US Army Corps of Engineers®

Frequently-Asked Questions (FAQs) About Coastal Inlets and U.S. Army Corps of Engineers' Coastal Inlets Research Program (CIRP)

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PURPOSE: The Coastal and Hydraulics Engineering Technical Note (CHETN) described herein provides answers to Frequently-Asked Questions (FAQs) about coastal inlets and about the Coastal Inlets Research Program (CIRP). The FAQs are grouped into the following categories:

a. General questions about coastal inlets.

b. Coastal inlet hydrodynamics.

c. Coastal inlet morphology.

d. Coastal inlet channels.

e. Coastal inlet structures.

f. CIRP.

g. Available tools for solving coastal inlet problems.

h. Miscellaneous inlet topics.

The FAQs contained in this CHETN are listed on the CIRP Web site at the following URL: *http://cirp.wes.army.mil/cirp/FAQs/*. The CIRP FAQs Web page is periodically updated and contains information developed subsequent to publication of this CHETN.

GENERAL QUESTIONS ABOUT COASTAL INLETS

1. Where Can I Look Up Terminology About Coastal Inlets? Glossaries of coastal terminology can be found in the Corps' Coastal Engineering Manual at *http://chl.erdc.usace.army.mil/CHL.aspx?p=s&a=ARTICLES;104* and in CIRP's Web-based general information system called "Inlets Online," *http://www.oceanscience.net/inletsonline/* that also houses aerial photographs of many Federal coastal inlets.

2. What Is a Coastal Inlet? A coastal inlet connects an ocean, sea, or lake through a typically narrow landmass to the water body behind it, such as a bay, estuary, lagoon, or river. Hydrodynamic forcing contributing to the water exchange that maintains the coastal inlet may be the tide, river flow, wind, or seiching. Bruun and Gerritsen (1960) gave this definition for a tidal inlet, which is the most common type of coastal inlet: "A tidal inlet is the waterway connection between the sea and a bay, a lagoon, or a river entrance through which tidal and other currents flow." They distinguish three inlet classifications based on origin: geological origin such as the Golden Gate; hydrological origin where a river enters the sea; and littoral origin such as openings through barrier islands. A tidal inlet is distinguished from a bay entrance, for example, such as New York Harbor in that the tidal flow is responsible for maintaining the channel of the inlet; without tidal flow, an inlet would close.

3. What Is the Interest of the U.S. Army Corps of Engineers in Coastal Inlets? The Corps is the Federal agency responsible for maintaining navigable inlets that have been authorized by the U.S. Congress, as well as for missions in federally authorized shore-protection and environmental sustainability projects, which often involve coastal inlets as a component. The Corps has, therefore, several responsibilities concerning Federal inlets. Inlets provide the entry point to coastal harbors and inland waterway systems, through which passes more than 95 percent of international freight and 2.3 billion tons of domestic and foreign commerce (*http://www.iwr.usace.army.mil/ndc/wcsc/wcsc.htm*). Inlets also serve as entry points to harbors of refuge during storms, provide access to the ocean for military vessels for national defense, serve fishing and recreational vessels, and promote water exchange and water quality in estuaries and bays.

4. How Many Federally Maintained Inlets Are There in the United States? According to the CIRP-developed Federal Inlets Database (*http://cirp.wes.army.mil/cirp/inletsdb/inletsdbinfo.html*), 154 inlets are maintained at some level by the Corps. This number does not include more than 200 primarily shallow-draft recreational inlets, many of which are found in the Great Lakes. There are numerous other inlets along the coasts of the United States that are not maintained by the Federal government. Some of the non-Federal inlets are maintained by state or local governments, whereas others are not maintained for navigation and are left to evolve naturally.

5. How Much Does the Corps Spend Annually Maintaining Coastal Inlets? Annual spending for maintenance dredging navigation channels through coastal inlets and maintenance of coastal inlet structures is in excess of $1 billion. These activities maintain the authorized depth and location of the navigation channel, promoting reliable navigation.

6. What Are the Largest and Smallest Coastal Inlets Maintained by the Corps? "Large" is defined here by reference to the tidal prism, which is the amount of water entering or exiting an (tidal) inlet on flood or ebb tide, respectively, excluding river flow. The largest inlet maintained by the Corps (through occasional dredging of the channel through the ebb shoal) is the entrance to San Francisco Bay. This inlet has a tidal prism of about 5.1 × 1,010 cu ft and a minimum cross-sectional area of about 9.3 × 105 sq ft. It is difficult to determine the smallest federally maintained tidal inlet because of limited data on tidal prism and cross-sectional area for many of the smaller inlets. As an example on the smaller side, Mattituck Inlet is located on the north shore of Long Island, NY. It is a federally maintained navigation project authorized in 1896 and has a tidal prism of 4.32 × 107 cu ft (Morgan et al. 2005), three orders of magnitude less than that of San Francisco Bay. Jarrett (1976) lists tidal prisms for 106 inlets.

7. What Are Deep-Draft And Shallow-Draft Navigation Channels? Deep-draft navigation channels are those with depths greater than 15 ft (Headquarters, U.S. Army Corps of Engineers 2004). Depths for navigation channels are typically referenced to mean lower low water (mllw), which is a tidal datum expressing the average of the lowest periodic tidal elevation occurring in a day. Typically, the tide is semidiurnal, meaning that there are two highs and two lows in a tidal day (24 hr, 50 min). The mllw datum is the average of the lowest of the lows in a day. On rivers and in the Great Lakes, other navigation depth datums are defined. The majority of deep-draft channels pertain to oceangoing ships with drafts of 30 ft or more. The most common deep-draft channel depths are between 36 and 45 ft, with an increasing number of inlets being maintained to 50-ft depths to accommodate the largest class of oceangoing vessels termed "Post-Panamax." Shallow-draft channels have maximum depth of 14 ft, but many small coastal inlets have shallow-draft channel depths averaging between 6 and 9 ft.

8. Who Do I Contact to Obtain Advice About My Inlet Problem? Corps employees and those working for other Federal agencies should contact the CIRP program manager, Dr. Nicholas Kraus (contact information given in the "Points of Contact" paragraph at the end of this technical note). Questions about a Federal inlet from the private sector should be directed to the Public Affairs Office of the Corps District in which the subject inlet is located.

COASTAL INLET HYDRODYNAMICS

9. What Is the Tidal Prism of an Inlet? The tidal prism P of an inlet is the volume of water that enters through the inlet channel during the flood tide, or exits during the ebb tide, excluding river flow and other nontidal flow sources. Tidal prism is sometimes estimated as the planform area of the bay times the magnitude of the water level increase in the bay during flood tide, $P = 2\, a_b A_b$, where a_b is the amplitude of the tide in the bay, and A_b is the bay area. In modern times, the tidal prism is measured with acoustic-Doppler velocity current meters that record the current through the water column. By making boat transects across an inlet entrance, the discharge (water velocity through the channel cross section, giving a volume of water per second) can be measured and related to the tidal prism.

10. Why Is Tidal Prism Significant? The tidal prism promotes circulation in the bay and flushing of water from the bay through the inlet to the sea. As water moves in and out of the bay through the inlet channel, it creates a current that removes sediment deposited in the channel by waves and currents. This self-scouring reduces blockage of the inlet by sand moving along the coast, thus keeping the inlet open or maintaining stability of the inlet channel cross section. Numerous geomorphic properties of tidal inlets, such as the volume of ebb and flood shoals, have been related to the tidal prism.

11. What Can Change Tidal Prism? The tidal prism can be reduced by either reducing the bay surface area (e.g., through land reclamation or by building causeways across a bay (Davis and Zarillo 2003) or by stabilizing the inlet channel with jetties in such a way that the bay tide amplitude is reduced due to flow resistance in the entrance channel. Tidal prism can be increased by excavating to increase the bay area or by modifying (typically, deepening) the inlet channel to reduce flow resistance and increase the bay tide amplitude.

12. How Is Tidal Prism Related to Inlet Channel Cross-Sectional Area? Because the tidal prism water volume must enter and exit through the relatively constricted inlet, flow increases and sediment is scoured until the inlet erodes to a stable channel cross-sectional area. Measurements of stable inlet minimum cross-sectional area below mean sea level show good correlation to the magnitude of the tidal prism. This relationship was first formalized into an equation by M. P. O'Brien (O'Brien 1931) and more thoroughly investigated for the Atlantic Ocean, Gulf of

Mexico, and Pacific Ocean coasts by Jarrett (1976). A relation between tidal prism and inlet channel cross-sectional area was first quantitatively inferred by LeConte (1905).

13. What Are Ebb-Dominant And Flood-Dominant Inlets? Consider a tidal inlet system that has no other source of water inflow or outflow except through the inlet channel. If the duration of the falling tide (ebb tide) exceeds that of the rising tide (flood tide), leading to a larger peak flood current (greater cross-sectional averaged peak flood velocity), the system is referred to as flood dominant or flood asymmetric. Conservation of mass requires that the same amount of water must move through the inlet during flood tide as during ebb tide. Because the flood tide occurs over less time, the flow rate must be greater. Similarly, if the duration of the falling tide is shorter than that of the rising tide, leading to stronger peak ebb current, the system is referred to as ebb dominant or ebb asymmetric. More information can be found in Walton (2002). See FAQ 14 for discussion of ebb bias and flood bias.

14. What Are Ebb-Biased And Flood-Biased Inlets? For a single inlet serving an otherwise closed bay system, if there are no river or other sources or sinks of water, the amount of water entering the inlet on flood and exiting on ebb must be the same. If, however, in a single-inlet system, water enters the bay through river discharge, freshwater aquifers in the bay, runoff from the land, or another source, there can be a net ebb current over a tidal cycle. Such an inlet is said to have an ebb bias. For bays served by two or more inlets, it is possible for one or more inlets to tend to be ebb biased, and the other or others to be flood biased. Such a bias can be caused by tidal phasing in the ocean, different depths in the inlet channels, or wind blowing over the bay in a predominant direction. See FAQ 13 for discussion of ebb dominance and flood dominance.

COASTAL INLET MORPHOLOGY

15. What Causes Ebb And Flood Shoals to Form? Water from the bay or ocean accelerates as it enters the inlet channel due to the Venturi effect. If the flow velocity in the entrance channel is greater than that of the adjacent water when exiting the entrance, a turbulent jet is formed. The jet spreads laterally into the adjacent regions, and jet velocity decreases as the jet widens. The stronger flow velocity in the jet mobilizes and transports sediment until eventually the jet velocity decreases to the point that sediment is deposited. This jetting mechanism is responsible for both ebb and flood shoals. (River deltas are created in the same way.) If sand is available for transport by the tidal jet as through wave action and the longshore current, the ebb and flood shoals can store a large volume of sediment. Waves also influence the morphology of the ebb shoal by opposing the current, causing the sand to deposit in a more restricted area than the flood shoal. Ebb shoals serve as a pathway for alongshore-moving sand to bypass the tidal inlet and continue moving downdrift.

16. What Is a Stable Inlet? Inlet stability can refer to either its location or to its channel cross section. Inlets without jetties, whether dredged or not, tend to migrate along the shore. Jetties stabilize the inlet location and navigation channel. Concerning channel cross-sectional stability, a stable inlet is one where the tidal flow passing through the inlet is sufficiently strong to maintain a minimum equilibrium cross section by flushing littoral sediment that enters the channel by currents and wave action. Observation shows that for inlets on sand coasts, the long-term mean-maximum current (the mean of maximum tidal current that typically occurs at spring tide) must exceed about 1 m/sec or 3.3 ft/sec to maintain channel cross-sectional stability (Bruun 1968). For stable inlets, a decrease in cross-sectional area causes increased flow velocity to maintain the same tidal prism exchange, and the increased water velocity erodes the sediment deposited in the channel.

17. What Makes an Inlet Unstable? Inlets become unstable if the tidal flow cannot adequately clear the channel free of littoral sediment, and the inlet cross-section decreases. Littoral sediment is sediment moving along the coast, typically transported by wave-induced currents. For unstable inlets, reduced cross-sectional area results in weaker flow velocity and a decrease in the tidal prism that further decreases the flow velocity until the entire inlet is choked with sand, and the inlet closes. One example of where this might happen is on a coast with a predominant littoral drift in one direction. Alongshore-moving sand builds a barrier that eventually extends past the original inlet and diverts the inlet channel in alongshore. This lengthened channel has greater flow resistance, decreasing the flow velocity and tidal prism. Geomorphic responses of inlets and inlet stability are discussed by FitzGerald et al. (2000) and by Davis and Zarillo (2003).

18. Is There a Method for Determining Whether an Inlet Will Be Stable or Unstable? Yes, Escoffier (1940, 1977) proposed an analytical technique based on the intersection of the tidal prism – inlet area relationship with a curve representing the maximum inlet velocity variation with minimum cross-sectional channel area. The maximum velocity curve increases from zero to a maximum value as the cross-sectional area increases, then it decreases with further increase in channel cross-sectional area. If the velocity curve and the tidal prism – inlet area curves intersect, there will typically be two intersection points, one representing a stable condition and one representing an inlet that will close. See Seabergh and Kraus (1997) for additional information.

19. What Is the Natural Bypassing of an Inlet? Natural inlet bypassing, the process by which sediment moves from the updrift to the downdrift side of an inlet, can be attributed to waves and tidal currents driving the longshore transport around the peripheral edge of the ebb-tidal shoal, thus promoting stability of downdrift shorelines (Dean 1988). This persistent transport of sediment along the outer edge of the ebb-tidal shoal by waves and tidal currents is referred to as a continuous bypassing mechanism. Discontinuous bypassing mechanisms involve the downdrift and onshore migration of bar complexes (FitzGerald 1988; Gaudiano and Kana 2000). Two of these mechanisms, stable inlet processes and ebb-tidal shoal breaching, are based upon the migration of large bar complexes formed on the downdrift side of the ebb-tidal shoal. A third discontinuous bypassing method is inlet migration and spit breaching. All discontinuous bypassing mechanisms result in the bypassing of large discrete packets of sediment. The mechanism by which inlets bypass sediments (continuous or discontinuous) determines erosion and accretion patterns on downdrift beaches. Refer to FitzGerald et al. (2000) for further discussion of natural mechanisms of sediment bypassing at tidal inlets.

20. What Is the Mechanical Bypassing of an Inlet? Mechanical inlet bypassing is the movement of sediment from the updrift to the downdrift side of an inlet by artificial means. Material may be taken from the updrift fillet, a deposition basin, the dredged channel, the ebb shoal or flood shoal, or other nearshore shoals. The mechanism for bypassing the material can be a hopper dredge, split hull dredge, pipeline dredge, or truck.

21. How Do Stabilized Inlets Interact with Adjacent Shorelines? The influence of a stabilized inlet on adjacent shorelines is determined by the magnitude and direction of net longshore transport. In situations where the inlet is sited at a nodal, or near-zero point in the net longshore transport rate, the adjacent shorelines will equilibrate in a relatively short time after the construction of a stabilized inlet with minimal changes to natural processes (Komar et al. 1976).

In situations where an inlet is located where net longshore transport is strongly biased in one direction, sediment is impounded by the updrift jetty, advancing the updrift shoreline and creating a triangular-shaped deposit referred to as an accretion fillet. Over the long term, this creates a deficit in the sediment budget downdrift of the inlet and results in recession of the downdrift shoreline, which can be reduced by sediment bypassing. The near field shoreline, located between the downdrift jetty and bypassing bar attachment point, experiences high rates of shoreline recession (Bruun 1995). Beneficial placement of material dredged from the navigation channel can mitigate near field shoreline recession. The far field shoreline, located downdrift of the bypassing bar attachment point, typically experiences recession rates greater than the long-term regional trend. The extent and magnitude of downdrift shoreline recession are dependent on the percentage of longshore transport bypassing the inlet.

COASTAL INLET CHANNELS

22. What Are the Mechanisms for Channel Infilling? Inlet entrance and approach channels have five characteristic signatures of shoaling (Pope 2000).

a. *Bank Encroachment*. Near the ends of jetties and along the sides of permeable jetties, channels can infill due to longshore transport of sediment entering the channel from the adjacent beaches. A shoal forms on the updrift side of the channel and constricts it. The classical jetty tip shoal is an example. In areas experiencing persistent strong wind, such as the Texas coast, wind blown transport of sediment can form similar shoals where the dry beach meets the inlet or jetty. Sediment contributing to bank encroachment by longshore transport typically represents the coarser material available at the site (e.g., sand, gravel, shell fragments). Wind-blown sediment usually consists of finer sands and silts.

b. *Shoaling*. In regions with weaker currents, such as offshore and back-bay portions of the channel, shoaling may occur through deposition of, primarily, suspended sediment in the bottom of the channel. Sediment around coastal inlets typically consists of fine to medium sand, silt, and mud. Some inlets may also contain gravel, such as on glacial coasts and in the Great Lakes. Uniform infilling may also occur due to a loss of hydraulic gradient, such as locations where the channel widens.

c. *Migration*. Migrating channels may maintain depth and width, but move away from the original dredged location. In some cases, such as after a severe storm, a channel may be entirely abandoned and switch to a new location.

d. *Channel slope failure*. Slope failure of the channel sidewalls can contribute to decreasing navigable depth of the channel. Slumping of the sidewalls can occur after deepening of a channel, if the side slopes exceed the stabile angle of repose of the sediment, or if loadings increase due to storm waves or earthquakes.

e. *Bed forms*. Although not necessarily related to shoaling in the channel, large bed forms caused by reworking of channel sediment can decrease navigable depth. Pope (2000) gives an example estimating that for a channel with mean grain size 0.3 mm, the channel would have only ripples with a flow speed of 0.4 m/sec, increase to sand waves (which could impede navigation) at 0.7 m/sec, and become planar at 1.5 m/sec.

23. Will Deepening a Navigation Channel Reduce Dredging Rate? There have been reports (formal and informal) concluding that deepening of a channel will improve hydraulic efficiency through it and, therefore, decrease or at least not change past dredging maintenance volumes. Such a conclusion should be viewed with caution and skepticism. Although a deeper channel may increase the current velocity in it because of reduced friction, a deeper channel decreases the potential for sediment resuspension and transport out of the channel. In addition, even if a channel is not widened after it is deepened, it will tend to widen due to channel side slope failure, again making sediment bypassing across it more difficult. A deepened channel may increase in effective length, thereby increasing the length to be dredged. Any increase in current velocity, which is typically minor, gained through channel deepening will not likely offset the improved sediment trapping capacity of a deeper and possibly wider channel. For design, combined modeling of waves, current, sediment transport, and channel deposition must be conducted to assess relative maintenance requirements. For certain situations, desk evaluation methods are available in support of reconnaissance estimates.

24. What Are Ways to Reduce Dredging Frequency of a Navigation Channel? The method used to reduce dredging frequency largely depends on the mechanisms causing the channel infilling (see FAQ 22).

a. *Bank encroachment*. For sediment moving over and through permeable jetties, raising and sand-tightening the structures will reduce channel infilling. If wind-blown transport of sediment into the channel is significant, vegetation and sand fences can reduce infilling.

b. *Infilling and migration*. The dredging frequency for channels that are infilling and/or migrating may be reduced by deepening the channel. Note that the terms “advance maintenance” and “over-depth dredging” are procedures that increase channel depth. Advance maintenance is an increased amount of dredging greater than the authorized depth to increase the time between required dredging, thereby reducing channel maintenance cost, because mobilization of equipment is an appreciable cost. Over-depth dredging is a small amount of allowed dredging beyond the authorized or specified depth in recognition of limitations in the measurement and dredging process in varying waves and water level. A deeper channel may decrease the dredging frequency; however, field experience indicates that the dredging quantity will increase.

c. *Channel slope failure*. Failure of side slopes due to channel designs exceeding the sediment stability angle can be alleviated through modifying the design, or anticipated as a mechanism for initial channel adjustment.

d. *Bed forms*. Channel bed forms that locally limit navigable depth are most practically dealt with by dredging to remove the material. Sometimes it is possible to create deposition basins or channel wideners to capture migrating bed forms (e.g., Johnston et al. 2002).

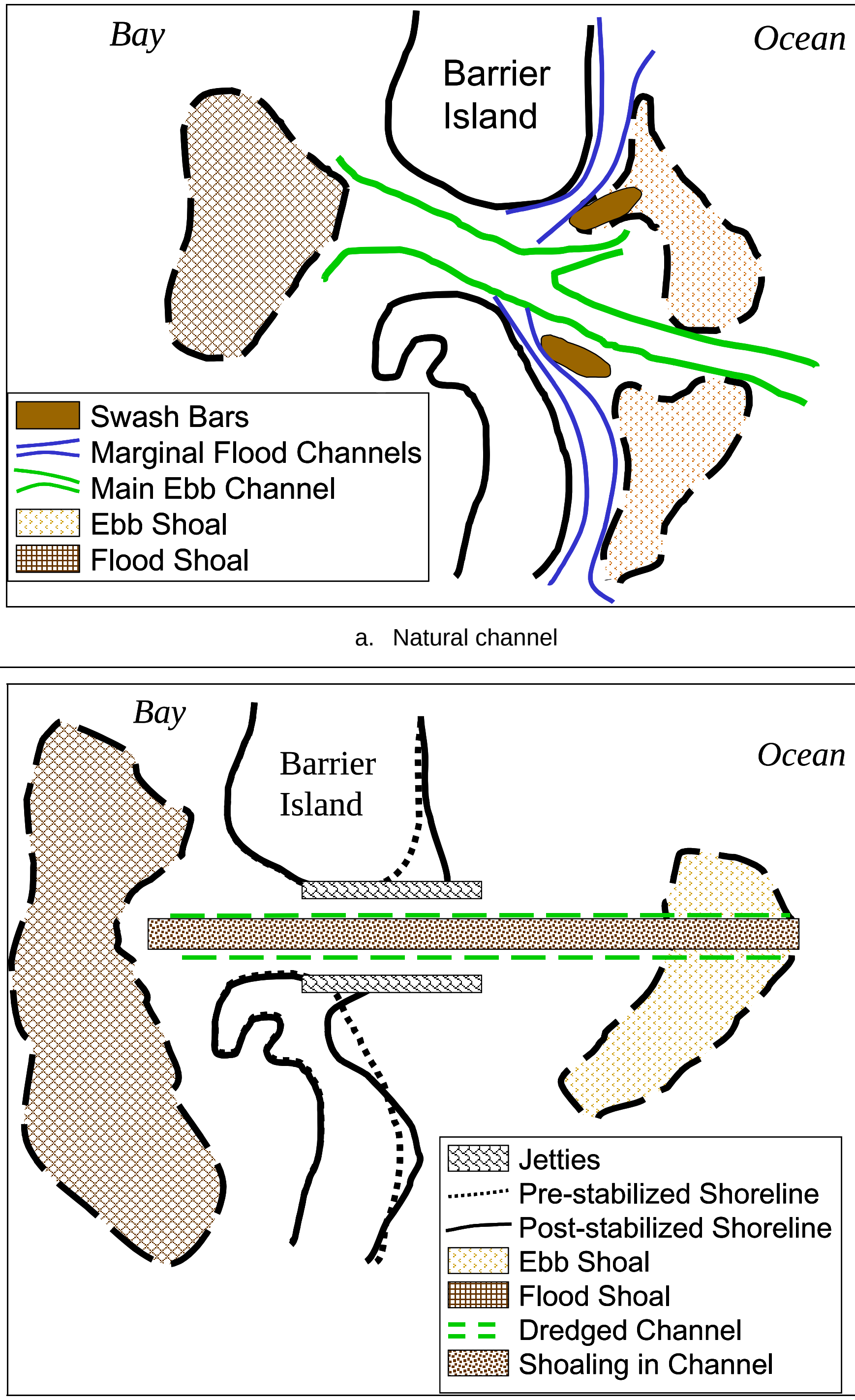
25. What Are the Differences Between Natural Inlet Channels and Those That Are Maintained Through Dredging? Table 1 lists selected differences between natural and maintained channels, and Figure 1 is a conceptualized drawing of both types. Many of the differences are related to the relative instability of natural channels, which can change course over time scales of days, weeks, and years. As the natural channel meanders and migrates, shoals in the vicinity of the channel also change, creating hazardous conditions for navigation. Waves may break on the shoals, and natural inlets can close for periods of time. The advantage of natural inlet channels is that they bypass sediment to the adjacent beaches. This bypassing may be regular, via the ebb-tidal shoal or inlet channel, or on irregular time intervals (taking years to decades) through welding of shoals to the beach.

Table 1
Comparison of Natural and Maintained[1] Channels

Property	Channel Type	
	Natural	**Maintained[1]**
Depth	Variable; typically less.	Typically greater; more uniform.
Width	Variable.	May be greater, depending on navigation needs; more uniform.
Tidal prism	Lower.	Typically greater
Center line	Possibly meandering; may migrate alongshore.	Straight, possibly with segments.
Navigation	Hazardous at times	Reliable.
Shoaling rate	Lower as channel fills and inlet bypasses sediment; Higher after storm currents flush channel clean.	Greatest immediately after dredging, then decreasing as channel approaches natural cross-sectional shape.
Migration	Possibly high and erratic	Halted with dredging (and jetties, if applicable).
Bypassing	Occurs due to: - Wave-induced transport via ebb shoal. - Tidal-transport via channel. - Migration and welding of bars.	Lacking immediately after inlet stabilization; may increase with time. Artificial bypassing can occur with placement of dredged material on adjacent beach.
Ebb and flood shoals	Channel may meander through shoals, bifurcating them due to storm events.	Can be further offshore (ebb) and into bay (flood) due to greater tidal prism and inlet flushing.
Waves and currents	Waves break on shoals. Currents may be strong in areas.	Typically lower waves and currents due to deeper channel.
Effect in regional sediment budget	After formation, initially captures sediment in ebb and flood shoals; can become less of a sink with time as bypassing begins.	Immediately after dredging, an inlet is a nearly total sink to the sediment budget; as the channel shoals, the inlet can become less of a sediment sink.
Can it be in equilibrium?	Yes – a quasi-equilibrium over years to decades.	No – channel will seek to return to natural condition.[2]

[1] Channels maintained through regular dredging at a specified depth; may also have jetties.
[2] Exceptions to this include: channels formed in geologically stable material, such as reef or limestone; channels that are cut into easily erodible material, and seek a "new equilibrium" (Indian River Inlet, DE); and channels that capture the tidal prism of other inlets that connect to the bay, also seeking a new equilibrium (Matagorda Ship Channel, TX).

Maintained channels are much more reliable and stable than natural inlet channels, and they provide safe navigation. However, they represent more of a sediment sink to the regional sediment budget; bypassing of sediments may take decades to evolve as the stabilized inlet reaches a new equilibrium, and may not occur at all. The maintained channel seeks to return to its original condition through shoaling. Both of these problems can be alleviated through dredging of the maintained channel and mechanical placement of the dredged material on adjacent beaches.



a. Natural channel

b. Maintained channel

Figure 1. Conceptualized drawing of natural and maintained inlet channels

COASTAL INLET STRUCTURES

26. Why Are Jetties Built? Jetties are constructed primarily to stabilize the location of the inlet and its channel, preventing inlet migration and protecting the channel against nearshore waves and currents. The jetties direct tidal flow in the navigation channel in a predictable manner, and inlet flow velocity is usually increased because of confinement of the tidal current, thus making conditions less favorable for sand deposition in the channel. The scouring action of the tidal current reduces required maintenance dredging. Jetties also provide wave protection for navigation channels for wave directions other than straight into the channel. This protection is essential in high-energy wave climates because it provides safe passage for vessels through the energetic surf zone and across the dangerous offshore bar with shallow water and breaking waves.

27. Why Do Some Inlets Have Only One Jetty, Whereas Others Have Two? Inlets located where longshore sediment transport is primarily in one direction may be adequately stabilized with a single updrift jetty. The channel through inlets stabilized by a single jetty tend to migrate toward the structure, which can result in a channel maintenance and navigation concern (Kieslich 1981). Some single-jetty inlets were originally envisioned as dual-jetty inlets, but after construction of the first (updrift) jetty either the second (downdrift) jetty was not needed, or funding was not available to complete the original plan. Inlets located where longshore transport has similar magnitude from both directions will not be protected by a single jetty.

28. What Factors Determine Distance Between Parallel Jetties? The leading factor determining minimum width between jetties for a dual-jetty (parallel) system is assuring adequate clearance for the intended navigation usage, involving consideration of channel width and adequate distance to preserve a buffer of bottom material near the jetties. Once this criterion has been met, a second width criterion relates to inlet cross-sectional area versus tidal prism (FAQs 9, 11). Limiting the width between jetties can result in greater tidal flow velocity that scours the channel and reduces channel maintenance dredging. The goal is to select a jetty separation that promotes increased channel scouring without creating an excessively strong inlet current that could degrade navigation reliability. Pragmatically, if an inlet existed prior to construction of the jetties, these structures are typically placed on the interior shallow margins of the natural inlet to reduce construction costs by minimizing structure length in deeper water (requiring greater stone volume).

29. What Determines Seaward Length of Jetties? As a first estimate, jetties extend to the offshore contour corresponding to the depth of the dredged navigation channel. The appropriate seaward extent of jetties is a compromise between navigation benefits gained by longer jetties, and reduced natural sand bypassing to the downdrift beaches offered by shorter jetties. Longer jetties protect navigation until vessels reach deeper water outside the surf zone under typical or moderately stormy wave conditions. They also prevent longshore-moving sand from shoaling the navigation channel, thus extending time between dredging cycles. However, longer jetties block more of the longshore sediment transport, increasing potential for the downdrift beaches to erode more than they would with shorter jetties that allow more sediment to be bypassed via the ebb shoal bar. This potential erosion must be remedied through mechanical bypassing of sediment trapped at the updrift jetty and dredged from the channel. In addition, construction costs increase with jetty length, not only because of additional material, but also because stable armor stone sizes increase as jetties are built into deeper water. Jetty construction cost is proportional to the volume of placed stone.

30. How Are Rubble-Mound Jetties Designed? There are two components to rubble-mound jetty design: functional design and structural design. Functional design corresponds to the planform layout of the jetty system needed to achieve the required functionality being sought. Functional design includes locations and orientations of the jetties; distance between the jetties; seaward extent of the jetties; landward jetty terminus necessary to prevent flanking; and assessment of impacts to the tidal prism, navigation channel, and adjacent shorelines. Also included in functional design might be criteria related to wave reduction in the navigation channel by minimizing wave overtopping. The second component, structure design, consists of determining the jetty cross-section dimensions necessary to meet the functionality criteria while remaining structurally intact during the design storm event. Structure design includes setting crest elevation to prevent overtopping, determining type of armor unit (stone or concrete units), calculating the stable armor unit weight, designing underlayers and core, designing the seaward round-head, and providing necessary scour protection. Geotechnical engineers assess the foundation material and design a mattress to distribute the structure weight. As a jetty progresses into deeper water, armor weight and crest elevation are increased, as necessary.

COASTAL INLETS RESEARCH PROGRAM (CIRP)

31. What Is the Objective of CIRP? The primary objective of CIRP is to conduct research and develop tools that reduce costs associated with operation and maintenance (O&M) of the nation's Federal navigable coastal inlets and channels. A central aspect of this objective is transfer of knowledge and tools developed by CIRP to Corps District and Division engineers, cost-sharing partners with the Corps, and to the private sector that supports the Corps' O&M mission.

32. What Are the Products of CIRP? CIRP produces a variety of products that support Corps coastal inlet operation and maintenance activities directly and indirectly. These include predictive numerical models of waves, currents, sediment transport, morphology change, and water-structure interaction; physical modeling technology; computer programs implementing new and existing analytical techniques; periodic technology-transfer workshops, and training with CIRP technology; and technical publications describing both applied and basic research advances. In addition, CIRP staff members advise and consult with District engineers on specific projects. CIRP products are listed at *http://cirp.wes.army.mil/cirp/cirp.html*.

33. How Is CIRP Structured? CIRP consists of six technical work units, each guided by a principal investigator and one administrative work unit. Overall technical direction within the CIRP is provided by a program manager, with oversight from the Navigation Program technical directors in the U.S. Army Engineer Research and Development Center and from Corps of Engineers Headquarters.

34. How Is Research Planned in CIRP? Research focus varies as new technology developments mature and are transitioned to Corps field offices (Districts). Constant interaction with engineers throughout the Corps in review of CIRP and in studies performed for Corps Districts identifies new needs for tools and technology, stimulating research paths and applied engineering development to fulfill those needs. CIRP is continuing to improve numerical modeling technology by addition of sediment transport capability and morphology change across several length and time scales, allowing prediction of navigation channel infilling, sand bypassing at inlets, and coastal morphology change in the vicinity of inlets. Capabilities are also being added to the newest

Boussinesq wave model, and laboratory tests are planned to develop clear guidance for selecting Boussinesq model coefficients appropriate for representing a wide range of coastal structures. New emphasis is being directed at problems related to maintenance and repair of inlet jetties, and CIRP is developing PC-based tools for predicting such things as channel infilling rates and shoal development. CIRP strives to develop practical and usable technology for Districts to solve problems of concern to the Corps' Federal navigation mission.

35. Who Determines the Research Direction for CIRP? Research direction of CIRP is a collaborative effort involving the principal investigators; program manager; technical directors at the U.S. Army Engineer Research and Development Center's Coastal and Hydraulics Laboratory (CHL); Corps Headquarters; and Corps Division and District engineers. Corps Division and District engineers (and their consultants) define problems and express needs. Headquarters has the national view of which needs are critical and of national priority. The principal investigators keep abreast of new developments, and they propose viable research and development that will result in practical solutions. The CIRP program manager serves as the catalyst that monitors the quality of the research and products, and assures everyone is making progress toward the solutions. The program manager also allocates appropriate resources to each project. The CHL technical directors assure linkages are made among Corps research programs and those of other Federal agencies to leverage expertise to the best advantage across all programs. CIRP welcomes suggestions for research needs, as well as bringing attention to particular problems at coastal inlets.

36. Who Can I Contact to Suggest Tools That Are Needed and Problems or Inlets With Problems That Might Be Addressed by CIRP? Contact the CIRP Program Manager, Dr. Nicholas Kraus, at the phone number or e-mail address listed in the "Points of Contact" paragraph at the end of this technical note. Alternately, contact any of the CIRP staff listed on the CIRP Web page, or bring your suggestion to the attention of any CHL employee you meet at Corps meetings, technical conferences, or while discussing other projects or studies.

37. Does CIRP Partner with Corps Districts to Solve Specific Inlet Problems? There are many examples of District inlet problems being studied by a joint team of District and CIRP engineers and scientists. Most of these studies are conducted as reimbursable work involving one or more experienced CIRP engineers or scientists. Usually the CIRP staff is not supported by CIRP while participating in the studies. However, there have been situations when CIRP recognized a benefit to be gained by contributing funds or staff time to a reimbursable project to acquire additional data or test predictive modeling technology that would advance ongoing research, particularly if applicable on a national level. Short-term consulting support by a CIRP staff member, typically limited to less than 2 weeks, can be attained through a request to the Dredging Operations Technical Support (DOTS) Program (*http://el.erdc.usace.army.mil/dots*).

38. Can CIRP Support Non-Federal Inlet Projects? Participation is typically limited to projects for which a Federal interest has been formally recognized. However, there are two exceptions. CIRP can partner with the private sector to compete for work outside the United States. The second exception is if CIRP identifies a non-Federal inlet to study that offers a particular set of problems or situation that would be of national interest to existing Federal inlet navigation projects. An example is study of the evolution of a newly opened inlet.

39. Does CIRP Sponsor External Research? CIRP has a long history of supporting research conducted by academic institutions and private sector firms. Some of the research and development efforts successfully completed under contract include major numerical model development, development and enhancement of the Surfacewater Modeling System (SMS), geomorphologic analysis and toolkit development, data collection covering a wide range of parameters, and Web-based tools. CIRP prides itself on its support of leading researchers in the arena of inlet processes.

40. What Mechanisms Are Used for Submitting a Research Proposal to CIRP? Unsolicited research proposals on any topic related to coastal inlets can be submitted to CIRP via the Broad Agency Announcement (BAA) process. The BAA is similar to a request for proposals, so any proposal received under the BAA is considered to be a competitive proposal that can be funded if the proposal is found to be technically sound, relevant to CIRP objectives, and if funds are available. Guidelines and forms for submitting a BAA proposal can be found at *http://www.mvk.usace.army.mil/contract/docs/2002BAA.pdf*.

41. What Are the Criteria for Successful Proposals? The most important criterion for a successful proposal is that the research produces one or more end products that have practical application for solving the real-world inlet and navigation problems faced by the Corps. Whereas CIRP recognizes the value of pure research and advancing understanding of inlet processes, our mission is to support the Corps O&M activities at federally maintained inlets and entrances. Other rating criteria include originality of the proposal, records of the proposers, probability of success within the proposed time and budget, and funding requested relative to available funds. BAA proposals are reviewed internally by at least three senior technical staff members.

AVAILABLE TOOLS FOR SOLVING COASTAL INLET PROBLEMS

42. What Types of Tools Are Available for Addressing Coastal Inlet Processes and Problems? Depending on the particular inlet problem, available tools include analytical techniques, simple PC-based computer programs, sophisticated numerical models solved over spatial grids, and small-scale physical models. Inlets are complex hydrodynamic and geomorphologic systems, and in many studies several types of tools may be required to answer specific problems. For example, analytical techniques and simple PC-based programs might be applied in the early stage of an inlet study to develop preliminary estimates of key inlet hydrodynamic parameters. GIS analysis of aerial photographs, bathymetry surveys, and shoreline position provides information of morphologic response to inlet modifications. More precise detail can be determined by applying sophisticated numerical models or physical models. Project cost and potential benefits contribute to any decision on what tools are brought to bear on any specific study. Kraus (2006) gives an overview of morphologic response to creation and modification of coastal inlets, including the navigation functioning of inlets.

43. What Problems Are Best Addressed by Physical Models? Physical models reproduce a portion of the inlet at small scale. Generally, the modeled area is no larger than about 1 or possibility 2 square miles. Physical models can represent complex hydrodynamics phenomena such as wave interaction with jetties, wave overtopping of jetties, wave diffraction and reflection inside an entrance, complex three-dimensional (3-D) flow separation at structures, and wave breaking over complex bathymetry. Physical models are commonly employed for verifying rubble-mound jetty stability (2-D and 3-D), determining overtopping and wave transmission, assessing scour potential, and investigating navigability issues. Physical models include all nonlinear physics without simplification, but care must be taken to minimize scaling distortion and laboratory effects that can render results questionable. Practical operational constraints typically limit the range of water level and wave conditions that can be represented in a physical model. Further information about physical model advantages and disadvantages can be found in Hughes (1993).

44. Who Conducts Physical Model Studies of Inlets? Physical models of inlet processes can be divided into two categories, research studies and site-specific studies. Researchers work with physical models to understand physical processes and, in some cases, develop relationships that support numerical model simulations. Physical models are also established to verify numerical models and assess the strengths and weaknesses of numerical approximations. Site-specific physical model studies are sponsored by Corps Districts or other agencies with the goal of solving particular problems at a project site or modifying the existing projects to gain additional functionality. Design and operation of an inlet physical model must be conducted by engineers and technicians experienced with the difficulties in achieving realistic simulations and valid results. These engineers work in conjunction with sponsors to develop an optimal testing plan to address the problems and issues. Wave flumes are limited to examining breakwater and jetty stability and wave processes at structures. Planform inlet models require substantial wave basins equipped with both wave and tidal current generation capability. Few large-scale facilities exist in the United States, and the largest, by far, is located in Vicksburg, MS, at the Coastal and Hydraulics Laboratory.

45. What Facilities Are Available at CHL for Coastal Inlet Physical Model Studies? The principal basin facility is the CIRP-operated generic inlet physical model (http://cirp.wes.army.mil/cirp/cetns/cetniv-19.pdf). This basin was designed to represent characteristics common to many inlets, but in an idealized manner. The basic model bathymetry was constructed in concrete (fixed-bed) with an offshore slope molded in the shape of an equilibrium beach profile. A navigable inlet with rubble-mound jetties cuts through the barrier beach to a back-bay area. The idealized model can simulate constant or varying ebb or flood tide, and waves can be added using an irregular wave generator. Typical studies include examining the benefits of jetty spurs to reduce movement of sediment into the inlet, understanding wave/current interaction, simulating formation of crenulate-shaped erosion at the landward jetty terminus, and developing equilibrium inlet cross sections. Other CHL facilities include wave basins for constructing and testing site-specific inlets and entrances, wave flumes for testing of jetty and breakwater cross-section design and armor stability, and a precision flow table (*http://cirp.wes.army.mil/cirp/cetns/chetn-iv55.pdf*) for rapid preliminary assessment of hydrodynamic changes brought about by inlet structure modifications.

46. Where Can I Find Information about Available PC-Based Computer Programs? CIRP and other research programs at CHL produce PC-based computer programs that automate calculation procedures for solving specific problems. These programs generally are simple to operate, and the computerized versions have undergone testing and feature user-friendly interfaces. The PC-based programs differ from the more sophisticated numerical models that solve governing equations over a spatial grid. When a program becomes available as a stand-alone code, it is described in a Coastal and Hydraulics Engineering Technical Note (CHETN) together with information about whom to contact to receive a copy of the code. The formal public release of a completed PC-based program is through the CEDAS suite of programs (*http://chl.erdc.usace.army.mil/CHL.aspx?p=s&a=Software;11*) being developed through a cooperative agreement between CHL and a private company. The CEDAS package replaces the former ACES computing software, but the ACES components are included in CEDAS. The private company assists in developing interfaces, help information, and other tasks that allow CIRP to conserve research funding.

47. What Is the Cost for these PC-Based Computer Programs? PC programs developed in CIRP and announced initially through a CHETN are typically free of charge and available to anyone who asks. Operation of these codes and evaluation of accuracy of results are the responsibility of the user. Because of the large and varied use of CIRP technology, our staff cannot typically answer questions about application, model input requirements, how to operate the code, or how to interpret results. If you find an error in a particular PC-based program, we would appreciate receiving a description of the problem. Codes that are included in the CEDAS software suite are more thoroughly tested within the interface. CEDAS is available free-of-charge to Corps staff. Additional information, software downloads, documentation, and registration information can be found at (*http://chl.erdc.usace.army.mil/CHL.aspx?p=s&a=Software;11*). The registration process involves generation of a software key specific to the computer on which CEDAS will be used. For those needing to purchase a license, contact Veri-Tech, Inc. (*http://www.veritechinc.net/*).

48. Do I Need any Additional Special Software to Run PC-Based Programs? Generally, PC-based programs are developed to run stand-alone on computers under some version of the Windows operating system, and no additional software need be installed or licensed to operate the codes. The exception is any GIS-based analysis program that is built to be operated in ARCVIEW®. Documentation about the program will give specific requirements.

49. What Is the Inlet Modeling System? The Inlet Modeling System (IMS) is an integrated numerical modeling system for simulating waves, currents, water levels, sediment transport, and morphology change at coastal inlets and entrances. Emphasis of the IMS is on navigation channel performance and sediment exchange between the inlet and adjacent beaches. A key objective of this work is to develop, test, and transfer the IMS to Corps Districts and industry for use on specific engineering studies.

50. What Sophisticated Numerical Models Are Available in IMS? Sophisticated numerical models in the IMS include codes that solve the governing differential equations over a gridded spatial domain using either a finite-difference or a finite-element solution scheme. Models being actively developed by CIRP or developed at CHL and applied to address coastal inlet problems include: (a) IMS-ADCIRC (*http://www.marine.unc.edu/C_CATS/adcirc/*), a finite-element 2-D tidal circulation and storm surge model; (b) IMS-M2/3D, a hydrodynamic, sediment transport, and morphology change model intended for local applications, primarily at inlets, the nearshore, and bays; (c) STWAVE (*http://chl.wes.army.mil/research/wave/wavesprg/numeric/wtransformation/stwave.htp*), an easy-to-apply, flexible, robust, model for nearshore wind-wave growth and propagation; and (d) BOUSS-2D, an advanced Boussinesq wave model. Some of these models are well along in development, relatively easy to apply, and are available for routine studies. Other models are in research development and lack complete full interfaces and documentation. Although the above-listed models can be run on a modern PC-based workstation, some large-scale, regional applications require mainframe computers.

51. Can Anyone Obtain these Models? The models IMS-ADCIRC, IMS-M2D, and STWAVE are included in the Surfacewater Modeling System (SMS). The SMS provides a uniform interface for various gridded models, and the system features easy grid development, preprocessing of input files, model operation, data and output visualization, and toolboxes to support modeling efforts. Specific models can be set up and run within the SMS. The SMS package is commercially available, but because CIRP and CHL provide funding for its support, SMS is provided at no cost for Corps staff. Others are required to purchase an SMS license, thereby sharing in SMS development cost. Models not yet released in the SMS are typically not available. However, specific studies requiring the capabilities of models still in development may be able to access a model under arrangement with the CIRP investigator.

52. How Does a Corps Employee Obtain the SMS or a Particular Numerical Model? Corps users can obtain the SMS package by going to the CHL Web site (*http://chl.erdc.usace.army.mil/CHL.aspx?p=s&a=Software;4*), then selecting **SMS Documentation and Registration**. Once the software is downloaded and installed, you will need to obtain a password to enable the SMS components. Double-click the SMS icon and select **Enable**; then you can either e-mail the security string to SMS@erdc.usace.army.mil or select the **On-line registration** button. This procedure generates a password that binds the SMS software to the computer on which you have installed the package. Your password will be sent in a separate e-mail. Use this password to unlock all the features of the SMS package, including the models in the Inlet Modeling System.

53. How Does Everyone Else Obtain a Particular Numerical Model? Non-Corps users can obtain the SMS package and password commercially from Environmental Modeling Systems, Inc. (*http://www.ems-i.com/*). After receipt of the licensing fee, a password will be generated to unlock all the package features. The password ties the software to the single machine on which the password request was generated.

54. Are There Manuals and Training Available for Applying Numerical Model? CIRP and other research programs at CHL offer periodic hands-on training sessions on the use and application of the IMS and other numerical models developed at CHL. The focus of the workshops varies from introductory to advanced, and often workshops are presented when major new features or capability become available. CIRP-sponsored workshops are announced in both the "News & Events" (*http://cirp.wes.army.mil/cirp/cirpnews.html*) section of the CIRP Web site, and in the quarterly CIRP internal Corps newsletters (*http://cirp.wes.army.mil/cirp/newsletters.html*). Workshops have been held in Vicksburg at CHL, at Corps District offices, and at some technical conferences. Training in SMS model use is also offered commercially by Environmental Modeling Systems, Inc. (*http://www.ems-i.com/*). Model documentation is usually a combination of published technical reports, technical notes, training tutorials, and Web-based documentation. The SMS does provide on-line help.

55. Who Do I Contact if I Am Having Problems Running a Particular Numerical Model? CIRP staff attempt to answer questions from Corps staff applying models to District projects. In some cases, the questions can be answered immediately or with little effort. Examples include range of input variables and how to display results. Questions requiring a significant expenditure of staff time are answered as feasible, and it may be necessary to provide funding in some instances. Often, such support is covered through District contributions to a numerical model maintenance program. The CIRP staff expects the person asking the question to be knowledgeable about the basic operation and applicability of the model of interest.

56. What Tools Are Available for Estimating Scour at Jetties? Scour at jetties can be caused by several mechanisms involving the combination of waves and tidal currents. Research in CIRP examined scour caused by jetting of tidal flows such as deflected ebb jets, jets formed by jetty orientation, and flow constriction jets. For specific jetty orientations, inviscid flow theory is used to create flow maps that show streamlines and lines of constant discharge per unit width. These flow maps indicate where the flow is strongest. The flow maps can be combined with a technique for estimating equilibrium scour depth. Two on-line flow net calculators are provided on the CIRP Web site under "Products & Tools" (*http://cirp.wes.army.mil/cirp/products.html*). Example applications are also given.

57. Is There a Method for Estimating Equilibrium Scour Depth? A simple technique for estimating the maximum equilibrium scour depth for flow through an inlet was described by Hughes (1999) in a CHETN titled "Equilibrium scour depth at tidal inlets" (*http://cirp.wes.army.mil/cirp/cetns/cetniv-18.pdf*). Equilibrium scour depth is estimated as a function of maximum discharge per unit width, sediment diameter, and sediment specific density. The methodology is intended only for sand-sized noncohesive sediment. An on-line calculator is provided on the CIRP Web site under "Products & Tools" (*http://cirp.wes.army.mil/cirp/products.html*).

58. Is There a Method for Estimating Navigation Channel Infilling Rates? There are several levels of technology available. (a) For reconnaissance studies or small projects with limited budgets, a morphology-based numerical model has been developed for estimating infilling of a dredged navigation channel by cross-channel sediment transport. The model and methodology are applicable to channels on the open coast and in estuaries, bays, and lakes. A central principle of the model is that an equilibrium or natural channel depth can be identified, and the rate of channel infilling is proportional to the deviation between the dredged depth and the natural depth. The model requires information readily obtained or estimated in engineering analysis as the channel depth in its natural condition prior to dredging and the rate of sediment transport approaching normal to the channel. A paper describing the model will be available soon. (b) At more advanced and computation-intensive level, the Inlet Modeling System (IMS) M2/3D model (Militello et al. 2004) is available to estimate channel infilling in either two-dimensional mode, which is suited for long-term simulations, and three-dimensional mode, which is more suited for detailed studies or complex areas.

59. How Do I Construct a Sediment Budget for an Inlet? CIRP has described the process for creating a sediment budget (Rosati and Kraus 1999) and developed and refined a computer program to assist creation of sediment budgets for inlets and adjacent shorelines. The PC-based program called the Sediment Budget Analysis System (SBAS) can be downloaded from the CIRP Web site under "Products & Tools" (*http://cirp.wes.army.mil/cirp/products.html*). The program has a user-friendly interface that enables rapid development of a sediment budget directly on top of aerial imagery of the area of interest. The SBAS eases construction of a sediment budget. The validity of the resulting budget depends on the quality and accuracy of the values entered. Kraus and Rosati (1998) discuss how to estimate uncertainty in sediment budgets.

60. How Can I Obtain CIRP Publications? A complete listing of technical reports, journal articles, and conference papers published by CIRP staff is included on the CIRP Web site under the "Publications" link (*http://cirp.wes.army.mil/cirp/cirppubs.html*). Electronic versions of the more recent reports and articles are available for free downloading on the Web site. Full versions of some of the older publications are not available, but all publication entries include the citation and abstract. Reprints of some journal articles and conference papers might be obtained directly from the authors upon request. Sweeping requests for hard copies of all publications (e.g., "Please send me a copy of every CIRP report.") cannot be fulfilled. Electronic versions of all Coastal and Hydraulics Engineering Technical Notes (CHETNs) related to inlets and CIRP can be downloaded from the CIRP Web site under the "Technical Notes" link (*http://cirp.wes.army.mil/cirp/cirpcetns.html*).

61. Where Can I Find Information About a Specific Inlet? CIRP maintains two databases related to tidal inlets and coastal structures that are accessible from the CIRP Web site. The Database of Navigation Projects and Structures (*http://cirp.wes.army.mil/cirp/structdb/structdbinfo.html*) contains information on over 1,200 coastal structures along with a few parameters related to associated tidal inlets. Many of the inlet records include aerial photographs. The second database provides additional information on 154 federally maintained tidal inlets (*http://cirp.wes.army.mil/cirp/inletsdb/inletsdbinfo.html*). Where both databases have an entry for the same inlet, the records are cross-linked. Some inlet record fields are sparsely populated. Work is underway to consolidate both databases and expand the amount of information contained in the records. Another on-line source for specific inlet photographs is "Inlets Online" (*http://www.oceanscience.net/inletsonline/*). Many inlets have been studied extensively by CIRP, by universities, and by consulting engineers. CIRP studies are typically published and available in electronic form from the CIRP Web site. Availability of studies conducted by others varies.

62. Are Data Available from CIRP? Data sets obtained by CIRP as part of the research program are usually described in the resulting technical publications. Data sets may be included as an appendix or they may be summarized. Data collected as part of a supported project study of an inlet may be similarly included in publicly available reports and technical articles. Requests for specific data should be sent to the person who authored the technical document.

MISCELLANEOUS INLET TOPICS

63. My Question Is Not Listed Above, What Can I Do? Tidal inlets and entrances encompass a wide range of topics, knowledge, problems, solutions, and analysis techniques. It is not possible to list all the questions that might arise. If your questions are not included in this technical note, the first place to look is the CIRP Web site (*http://cirp.wes.army.mil/cirp/cirp.html*). The Web site contains a cornucopia of inlet information including publications, technical notes, photographs, presentations from past workshops, and more. The FAQs included in this CHETN are duplicated on the CIRP Web site, and new FAQs are added as they arise. Technical papers describing new research findings about tidal inlets can be found in a variety of mainstream journals and in the proceedings of technical conferences. Several books contain authoritative chapters about tidal inlets, inlet hydrodynamics, and inlet sedimentation.

64. Where Can I Send My Suggestion for a FAQ? If you have a question or a suggestion for a FAQ, please contact Dr. Steven Hughes at the phone number or e-mail address given in the "Points of Contact" paragraph. We will do our best to provide an answer and include your FAQ on the CIRP Web site.

65. What if I Do Not Agree With the Answer to a FAQ, or I Have Additional Comments? We are interested in hearing from you. The CIRP team has attempted to provide short and accurate responses to all the FAQs listed in this technical note. However, we appreciate having mistakes identified or differences of opinion expressed; and we are open to discussing these. Whereas changing the answer to a FAQ in this technical note is difficult, the corresponding version on the CIRP Web site can be updated to reflect corrections. Such updates will be clearly labeled to avoid confusion when compared to the original technical note version. Contact Dr. Steven Hughes at the phone number or e-mail address given in the "Points of Contact" paragraph, and he will refer you to the CIRP team member most knowledgeable on the subject matter of the FAQ in question.

SUMMARY: This CHETN provides answers to Frequently-Asked Questions (FAQs) about coastal inlets and the Coastal Inlets Research Program (CIRP). The purpose of the CHETN is to assemble concise and informative responses to common questions. However, the responses are necessarily short; and in many cases significant additional explanation may be warranted. Selected references have been given for additional information. Suggestions for additional FAQs are welcomed (see FAQ 64).

POINTS OF CONTACT: This CHETN is a product of the Inlet Structures Work Unit of the Coastal Inlets Research Program (CIRP) being conducted at the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. Questions about this technical note can be addressed to Dr. Steven A. Hughes (Voice: 601-634-2026, Fax: 601-634-3433, e-mail: Steven.A.Hughes@erdc.usace.army.mil). For information about the Coastal Inlets Research Program (CIRP), please contact the CIRP program manager, Dr. Nicholas C. Kraus, at 601-634-2016 or Nicholas.C.Kraus@erdc.usace.army.mil. Beneficial reviews and several FAQ questions and answers were provided by CIRP staff members Ms. Mary A. Cialone, Ms. Julie D. Rosati, and Dr. Brian K. Batten. This technical note should be cited as follows:

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