development of a shoreline bulge comparable to that presently existing on the west end of Emerald Isle. The wave refraction pattern around the ebb tide delta on the Bear Island side will provide some wave sheltering immediately to the west of the

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delta which will contribute to the accretion of the shoreline on the east end of Bear Island.

Cumulative Effects. The new channel is expected to maintain a certain degree of stability for at least 15 and perhaps 35 years. As long as the ebb tide delta and the associated wave refraction patterns remain in this location, the east end of Bear Island will be positively impacted by the reduction in exposure to direct wave attack.

Compatibility with Project Objectives. The development on the west end of Emerald Isle would eventually be exposed to direct wave attack as the ebb tide delta adjusts to the new channel location. The wave exposure could increase the risk of damage to ocean front structures during severe storms. However, the width of beach and size of dunes that would remain on the west end of Emerald Isle following the channel relocation appear to provide a higher degree of protection than that which presently exists along most sections of Emerald Isle (see Appendix B).

### 5.17.3 Littoral Transport

Alternatives A, B, and C would have similar impacts on littoral transport as described below.

Direct and Indirect Impacts. Littoral transport on the west end of Emerald Isle east of the influence of Bogue Inlet is predominantly to the west with the net transport averaging 272,000 cubic yards/year to the west. The gross rate of transport, i.e., the sum of material moving to the east and west, averages 863,000 cubic yards/year. In the area immediately east of Bogue Inlet that is influenced by the inlet's ebb tide delta, the net rate of sediment transport appears to be near zero as evidenced by the relative stability of that section of the shoreline (see Appendix B).

Under Alternatives A, B, and C, Phase 3 of the permitted Emerald Isle beach nourishment project would be nourished with material obtained from an offshore borrow area. The design template for the beach fill would add a net of approximately 35 cubic yards of fill material per foot of shoreline. This should increase the width of the dry beach approximately 80 feet immediately following construction with the net increase in dry beach adjusting to around 40 feet within a few months following placement. The main fill for Phase 3 would end approximately 6,500 feet east of Bogue Inlet while the 2,000-foot western taper section would extend the fill to within 4,500 feet of the inlet. The west end of the Phase 3 fill including the taper section would be located in an area where the width of the existing beach is relatively wide and net sediment transport rates are near zero as a result of the wave refraction patterns around the existing ebb tide delta. Consequently, sediment transport off the west end of the fill should not differ

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significantly from the existing rates in the area and would therefore not have any impact on shoaling in Bogue Inlet.

Cumulative Effects. Alternatives A, B, and C would not impact the future rates of littoral transport rates except in those areas influenced by the eastward migrating ebb tide delta.

Compatibility with Project Objectives. The littoral transport regime in the vicinity of Bogue Inlet would remain unchanged and would therefore not have any impact, positive or negative, on project goal and objectives.

**Alternative E – Channel Relocation without Beach Nourishment**

Direct and Indirect Impacts. The movement of the inlet channel and concomitant reformulation of the inlet's ebb tide delta to the west would result in net sediment transport rates along the west end of Emerald Isle increasing from its present value estimated to be close to zero to a rate comparable to the net rate applicable for the shoreline east of the influence of the inlet, i.e., a rate approaching 272,000 cubic yards/year to the west. This increase in the net rate of transport would occur over a period of 8 to 10 years as the ebb tide delta of Bogue Inlet and the shoreline on the west end of Emerald Isle adjust to the new channel position. The adjustment of the shoreline will result in the erosion of approximately 565,000 cubic yards from the shoreline west of Spinnaker's Reach to Bogue Inlet.

The main portion of the Phase 3 fill and the 2,000-foot taper section would extend into the east portion of the 7,500-foot shoreline segment predicted to be impacted by the relocated channel and would add approximately 70,000 cubic yards of fill material to the shoreline impact area. The relatively small increase in beach width associated with the Phase 3 fill combined with the 2,000-foot taper section will not have a significant impact on net sediment transport rates off the west end of the fill. Over the 8 to 10 year shoreline adjustment period, net sediment transport near the west end of the Phase 3 fill will gradually increase from near 0 to 272,000 cubic yards/year. The sediment eroded off the west end of Emerald Isle, including the Phase 3 fill, and the material transported landward from the abandoned portion of the Bogue Inlet ebb tide delta will be transported into Bogue Inlet and will contribute to the development of the sand spit off the west end of Emerald Isle as well as contribute to shoaling of the relocated channel. Since the existing channel will be filled under Alternative E, the rate of spit development will be relatively rapid with the spit expected to merge with the sand dike within 2 years of the channel relocation. The direct filling of the existing channel will also contribute to higher rates of shoaling in the relocated channel with controlling depths in the new channel decreasing to around 8 feet below MLW within 9 to 10 months after construction

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On Bear Island, sediment transport to the east along the east end of the island should decrease in response to the new location of the inlet ebb tide delta and associated shoreline bulge that would form immediately west of the inlet. The reduction in east transport would retain sediment along the ocean shoreline contributing to the eventual accretion of the east portion of the island.

Cumulative Effects. Near the end of the 8 to 10 year shoreline adjustment period, sediment transport along the west end of Emerald Isle, from the west terminus of the Phase 3 fill to Bogue Inlet should be rather uniform averaging around 272,000 cubic yards/year. This would result in the shorelines closer to the inlet behaving in a manner similar to the shorelines located farther to the east. As a result, shoreline changes close to the inlet should moderate with annual recession rates approaching 1 to 2 feet per year.

Sediment transport from Bear Island into Bogue Inlet would be reduced with the sediment being retained along the ocean shoreline. The retention of this sediment on the ocean shoreline will eventually result in Bear Island accreting close to 500 feet near Bogue Inlet to around 100 feet 7,500 feet west of the inlet (see Appendix B).

Compatibility with Project Objectives. The movement of the abandoned ebb tide delta material and the accumulated littoral material on the west end of Emerald Isle into Bogue Inlet would serve to enhance the development of the new sand spit off the west end of Emerald Isle. This would result in the restoration of the inlet habit to a condition comparable to that which existed in the late 1970's to early 1980's.

**Alternative F – Channel Relocation with Beach Nourishment**

Direct and Indirect Impacts. Changes in littoral transport on the west end of Emerald Isle would be essentially the same as that described for Alternative E. Since the inlet material would be used to nourish Phase 3 of the permitted Emerald Isle beach nourishment project, residual currents in the existing channel could result in the onshore movement of material from the abandoned ebb tide delta taking slightly longer than Alternative E; however, the sand dike is expected to effectively reduce the flow in the existing channel to near zero so the onshore movement of the ebb tide delta material should still occur in a time frame comparable to Alternative E. The width of the Phase 3 fill will be slightly less than the width of the fill under Alternative E, however, the narrower width will not result in any significant differences in sediment transport off the west end of the fill compared to Alternative E. Material moving off the west end of Emerald Isle and onshore from the abandoned portion of the ebb tide delta will deposit in the existing channel in the form of a recurved sand spit that will eventually merge with the sand dike. The time required for the sand spit to merge with the sand dike would be 4 to 6 years. Also, since some of the material moving off the west end of Emerald Isle

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would be intercepted by the existing channel, shoaling rates in the new channel would be slightly less until the existing channel is completely filled. The time required for controlling depths to reach 8 feet MLW would be 12 months compared to the 9 to 10 months for Alternative E.

Cumulative Effects. Near the end of the 8 to 10 year shoreline adjustment period, sediment transport along the west end of Emerald Isle, from the west terminus of the Phase 3 fill to Bogue Inlet should be rather uniform averaging around 272,000 cubic yards/year. This would result in the shorelines closer to the inlet behaving in a manner similar to the shorelines located farther to the east. As a result, shoreline changes close to the inlet should moderate with annual recession rates approaching 1 to 2 feet per year.

Sediment transport from Bear Island into Bogue Inlet would be reduced with the sediment being retained along the ocean shoreline. The retention of this sediment on the ocean shoreline will eventually result in Bear Island accreting close to 500 feet near Bogue Inlet to around 100 feet 7,500 feet west of the inlet.

Compatibility with Project Objectives. The movement of the abandoned ebb tide delta material and the accumulated littoral material on the west end of Emerald Isle into Bogue Inlet would serve to enhance the development of the new sand spit off the west end of Emerald Isle. This would result in the restoration of the inlet habit to a condition comparable to that which existed in the late 1970's to early 1980's.

### **5.18 INFRASTRUCTURE**

Alternatives A and B would have the same impacts on infrastructure as described below.

Direct and Indirect Impacts. Erosion of the inlet shoreline over the next 10 years would affect the infrastructure that serves the Pointe subdivision. Once a portion of a utility service line or road is threatened, the Town of Emerald Isle would have to disconnect and reroute service lines and modify traffic and access to alternate routes to serve remaining properties. Since the migration of the inlet shoreline would be progressive, the Town would have to make numerous responses to emergencies affecting the infrastructure system over the next 10 years. Disconnecting and rerouting the utility service system and access provision would necessitate ongoing planning and response to loss of infrastructure in the western portion of the Town. The economic impact associated with the loss of infrastructure under Alternatives A and B is provided in Section 5.23.

Cumulative Effects. The uncontrolled eastward migration of the inlet shoreline over the next 10 years would continue to impact roads and utilities in the Pointe subdivision. A summary of the economic impact of the inlet shoreline erosion on

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infrastructure is provided in Section 5.23.

Compatibility with Project Objectives. Alternatives A and B are not compatible with the project objectives.

**Alternative C – Without Project - Sand Bag Revetments**

Direct and Indirect Impacts. Erosion of the inlet shoreline over the next 10 years would affect the infrastructure that serves the Pointe subdivision. Once a portion of a utility service line or road is threatened, the Town of Emerald Isle would have to disconnect and reroute service lines and modify traffic and access to alternate routes to serve remaining properties. Since the migration of the inlet shoreline would be progressive, the Town would have to make numerous responses to emergencies affecting the infrastructure system over the next 10 years, however, the number of responses should be reduced by the installation of the sandbag revetments. Disconnecting and rerouting the utility service system and access provision would necessitate ongoing planning and response to loss of infrastructure in the western portion of the Town. The economic impact associated with the loss of infrastructure under Alternative C is provided in Section 5.23.

Cumulative Effects. The eastward migration of the inlet shoreline over the next 10 years would continue to impact roads and utilities in the Pointe subdivision. A summary of the economic impact of the inlet shoreline erosion on infrastructure is provided in Section 5.23.

Compatibility with Project Objectives. The sand bag revetment alternative does not support the project objectives.

Alternatives E and F would have the same impact on infrastructure as described below.

Direct and Indirect Impacts. Relocation of the inlet channel will have immediate direct and indirect impacts on the infrastructure at the Pointe by altering the erosion trends of the inlet shoreline. Infrastructure in the area will be protected from impacts resulting from inlet shoreline loss.

Cumulative Effects. Cumulative effects associated with the channel relocation include the preservation of existing infrastructure in the area and elimination of the need to expend additional Town resources to address infrastructure loss at the Pointe.

Compatibility with Project Objectives. Alternatives E and F support the project objectives.

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**5.19 WATER COLUMN**

**5.19.1 Marine**

Alternatives A, B, and C would have the same impacts on the marine water column as described below.

Direct and Indirect Impacts. Alternatives A, B, and C would result in regular channel maintenance by the USACE Navigation Branch and the use of an offshore borrow area to complete the Phase 3 beach nourishment project. The potential effects to the marine water column from maintenance dredging include an increase in sedimentation during dredging, which stresses the growth and reproductive energies of benthic organisms, and an increase in turbidity, which reduces the penetration of light, required by photosynthetic organisms found in the water column. Maintenance dredging involves the discharge of dredged material into the open waters of Bogue Inlet. Thus, water quality within the water column would also be impacted by the discharge of sediment into the inlet, which could lead to a decrease in the quality of marine water column resources. Offshore dredging from a borrow site would also lead to increases in turbidity and sedimentation within the marine water column.

Cumulative Effects. Cumulative impacts on the marine water column may occur if sedimentation and turbidity levels are high or maintained for long periods of time, making the water column uninhabitable. Considering that the material relocated during maintenance dredging activities contains a low percentage of silt, long-term effects to the marine water column are not anticipated. Depending upon the characteristics of the offshore borrow site selected for use in the Phase 3 project, there may be an effect on the marine water column during project construction, but these effects are not expected to be cumulative.

Compatibility with Project Objectives. Alternatives A, B, and C do not support the project objectives to relocate the inlet channel to the center of the inlet complex or provide beach quality material for restoration of the ocean shoreline within the Phase 3 project area.

**Alternative E – Channel Relocation without Beach Nourishment**

Direct and Indirect Impacts. Dredging activities have been shown to increase turbidity within the marine water column. Increased turbidity can create stress to resident flora and fauna by blocking essential light. The sediments of Bogue Inlet have low silt percentages (1.25%) which should allow the project to be constructed without exceeding the State standard outside the immediate construction area. Thus, it is not expected that the channel relocation without beach nourishment project will cause excessive increases in turbidity in the area

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except in the immediate area of the sand dike during its construction and during the filling of the existing channel with the stockpiled material. Any turbidity increases will be within the state standards and short-lived. Therefore, any direct and indirect effects to the water column are expected to be temporary and minimal.

Cumulative Effects. Turbidity and sedimentation levels are not expected to exceed State standards except in the vicinity of the sand dike during its construction and during the filling of the existing channel with the stockpiled material. Therefore, no cumulative effects to the marine water column are expected from this alternative. Dredging from offshore borrow areas will likely occur with the channel relocation without beach nourishment alternative, and the cumulative effects should be similar to those listed for the no action alternative.

Within a period of 1 to 2 years following the channel relocation, maintenance dredging in the inlet channel would be resumed with the dredged material discharged in the open waters of Bogue Inlet.

Compatibility with Project Objectives. This alternative is compatible with most of the project objectives.

**Alternative F – Channel Relocation with Beach Nourishment**

Direct and Indirect Impacts. Turbidity levels are expected to increase during dredge operations, particularly in the vicinity of the sand dike, but are expected to quickly return to natural levels once the project has been completed. The small percentage of fines (1.25%) and fine to medium sized sand particles (0.27 mm) dredged from the new channel location will have a low suspension time and its effects on the marine water column within the area should be minimal. It is expected that any change in the marine water column will be temporary and minimal.

Cumulative Effects. Nourishment of the beach will be conducted using sediments dredged from the Inlet during the relocation of the channel. Dredged sediment will also be used to create a sand dike on the western edge of Emerald Isle. Deposition of sediment into the open waters of Bogue inlet therefore will be minimized as the dike is constructed. The quality of the marine water column should not experience any cumulative impacts.

Within a period of 1 to 2 years following the channel relocation, maintenance dredging in the inlet channel would be resumed with the dredged material discharged in the open waters of Bogue Inlet.

Compatibility with Project Objectives. This alternative is compatible with the project objectives.

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**5.19.2 Estuarine**

Alternatives A, B, and C would have the same impacts on the estuarine water column as described below.

Direct and Indirect Impacts. Alternatives A, B, and C would result in regular channel maintenance by the USACE Navigation Branch and the use of an offshore borrow area to complete the Phase 3 beach nourishment project. The potential effects to the estuarine water column from maintenance dredging include an increase in sedimentation during dredging, which stresses the growth and reproductive energies of benthic organisms, and an increase in turbidity, which reduces the penetration of sunlight required by photosynthetic organisms found in the water column. Maintenance dredging involves the discharge of dredged material into the open waters of Bogue Inlet. Thus, water quality within the water column would also be impacted by the discharge of sediment into the inlet, which could lead to a decrease in the quality of estuarine water column resources. The potential for significant negative impacts on the estuarine resources is relatively low due to the low suspension time and travel distances associated with suspended sediment in the inlet. Offshore dredging from a borrow site is not likely to lead to increases in turbidity and sedimentation within the estuarine water column.

Cumulative Effects. Cumulative impacts on the estuarine water column may occur if sedimentation and turbidity levels are high or maintained for long periods of time, making the water column uninhabitable. Considering that the material relocated during maintenance dredging activities contains a low percentage of silt, long-term effects to the estuarine water column are not anticipated. Depending upon the characteristics of the offshore borrow site selected for use in the Phase 3 project, there may be an effect on the estuarine water column during project construction, but these effects are not expected to be cumulative.

Compatibility with Project Objectives. Alternatives A, B, and C do not support the project objectives.

**Alternative E – Channel Relocation without Beach Nourishment**

Direct and Indirect Impacts. Dredging activities have been shown to increase turbidity within the estuarine water column. Increased turbidity can create stress to resident flora and fauna by blocking essential light. The sediments of Bogue Inlet have low silt percentages (1.25%) which should allow the project to be constructed without exceeding the State standard except in the vicinity of the sand dike and during the filling of the existing channel. Thus, it is not expected that the channel relocation without beach nourishment project will cause excessive increases in turbidity in the area. Any turbidity increases will be within the state

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standards and short-lived. Therefore, any direct and indirect effects to the water column are expected to be temporary and minimal.

Cumulative Effects. Turbidity and sedimentation levels are not expected to exceed State standards and therefore, no cumulative effects to the estuarine water column are expected from this alternative. Dredging from offshore borrow areas will likely occur with the channel relocation without beach nourishment alternative, and the cumulative effects should be similar to those listed for the no action alternative.

Compatibility with Project Objectives. This alternative is compatible with the project objectives.

**Alternative F – Channel Relocation with Beach Nourishment**

Direct and Indirect Impacts. Turbidity levels are expected to increase during dredge operations, particularly in the vicinity of the sand dike, but are expected to quickly return to natural levels once the project has been completed. The small percentage of fines (1.25%) and fine to medium sized sand particles (0.27 mm) dredged from the new channel location will have a low suspension time and its effects on the estuarine water column within the area should be minimal. It is expected that any change in the estuarine water column will be temporary and minimal.

Cumulative Effects. Nourishment of the beach will be conducted using sediments dredged from the Inlet during the relocation of the channel. Dredged sediment will also be used to create a sand dike on the western edge of Emerald Isle. Deposition of sediment into the open waters of Bogue inlet therefore will be minimized as the dike is constructed. The quality of the estuarine water column should not experience any cumulative impacts.

Compatibility with Project Objectives. This alternative is compatible with the project objectives as they relate to preservation of the estuarine water column resources.

## **5.20 URBAN QUALITY**

Alternatives A, B, and C would have similar impacts on urban quality as described below.

Direct and Indirect Impacts. Alternatives A, B, and C would lead to the continued erosion of western Emerald Isle and threatened homes and roads would be abandoned and demolished or relocated to other areas within the town limits of Emerald Isle. During those times when demolition or relocation activities are underway, the presence of construction equipment would temporarily detract from the aesthetics of the town.

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Cumulative Effects. Channel migration to the east and erosion of western Emerald Isle and Bogue Banks is expected to continue. Thus, Alternatives A, B, and C would lead to a reduction in storm protection, and continued loss of land along western Emerald Isle and Bogue Banks. Continued loss of land will lead to the destruction of multiple residences and infrastructure in the Pointe subdivision. Continued erosion along the Town's western boundary will result in a significant loss of land, property, and roads, which will negatively affect the urban quality of Emerald Isle.

Compatibility with Project Objectives. Alternatives A, B, and C do not support the project objectives.

### **Alternative E – Channel Relocation without Beach Nourishment**

Direct and Indirect Impacts. The presence of dredging equipment within the project area would temporarily detract from the aesthetics of the environment, thereby possibly temporarily affecting the visual aesthetics associated with urban quality in Emerald Isle. Relocation of the inlet channel will reverse the erosion conditions currently affecting the area, and result in accretion of additional supratidal land adjacent to the Pointe neighborhood. An increase in home values resulting from the accreted property will result in an increase urban quality on the western end of Emerald Isle.

Cumulative Effects. Relocation of the inlet channel would benefit residential property owners and the Town of Emerald Isle by preventing erosion and thus, the loss of property and infrastructures along the western edge of the Pointe. An increase in property values in the area is expected to result if the channel relocation without beach nourishment alternative is selected. The Town of Emerald Isle will be required to appropriate additional funds under this alternative to implement the Phase 3 beach nourishment project along the ocean shoreline. If ad valorem taxes are increased to finance the project, the urban quality of the Town may be cumulatively affected. If taxes are not increased, the Town may have to identify other measures to finance the project.

Compatibility with Project Objectives. This alternative is compatible with the project objectives related to erosion control at the Pointe but does not support the project objectives related to beach nourishment and restoration of the Phase 3 shoreline.

### **Alternative F – Channel Relocation with Beach Nourishment**

Direct and Indirect Impacts. The presence of dredging equipment within the project area would temporarily detract from the aesthetics of the environment, thereby

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possibly temporarily affecting the visual aesthetics associated with urban quality in Emerald Isle. Relocation of the inlet channel will reverse the erosion conditions currently affecting the area, and result in accretion of additional supratidal land adjacent to the Pointe neighborhood. An increase in home values resulting from the accreted property will result in an increase urban quality on the western end of Emerald Isle.

Along the Phase 3 shoreline temporary direct impacts from construction activities will be offset by the additional storm protection benefits resulting from the placement of additional dry beach within the project area. Increased tourism and the revenues generated may indirectly affect the urban quality of the Town.

Cumulative Effects. Implementation of Alternative F would have an indirect positive impact on urban quality by restoration of land lost due to erosion along western Emerald Isle and Bogue Banks. Restoration of eroding land would benefit residential properties along western Emerald Isle by preventing property damage as a result of erosion. Renourishment of the beach along Bogue Banks will lead to an increase in the capacity for recreational beach activity, which would then lead to an increase in tax revenue and tourism commerce.

Compatibility with Project Objectives. This alternative is completely compatible with the project objectives and satisfies the project needs of the Town of Emerald Isle.

## **5.21 SOLID WASTE**

### **Alternative A – No Action**

Direct and Indirect Impacts. The continued eastward migration of the Bogue Inlet shoreline could result in the destruction of homes, roads, and service utilities within the Pointe Subdivision. If threatened structures are not moved out of the Pointe subdivision, they would have to be demolished with the debris deposited in local sanitary landfills. The same would apply to damage to the subdivision roads and some service utilities. Depending on the rate of inlet shoreline erosion, the continued eastward migration of the inlet shoreline could impact between 36 and 51 homes over the next 10 years and up to one-half mile of roads and utilities.

Cumulative Effects. The cumulative effect of demolition and removal of homes and infrastructure debris from the western end of Emerald Isle will reduce the amount of space available at the local landfill over the next ten years. The volume of material that may have to be placed in the landfill is not likely to be considered significant by Carteret County, but ultimately this additional material will have to be accounted for in the County's long range plan for solid waste facilities.

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Compatibility with Project Objectives. This alternative is not compatible with the project objectives.

Alternative B – Without Project – Relocate Homes

Direct and Indirect Impacts. The continued eastward migration of the Bogue Inlet shoreline could result in the destruction of roads and service utilities within the Pointe Subdivision with the debris transported to local landfills. Relocation of the threatened structures would require removal of hardstands such as concrete foundations and driveways with this debris also deposited in local landfills. Depending on the rate of inlet shoreline erosion, the continued eastward migration of the inlet shoreline could impact between 36 and 51 homes over the next 10 years and up to one-half mile of roads and utilities.

Cumulative Effects. The cumulative effect of removal of homes and demolition of infrastructure on the western end of Emerald Isle will reduce the amount of space available at the local landfill over the next ten years. The volume of material that may have to be placed in the landfill is not likely to be considered significant by Carteret County, but ultimately this additional material will have to be accounted for in the County's long range plan for solid waste facilities.

Compatibility with Project Objectives. This alternative is not compatible with the project objectives.

Alternative C – Without Project - Sand Bag Revetments

Direct and Indirect Impacts. The continued eastward migration of the Bogue Inlet shoreline could result in the destruction of homes, roads, and service utilities within the Pointe Subdivision. If threatened structures are not moved out of the Pointe subdivision, they would have to be demolished with the debris deposited in local sanitary landfills. The same would apply to damage to the subdivision roads and some service utilities. If the home owners and the Town of Emerald Isle elect to continue to install temporary sand bag revetments to provide interim protection to threatened homes, the sand bag revetments must be removed once they have reached the end of their permit period (2 years for homes and 5 years for large structures including roads). In general, the bag material is not salvageable and would also have to be deposited in local landfills. Depending on the rate of inlet shoreline erosion, the continued eastward migration of the inlet shoreline could impact between 23 and 32 homes over the next 10 years and up to one-half mile of roads and utilities.

Cumulative Effects. The cumulative effect of demolition and removal of homes and infrastructure debris from the western end of Emerald Isle will reduce the amount of space available at the local landfill over the next ten years and may alter the .

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The volume of material that may have to be placed in the landfill is not likely to be considered significant by Carteret County, but ultimately this additional material will have to be accounted for in the County's long range plan for solid waste facilities.

Compatibility with Project Objectives. This alternative is not compatible with the project objectives.

Alternatives E and F would have the same impact on solid waste as described below.

Direct and Indirect Impacts. Alternatives E and F would not have any direct or indirect impacts on solid waste resources in the Town of Emerald Isle or Carteret County.

Cumulative Effects. None.

Compatibility with Project Objectives. Alternatives E and F are compatible with the project objectives.

## 5.22 DRINKING WATER

Alternatives A, B, and C would have similar impacts on drinking water as described below.

Direct and Indirect Impacts. Erosion of the inlet shoreline over the next 10 years would affect the potable water distribution system that serves the Pointe subdivision. Once a section of the service line is threatened, the Town of Emerald Isle would have to disconnect that section of the line and reroute it to serve remaining properties. Since the migration of the inlet shoreline would be progressive, the Town would have to make numerous responses to emergencies affecting the water distribution system over the next 10 years. Disconnecting and rerouting the potable water service system would necessitate implementation of a boil water directive for all affected residents for some period of time following resumption of service.

Cumulative Effects. Impacts on drinking water would be continues and cumulative as long as the inlet shoreline continues to migrate to the east.

Compatibility with Project Objectives. Alternatives A, B, and C are not compatible with the project objectives.

Alternatives E and F would have the same impacts on drinking water as described below.