CHAPTER 2

Project Study Formulation

2-1. Project Design. Design of a navigation project requires an understanding of the port and waterway needs, assembly and evaluation of all pertinent information, and development of a rational improvement plan. The planner/design engineer is responsible for developing and formulating several project design alternatives. This will allow the economically optimum plan to be clearly evident and readily substantiated. Project safety and efficiency should receive primary consideration before the cost-effectiveness of the project is determined. Planning for the project will require the anticipation of any possible development and operational problems and evaluation of alternative solutions. The cost of each proposed project must be considered in the development or improvement of the alternative deep-draft channel designs. A navigation project study plan should also be developed that will provide guidance during project formulation at all stages of project planning and design.

2-2. Typical Project Elements. Figure 2-1 presents an example generic harbor defining many of the typical project elements discussed below. The following project features are normally the responsibility of the Corps:

a. *Entrance channel*. A navigable channel connecting the ocean or lake to an enclosed water body such as a bay, estuary, river, or mouth of a navigable stream.

b. *Jetties*. Structural features that provide obstructions to littoral drift, control entrance currents, prevent or reduce shoaling in the entrance channel, maintain channel alignment, and provide protection from waves for navigation.

c. *Breakwaters*. Structures designed to provide shelter from waves and improve navigation conditions. Such structures may be combined with jetties where required (EM 1110-2-2904).

d. *Interior channel*. The access channel system inside a water body that connects the entrance channel (inlet or bar) to a port or harbor with appropriate ship facilities. Interior channels are usually located to provide some protection from waves and weather and are located in bays, estuaries, or rivers.

e. *Turning basin*. An area that provides for the turning of a ship (bow to stern). Turning basins are usually located at or near the upper end of the interior channel and possibly at one or more intermediate points along long channels.

f. *Anchorage area*. An area inside a water body providing the ships some protection from the weather while lying at anchor to stand by, load or unload cargo, await repairs, etc.

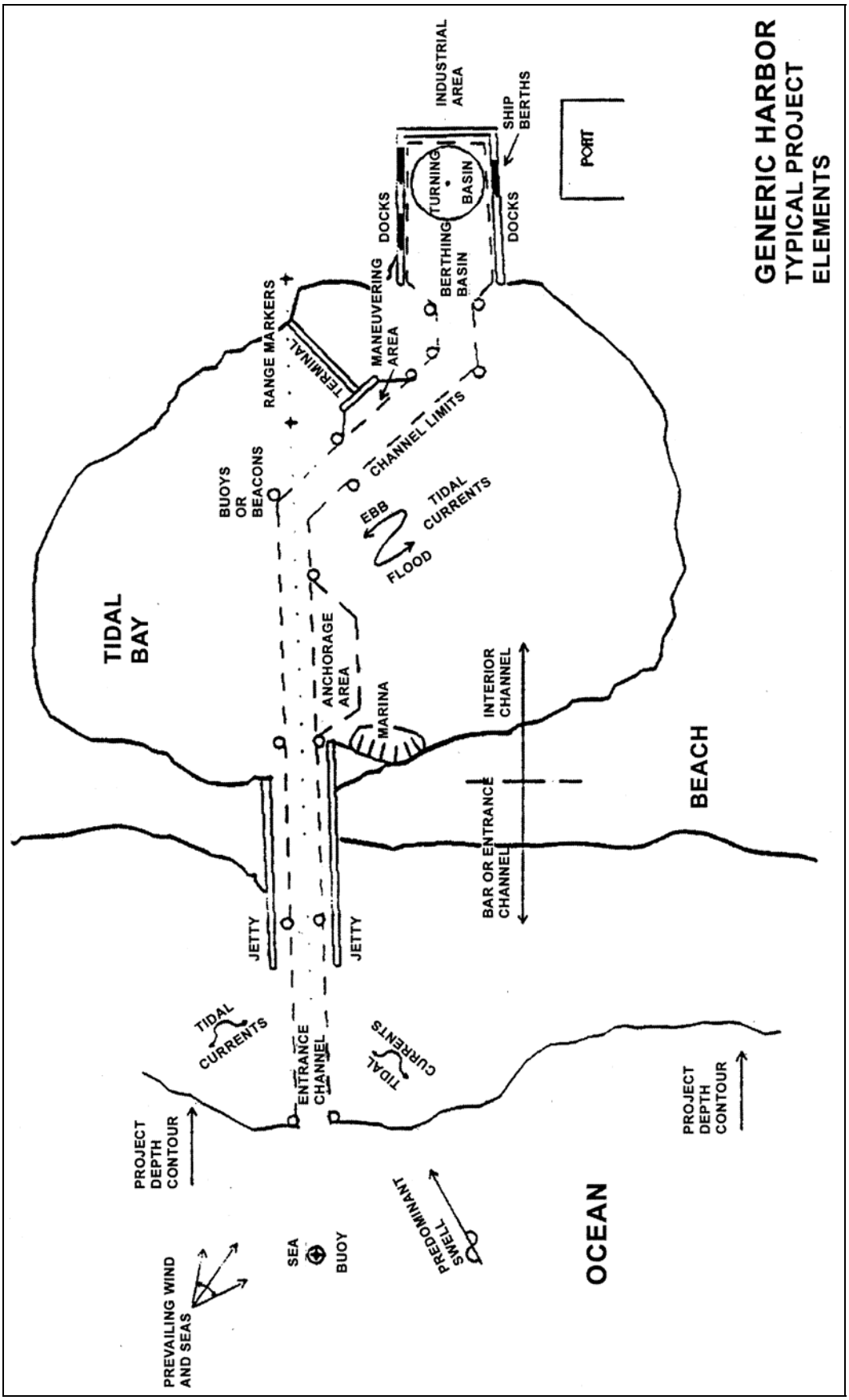

Figure 2-1. Generic harbor with typical project

g. *Special features*. Specifically designed structural elements that provide for special project design requirements, such as salinity control barriers, ship locks, ice control booms, bridge pier protection (fendering systems), hurricane barriers, sediment traps, and other similar control works.

2-3. Planning Procedure. The following checklist should be used during preliminary project planning:

a. Review appropriate HQUSACE Engineer Regulations (ER's), Engineer Manuals (EM's), and Engineer Technical Letters (ETL's).

b. Consult with local port authority, pilot associations, and harbor terminal users.

c. Collect and analyze pertinent physical and environmental data.

d. Review appropriate local pilot or captain ship maneuvering strategy and evaluate existing project navigation conditions.

e. Determine volume and type of ship traffic and largest ships to be accommodated.

f. Determine volume and type of commodity that will be moved.

g. Determine amount, type, and frequency of hazardous cargo (liquified natural gas (LNG), ammunition, oil, radioactive, etc.) movement and evaluate special requirements.

h. Select and list the required project design operational conditions.

i. Select channel layout and alternative dimensions to be considered and determine advantages and disadvantages with annual costs.

j. Assess any adverse environmental and other impacts.

k. Define environmental mitigation needs and enhancement opportunities, especially beneficial uses for dredged material.

2-4. Design Considerations. The amount and type of ship traffic that will use the navigation channel are very important in project planning and design. The project economic considerations will require information on commodities moved by the ship traffic. The designer will use information on the type of traffic to select the design ship, which is usually the largest ship of the major commodity movers expected to use the project improvements on a frequent and continuing basis. The amount of ship traffic and the length of access channel will determine the mode of navigation traffic to be provided, whether one-way or two-way. Consideration should also be given to providing one-way traffic for large ships and two-way traffic for smaller vessels, and providing channel segments with passing lanes. The designer should consider a stepped channel with different depths for loaded ballasted ships. Project layouts should be prepared using various channel alignments and dimensions and each alternative evaluated on the basis of economic efficiency involving commodity tonnage moved, ship transit time, safety, environmental and social impacts, and construction and maintenance costs.

2-5. Project Safety. The designer must consider and include aspects of project safety, efficiency of ship operations, and reliability of the proposed project. Safety of the project will depend on the size and maneuverability of the ships using the waterway, size and type of channel, aids to navigation provided, magnitude and direction of currents in the waterway, wind and wave effects, and experience and judgment of the local pilots. Since human factors (pilot skill and diligence) are involved in navigation channel safety and are difficult to evaluate, potentially hazardous conditions should be eliminated in the project design insofar as practicable. Therefore, optimum design of a specific waterway will require an evaluation of the physical environmental conditions, especially the currents and weather conditions and judgment of safety factors based on local pilot information.

2-6. U.S. Coast Guard. Consultations should be conducted with the local Coast Guard office in both the preliminary and final design processes. Their views on navigation channel and bridge safety, ship maneuverability, navigation traffic management, navigation operational restrictions, and optimum placement of aids to navigation should be incorporated into the design and presented in appropriate reports and design memoranda.

2-7. Physical Data. The design of a navigation project will require the collection, analysis, and evaluation of information on many aspects that impact project design. The following data are required:[1]

a. Design ship.

(1) Type, *size*, and dimensions (length, beam, draft).

(2) Maneuverability and normal operational speed.

(3) Engine type and power rating.

(4) Bow and/or stern thrusters—power and thrust.

(5) Number and frequency of transits.

(6) Type of cargo handled.

(7) Cargo load condition (trim and draft).

(8) Number and size of screws and rudders.

(9) Definitive maneuvering trial or computed data.

(10) Ballasted operation condition (trim and draft).

b. Waterway traffic.

(1) Ship size variation for present and future channel.

[1] Many of the design factors may be seasonal, including the ship traffic volume and size mix. Seasonal variations in traffic mix and other parameters, e.g., wind, waves, fresh water inflows, etc., should be identified in the data gathered.

(2) Smaller vessel use and congestion.

(3) Navigation cross-traffic condition.

(4) Ship meeting, passing, and overtaking.

(5) High number of small craft (sailing ships, fishing vessels).

c. Weather.

(1) Visibility, day or night transits.

(2) Frequency of fog, smog, snow, storms.

(3) Ice conditions (thickness, duration, extent).

(4) Rainfall and temperature.

d. Currents.

(1) Speed, direction, and duration--flood and ebb.

(2) Astronomical tide and/or river flow.

(3) Tide height/current relation.

(4) Wind tide--induced currents.

(5) Current variation with depth.

e. Wind and waves.

(1) Wind force, direction, and duration.

(2) Wind generated waves--heights, period, length, direction, duration, and frequency.

(3) Wind variability or gustiness.

(4) Swell waves--heights, period, length, direction, duration, and frequency.

(5) Waves from passing vessels.

(6) Surges and seiching in berthing areas, particularly where containerships are loaded and unloaded.

f. Navigation constraints.

(1) Obstructions--sunken vessels, abandoned structures.

(2) Overhead bridges and power line crossings--location, type, and clearances.

(3) Dredging operations--location and frequency.

(4) Visible obstructions--high banks, headlands.

(5) Turns and curves with crosscurrents.

(6) Strong changes in banks and currents--ends of jetties, side channels, and anchorages.

(7) Shipyards, terminals, and other moored ships.

(8) Small-craft harbors and marinas.

(9) Underground pipelines and cables--location, type, and clearances.

g. Water level.

(1) Tidal variation--range, type of tide (diurnal, semidiurnal, or mixed).

(2) Tide datum plane--average high and low water.

(3) Upland river inflow--frequency and duration of effect.

(4) Abnormal high and low hurricane, storm surge, and wind tide.

h. Channel data.

(1) Channel and overbank hydrography.

(2) Channel cross section (canal, trench, shallow water).

(3) Alignment and configuration--turns and curves.

(4) Channel depth, width, and side slopes.

(5) Navigation traffic pattern (one-way, two-way).

(6) Dock and pier configuration--open (piles) or closed (solid, filled construction), finger piers, parallel to channel berthing.

(7) Length of channel.

(8) Intersecting lanes, one-way sections in two-way channels, passing areas in one-way channels.

(9) Approach fairways

i. Operational factors.

(1) Limits for ship transit operations--wind, daylight/night, tide height, current window.

(2) Limits for ship sizes.

(3) Bar closure--waves, fog, and wind.

(4) Required underkeel ship clearance.

(5) Ship traffic daily variation.

(6) Speed reduction to increase safety.

(7) Tidal advantage--riding high tide for larger draft.

(8) Ship lightering--offloading to smaller ships, boats, barges.

(9) Required spacing between ships in tandem.

j. Geotechnical.

(1) Stability of side slopes.

(2) Dredging conditions--hazardous, toxic, and radioactive waste (HTRW), and other polluted material.

(3) Subsurface bedrock.

(4) Soil properties--bed and bank material (soft, fluid “mud,” or hard).

k. Sedimentation.

(1) Rate of and tendency for siltation.

(2) Sediment sizes and distribution.

(3) Movement--scour and shoal areas.

(4) Source of sediments--upland or littoral.

(5) Sediment management facilities and techniques.

l. Water quality.

(1) Salinity distribution and variability.

(2) Dredge disposal areas.

(3) Biological population--type, density, and distribution.

(4) Environmentally sensitive areas.

m. Special concerns.

(1) Large change in channel alignment.

(2) Substantial increase in ship size or load or change in type.

(3) Major increase in port or terminal ship traffic.

(4) New port with new pilots.

(5) Effectiveness of proposed plans to deliver benefits.

(6) Known safety problems.

n. Design opportunities.

(1) Channel curves--changing to straight segments.

(2) Channel width--review for possible reduction or need, for local wideners.

(3) Duplicate channels--ensure absolute requirement.

(4) Multiple turning basins--possible reduction of number.

(5) Anchorage areas--determine usage and possibly abandon some.

o. Support services.

(1) Licensed pilotage.

(2) Tug availability--power, number, and bollard pull.

(3) Aids to navigation--buoys, channel markers, and range markers.

(4) Vessel traffic service--advisory or control.

(5) Information availability (hydrological and hydrometeorological data).

(6) Dredging and charting services--frequency, accuracy.

2-8. Typical Engineering Studies. The following list gives some examples of topics that require detailed coverage in normal navigation project design. More information on some of these topics is presented in subsequent portions of this manual.

a. Design ship.

b. Water level.

c. Currents.

d. *Waves.*

e. *Sedimentation.*

f. *Channel depth.*

g. *Channel width.*

h. *Channel alignment.*

i. *Dredging and disposal.*

j. *Turning basins.*

k. *Entrance channel.*

l. *Jetties and breakwaters.*

m. *Environmental impacts.*

n. *Accident record.*

o. *Pilot interviews.*

p. *Aids to navigation.*

q. *Model testing.*

(1) Hydraulic/tidal.

(2) Sedimenation.

(3) Salinity.

(4) Water quality.

(5) Ice.

r. *Ship simulation study.*

s. *Operation and maintenance plan.*