Final Report

Deep-Draft Navigation Channel Design: Summary & Analysis of Design & Maintenance Survey Results

Part 1 of 2

A Document Prepared in Fulfillment of Milestone Number 5
of the U.S. Army Corps of Engineers' R&D Work Unit Entitled

Impacts of Navigation Trends on Channel Usage and Design

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Executive Summary

This report presents and summarizes the findings of several face-to-face and mail surveys of U.S. Army Corps of Engineers (USACE) personnel performed during 1998-1999 regarding deep-draft channel design and maintenance practices, polices and guidance. This effort was undertaken as part of the USACE Institute for Water Resources' R&D work unit entitled, "Impacts of Navigation Trends on Channel Usage and Design."

Representatives from districts, divisions, the USACE Waterways Experiment Station (WES) and USACE headquarters with expertise in one or more aspects of the channel design process provided responses to the surveys. Most of the district interviews were conducted face-to-face, the division surveys were all mail-in surveys, and both the WES and headquarters surveys were conducted face-to-face. Within each district, respondents represented planning, engineering and operations functional groups. Survey question topics included:

- design vessel and vessel mix,
- environmental design parameters,
- channel design methods,
- special interest projects,
- operation and maintenance decision-making, and
- general conclusions, recommendations and suggestions from the respondents.

The text portion of this report is presented as "Part 1," which includes summaries and discussions of the responses received. The appendices comprising "Part 2" include the survey questions as presented to the respondents and their responses to the surveys. The results from these surveys are used throughout other portions of the parent project; however, these survey results in themselves provide a significant stand-alone statement.

Many significant findings about channel design and maintenance practices have been extracted from the surveys and appear in the results and conclusions sections of this report. Perhaps the most notable lie within the issues of technical review and the divisional impact on district projects. Each channel design project must undergo independent technical review; however, how and by whom this technical review is performed varies between districts. The divisions' impacts on channel design and, in particular, O&M plans appears unclear. In response to the question "What impact do you have on the final O&M plan?," six of eight division respondents did not (or could not) provide a direct answer. As further discussion in the text reveals, district personnel seem to want more technical guidance, references and/or technical consistency within the Corps structure.

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Abbreviations and Acronyms

ITR	Independent Technical Review
N.A.	not applicable
N.Q.	not queried
N.R.	no response
O&M	Operations and Maintenance
PED	Preconstruction, Engineering and Design
PIANC	Permanent International Association of Navigation Congresses
PMCL	Planning and Management Consultants, Ltd.
QA/QC	Quality Assurance / Quality Control
USACE	U.S. Army Corps of Engineers
WES	Waterways Experiment Station

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1. Introduction

This report presents and summarizes the findings of several face-to-face and mail surveys of U.S. Army Corps of Engineers (USACE) personnel performed during 1998-1999 regarding actual deep-draft channel design and maintenance practices, polices and guidance. This effort was undertaken as part of the USACE Institute for Water Resources' R&D work unit entitled, "Impacts of Navigation Trends on Channel Usage and Design."

Representatives from districts, divisions, the USACE Waterways Experiment Station (WES) and USACE headquarters with expertise in one or more aspects of the channel design process provided responses to the surveys. Most of the district interviews were conducted face-to-face, the division surveys were all mail-in surveys, and both the WES and headquarters surveys were conducted face-to-face. Within each district, respondents represented planning, engineering and operations functional groups. Survey question topics included:

- design vessel and vessel mix,
- environmental design parameters,
- channel design methods,
- special interest projects,
- operation and maintenance decision-making, and
- general conclusions, recommendations and suggestions provided by the respondents.

Details on all of the survey instruments and their development appear in PMCL's report, "Navigation Channel Design and Maintenance: Summary of Survey Instrument Design and Test Interviews" [December 1998]. For details on the survey execution, as well as pre- and post-survey activities, see PMCL's report, "Implementation of the Navigation Channel Design and Maintenance Survey" [July 1999].

1.1 Discussion of the Appendices to this Report

Appendix A includes the survey instruments (questions) as presented to the districts, divisions, WES and headquarters. The Baltimore and Norfolk district interviews were performed using a test survey, which differed slightly from the district survey used in the other district interviews.

Responses were subsequently documented in a survey response database by PMCL. Inspection of this database by the present authors revealed significant errors and inconsistencies in transcription that required correction before the survey results could be analyzed and promulgated. To this end, all existing audio tape recordings of face-to-face interviews and available hand-written records taken during the interviews were reviewed and necessary changes to the original database have been made. These updates are included in the present report and its appendices. In short, the authors of this report have

made considerable effort to ensure that the information contained herein is as accurate as possible.

Appendices B and C include the district survey responses. These are essentially raw responses, with direct name references removed. For example, if a survey respondent answered, "I don't know – Joe [from Operations] has those numbers," the answer would appear as "I don't know – Operations has those numbers." Appendix B presents the results grouped by districts; i.e., all questions and responses from one district appear, then the questions and responses from the next district appear, and so on. Appendix C presents the results grouped by questions; i.e., all responses to question 1 appear, then all responses to question 2, and so on. Although Appendices B and C are redundant, it is useful to have the responses in both formats for ease in interpretation of the results.

Appendix D presents the division, WES and headquarters survey responses grouped by division/WES/headquarters; i.e., all questions and responses from one division appear, then the questions and responses from the next division appear, and so on.

1.2 Interpretation of the Survey Responses

The responses to the survey questions do not necessarily reflect the complete official policy or procedure of the organizational group (district, division, etc.) represented. For example, when asked about vessel parameters that affect the design of the channel, if a respondent did not include "maneuverability" within the response, it does not mean that the district design procedure neglects vessel maneuverability in designing a channel. It usually means that maneuverability was not forefront in the respondent's mind. What is most important is usually what was said during a response – not what was omitted.

It is important to mention that the forthcoming information was gathered in order to ultimately make recommendations for improving channel design and maintenance policies, guidance and procedures. Respondents were assured that the survey was not meant to be an examination of their competence or as a check on their procedures; rather, it was intended to serve as a realistic insight into actual design practices. The respondents' responses and their general participation in these surveys should not have any negative impacts on them as individuals nor on the functional or organizational group they represent.

2. Location Summary of Surveys Conducted

Nearly all USACE districts and divisions involved in deep-draft navigation channel design and maintenance were surveyed, along with WES and headquarters. In total, 36 face-to-face interviews at 18 discrete locations (16 districts, plus WES and headquarters) were conducted and 10 of 12 mail-in surveys were completed (8 divisions plus 2 of 4 districts). A graphic showing the distribution of face-to-face and mail-in surveys appears in Figure 2-1.

The face-to-face interview effort involved contributions from a team consisting of personnel from the Navigation Analysis Division of the Institute for Water Resources (IWR), the United States Naval Academy (USNA), Planning and Management Consultants, Ltd. (PMCL), and district personnel from the U.S. Army Corps of Engineers, as shown in Table 2-1. Special thanks are extended to all Corps district personnel who were interviewed, as well as to all personnel who returned mail-in surveys, or otherwise offered their expertise to this project. Their time and responsiveness to the research activities involved in this study are respectfully acknowledged.

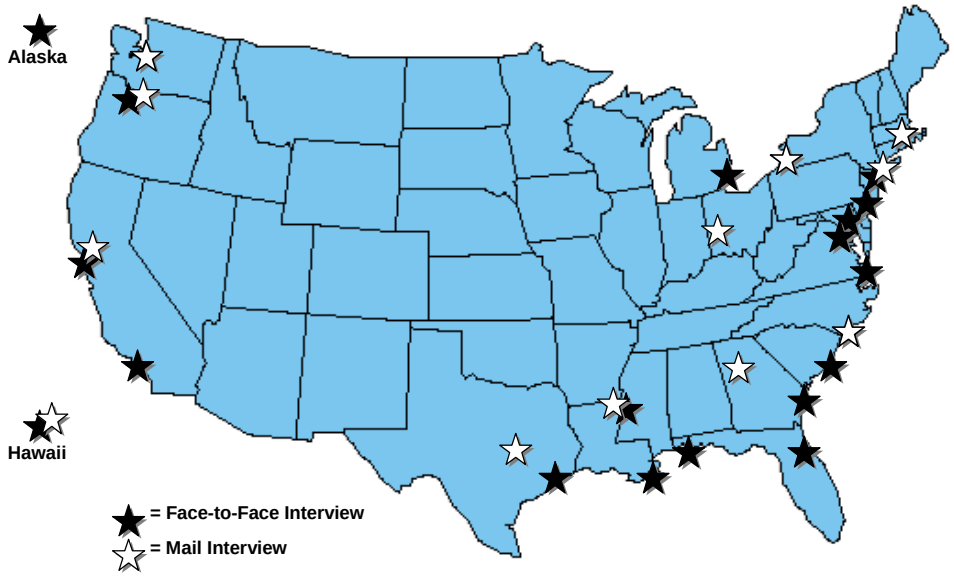

Figure 2-1. Graphic illustrating locations of face-to-face and mail-in surveys.

Table 2-1. Summary of surveys conducted, in chronological order.

District / Division	*Interview Sessions*	*Interview Team*
Baltimore District (NAB) pre-test	3	D.Hayes (PMCL), R. Harrelson (PMCL), J. Waters (USNA)
Norfolk District (NAO) pre-test	3	D. Hayes (PMCL), R. Harrelson (PMCL), J. Waters (USNA)
San Francisco District (SPN)	3	D. Hayes (PMCL), R. Mayer (USNA)
Los Angeles District (SPL)	2	D. Hayes (PMCL), J. Kiefer (PMCL), D. Dunnigan (IWR)
Headquarters	4	M. King (IWR), J. Waters (USNA)
New York District (NAN)	3	R. Harrelson (PMCL), J. Waters (USNA), P. Thorpe (IWR)
Philadelphia District (NAP)	2	R. Harrelson (PMCL), J. Waters (USNA)
Savannah District (SAS)	2	R. Harrelson (PMCL), R. Mayer (USNA)
Charleston District (SAC)	2	R. Harrelson (PMCL), J. Langowski (PMCL)
Jacksonville District (SAJ)	2	R. Harrelson (PMCL), D. Kriebel (USNA)
Mobile District (SAM)	1	R. Harrelson (PMCL), M. King (IWR)
Galveston District (SWG)	1	R. Harrelson (PMCL), J. Waters (USNA)
New Orleans District (MVN)	2	R. Harrelson (PMCL), J. Langowski (PMCL), J. Waters (USNA)
Alaska District (POA)	1	R. Harrelson (PMCL), M. King (IWR)
Honolulu District (POH)	1	R. Harrelson (PMCL), J. Waters (USNA), K. Knight, San Francisco District
Portland District (NWP)	1	J. Langowski (PMCL), M. King (IWR), D. Kriebel (USNA)
Detroit District (LRE)	2	J. Langowski (PMCL)
Waterways Experiment Station (WES)	1	R. Harrelson (PMCL), M. King (IWR), D. Kriebel (USNA), R. Mayer (USNA)
South Atlantic Division (SAD)	(Mail-in)	(PMCL)
South Pacific Division (SPD)	(Mail-in)	(PMCL)
Northwestern Division (NWD)	(Mail-in)	(PMCL)
Great Lakes and Ohio River Division (LRD)	(Mail-in)	(PMCL)
Pacific Ocean Division (POD)	(Mail-in)	(PMCL)
Southwestern Division (SWD)	(Mail-in)	(PMCL)
Mississippi Valley Division (MVD)	(Mail-in)	(PMCL)
North Atlantic Division (NAD)	(Mail-in)	(PMCL)
Wilmington District (SAW)	(Mail-in)	(PMCL)
New England District (NAE)	(Mail-in)	(PMCL)
Buffalo District (LRB)	(Mail-in)	(N.R.)
Seattle District (NWS)	(Mail-in)	(N.R.)

3. Survey Results

The raw results from the surveys appear in the appendices to this document. Summary results and tabulations appear in the following subsections.

3.1 District Survey Results

The complete district survey results appear in Appendix B (in district order) and Appendix C (in question order). In this present section, the results from the district surveys have been summarized and presented as succinctly as possible. Note that districts may have more than one response for a particular question. And, occasionally the multiple responses may seem to conflict. This is primarily[1] because representatives from two or more functional groups were interviewed separately and either the respondents (1) interpreted the question differently and/or (2) responded to the question with respect to what is done in their particular functional group, which actually may differ from what occurs in another functional group. For example, question D2, "Do you select a single design vessel or a statistical mix of vessels …?" may truly yield different responses depending on who is answering the question. An economist or planner naturally must look at the entire fleet of vessels calling on the port and perform an analysis [statistical or otherwise] on multiple vessels; whereas an engineer often chooses a single [usually large] vessel when determining channel dimensions. Therefore, it follows that a planner's response to the question may be "multiple vessels," and the engineer's response may be "single vessel." More discussion of the responses, including such conflicts, appears in the following "Summary and Conclusions" section.

In this section of the report, each question is listed and then usually followed by a table summarizing the responses received. For ease of reference and clarification, each response is attributed to the respective district using a one-letter district designation, as shown in Table 3-1. The lettering convention is essentially the first letter of the district name, with a few exceptions due to conflicts.

Table 3-1. One-letter USACE district abbreviations used in survey results summaries.

A	Alaska	**H**	Hawaii	**P**	Philadelphia
B	Baltimore	**J**	Jacksonville	**R**	Portland
C	Charleston	**L**	Los Angeles	**S**	San Francisco
D	Detroit	**M**	Mobile	**V**	Savannah
E	New England	**N**	Norfolk	**W**	Wilmington
G	Galveston	**O**	New Orleans	**Y**	New York

[1] Human error in responses is also a possibility. Most of these surveys were conducted face-to-face, often without reports, guidance, documentation, etc. on-hand. However, all respondents were chosen as competent experts actively involved in channel design and/or maintenance, and their perceptions on channel design and maintenance issues, whether or not in complete accordance with the district's official procedures or policies, is still significant.

3.1.1 Overview Question

D1. Considering all phases of design, reconnaissance, feasibility, preconstruction, engineering, and design (PED), and construction, briefly describe the overall process you use to design deep draft navigation channels and your role in the design process.

The primary purpose of the overview question was to help the respondent begin considering all aspects of channel design and maintenance and to more clearly explain to the interviewers the aspects in which they are most involved. As mentioned previously, the content and depth into which the survey respondents answered each question varied greatly. However, most district respondents either stated or supported the following general channel design process summary:

- First, a request is made from a sponsor in response to a need; study authorization is obtained.
- A reconnaissance phase is initiated to determine if there is federal interest in the project.
- If there is federal interest, the process moves to the feasibility phase in which benefits are more clearly quantified, design alternatives are compared, ship simulation is usually performed, and the best channel design alternative is selected.
- PED is then undertaken and leads to the final plans and specifications of the design. Simulation data is ideally used in this phase to refine estimates of channel dimensions.
- The project is then constructed. In many (but not all) districts, the construction contract is administered by the operations and maintenance (O&M) functional group.
- The O&M functional group overseas maintenance and operations of the channel once it is constructed.

Additionally, the following notable findings surfaced:

- Most districts indicated that they follow the Corps guidance fairly directly. In most districts, planning performs most of reconnaissance and feasibility; engineering usually gets involved in projects either during the feasibility or the PED phase.
- During reconnaissance, coordination with representatives from the various user groups (e.g., port authorities, pilots) and other governmental agencies (e.g., environmental, USCG) is essential.
- In many districts, O&M personnel have very little involvement in the design of a navigation channel project until construction or post-construction.
- Although most districts are most often involved in modifying existing projects, Corps guidance is geared towards new construction, not incremental changes. One respondent noted, “Track records on channel improvements are perhaps better than specific channel guidance … if something needs fixing, we can’t really use Corps guidance – we need something based on more practicality.”

- Some districts employ interdisciplinary design teams (i.e., one or more representative(s) from the planning, engineering, O&M, etc. functional groups) throughout all of the design phases. These districts indicated that the varied composition of the team improved not only communication between all functional groups, but also improved the resulting channel design.

3.1.2 Design Vessels and Vessel Mix

D2. Do you select a single design vessel or a statistical mix of vessels when designing a channel?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Single vessel	◆			◆		◆		◆				◆	◆		◆			
Two vessels			◆										◆					◆
Multiple vessels			◆			◆			◆						◆	◆		
Statistical mix		◆			◆		◆	◆	◆	◆	◆	◆				◆	◆	

D2a. How is this design vessel selected?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Largest (or close to largest) vessel from the fleet			◆	◆		◆			◆			◆	◆	◆	◆	◆	◆	◆
Fleet database and historical traffic		◆						◆			◆				◆			
Driven by economics									◆							◆		
Sponsor requests											◆							◆
Other	◆									◆		◆				◆		
Vessel class that represents the highest %age of the fleet, consult with designers; largest vessel recommended by Corps; 95% of fleet could be semi-submersible oil rig; Worst handling characteristics																		

D2b. If a vessel mix is chosen, how is it represented in design?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
As a composite vessel								◆	◆	◆								
As many vessels		◆					◆								◆	◆	◆	
Parametric Approach									◆									

D2c. Do you design for future ships? If so, how far ahead do you plan?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
No		◆		◆										◆		◆		
Yes			◆						◆				◆		◆	◆		◆
Yes, 10 years								◆		◆		◆					◆	◆
Yes, 20 years	◆					◆	◆				◆							

D2d. From what sources do you obtain information regarding ship design or potential use of the channels?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Users (shippers)	◆		◆				◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆
Pilots				◆						◆			◆		◆		◆	◆
Trade journals			◆					◆		◆					◆		◆	◆
Shipping records						◆				◆			◆		◆			
Port authorities			◆	◆				◆		◆		◆				◆		◆
Lloyd's								◆							◆	◆	◆	
IWR			◆		◆			◆									◆	
Consultants						◆									◆	◆		
Waterborne commerce data						◆						◆						
Builders																◆		◆
Other:				◆	◆													◆
Greenwoods (vessel dimensions); Coast Guard; public notices																		

D3. What are the significant design parameters of the design vessel and the vessel mix?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Draft	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Beam	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Length	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Maneuverability	◆			◆	◆	◆	◆				◆	◆	◆			◆		◆
Type		◆	◆						◆	◆	◆				◆		◆	
Speed	◆									◆			◆			◆		◆
Environmental factors such as tides and currents				◆	◆						◆			◆	◆			
Air draft															◆	◆	◆	◆
Squat	◆								◆				◆		◆			
Underkeel clearance											◆			◆		◆		
Sail area															◆	◆		
Trim									◆				◆					
Horsepower								◆				◆						
Deadweight															◆		◆	
Other Sponsor wishes; thrusters, number of propellers and rudders; future traffic; TEU; ship routes, frequency of visits; foreign port depth						◆		◆	◆						◆		◆	

D4. How do you determine the value(s) for each significant design parameter?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Users	◆		◆				◆					◆			◆		◆	◆
Design vessel		◆							◆	◆			◆					◆
Corps EM and formulas				◆					◆						◆	◆		
Fleet statistics	◆	◆								◆			◆	◆	◆			
Pilots						◆						◆			◆	◆	◆	
Lloyd's			◆												◆		◆	
IWR															◆		◆	
Models and simulations									◆						◆			
Industry and maritime references								◆			◆							
Other Physical channel limits; waterborne statistics; coast guard; PIANC guidelines; transit study; ship designers; squat and salinity; Fairplay						◆						◆		◆	◆	◆	◆	◆

D4a. Are there any special design tools, software, or standard rules/procedures that you use to make these determinations?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
No	◆						◆					◆					◆	◆
Spreadsheets			◆			◆		◆			◆				◆			
Models and simulations						◆			◆						◆			
Corps EMs and formulas									◆	◆					◆			
WES publications and software									◆						◆	◆		
Other dBase Software and queuing models; pilots, Coast Guard; channel condition reports; ASCE Journals; transit study						◆		◆					◆	◆				

D5. What are the significant environmental design parameters for channel design?

Very significant ❖, significant ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Environmental Laws/Regs:																		
CWA, CZM, ESA, NEPA						◆						◆						
Geologic Parameters/Concerns:																		
Bathymetry										◆								
Bottom material		◆		◆						◆	◆	◆						
Dredge materials/disposal		◆		◆								◆	◆		◆	◆		
Littoral Transport							◆											
Shoaling Rate/Sedimentation										◆			◆			◆		
Hydrodynamic Parameters/Concerns:																		
Currents/Cross-Currents		◆			❖		❖		◆	◆	◆	◆	◆		◆	◆	◆	◆
Tides/Surge		◆	◆		❖	❖		◆	◆	◆	◆	◆	❖					◆
Waves/Swell		◆	◆						❖	◆	◆		◆	◆	◆	◆	◆	◆
Meteorological Parameters/Concerns:																		
Fog/Visibility		◆							◆			◆						
Thunderstorms		◆																
Wind		◆	◆			❖	❖		◆	◆	◆	◆			◆	◆	◆	◆
Other Environmental Parameters/Concerns:																		
Air, Noise, Water Pollution	◆			◆											◆	◆		
Bank effects, Channel suction								◆										
Ice	◆	◆																
Salinity		◆									◆					◆		◆
Saltwater intrusion, SW/FW interface						❖										◆		
Sand waves														◆				
Ship-induced waves								◆								◆		
Shoreline erosion													◆					
Site Features/Concerns:																		
Bridges, Docks, U/W wrecks												◆			◆			
Natural channel configuration/constraints										◆								
Eco-System Concerns:																		
Eco-systems: coral reefs, eel grasses, wetlands	◆		◆				◆					◆				◆		
Wildlife Habitats, general				◆								◆		◆				
Wildlife: birds, crabs, oysters, salmon, seals, turtles, whales	◆	◆	◆			◆	◆					◆		◆	◆			

3.1.3 Environmental Design Parameters

D6. How do you determine the value for each significant environmental design parameter?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Records of tides, winds, waves, currents, shoaling		◆	◆			◆		◆	◆	◆		◆		◆	◆	◆	◆	
Models and Simulations			◆			◆		◆	◆	◆			◆		◆	◆		◆
NOAA and National Weather Service			◆			◆				◆	◆		◆					◆
WES			◆						◆	◆			◆			◆		◆
Ecological assessment	◆			◆			◆			◆		◆						
Corps ER and EM		◆										◆				◆		
Cost												◆				◆		
Pilots											◆					◆		
Other Operating procedures; Fish and Wildlife Department; hydrographic surveys; regulations; consultants		◆					◆			◆	◆	◆						

D6a. Are there any special design tools, software, or standard rules/procedures that you use to make these determinations?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
WES							◆	◆	◆	◆		◆	◆		◆	◆		
Models and simulations							◆		◆				◆		◆	◆	◆	
University assistance		◆										◆			◆			
Info from NOAA and National Weather Service		◆					◆											
Ecological assessment				◆								◆						
Other Environmental regulations; target return periods; beneficial use of material program (BUMP); PIANC guidelines (better than Corps); environmental meetings; pilots; Corps EMs; configure channels along currents						◆		◆			◆	◆	◆	◆	◆			◆

D7. How is the vessel response to environmental design parameters established?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Models and simulations			◆			◆	◆		◆	◆	◆	◆	◆		◆	◆	◆	◆
WES			◆	◆		◆							◆			◆		◆
Corps EM	◆	◆						◆	◆									
Other Pilots; records of arriving vessels; squat									◆						◆			

D7a. How are wind, currents, or waves considered in selecting channel alignment?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Models and simulations			◆	◆		◆	◆	◆	◆				◆	◆	◆	◆	◆	
WES			◆	◆		◆												
Follow existing channel alignment	◆												◆		◆			◆
Pilots							◆		◆				◆					
Not considered / no choice												◆						◆
Historical records																◆	◆	
Other Channel aligned with current; use mean lower low water datum from NOAA; self-scouring channels										◆	◆		◆					

D7b. How are they accounted for in selecting channel alignment?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Models and simulations				◆			◆	◆	◆				◆	◆	◆		◆	
Corps EM and ER	◆						◆						◆					
Cost			◆			◆										◆		
Pilots			◆										◆					
Other Trim and squat; ecological assessment; channel depth and width; NOAA; WES			◆							◆	◆		◆					

3.1.4 Channel Design Methods

D8. How are the values determined for these additional significant parameters?

Vessel Draft

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Design vessel		◆					◆		◆									◆
Survey of the fleet								◆					◆					
Cost			◆	◆														
Users				◆						◆								
Historical information			◆											◆				

Underkeel Clearance

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Pilots						◆	◆		◆				◆			◆		◆
2’ clearance						◆		◆	◆			◆	◆					
Squat				◆					◆									◆
Corps EM										◆			◆		◆	◆		
Bottom condition				◆							◆					◆		
2’ for soft bottom, 4’ for hard bottom										◆								◆
Design vessel			◆						◆									
Cost											◆				◆			
Coast Guard									◆				◆					
Other 10’ clearance; historical database; WES; maritime advisor; transit study; 5’ for soft bottom, 7’ for hard bottom; 4’ clearance; models and simulations	◆	◆							◆				◆	◆	◆	◆	◆	

Vessel Beam

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Design vessel		◆					◆		◆									◆
Survey of the fleet				◆									◆					
Other Lloyd’s; users; historic records			◆							◆				◆				

Vessel Speed

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Pilots			◆	◆				◆					◆	◆	◆	◆		◆
Ship simulations								◆									◆	
Other Corps ERs and EMs; Lloyd's; not considered; Coast Guard; Port Authorities; users; design vessel; survey of the fleet; GPS studies; IWR; tied into underkeel clearance		◆	◆				◆		◆	◆			◆	◆	◆	◆		◆

Density of Water

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Not considered	◆			◆			◆		◆				◆		◆			
Corps ERs and EMs		◆								◆								
Other Historical records; 3d models to find salinity wedge; plan for fresh water and adjust as needed; monitored and adjusted; tied into underkeel clearance; ship simulation models			◆					◆						◆		◆	◆	

Waves, Winds

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Historical records	◆		◆	◆														◆
NOAA and National Weather Service	◆									◆								
Models and simulations								◆									◆	
Other WES; STWave models; Corps ERs and EMs; not considered	◆	◆												◆				

Tides, Currents

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Models and Simulations	◆									◆							◆	
NOAA	◆															◆		
Other WES; Corps ERs and EMs; historical information; not considered; included in locally preferred depth; "very important;" use mean lower low tide; USGS	◆	◆	◆	◆					◆					◆	◆	◆		

Ship-Induced Waves

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Not considered							◆		◆						◆	◆		
Ecological assessment				◆		◆								◆				
Other Software; standard guides; from design vessel; users; theoretical analysis; WES; pilots; ship simulation models			◆						◆	◆		◆	◆				◆	◆

Vessel-Bank Clearance

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Corps		◆					◆		◆	◆		◆	◆			◆		◆
Models and simulations						◆	◆					◆			◆		◆	
Not considered									◆					◆		◆		
Pilots													◆	◆				
Other Included in design output; users; WES; PIANC guidelines; benefit/cost ratios; physical restrictions; GPS studies; requirements from local authorities			◆	◆		◆					◆		◆	◆	◆			◆

Vessel-Vessel Clearance

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Corps		◆					◆		◆	◆		◆	◆					◆
Models and simulation						◆	◆		◆								◆	
One-way traffic															◆	◆		
Other Included in design output; users; WES; PIANC; benefit/cost ratios; pilots; not considered			◆	◆		◆					◆		◆	◆				◆

D8a. Are there any special design tools, software, or standard rules/procedures that you use to make these determinations?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
No	◆			◆			◆	◆		◆			◆					
Models and simulation									◆			◆		◆	◆		◆	
Corps manuals									◆							◆		◆
Surveys and studies												◆		◆				
WES						◆										◆		
Other Automated Coastal Engineering Systems (ACES); insurance companies; PIANC guidelines			◆															◆

D9. Are there any other significant channel design parameters not covered above?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
No						◆	◆						◆					◆
Traffic		◆	◆														◆	
Shoaling								◆		◆		◆						
Ice	◆			◆														
Other Visibility, shipboard navigation, tidal direction; historic records; WES; vessel exposure (distance from shore), seiche (wind or pressure setup that can change lake levels), lake levels; tides; currents; vessel beam; deadweight; number of screws, rudders, and thrusters; age; submerged area; sail area; land-side facilities; vessel length; navigation constraints; soil type; future O&M requirements; dredging and disposal; sand waves; channel width; bank erosion; adjacent channels; estuaries; uneven banks; varying depths; underwater naval sensors; utilities; property rights; tunnels; firing ranges; sloping bottom condition; pilot influence; ocean entrance swells; side slopes; channel usage; rock tolerance	◆		◆	◆				◆	◆	◆	◆	◆		◆	◆	◆		

D10. How do you determine the values for those other significant channel design parameters?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Corps		◆														◆		
Users								◆		◆								
Surveys								◆		◆								
Models and simulations		◆													◆			
Other Pilots; Lloyd's, design vessel; WES, borings, records of shoaling, environmental agencies; work with economists and proponents; river forecasting system, National Weather Service; 3 on 1 for side slopes; initial over-dredging; passing lane study	◆		◆							◆	◆			◆	◆	◆	◆	

D11. How do you choose the appropriate design variables (value) for the following components of a channel.

D11a. Channel cross-sections (depth, width, side slopes)

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Soil type for side slopes			◆				◆	◆	◆	◆	◆		◆		◆	◆		◆
Existing channels				◆					◆		◆	◆			◆	◆		◆
Models and simulation [width]			◆						◆	◆			◆			◆	◆	
Cost [depth]			◆			◆		◆			◆		◆			◆		
1:3 to 1:5 side slope								◆	◆				◆		◆	◆		◆
Design vessel	◆						◆			◆			◆			◆		
Corps									◆	◆		◆			◆			
Engineering design criteria						◆		◆			◆							
Other Historic water levels for depth; NED or local plan for depth; advanced maintenance; traffic and maneuverability for width; natural channel alignment; 1:1 side slope for rock; width and depth from initial design; work with users for depth; GPS; pilots; 1-2%side slopes				◆					◆	◆	◆	◆		◆				◆

D11b. Channel Bends

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Models and simulations			◆			◆		◆	◆	◆			◆		◆	◆	◆	◆
Corps	◆			◆						◆					◆			◆
Existing channels	◆								◆									
Pilots														◆				◆
Other Maneuverability; users; straight channels; cost; locally preferred plan; GPS; historic safety record			◆	◆			◆	◆	◆					◆				

D11c. Turning basin areas (length, width, depth, side slopes)

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Models and simulations			◆			◆	◆		◆	◆			◆				◆	
Design vessel length and maneuverability	◆							◆		◆					◆	◆		◆
Corps				◆			◆			◆					◆	◆		
Soil type for side slopes										◆					◆	◆		
Tugs			◆								◆					◆		
Pilots													◆		◆	◆		
Current configuration									◆						◆			
Other Cost; users; 1.2-1.5 length of vessel; locally preferred plan; not considered; site parameters; avoid pulling our seagrass			◆	◆				◆	◆					◆	◆			

D11d. Anchorage areas (length, width, depth, side slopes)

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
No anchorage areas or not considered							◆		◆					◆	◆	◆		
Pilots						◆		◆			◆		◆					
Models and simulation						◆				◆							◆	
Mooring method								◆		◆								
Size and number of ships								◆		◆								
US Coast Guard																◆		◆
Other Design vessel maneuverability; users; currents and tides; Corps EM; ship length	◆					◆		◆		◆			◆					

D12. How do you determine the change in maintenance dredging needed as a result of a change in the design of an existing channel component?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Records of maintenance and shoaling	◆		◆	◆	◆	◆		◆	◆	◆		◆	◆	◆	◆	◆		
Models and simulation			◆					◆				◆				◆	◆	◆
Other	◆		◆				◆			◆						◆		
Grain size, theory of scour and shear force; impact on future maintenance; no river so not an issue; WES; changes to freshwater/ saltwater interface																		

D13. How is the layout of the channel determined?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Follow existing channel	◆	◆	◆	◆		◆			◆	◆	◆	◆	◆		◆	◆		◆
Geographic features such as deep water		◆						◆		◆	◆		◆	◆				
Models and simulation		◆				◆			◆							◆	◆	◆
Cost		◆	◆					◆			◆							
Pilots											◆					◆		◆
Corps		◆														◆		
Users		◆		◆														
Access to port facilities			◆						◆									
Other							◆		◆	◆		◆						
Short and straight channels; harbor resonance; environmental mitigation; avoid environmental resources; hydrographic surveys																		

D14. How are decisions regarding single or multi-lane (passing) traffic made?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Cost		◆	◆			◆			◆	◆		◆	◆		◆	◆		
Amount of traffic	◆			◆					◆	◆			◆					◆
Pilots		◆						◆			◆		◆			◆		
Models and simulation						◆			◆			◆	◆					
Users						◆	◆		◆									
Geographical restrictions	◆		◆															
Port authorities		◆							◆									
WES						◆			◆									
Designed for multi-lane							◆							◆				
Other		◆								◆		◆			◆		◆	
Corps; ecological considerations; Coast Guard regulations; not an issue; passing lane study																		

D15. How do local sponsors in your district, such as port authorities, carriers, local and state governments, influence the final dimensions of channels?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Cost-sharing partners	◆	◆	◆	◆		◆		◆	◆			◆	◆			◆		◆
Port authority involvement		◆	◆	◆				◆	◆				◆	◆	◆	◆		◆
Shipper demands	◆			◆		◆			◆						◆	◆		
Pilot requests			◆									◆	◆		◆	◆	◆	
Environmental regulation				◆						◆					◆			◆
Design vessel							◆								◆			
Other					◆		◆	◆	◆		◆		◆					◆
NIMBY; access to port facilities; sponsor payment for bigger channels; they have little influence; speed of project construction; “quite a bit of influence,” loss of lightering business																		

D16. What procedures are used to account for the risk and uncertainty in channel design?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Future shipping and fleet analysis		◆				◆			◆	◆					◆	◆		◆
No procedures						◆			◆		◆		◆	◆				◆
Models and simulations		◆	◆				◆		◆								◆	
Sensitivity analysis							◆	◆		◆					◆			
Wind, wave, and tide analysis	◆															◆		
WES			◆					◆										
Pilot wishes												◆						◆
2' underkeel clearance			◆												◆			
Other Channel fleet; 1' underkeel clearance for hard bottoms; Corps ER 1105-2-100; "the Corps should probably have more guidance on utilization of risk and uncertainty in channel design;" historical records; IWR		◆		◆						◆				◆	◆			◆

D17. Do you use ship simulation during the design process?

D17a. If so, what types and at what stage of the design process?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
No							◆											
Yes	◆	◆	◆	◆		◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Phase: not specified	◆			◆		◆		◆				◆			◆			
Phase: feasibility and/or pre-feasibility			◆					◆	◆	◆	◆	◆			◆	◆		◆
Phase: PED		◆							◆		◆	◆	◆	◆	◆	◆	◆	◆
Type: not specified	◆			◆		◆		◆	◆		◆	◆	◆		◆	◆	◆	◆
Type: WES		◆	◆						◆	◆	◆		◆		◆			◆
Type: non-WES, e.g., CAORF, Star									◆						◆			
Type: GPS has replaced ship simulation														◆				

D17b. What input does the District provide to carry out simulations?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Design vessel			◆	◆		◆		◆	◆				◆		◆	◆		
Channel bathymetry, buoys				◆					◆			◆		◆	◆	◆	◆	
Pilots			◆			◆			◆		◆			◆			◆	◆
Environmental conditions								◆	◆		◆	◆			◆	◆		
All of the data			◆							◆								

D17c. What information is gained from these simulations?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Channel width, alignment and optimization		◆	◆	◆		◆			◆		◆		◆		◆		◆	◆
Safety of design		◆						◆	◆	◆		◆		◆	◆			
Maneuverability (speed, rudder angle)		◆	◆	◆				◆						◆		◆		
Traffic						◆			◆					◆				
Increase pilot confidence												◆					◆	
Other Current, salinity, sedimentation; sell project to public			◆												◆			

D17d. How useful is this information (i.e., simulation output) in the final design?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Finds necessary alterations		◆	◆	◆					◆	◆		◆			◆	◆		
Very useful			◆	◆					◆			◆			◆	◆	◆	
Somewhat useful						◆		◆		◆			◆			◆		◆
Not useful									◆					◆				

D18. What district-specific guidance (such as "rule of thumb"), other than Corps manuals, ERs, texts, and/or software, do you use during channel design? *Can you provide document numbers or titles for USACE documents that you utilize?*

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
None	◆		◆			◆	◆	◆					◆				◆	
Use pilots' underkeel clearance									◆							◆		
ER 1105-2-100										◆					◆			
Other 40' clear depth approach and 5' bridge clearance; MARAD "Merchant Fleet Forecast of Vessels in U.S. – Foreign Trade;" align channel with the river naturally; PIANC guidelines; 5' advanced maintenance dredging; beneficial use of dredged material; WES papers; 2' offset on the bar for wave effects				◆						◆		◆		◆	◆	◆		◆

D19. What is the technical review procedure for channel design?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Internal review	◆		◆	◆		◆	◆	◆	◆	◆		◆	◆	◆	◆	◆		◆
External review	◆			◆		◆	◆		◆	◆			◆	◆	◆	◆		
Independent technical review	◆		◆				◆	◆	◆			◆			◆	◆	◆	◆
Bidability, constructability, operability review				◆				◆								◆		
WES				◆			◆											
Other Consultants; Corps HQ; simulations; sponsor review; Coast Guard and pilot review	◆			◆				◆	◆							◆		

3.1.5 Special Interest Projects

D20. What are the piloting requirements of your ports?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
State pilot for all ships			◆	◆		◆		◆	◆	◆			◆	◆	◆	◆		◆
State pilot for foreign ships		◆									◆	◆						◆
Federal pilot for American ships [coastwise]		◆										◆						
Military exempt from pilots		◆	◆															
Other Special pilot required for entrance	◆																	

D20a. Do you consult pilots in the design phase?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

D20b. If so, what ***type*** of pilot information is most helpful in the design phase?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Channel dimensions	◆			◆		◆	◆	◆		◆		◆	◆	◆	◆	◆	◆	◆
Speed and maneuverability			◆	◆	◆	◆			◆			◆	◆	◆	◆	◆		◆
Environmental factors [wind, currents, tides, shoaling, fog]				◆	◆			◆		◆			◆		◆	◆		
Simulations			◆						◆	◆	◆				◆			◆
Traffic patterns			◆						◆			◆	◆					◆
Underkeel clearance								◆	◆						◆	◆	◆	
Channel markers						◆						◆			◆			
Design vessel dimensions					◆													◆

D21. For the following areas of deep-draft projects in your district, please (a) indicate if there are any piloting or safety concerns, (b) state what these concerns are and the specific locations, and (c) rank these areas from 1 as the most problematic to 7 as least problematic area of a channel.

D21a. Navigation Channel

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes	❖	●	◆	❖ ●		◆		❖ ■	❖	●	❖	❖ ◆	●	❖	❖ ◆	■		
No							❖		◆		◆		◆				◆	◆
Channel dimensions	◆	◆	◆	◆						◆		◆	◆			◆		◆
Shoaling and bank shear								◆	◆		◆	◆			◆			
Navigation aids		◆				◆							◆					
Rocks and shoals	◆			◆											◆			

D21b. Turning Basin

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes		⬩	◆	⬩ ◆				❖ ●	◆		■		● ⬩		■ ◆			
No	◆		◆			◆	■		◆	◆	◆	◆		◆		●	◆	◆
Wind, current and tide				◆			◆	◆					◆					
Shoaling								◆	◆						◆			
No turning basins												◆				◆		
Large vessels		◆									◆							
Property									◆						◆			
Other New turning basins are not justifiable; cross-channel; narrow channels			◆	◆												◆		

D21c. Anchorage Areas

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes	■		◆	⬩				◆				◆	■		◆			■
No		⬩		◆		◆	◆	◆	⬩ ◆	◆	⬩ ◆		◆	◆	⬩	⬩	◆	◆
No maintained anchorages			◆	◆					◆					◆				
More anchorages requested			◆								◆	◆	◆					
Coast Guard maintains anchorage								◆				◆						
Other Safety concerns; larger anchorages needed for larger vessels; new anchorages are not justified; cross-currents; problems with bank revetments; shoaling	◆	◆	◆					◆				◆			◆			

D21d. Maneuvering Areas

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes			◆			◆		◆	■	■			■		◆			●
No	◆	◆	◆	◆			◆	◆	◆		⬩ ◆	◆	◆	◆	⬩	⬩	◆	◆
No maneuvering areas	◆			◆									◆	◆				◆
Passing problems						◆		◆					◆					
Current, bank shear, bars and shoaling								◆		◆					◆			
Other Short stopping distance; too narrow (ER has not kept up with vessel changes)									◆			◆						

D21e. Just Seaward of the channel

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes		❖						◆				◆ ■		■	● ◆			◆
No	◆		◆	◆		◆	◆	◆	◆	◆	◆ ⬩		◆		⬩		◆	◆
Currents, drift, waves								◆						◆	◆			
Other Depth, large vessels; entrance; shoaling and maintenance; debris; lighthouse		◆										◆						◆

D21f. Channel/private port interference

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes								❖ ■							◆			■
No	◆	⬩	◆	◆		◆	◆		◆	◆	⬩		◆	◆	⬩	⬩	◆	◆
Other State-owned ports so no interface; docks adjacent to channel; side channels; large vessels stick into the channel when docked; buildup of shops along shore; "No Man's Land"; shoaling							◆	◆	◆			◆			◆			◆

D21g. Turns

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Yes	◆	■	◆	❖ ■		◆		●	❖ ◆		◆	◆	❖ ●	❖	◆	❖	■	❖ ● ◆
No							◆	◆		◆	◆ ●	◆			◆			
Turns too sharp			◆	◆								◆	◆					◆
Channel dimensions	◆								◆							◆		
Shoaling and bank shearing												◆			◆	◆		
Other Currents; passing; maneuvering				◆				◆						◆				

D21h. Other

1❖, 2■, 3●, 4+⬩, unspecified ◆	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Traffic, passing				■			◆			❖	◆	●	❖				❖	
Bridges				■							◆					■		
Navigation aids				●									❖					
Conflict between barges and deep-draft						◆							❖					
Finding the true bottom										❖		●						
Other String shoals; dredge safety; intersections with no turns; captains do not know true draft; dikes; debris								◆	◆			●						⬩

D22. How do you generally learn about accidents/incidents?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Coast Guard	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆		
Media	◆	◆	◆	◆	◆	◆			◆		◆	◆	◆	◆	◆			◆
Word of mouth		◆							◆		◆	◆			◆			◆
Pilots	◆	◆				◆		◆								◆		
Port authority							◆	◆	◆	◆								
Other Shippers; no accidents	◆																◆	

D23. Rate the severity of the accidents/incidents that occur within the following areas of a channel:

❖ severe, ■ moderate, ● minor, ◆ unspecified	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Within navigation channel	●		■	■ ❖	●	●	●	● ❖		●	❖	●	■	● ■		■ ❖	●	■
Within turning basin	●		●			●	●	● ■	●	●	■	●	●			●		●
Within anchorage areas	●		●			●	●	●	●	●	❖	●	●	●		■		●
Within maneuvering areas	●		■	■ ❖		■	●	● ■	●	●	●	●	■			●		●
Just seaward of the channel	●		●				●	● ❖	●	●	❖	●	● ■ ❖			■		●
Channel/private port interface	●		●			■	●	● ■	●	●	■	●	● ■ ❖	●		■		❖
Vessels leaving the channel	◆				●			◆										◆
Bridge				■												❖		◆
At turns		◆												●				
Other Passing; terminal interface; hurricanes; recreational craft; tides; oil barge explosion; damage to private property; oil spills		◆			❖ ●		■	❖										◆

D23a. Approximately how many accidents/incidents per year do these channels experience that can be attributed to channel features such as channel width, depth, bends, and so on? Please provide examples, if available.

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Very few or none			◆			◆	◆		◆	◆		◆	◆		◆		◆	◆
One every 1 to 3 years	◆			◆				◆						◆		◆		◆
Other 2 per year; 15-25 per year				◆							◆							

D24. What are the perceived causes of these accidents/incidents?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Pilot error	◆		◆	◆	◆		◆	◆		◆	◆	◆	◆	◆		◆		◆
Mechanical failure								◆				◆	◆	◆		◆		◆
Wind, current, tides, fog, storms, shoaling				◆				◆		◆					◆			◆
Lack of depth, ships larger than channel design, overloading				◆	◆					◆				◆				
Other Improper position of channel markers; salt water vessels with too much freeboard and improper winches; passing vessels; poor communication between pilot and port			◆	◆					◆									

D25. What historical channel safety problems and/or other problems have been experienced? How have they been fixed? Please provide specific examples.

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Turns and entrances (fixed through reducing angles; widening; tugs; aids to navigation)		◆	◆	◆		◆		◆		◆			◆	◆		◆		◆
Waves, currents, shoaling (fixed through structures; routine maintenance; delivery order contract; re-dredge; new disposal site; alignment adjustment)				◆					◆		◆	◆	◆	◆	◆			
Larger ships than original design					◆			◆			◆							
Problems fixed through economics			◆				◆											
Other Pilot error; underwater pinnacles; few navigation aids; traffic (VTS, communication); private sand mining rather than dredging; Naval vessels; bridges (removal or rebuilding)	◆										◆	◆				◆		◆

D26. What factors and/or unique characteristics of channels in your district presently do or may possibly contribute to safety problems, for example, bridge characteristics, recreational traffic, or communications problems?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Bridge or wire			◆	◆	◆	◆		◆		◆	◆		◆	◆	◆	◆		◆
Recreational craft		◆		◆	◆	◆		◆	◆		◆				◆			◆
Lack of communication		◆							◆		◆	◆						
Shoaling	◆										◆				◆			
Naval ships		◆							◆		◆							
Fishing					◆	◆						◆						
Larger vessels	◆		◆															
Narrow and shallow channels																◆	◆	
Crossing channels										◆								◆
Other Currents, ice, visibility; no problems; severe tides; dikes; underwater tunnels; fog, wind; historic shipwrecks	◆				◆		◆				◆	◆			◆	◆		

D27. Do you foresee any other safety problems arising in your channel(s) in the near term? … in the future? If so, what are they? *(e.g., larger or deeper draft vessels, increased operating speeds, congestion)*

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Larger vessels	◆		◆		◆		◆	◆	◆	◆	◆	◆	◆		◆	◆		◆
Increasing traffic					◆	◆	◆	◆	◆	◆		◆	◆			◆		
Recreational craft				◆									◆	◆		◆		
Containerization									◆			◆	◆					◆
No problems foreseen				◆									◆			◆	◆	
Economic concerns								◆	◆						◆			
Other Equip ships with GPS; desire for efficient and risk-free channels; navigation, lower lake levels; political considerations; ecological concerns; time-constrained ships; communications; shoaling; underwater hazards; awkward piers	◆		◆	◆				◆	◆			◆		◆	◆			

D28. When a channel problem is identified, what process do you use to remedy the problem?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Work within operations and maintenance when possible	◆	◆		◆						◆			◆			◆		◆
Larger problems treated as new project									◆					◆	◆	◆		◆
Study					◆			◆			◆		◆					
Hydrographic survey	◆														◆			◆
Congressional authorization for large projects		◆									◆							
Handled by continuing authorities											◆							◆
Other Coast Guard navigation aids; things happen too slow; any authorization possible; problem-solving team; operations coordinates with engineering; emergency dredging authority; ship simulation; the state takes care of it		◆	◆			◆				◆				◆	◆		◆	

D28a. How long does the process take from problem identification to action, and from action to problem resolution?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Over 2 years for action, many years for resolution			◆	◆	◆	◆		◆			◆		◆		◆		◆	◆
Few days for action (emergency/shoaling/blockage)	◆	◆		◆					◆		◆	◆	◆	◆		◆		
1 to 3 months for resolution (emergency/shoaling)	◆		◆	◆											◆			
6 to 12 months for action		◆							◆						◆			
1 to 2 years for action, 1 to 2 years for resolution	◆													◆				
Depends on the complexity of the problem/type of project/environmental factors										◆						◆		
Other Delivery order contracts can save 90 days											◆							

D28b. What external factors impact the speed of the resolution process? To what extent do they impact the speed of the resolution?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Ecological issues and environmental agencies (slow)	◆	◆	◆					◆	◆	◆					◆	◆	◆	◆
Sponsors (slow. accelerate)	◆		◆	◆	◆					◆							◆	◆
Funding (slow, determines speed, accelerate)	◆		◆			◆		◆	◆									◆
Politics (slow, accelerate)		◆						◆		◆				◆				◆
External coordination (slow)								◆	◆						◆			◆
Authorization, approval, regulation (slow)										◆	◆							
Equipment availability (slow)												◆				◆		
Dredged materials (slow)									◆									◆
Other Weather (slow); strong opposition (slow); natural disaster (slow); safety issues (slow); continued authorities (slow); emergency situations (accelerate); size of the problem; simulations and subsurface investigations (slow)	◆		◆								◆		◆			◆	◆	◆

3.1.6 Operations And Maintenance Decision-Making

D29. How are decisions on the schedule, scope, and specifications of maintenance dredging determined?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Condition surveys	◆		◆	◆	◆		◆		◆		◆	◆	◆			◆	◆	◆
Historical dredging cycles and shoaling rates						◆	◆	◆		◆		◆	◆	◆	◆	◆		◆
Ecological concerns	◆		◆		◆					◆	◆				◆	◆	◆	
Funding guidelines				◆				◆				◆					◆	◆
Channel usage, traffic, future needs of the port						◆								◆				◆
Storms and inland conditions										◆					◆			
Other Local user feedback; annual maintenance schedule; equipment availability; customer need			◆	◆			◆										◆	

D29a. Who is involved, to what extent, and what are their responsibilities?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Construction and operations	◆			◆	◆	◆	◆	◆	◆	◆			◆	◆	◆	◆	◆	◆
Project management division or manager	◆		◆					◆	◆	◆		◆					◆	
Engineering	◆		◆	◆	◆	◆		◆					◆					
Environmental agencies and groups					◆											◆	◆	
Planning					◆				◆							◆		
Contracting division	◆					◆												
Other Real estate division; state port authority; sponsors; customers; navigation section	◆		◆		◆											◆	◆	

D30. How do budgetary limits affect O & M dredging decisions in your district?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
High priority areas are dredged, low priority areas are not								◆	◆	◆	◆			◆	◆			
Not a problem					◆		◆					◆						◆
Maintenance dredging is spread into many years	◆			◆				◆										◆
Less dredging than planned									◆								◆	
Other Reprogram funds; lobby for more money			◆												◆			

D30a. What happens if a budgetary limit arises?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Maintenance is delayed or backlogged	◆			◆	◆			◆			◆		◆				◆	◆
Money from political interests					◆				◆	◆							◆	◆
Redistribution of funds from other projects			◆		◆					◆					◆		◆	
Less dredging																◆	◆	
Other Dredging stops; projects are prioritized									◆					◆				

D30b. Who decides which projects will be dredged each year?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Operations	◆			◆		◆		◆	◆	◆	◆			◆	◆	◆		◆
Project management or chiefs	◆		◆					◆		◆		◆	◆	◆				
Engineering			◆	◆				◆			◆						◆	
Within the district									◆	◆							◆	◆
Customers					◆				◆	◆	◆							

D30c. To what extent do these budgetary limits affect decisions? Please cite examples.

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Delayed and phased maintenance	◆			◆					◆	◆				◆				
Some projects are not fully maintained								◆			◆				◆		◆	◆
No effect					◆				◆			◆			◆			◆
Other Urges proponents to find money; scope of work is reduced			◆							◆								

D31. Are all your navigation projects dredged to their authorized depths?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
No		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆
Yes	◆		◆												◆	◆		

D31a. If not, what are the reasons? Please provide examples.

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Lack of deep-draft traffic		◆		◆	◆		◆	◆		◆	◆	◆	◆	◆	◆			
Disposal area availability						◆			◆	◆			◆				◆	
Funding								◆	◆									
Other Not justified; sponsor choice; advanced maintenance; environmental windows			◆		◆					◆							◆	

D31b. If channels are over- or underdredged, what percentage (or number) of the channels are overdredged (including advanced maintenance dredging) and what percentage (or number) of the channels are underdredged?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
100% overdredged for fully maintained channels	◆		◆					◆		◆		◆						
Few overdredgings				◆	◆				◆					◆	◆	◆	◆	◆
Few underdredgings		◆							◆								◆	◆
No under- or over-dredgings							◆											

D32. How is advanced maintenance dredging determined?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Shoaling rates	◆	◆	◆		◆		◆	◆	◆	◆		◆	◆		◆	◆	◆	
Economic justification	◆	◆		◆	◆							◆			◆	◆	◆	
Dredging history	◆				◆							◆	◆	◆		◆		
Division or headquarters approval		◆					◆	◆								◆		◆
Safety		◆		◆		◆												
Use			◆								◆							
Other Equipment availability; customer need; sedimentation models; engineering; WES; ecological considerations; political pressure				◆		◆		◆		◆								◆

D32a. Who makes the final dredging/width determination?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Operations				◆	◆	◆						◆	◆	◆	◆	◆	◆	◆
Division approval								◆		◆		◆		◆	◆		◆	◆
District			◆					◆		◆					◆		◆	
Engineering				◆										◆	◆	◆		◆
Economic analysis												◆			◆	◆		◆
Project manager or chiefs			◆			◆		◆										
Authorized project limits	◆						◆											

D33. What is the review process for short-term (maintenance cycle) and/or long-term (reformulation) changes to a navigation project?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Operations and maintenance cycle review					◆			◆	◆			◆	◆	◆	◆			◆
Economic review			◆							◆		◆		◆				
Ecological review										◆				◆		◆		◆
Engineering review	◆							◆	◆						◆			
Sponsors and port authority	◆							◆									◆	◆
Internal review						◆						◆					◆	◆
Division review															◆	◆	◆	
Planning department												◆			◆	◆		
BCOE analysis	◆														◆			
No regular review process			◆				◆											
Other Full district review; state permits; feasibility reports; project management review; congressional direction; planning/ improvement; Corps review; whole system is examined for needed changes; quality control team	◆				◆			◆	◆	◆	◆				◆			◆

D33a. What typically triggers the need for decisions regarding changes?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Users and port authorities								◆	◆			◆					◆	◆
Storms and environmental changes				◆	◆					◆						◆		
Changed demand and use	◆				◆					◆								
Operations and maintenance													◆		◆	◆		
Pilots			◆															◆
Other Budget cycle, political pressure, marketplace, inadequate funding									◆					◆				◆

D33b. Who authorizes changes?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Corps division or HQ								◆		◆		◆		◆	◆	◆	◆	
Operations				◆					◆	◆				◆	◆	◆	◆	◆
Congress	◆				◆				◆		◆						◆	
Funding approval			◆										◆					
Engineering				◆	◆													
District								◆							◆			
Project manager			◆										◆					

D34. What unique guidance, such as district-specific guidance, manuals, texts, and software, do you use during operations and maintenance planning?

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Corps regulations (e.g., EM 1110-2-1003, EM 130-2-520, EM 1110-2-310, EM 385-1-1)	◆				◆		◆			◆					◆			
Maintenance database and history								◆		◆		◆						
Nothing		◆														◆	◆	◆
Scheduling programs (e.g., MSProject)	◆														◆			
GIS										◆					◆			
Dredged Material Management Plan														◆	◆			
Other Spreadsheet; standard dredging templates; multi-year maintenance contracts; CAD programs; harbor operations manuals; DIS, DMSmart, silent inspector; users; engineer apprentice program; disposal management system; budget estimating programs; hydrographic surveys; resident management software	◆			◆				◆	◆	◆		◆	◆	◆	◆			◆

3.1.7 Conclusions, Recommendations and Suggestions

D35. Do you have any suggestions for changes to the current Corps channel design processes or procedures?

D36. Do you have any suggestions for changes to current Corps channel design regulations and/or guidance tools?

D37. Do you have any other suggestions, comments, or recommendations regarding Corps channel design?

General Processes, Procedures, Regulations, Guidance

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Process/regs is/are good/adequate			◆	◆	◆						◆						◆	
Engineering guidance is good						◆									◆			
Processes should be streamlined/simplified; the process takes too long		◆						◆	◆	◆			◆					
Process/guidance does not work well for small projects/small populations							◆			◆		◆						◆
Guidance for planning and engineering often conflict								◆					◆					◆
Want new, revised EM		◆							◆	◆				◆				◆
Current Guidance is too simplistic: need something between a simple diagram and ship simulation														◆				
Users do not use channels the way they were/are be designed to be used				◆	◆	◆				◆	◆							◆
Need to coordinate/resolve conflicts and differences in opinion between different agencies: e.g., local, state, federal, environmental		◆	◆	◆		◆		◆		◆		◆	◆	◆				◆
Need more oversight; need standard evaluation criteria						◆			◆					◆	◆			◆

Design Vessel

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Design vessel is difficult to define					◆		◆											
Very difficult to look 50 years into future					◆		◆											
There is difficulty in dealing with different [non-ship] vessel types: e.g., oil rigs and barge traffic; difficult to quantify benefits.						◆	◆					◆						

Environmental

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Bigger and bigger problems with environmental issues, agencies, coordination						◆							◆				◆	◆
Corps need to look at environmental impacts more/Update environmental guidance								◆					◆			◆		◆
Environmental windows are a significant problem/need clearer guidance														◆			◆	◆

Channel Design; Engineering Issues; R&D

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Need more risk/risk guidance		◆										◆	◆		◆			
Engineering/Guidance is too conservative									◆		◆							◆
Need to look at other guidance; e.g., PIANC		◆							◆		◆		◆					
Vessel wake and wave attenuation need to be addressed			◆										◆			◆		
Promulgate [circulars on] new technologies that can be used										◆	◆							
Additional software desired; e.g. software to crunch #s and decide on channel width & side-slope													◆					
Need more/updated guidance on vessel response in waves														◆				
Need to refine guidance on channel bends/curves												◆						
More emphasis should be placed on density (SW/FW) issues												◆						
Must consider seiche				◆														
Must consider low lake levels				◆														

Ship Simulation

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Ship simulation good/most accurate/design should rely on simulation output															◆		◆	
Value added may not justify cost	◆	◆		◆							◆							
Waiver should be at the division level, not at HQ; Revoke requirements for ship simulation without waiver	◆								◆			◆						◆
DGPS is good/should be used more	◆										◆			◆				
Simulators should be refined							◆											
Desktop versions of simulators should be made available to districts																◆		
WES should use simulator for non-reimbursable work, too																◆		

O&M

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Environmental issues (including disposal) create difficulties/need more guidance & tools						◆		◆		◆			◆	◆			◆	◆
Change ER to allow spot dredging of rock w/ O&M funds								◆										
Should be able to do widenings and other minor changes under O&M budget								◆										
O&M/Construction should be more involved in design early on												◆			◆			◆
Newly constructed channels work well, but as they change, things do not work well												◆						
Need to reduce shoaling in new designs																		◆
Budget cycle should be modified so that all bids are not announced at once; could result in savings											◆							
Advanced maintenance should be a district decision; Remove ER 1130-2-520, the requirement to gain permission for all advanced maintenance										◆						◆		
Remove sponsor cost-sharing for adv. maint.										◆								
Hydrographic surveys quality improvements could save a lot of money – increase expertise; consider "navigable depth"										◆				◆	◆		◆	
Corps should review Level 1 funding more than it does; it should not be a "given"																		◆
Recommend "Silent Inspector" aboard all contracted dredging vessels														◆				

Other

	A	B	C	D	E	G	H	J	L	M	N	O	P	R	S	V	W	Y
Corps channel design and approval should be done w/ national or regional perspective, e.g., no need for every port to be 50'					◆										◆	◆		
There is no way to build w/o Congress no matter how important							◆											
Cost-sharing computation is cumbersome										◆	◆							
Corps forbids single-user projects, however, many projects actually do boil down to single user projects; Corps should acknowledge											◆							
Local sponsors should have an avenue to pay for or "buy up" a design feature					◆													
Involvement of multidisciplinary teams throughout design is good/should be implemented												◆						
Functionality borders: who is in charge of what?																		◆
Distinguish more clearly between lump sum costs and unit costs and their uses.																		◆
Many times money is available for study, but not for work								◆										
Consolidate guidance on channel design into single reference									◆									
Make more Corps docs available on WWW													◆					
Some equations found in older EMs should be referenced in newer version for ease of use								◆										
Some formulas may be outdated									◆									
Need to look at impact of real environment; No guidance for dealing with "outliers," i.e. channel properties that exist but are not ideal but cannot be changed		◆								◆				◆				
Need to address utilities in channels; limited DOT guidance																		◆
Interested in compendium of channel dimensions by region	◆																	
Interested in "lessons learned" from other designs	◆									◆								
The key to a good channel design is experience, trust, communication and continuity. Commercial traffic requires continuity											◆							

3.2 Division and Headquarters Survey Results

In this section, the questions asked of the divisions have been listed for each subcategory; then a summary of the responses received from each section follows. See Appendix D for the complete responses.

3.2.1 Channel Design Practices

H1. Describe the process your division uses to review channel design projects.
H2. What do you do to ensure that the channel design is done according to regulation?
H3. When do navigation designs from your division generally go to WES for ship simulations? That is, do all designs undergo ship simulations and at what phase of study are they usually done?
H4. What types of feedback does the division provide to the channel designers, i.e. planners and engineers?
H5. What impact do you have on the final design of a channel?

- Channel design project review is conducted through an independent technical review (ITR) at the district level. The review can be performed by a team of individuals from within the same district, from another district within the division, or by an outside contractor. The division's role is to perform quality assurance (QA) checks on the quality control (QC) measures that the district has implemented during the design and the ITR. The divisions therefore do not perform a technical review; they usually ensure that the proper EMs, etc. have been utilized, and that the design team and ITR team have been adequately staffed. Only policy review is conducted at the headquarters level.
- According to the headquarters respondents, technical review is done exclusively by the [division-level] ITR team. One respondent from headquarters stated that although divisions are only supposed to do policy review, they manage to look at the technical aspects, too.
- The district respondents stated that they maintain the latest ERs, EMs, etc., and check/assure that district designers utilize these to assure the best possible design.
- Not all channel designs must undergo ship simulation; a waiver can be obtained. If simulation is performed, it usually begins during the feasibility stage, and sometimes during PED. If a district does not contract WES to perform the simulation, WES is still involved with the scope of work, and acts as the technical advisor.
- Although some division respondents stated that they maintain open communication with the districts, their official role is strictly QA, i.e., to make sure QC processes are in place. When asked what the divisions' impacts on the final design are, the responses ranged from "none" to "varies … from small to significant."

3.2.2 Operation and Maintenance Decision-Making

H6. Describe the process used to review operations and maintenance (O&M) plans.
H7. What are the significant components of an O&M plan?
H8. How are these components of an O&M plan evaluated?
H9. What types of feedback do you provide to the Districts on the O&M plan?
H10. What impact do you have on the final O&M plan?
H11. How do budgetary limits affect the division's O&M dredging decisions?
  H11a. What happens if a budgetary limit arises?
  H11b. Who decides which projects will be dredged each year?
  H11c. To what extent do these budgetary limits affect decisions? Please cite examples.
H12. Are all navigation projects in your division dredged to their authorized depths?
  H12a. If not, what are the reasons?
  H12b. If channels are over- or underdredged, what percentage (or number) of the channels are overdredged (including advanced maintenance dredging) and what percentage (or number) of the channels are underdredged? Please provide examples.
H13. How is advanced maintenance dredging determined?
  H13a. Who makes the final dredging depth/width determination?
H14. What is the review process for short-term (maintenance cycle) and/or long-term (reformulation) changes to a navigation project?
  H14a. What typically triggers the need for decisions regarding changes?
  H14b. Who authorizes changes?

- Most of the responses to these questions about O&M decision-making reiterated the QA/QC system. Although many division respondents recognized a variety of significant components of an O&M plan, the details of the plan are reviewed and addressed in the district-level ITR.
- Regarding question H10 – the impact that divisions have on O&M plans – only one of eight respondents indicated that the division actively mentors the district activity in this area. One respondent stated "only from budgetary standpoint," while the remaining six respondents either did not know, did not respond, or replied that the question was not applicable.
- If budgetary limits arise, dredging must be prioritized. Some O&M activities are deferred.
- Headquarters responded that many times decisions are based too much – sometimes exclusively – on how things have been done in the past. Sometimes the most cost-effect methods are not addressed. The focus should be on the most economical way to maintain the channels.
- The dredged material management planning team is not very active in HQ. Beneficial use of dredged material is not done as much as it should be.
- A respondent suggested the concept of "performance measures" – essentially agreed-upon levels of service. For example, in some channels, seasonal fluctuations in commodity and/or environmental conditions may not require the channel to be at its full depth year-round. In such cases, and depth of 40-ft could be provided 50% of the year and 38-ft during times when greater depth is not required. Environmental criteria should be factored in.

3.2.3 Special Interest Projects

H15. What is the process used to identify and address problematic channels?
H16. Do you see any of the channels maintained by the Corps as problematic?
  H16a. If so, please provide more information on the problems, e.g. where and what are the problems?
  H16b. Please provide examples of problems that have been solved and how they were solved.
H17. Explain how you generally learn about accidents/incidences in Corps maintained channels.
H18. What external factors impact the speed of resolving problematic channels in your division?

The answers to the questions in this section were quite varied. The key information from the many responses appears here; more information may possibly appear in the raw responses.

- While some of division respondents indicated that the process to identify and address problematic channels begins with districts (usually in response to immediate port or USCG concerns), others indicated local/regional task forces or study teams as the mechanism for dealing with problems.
- Most respondents indicated that the divisions learn of accidents/incidents from districts and/or from the USCG; other responses included harbor officials, users, or the media.
- Respondents from headquarters and seven of eight divisions indicated that there exist problematic channels within Corps. The following is a brief summary of the locations and issues discussed:
  - Safety problems often occur when a project is used by a vessel different from the design vessel, e.g., when a 4-barge tow is used in a project designed for a 2-barge tow. Usually, reformulation is required if the design vessel changes.
  - Dangerous conditions sometimes exist at entrance channels – these problems have been addressed through ship simulation, model studies, pilot/user input.
  - Contaminant hotspots outside of navigation channels add contaminants into the channels; this creates a serious liability and disposal problem.
  - Intersections of channels have become problems, largely due to increased volume and physical dimensions of vessel traffic. Particular examples cited were at the intersection of the Houston Ship Channel and the GIWW and the intersection of the Matagorda Ship Channel and the GIWW (which also has a serious current and shoaling problem). A relatively lengthy process toward a solution must be undertaken, which is not palatable to the users because of the risk of disaster that exists within that time frame.
  - Other specific locations highlighted include:
    - Panama City Harbor – entrance – the district is working on solutions.

        - Toussaint Harbor – ordnance was found in channel – afterward, cost to dredge is 3-4 times higher than normal due to special handling requirements; no solution has been identified as of yet.
        - Southwest pass of the Mississippi River – large dredging quantities are required to maintain 45-foot channel – no cost-effective solution has been identified.
        - Brewerton and Tolchester channels in Baltimore – bend widenings – addressed by district, each a different solution, one through O&M, the other required reformulation.
        - Locations that the headquarters personnel drew attention to included Wilmington Harbor; C&D Canal (widenings); Pascagoula harbor (passing lane); Moorehead City (channel was deepened, but the bend was not widened); Portland District (WES study on turn-shear due to shoaling – looking at stepped cut into turn); Port Canaveral (cruise ships); Marina Del Ray (very high shoaling that was not budgeted for – local sponsor paid 50% of the O&M to dredge – but may cause priority problems in future); and San Juan Harbor.
    - A respondent from headquarters noted that HQ becomes quite concerned when a project's O&M funds exceed $1M.
    - Headquarters personnel also noted that there are authorities (Congressional authorizations) that can be used to straighten bends and turns for safety reasons: Sect 5 of the 1915 Rivers and Harbors Act; and Sect 224 of the 1992 WRDA.

3.2.4 Conclusions, Recommendations and Suggestions

H19. Do you have any suggestions for changes to the current Corps channel design processes or procedures?
H20. Do you have any suggestions for changes to current Corps channel design regulations and/or guidance tools?
H21. Do you have any other suggestions, comments, or recommendations regarding Corps channel design?

- Six of the eight division respondents had no input for these questions. The remaining division respondents stated the following concerns and recommendations:
    - The requirement that the depth of the channel be based on an optimization process (the incremental benefit for the next foot exceeds the incremental cost) is complicated by separately established "design criteria." This dual determination can be confusing.
    - The process is too slow. By the time planning, design and construction of a channel is completed, deeper depths than previously designed are required.
    - Dredging is being severely constrained by environmental windows, adding significantly to time and costs. The window times and durations need to be fully and scientifically evaluated.

- Headquarters, on the other hand, had many suggestions and comments. Following is a brief summary of the responses:

  General Comments

  - People who write the guidance should be the ones who review the projects and monitor compliance with the guidance.
  - Consistency is lost when many different people interpret the guidance.
  - We need to find places to innovate/new way of looking at things.

  Design Vessel Comments

  - Perhaps design vessel determination should be risk-based; i.e., the probability that the design vessel will call on the port should be estimated.
  - When looking at the future fleet, we should be careful at interpreting the information and ask, "Are vessels on order for specific routes that won't be used in U.S. trade?"
  - We must get away from the concept of a design ship.
  - Need to optimize [economics based on all vessel traffic] first, then select design vessel.
  - We need to address the future "future" fleet.

  Design Comments

  - Engineers have a different concept of safety than formulators; engineers believe safety clearances must be provided, whereas economists believe the safety must be justified.
  - Do different vessels need different types of channel/projects?
  - Can we speed up vessel transits through the channels?
  - We need to understand the dynamics of the interaction between the channel dimensions and vessel characteristics.
  - Side slope stability is an important issue. There's a tendency to reduce costs by reducing – or not appropriately increasing – side slopes when channels are widened.

  O&M Issues

  - Benefits should be increased through increases in operations and vessel efficiency and decreases in accidents. Costs should be decreased through better initial design or design that reduces O&M costs. The most need is in O&M.
  - From the DMMP standpoint: the Corps districts do not use Section 204 [construction of projects by non-federal interests] as enthusiastically as they could; perhaps it is general misunderstanding, mixed positive/negative impressions of the concept, the potential costs involved,

confusion about the benefits. Districts need to know it is available, especially if there is a rationale for the project.

- Outside (ocean) channels could be dredged deeper than they currently are to provide for natural hydraulic dredging of the interior channels. Perhaps there is guidance that encourages districts to look into this.
- Regional teams could/should solve regional problems. The regional problems are supposed to be solved at the lowest level, but not on a project-by-project basis. The dredging teams are supposed to be proactive, not reactive to problems.
- Local planning groups may be proposed to deal with dredged material management as an outgrowth of the regional dredging teams.
- There is a need to develop – and distribute to designers – a list of high risk factors that typically result in more dredging.

3.3 WES Survey Results

In this section, the questions asked of WES have been listed for each subcategory; then a summary of the responses received follows. The raw responses appear in Appendix D.

3.3.1 General Overview Question

W1. Considering all phases of design, reconnaissance, feasibility, preconstruction, engineering, and design (PED), and construction, briefly describe your role in the design process.

Respondents stated that WES prefers to be involved early on in a channel design but often actually gets involved after a district already has a plan in mind. Most often, WES performs ship simulation model studies, unless a district can justify that simulation is not necessary. While there is a recommended phase during which this is accomplished, there is some flexibility. In addition to simulations, WES provides: desktop studies, field studies, physical modeling, and GPS tracking (which is becoming more and more prevalent).

Respondents indicated varied areas and types of technical expertise and consulting which WES provides to districts, including harbor response, entrance channel wave climate and prediction of shoaling potential in addition to assessing vessel motion for the channel and the harbor.

3.3.2 Design Vessels and Vessel Mix

W2. What advice do you give Districts in selecting a design vessel?
W3. What are the significant design parameters of the design vessel and vessel mix?
W4. How do you recommend determining the value(s) for each significant design parameter?
W4a. Are there any special design tools, software, or standard rules/procedures that you recommend using to make these determinations?

WES does not select a design vessel for a district, but WES personnel can assist a district in choosing a vessel for simulation. The WES respondents stated that the most significant vessel design parameters are class, length, beam, draft, and thrusters. The

physical site is also important. Usually the districts have most of the parameters decided upon before approaching WES; WES usually recommends using the deepest draft vessels that would use the channel.

WES respondents did not indicate that they use any special tools, software, etc. related to design vessel selection and parameterization.

3.3.3 Environmental Design Parameters

W5. What are the significant environmental design parameters for channel design?
W6. How do you recommend determining the value for each significant environmental design parameter?
  W6a. Are there any special design tools, software, or standard rules/procedures that you recommend using to make these determinations?
W7. How do you recommend estimating vessel response to environmental design parameters?
  W7a. How should wind, currents, or waves be considered in selecting channel alignment?
  W7b. How should they be accounted for in selecting channel alignment?

The significant environmental design parameters vary by project, but generally include current, wind, bank effects, two-way traffic and waves; environmental concerns, such as contaminated sediments present significant issues; local structures such as bridges in waterways and the alignment of docks also affect the design. There is no standard "checklist."

To determine the values of each parameter, WES respondents indicated that they use a "maximum credible, worst-case scenario," or, in other words, the worst conditions the vessel would still operate in. Since simulations are expensive, WES tries to test what is needed, but cannot test every situation.

Pilots are very important in determining vessel response, and all numerical models are validated by field data. WES is also working on an R&D unit for ship vertical motions. The magnitude and orientation relative to vessel motion needs to be considered, but channel alignment and location are usually already set and not changed significantly.

3.3.4 Channel Design Methods

W8. How do you recommend determining the values for these additional significant parameters? (Only those not discussed above.)
  Vessel draft; Underkeel clearance; Vessel beam; Vessel speed; Density of water; Waves, winds; Tides, currents; Ship-induced waves; Vessel-bank clearance; Vessel-vessel clearance
  W8a. Are there any special design tools, software, or standard rules/procedures that you recommend using to make these determinations?
W9. What are significant channel design parameters not covered above?
W10. How do you recommend determining the values for these other significant channel design parameters?

W11. How do you recommend choosing the appropriate design variables (value) for the following components of a channel:
  W11a. Channel cross-sections (depth, width, side slopes)
  W11b. Channel bends
  W11c. Turning basins areas (length, width, depth, side slopes)
  W11d. Anchorage areas (length, width, depth, side slopes)

W12. How do you recommend determining the change in maintenance dredging needed as a result of a change in the design of an existing channel component?

W13. How do you recommend determining the layout of the channel?

W14. How do you recommend making decisions regarding single or multi-lane (passing) traffic?

W15. How do local sponsors, such as port authorities, carriers, local and state governments, influence the final dimensions of channels?

W16. What procedures are used to account for risk and uncertainty in channel design?

W17. What ***unique*** guidance, such as WES-specific guidance, manuals, texts, and/or software, do you use during channel design?
  W17a. Could you provide us with a copy of items other then EMs, ERs, etc.?

- The following parameter determination recommendations were mentioned or discussed:
  - Underkeel clearance – model studies
  - Vessel speed – local knowledge and standard operating procedures
  - Density of water – usually not addressed by WES, but is noted in the EM
  - Waves, winds – hindcasts and local knowledge
  - Tides, currents – field studies and numerical models
  - Ship-induced waves – presently being researched
  - Another parameter mentioned was drawdown effects on inland waterways, for which the respondents indicated WES was putting together a list of models.
  - The respondents recommended no special design tools or procedures for deep-draft design.
- The following recommendations were made for choosing channel components:
  - Channel cross-sections (depth, width, slope) – WES respondents indicated that they do not have much input on this; it depends on the composition of the channel bottom. The respondents indicated that they generally start with Corps guidance and modify as appropriate.
  - Channel bends – use simulator; also consider channel material and overbank depth.
  - Turning basin areas – values from simulators or physical models; could use DGPS or perform a model study.
  - Anchorage areas – pilot experience.
- To determine the change in maintenance dredging as a result of a design change, WES respondents indicated that sediment studies may be performed at WES by DOER (Dredging Operations and Environmental Research); physical and numerical model studies can also be performed to assist predictions.
- The layout of the channel is ultimately done with the simulator. Locations of deep water and economics are significant components contributing to the final decision.

- Decisions on single versus multi-lane channels are usually made before the simulator study – and usually based on what has been done historically. Often cost-share partners are highly influential in this decision.
- Regarding outside influences on channel final dimensions:
    - Many of the final decisions are based on sponsor needs, especially from the local and state governments.
    - As cost-share partners, port authorities seek the best project for the money.
    - Sometimes WES doesn't get involved until the final design and after cost-sharing decisions have been completed.
- WES respondents indicated that they do not account for risk and uncertainty. For the physical simulation model study of Barbers Point, however, numerous transits were made over a range of conditions so as to obtain some probability of a safe channel depth.
- PIANC guidance and references are used during design and design decisions. The respondents mentioned no other unique guidance or references.

3.3.5 Special Interest Projects

W18. For the following areas of deep-draft projects, please rank these areas from 1 as the most problematic, in your opinion, to 7 as the least problematic, in your opinion, area of channels. Also provide examples of projects or channel locations where problems exist, have existed in the past, or may exist in the future.

Navigation channel; Turning basin; Anchorage areas; Maneuvering areas; Just seaward of the channel; Channel/private port interface; Turns; Other

W19. How do you generally learn about accidents/incidences?

W20. Rate the severity of the accidents/incidences that occur within the following areas of a channel:

Within the navigation channel; Within the turning basin; Within the anchorage areas; Within the maneuvering areas; Just seaward of the channel; At the channel/private port interface

W21. What historical channel safety problems and/or other problems have been remedied and how? Please provide specific examples.

W22. What factors and/or unique characteristics of channels presently do or may possibly contribute to safety problems? For example, bridge characteristics, recreational traffic, or communications problems?

W23. Do you foresee any other safety problems arising in the near term? ... in the future? If so, what are they? *(e.g., larger or deeper draft vessels, increased operating speeds, congestion)*

W24. When you are asked to assist in solving a channel problem, what is the process to remedy the problem?

W24a. How long does the process generally take from problem identification to action, and from action to problem resolution?

W24b. What external factors impact the speed of the resolution process? To what extent do they impact the speed of resolution?

- WES respondents indicated (1) the navigation channel, (2) turns, (3) structures (such as bridges) and (4) turning basins as the top four most problematic areas in channel design. They also mentioned that getting aligned in the channel may be a problem just seaward of the channel due to longshore currents. They rated the incidents in the navigation channel as "severe" and in the other areas as "minor."

- WES respondents indicated that they learn of accidents/incidents when they are asked to look at problems, and/or from pilots and news sources.
- The intersection of the Houston ship channel and the GIWW was mentioned – it is a deep/shallow draft interface that has been built and is being used successfully.
- Factors that contribute to safety problems mentioned include:
    - Combined cross-currents and longshore currents such as at Barbers Point
    - Any structure, even its perception, and anything near the channel
    - Reduction in crew sizes leads to human factors issues
- When asked, "When you are asked to assist in solving a channel problem, what is the process to remedy the problem?," the respondents replied, "We are not really asked to fix channel problems. Often we look at just one safety area and nothing else."

3.3.6 Ship Simulation

W25. When do navigation design projects require ship simulations from WES?
W26. At what stage of the channel design process do Districts generally come to WES for ship simulations?
W27. What types of ship simulations do Districts request of WES for purposes of channel design?
W28. Describe the general process of ship simulation.
W29. What type of data from the simulation is provided to the District?
W30. How do Districts use the data generated by the ship simulation process?

- Ship simulation is required unless a district obtains a waiver. The simulations do not have to be performed at WES; WES will work with a private simulator firm and then prepare the final report.
- Simulation is performed at various stages, but WES respondents reiterated that they prefer districts to begin consulting with WES early on in the design process. The types of simulations also vary – from recommending the best of a set of alternatives to "tweaking" existing designs.
- The general computer ship simulation process as described is as follows:
    - WES performs onsite reconnaissance at the beginning of the study. WES personnel will ride vessel(s) with pilots, take videos and stills to develop the visual scene, discuss the vessel operations and discuss the proposed plan with the pilots. This part of the process is very important and significantly helps the success of the simulation.
    - A model is developed and validated by using two pilots familiar with the waterway. The model is "tweaked" [calibrated] until the vessel response matches pilot expectations.
    - A full set of existing conditions is run, and then proposed conditions are added into the model in preparation of the formal testing program.
    - The results from proposed conditions are compared to the results from existing conditions.
    - In general, WES provides recommendations to districts, but usually not unique circumstances.

3.3.7 Conclusions, Recommendations and Suggestions

W31. Do you have any suggestions for changes to the current Corps channel design processes or procedures?
W32. Do you have any suggestions for changes to current Corps channel design regulations and/or guidance tools?
W33. Do you have any other suggestions, comments, or recommendations regarding Corps channel design?

- The WES respondents emphasized that there needs to be more focus on the engineering aspects of the design. There should be more funding for updating design guidance, and additional research is needed to better define channel requirements as well as improve design tools. They also mentioned that while a lot of design is based on experience and rules of thumb, some of the rules-of-thumb used at the districts should be overruled.
- The absence of any technical reviewers at headquarters was mentioned by the respondents.
- WES respondents stated that there is not a lot of interest in the EMs since the district designers ask WES specific questions anyway.
- The issue of channel availability was discussed. Operators want 100% availability of the channel, while pilots understand that there cannot be 100% availability. Designers may be overly conservative in an effort to provide no channel "downtime."

4. Summary of Findings and Conclusions

Surveying all USACE districts and divisions involved in deep-draft navigation channel design was quite an ambitious endeavor, perhaps surpassed only by the effort involved in assimilating and analyzing the data obtained. While additional issues and concerns may exist that are not represented in this report, the authors are confident that most of the key issues have been revealed though this survey process.

The following is a condensed summary of the key findings from the surveys. These findings are meant to highlight particular issues and concerns that the authors found particularly interesting, compelling, and/or may warrant further attention. Many additional findings appear in the previous section.

General Processes, Procedures, Regulations, Guidance

The overall design process as discussed or implicitly supported by the respondents is depicted in Figure 4-1. Vessel simulation is a required component of every study, unless a waiver is granted. The simulation study is usually performed during feasibility, but may be conducted within other phases. The simulation study is often conducted by WES, but may be conducted by another contractor, in coordination with WES.

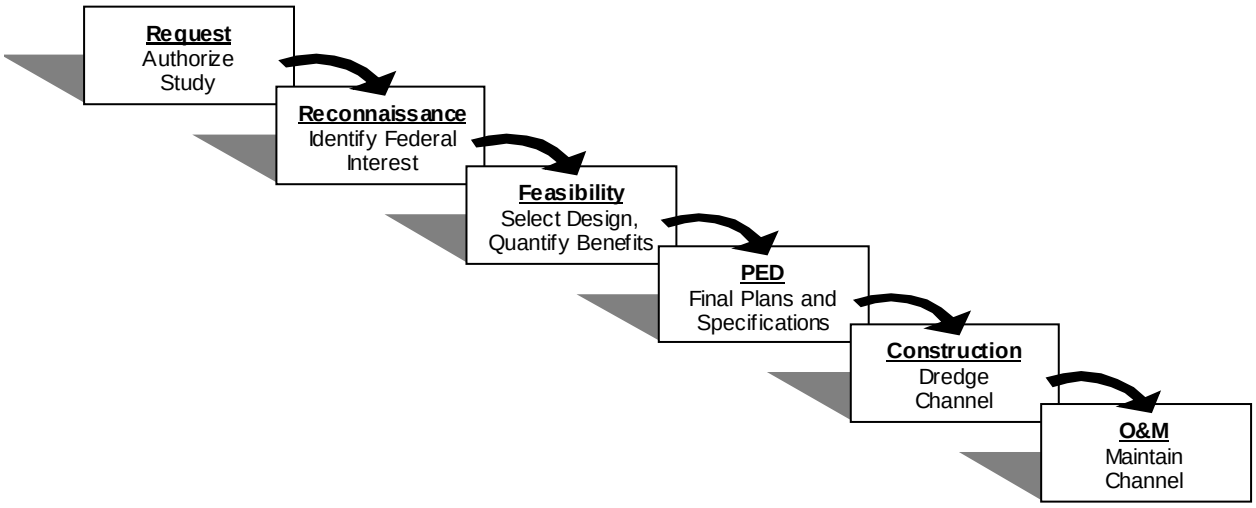

Figure 4-1. Channel design phases as discussed in survey responses.

- Most districts indicated that they modify existing projects, and that Corps guidance is geared more toward new projects, not incremental changes.
- All districts that employed multidisciplinary (i.e., multi-functional) groups throughout the entire design indicated that it aided and improved the channel design process and results.

- Many respondents indicated that the overall channel design process takes too long; however, no respondent offered any suggestions to expedite the process.
- Some type of flexible planning process is necessary. One district discussed an experience in which a project received bids that were half the expected cost. Instead of being able to utilize the additional funds to increase the design depth of the channel, the district had to construct the channel as planned, and then commence a new study for deeper depth.

Design Vessel

- Many district respondents indicated that they have difficulty obtaining the necessary information for selecting design vessel characteristics, due in part to proprietary issues with shippers.
- There is also significant difficulty in projecting future needs. While district personnel are aware that they must consider future needs, many indicated that they cannot and do not justify the "if we build it, they will come" mentality.
- Two districts stated that they had difficulty in dealing with Corps guidance and regulations when the design vessel is not a ship.

Environmental Issues

- The issue of environmental windows is a significant concern mentioned by nearly all districts and divisions. There is no governing authority overseeing all of the federal, regional, state and local environmental interests, and no authority to provide guidance on what to do when environmental windows are excessively restrictive to channel construction or maintenance.
- Dredge disposal is also becoming more and more of a critical economic issue within the channel design and channel maintenance.
- WES respondents stated that they do not address water density in simulation studies. However, some districts are facing significant saltwater intrusion environmental effects and also areas of high shoaling at the location of saltwater/freshwater interface. Incorporation of salinity effects in simulation may assist in further environmental studies as well as aid in determining locations of high siltation.

Channel Design; Engineering Issues, R&D

- Many respondents from districts, headquarters, and WES stated that there is a need to focus more on the engineering aspects of design. Some respondents also suggested that design guidance should be updated, improved and/or made more easily available. There is also a desire for expedited technology transfer throughout the Corps.
- In some districts, the engineering functional group has very little to do with the design until PED – a phase in which many design parameters are difficult to change.

- There seems to be a chicken-and-egg syndrome regarding vessel speed within a channel. Headquarters respondents want channel designers to increase vessel speed through channels. However, a channel is designed assuming that the vessel speed doesn't increase.
- There is no USACE guidance on ship-induced waves. However, several districts and WES expressed an interest in the topic. There is also interest in associated wave attenuation.
- Another area of technical interest included vessel response in waves, especially in the vicinity of entrance channels.
- There is a need to address and implement the concept of risk and uncertainty. At this time neither WES nor any of the districts interviewed implement it into their designs or design processes.
    - A survey respondent stated that engineers have a different concept of safety than formulators; engineers believe safety clearances must be provided, whereas economists believe the safety (e.g., the safety clearance) must be justified.
    - The concept of providing for less than 100% availability (as mentioned in a few of the interviews) needs to have some basis in probability, uncertainty and risk.

Ship Simulation

- There are widely disparate views and impressions of ship simulations. Some say it is too costly and the value added may not justify the costs, while others say that the simulation provides the most important information. With economics such a critical theme throughout the channel design process, it follows that the economics of ship simulation should be considered.
- The uses and applications of DGPS to navigation studies and other technical studies are developing very quickly. Many of those surveyed want to see more – especially for validating, calibrating, and/or replacing some computer-based ship simulation studies.
- Some respondents mentioned that a better understanding of the dynamics and the interaction between the channel dimensions and vessel characteristics is needed. It follows that use of simulation may be the best tool to investigate this in a meaningful way.

O&M

- There is significant interest among all organizational groups to reduce costs associated with the operations and maintenance of channels. However, innovation to reduce O&M costs in new designs is rare.
- Some innovation with respect to O&M issues includes use of sediment basins, and, on the financial side, use of delivery order contracts.
- There is a need to investigate channel side slopes in more detail. Slope stability is a critical issue. Side slopes also affect bank effects – but to what extent is not clear.

- Many respondents have concerns over the restrictions regarding advanced maintenance of channels. Some respondents believe that advanced maintenance should be a district-level decision, and should not require higher-level permission; others believe cost-sharing requirements should be removed from advanced maintenance. For both groups, the underlying issue appears to be economics. Advanced maintenance, when properly applied, may reduce the overall cost to maintain the channel, yet current restrictions may discourage use of advanced maintenance and, thereby, end up costing the district more to maintain the channel.
- Operations and maintenance personnel often have difficulty maintaining channels after they have been designed and constructed. In some cases, their involvement earlier in the design could have alleviated some problems. In short, many respondents asserted that O&M and Construction functional groups should be involved in a design early on.
- When the divisions were asked, "What impact do you have on the final O&M plans?," only one of eight divisions indicated that they actively mentor the district activity in this area. One stated "only from budgetary standpoint," while the remainder either did not know, did not respond, or replied that the question was not applicable.

Other

- In discussion of the Corps' guidance, it was suggested that the writers of guidance perform technical review, so that the guidance is inherently most tailored to processes and concerns of ongoing designs.
- Numerous respondents noted that there are no longer individuals at headquarters – or even at the division level – performing technical design review. Many district respondents stated a desire to have more oversight and standard evaluation criteria for channel designs throughout the Corps. Presently, independent technical review can vary significantly between two adjacent districts. It was also noted that although there are personnel within divisions and headquarters with technical expertise, most of these are the legacy from when there were official technical positions within divisions and headquarters. In the future, the availability of technical expertise within the higher levels of the Corps may be jeopardized.

And finally, the following are a few general comments stated within the interviews that have broad applicability and potential implications:

- "It is good for the U.S. to have some conformity with the rest of the world on channel design and not have the U.S. with the narrowest designs. Policies and regulations are forcing the Corps into narrower channels. There is a lot more to designing channels than using formulas found in the guidance."
- "The key to a good channel is experience, trust, communication and continuity. Commercial traffic requires continuity."