Committee on Tidal Hydraulics

Minutes of the 103rd Meeting

20-22 September 1994

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Executive Summary

The 103rd meeting of the Committee on Tidal Hydraulics was held at the U.S. Army Engineer District, Savannah, on 20-22 September 1994. The Savannah Harbor project was the primary focus of the meeting.

Technical presentations were made on Savannah Harbor and the effects of removing the tide gate from operation and of deepening the channel in 1992. The Long-Term Management Strategy for dredging and disposal provides for most effective measures for the next 20 years of harbor operation and maintenance. The Savannah River Basin project addresses goals of maintaining water quality and flood protection. A proposed project for deepening Brunswick Harbor was also presented.

During the Executive Session, the Committee provided comments on questions about Savannah Harbor posed by the District and reviewed the Grays Harbor Project, Cohesive Sediments Research Newsletter, CTH Bibliography, and the CTH White Paper on R&D.

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Minutes of the 103rd Meeting

20-22 September 1994

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1. The 103rd Meeting of the Committee on Tidal Hydraulics (CTH) was held 20-22 September 1994 in Savannah, GA, at the invitation of Colonel Wayne M. Boy, District Engineer, U.S. Army Engineer District, Savannah.

2. On 20-21 September, the CTH held Technical Sessions on Savannah District projects and Grays Harbor, Washington. An Executive Session was held during the afternoon of 21 September and morning of 22 September.

3. Attendees were:

Committee on Tidal Hydraulics

Mr. Frank A. Herrmann, Jr., Chairman	Waterways Experiment Station
Mr. William H. McAnally, Jr., Executive Secretary	Waterways Experiment Station
Mr. Samuel B. Powell, Liaison	Headquarters, U.S. Army Corps of Engineers
Mr. Lincoln C. Blake	Charleston District
Mr. H. Lee Butler	Waterways Experiment Station
Mr. A. J. Combe	New Orleans District
Mr. Jaime R. Merino	South Pacific Division
Ms. Virginia R. Pankow	Water Resources Support Center
Mr. Edward A. Reindl, Jr.	Galveston District
Mr. A. David Schuldt	Seattle District
Mr. Ronald G. Vann	Norfolk District
Mr. Chuck J. Wener	New England Division

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Consultants

Dr. Ray B. Krone	Professor Emeritus, University of California at Davis
Dr. Donald W. Pritchard	Professor Emeritus, State University of New York at Stony Brook

Other Corps of Engineers Representatives [1]

Dr. Bert Holler	South Atlantic Division
Ms. Donna Richey	Waterways Experiment Station
Ms. Susan Durden	Savannah District
MAJ Bob Unger	Savannah District
Mr. Wade Seyle	Savannah District
Mr. William Bailey	Savannah District
Ms. Monica Simon Dodd	Savannah District
Mr. Joe Hoke	Savannah District
Mr. Mark Reynolds	Savannah District

4. The minutes are divided into discussions of presentations made at the Technical Sessions and actions taken at the Executive Session. The order of the minutes is not necessarily the chronological order in which these matters were considered at the meeting.

[1] Attended Technical Sessions only.

Technical Sessions

5. MAJ Bob Unger, Savannah District, welcomed the CTH and guests. He briefly described the Savannah District's civil and military work loads, noting in particular its hazardous and toxic wastes cleanup mission and its support of the Hurricane Albert recovery efforts. He welcomed the CTH review of District projects, particularly Savannah Harbor.

6. Mr. Frank A. Herrmann, Jr., Chairman of the CTH and Director of the Waterways Experiment Station (WES) Hydraulics Laboratory, expressed the thanks of the CTH to the District for their invitation to meet in Savannah. He noted that salinity intrusion questions in the Savannah and Delaware estuaries were among the reasons for forming the CTH in 1947. The CTH later addressed shoaling in Savannah Harbor. Mr. Henry Simmons, now a CTH consultant, previously a CTH member and the WES engineer in charge of the Savannah Harbor physical model, has played a major role in the harbor for many years and is the primary source of corporate memory on the subject. Mr. Simmons could not attend the meeting for health reasons.

Savannah Harbor Tide Gate Project

7. Mr. Wade Seyle, Savannah District, presented the Savannah Harbor Tide Gate project, which is located on the Georgia-South Carolina border (Enclosure 1). The harbor is the site of the Port of Savannah and the Savannah National Wildlife Refuge, and home to several endangered species—sea turtles, wood storks, and short nose sturgeon. It is a rapid deployment port for the U.S. Army. A sunken Confederate Ram lies in the harbor and must be protected.

8. The Savannah District is responsible for maintaining the navigation channel and protecting Fort Jackson against erosion. Shoaling has been changing in response to hydrologic changes and numerous harbor changes since 1971, and the District has insufficient resources to properly monitor the channels. They are asking the CTH to advise on the most economical and efficient way to maintain the harbor.

9. The harbor includes a 20-mile-long interior channel plus an 11.4-mile-long entrance channel. The entrance channel is 44 ft deep by 600 ft wide. From the entrance to Kings Island turning basin, the authorized channel is 42 ft by 600 ft, and then 36 ft deep by 600 ft wide to the upper end of the project. The most recent channel improvement was deepening 31 miles of channel by 4 ft, completed in 1994. The most recent channel widening was by 100 ft over 5 miles of channel near the Talmadge Memorial Bridge in 1991. Enclosure 2 lists authorized depths by channel station numbers.

10. Extensive, year-round maintenance dredging (approximately 7 million cu yd per year, Enclosure 3) is required in the harbor, and sediments are primarily fine-grained, forming fluff during neap tidal range conditions. Dredged material disposal is in eight diked areas on the South Carolina side of the river. Since the 1970's, advance maintenance of 0 to 4 ft (mostly 2 ft, Enclosure 2) has been performed on a reach-by-reach basis. An additional 800,000 cu yd are dredged from the entrance channel and disposed offshore.

11. The tides are semidiurnal, with a mean range of 7 ft and a spring range of 9 ft. Maximum tidal currents are typically 5 to 6 fps. River inflows of 7,000 to 20,0000 cfs are controlled by three dams 120 miles upstream. Mr. Joe Hoke, Savannah District, described the freshwater flow controls, mainly for hydropower. Enclosure 4 lists average discharges for several points in the basin.

Mr. Seyle presented 1991-1993 suspended sediment data (Enclosure 5) at Clyo, which is about 51 miles upstream from Savannah, showing loads ranging from 157 to 1150 tons per day.

12. In 1972-1976 a tide gate and sediment trap were constructed in Back River, together with New Cut, a channel connecting Back River to Front River through Kings Island (Enclosures 1, 6, and 7). The tide gate consisted of 14 hinged, gravity-operated gates that opened on flood phase tides and closed during the ebb phase. The tide gate, sedimentation basin, and connecting channel were subjected to extensive physical model tests at WES. The gate caused deposition in the sediment basin and scour in Front River, as planned, reducing dredging volumes and unit costs (from $1.25 per yard in the channel to $0.30 per yard in the basin). Although the total annual dredging volume was not changed, about 4 million cubic yards per year shifted from the channel to the sediment basin. Total dredging cost savings were $2 million per year. Dredging is performed in specified windows throughout the year for fish and wildlife protection.

13. The Fish and Wildlife Service and Savannah National Wildlife Refuge became concerned that the tide gate was increasing salinities in the upper Back River and that New Cut was flushing striped bass larvae from the system. At their request, the tide gate was pinned in a fixed open position from 15 March to 1 June (the fish spawning period) during 1989-1991 and was permanently pinned open in 1991. In 1992, New Cut was closed. Since that time, salinities at the National Refuge have declined. Previous physical model studies had shown the need for a freshwater diversion canal near the upper end of Back River to control salinities at the National Refuge. Although a canal was constructed, it did not carry sufficient freshwater discharge to control salinities at the refuge.

14. Since the most recent channel deepening (1994) and opening the tide gate (1992), harbor shoaling and unit cost have increased.

15. An analysis by Mr. Simmons[1] showed that with increased channel depth, shoaling increased and moved upstream. The present 7 million cubic yards per year (plus or minus about 20 percent) appears to be the limit of sediment supply. The tide gate had shifted the shoaling peak downstream, and that effect can be expected to be reversed with the gate open and New Cut closed. During a field trip during the meeting, the Committee observed strong ebb currents through the tide gate structure about 2 hours before low water. The predicted tide range that day was 8.8 ft.

16. The District hypothesizes that the sediment basin is still somewhat effective, even though at 38 ft deep it is 4 ft shallower than the channel. They propose a monitoring program to

a. Develop efficiency curves for the sediment basin without the tide gate.

b. Determine new shoaling patterns in the navigation channel with New Cut closed.

c. Determine an optimum sediment basin dredging schedule.

d. Schedule disposal area maintenance.

e. Optimize advance maintenance dredging.

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[1]H. B. Simmons. (1965). "Channel depth as a factor in estuarine sedimentation," Technical Bulletin Number 8, Committee on Tidal Hydraulics, Corps of Engineers, U.S. Army, published by U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

17. The request posed by the District asked the CTH to

a. Review results of Savannah Harbor investigation and model study for the tide gate and sediment basin to determine

(1) Optimum procedures to maximize shoaling and efficient dredging of the sediment basin with the tide gate out of operation and New Cut closed.

(2) If modification should be made to the physical dimensions of the sediment basin to optimize the volume of material it can trap with the tide gate open.

b. Develop and recommend a monitoring plan and analysis procedure to determine the long-term shoaling rate and shoaling location in the navigation channel and sediment basin.

c. Recommend a salinity monitoring plan to collect salinity data from the navigation channel and Back River systems that will be important to future navigation improvement features.

Savannah Harbor Long-Term Management Strategy

18. Ms. Susan Durden, Savannah District, described the harbor Long-Term Management Strategy (LTMS). With a 20-year time horizon, the LTMS addresses operation and maintenance of Savannah Harbor, navigation and navigation-related issues, dredging and available disposal sites, and cost effectiveness. Disposal of dredged material is already an issue, and the Port of Savannah is projected to exceed its capacity for traffic within 10 years.

19. Goals for the Savannah LTMS are to

a. Maximize availability of the design 42-ft channel.

b. Maximize life of the disposal areas.

c. Determine the least-cost plan for dredging and disposal.

d. Develop an environmentally sound, scientific basis for decision making.

e. Obtain agreement on a plan by all parties involved.

20. Products of the effort will be a long-range disposal plan (draft complete in October 1994, final in spring 1995) and a comprehensive operation and maintenance Environmental Impact Statement (draft in internal review.)

Savannah River Basin Watershed Study

21. Ms. Monica Simon Dodd, Savannah District, presented the Savannah River Basin Watershed Comprehensive Study. The study, the purpose of which was to balance upstream and downstream water needs (water quality, hydropower, water supply, and flood control), began in 1990; but the local sponsors could not fund their portion, so the work stopped in 1992. It is anticipated that the

study will be restarted in Fiscal Year (FY) 1996 with Operations and Maintenance (O&M) funds to examine rehabilitation of hydropower, water quality in the reservoirs, and damage below Thurmond Dam. It will be coordinated with new initiatives of drought response coordination and the Environmental Protection Agency's watershed study.

Lower Savannah River Basin Restoration Study

22. Ms. Dodd described the Lower Savannah River Basin Study, which examined 40 river oxbow cutoffs and found that flow in 12 of them needed to be restored for environmental benefits and improvement of water quality at the City of Savannah freshwater intake. The feasibility study, with the city as local sponsor, is examining the cutoff restoration and relocation of the freshwater intake point. Cutoff number 3 is being carefully examined, with WES modeling of hydrodynamics and navigation in the bends. Deauthorization of the navigation channel is an alternative under consideration.

Brunswick Harbor

23. Mr. Mark Reynolds, Savannah District, presented the Brunswick Harbor, Georgia, feasibility study. In 1992 a reconnaissance study recommended a 4-ft channel deepening to depths of 36 ft over the entrance channel bar and 34 ft in the interior channel. A review by Headquarters, U.S. Army Corps of Engineers (HQUSACE), reduced the deepening to 2 ft. The project was suspended, but it is anticipated that a feasibility study will be initiated in FY 95. The Savannah District is now working on an Initial Project Management Plan (IPMP) with the Georgia Port Authority with a goal of 1998-1999 project authorization.

24. The Sidney Lanier Bridge in Brunswick prevents deepening the channel reach passing under the bridge, so the Georgia Department of Transportation plans to replace it. Since rock underlies part of the estuary, they may relocate the navigation span to a location that avoids rock dredging.

Grays Harbor, Washington

25. Mr. William H. McAnally, Jr., WES, introduced the Grays Harbor CTH project. In June 1994, Mr. Herrmann formed a joint CTH-Coastal Engineering Research Board subcommittee to respond to the Seattle District's request for a review of a shoreline breach at Grays Harbor, Washington. The committee held a public meeting at Grays Harbor to review the project, and a draft report has been prepared.

26. Mr. A. David Schuldt, Seattle District, gave a background of the breach and the Corps of Engineers response. After a number of years of erosion of the beach south of the inlet, in December 1993 a storm caused a breach just south of the south jetty. The breach did not grow, but local governments expressed concern over potential threats to public facilities and the navigation facility.

27. On September 6, 1994, work began to close the breach by pumping dredged sand from the inlet channel onto the beach. The dredge has been producing 10,000 cu yd per day at a cost of about $6 per cubic yard. The District plans to pump 600,000 cu yd onto the eroded beach. They have

budgeted $3.5 million in FY 95 to fill the beach again and study a long-term solution to the erosion problem.

28. A consultant to the City of Westport, WA, recommended that the navigation entrance channel be moved from close to the south jetty to midway between the north and south jetties. The required dredged material would be placed on the beach on the estuary side of the breach.

Executive Session

29. **New Member.** Mr. Herrmann welcomed Mr. A. J. Combe, New Orleans District, to the CTH.

30. **Minutes of the 102nd Meeting.** Dr. R. B. Krone, Consultant, noted that his title in the minutes should be corrected to Professor Emeritus. The minutes were approved as corrected.

31. **Fiscal Report.** Mr. Herrmann submitted the Committee's FY 93 final report and an interim statement for FY 94. Both reports were approved. Mr. Samuel B. Powell, HQUSACE Liaison, said that $30,000 has been requested for the CTH in FY 95.

32. **Discussion of Savannah Harbor Projects.** Mr. Herrmann began the discussion of Savannah Harbor by appointing the following subcommittee to prepare a draft report on the Tide Gate Project: Dr. Krone; Dr. Donald W. Pritchard, Consultant; Mr. Ronald G. Vann, Norfolk District; and Mr. Edward A. Reindl, Jr., Galveston District.

33. Dr. Krone began the discussions by listing some salient points according to the questions posed by the District.

a. *Optimum procedures to maximize the shoaling and efficient dredging of the sediment basin with the tide gate out of operation and New Cut closed.* Modifications should be made to the physical dimensions of the basin to optimize the volume of material it can trap with the tide gate open. As sediment basins fill, their trap efficiency usually falls. The following will assist in finding the optimum dredging frequency and basin size:

(1) Data are needed on the temporal and spatial rate of basin filling. Hydrographic data are essential, and they must be accurate to avoid being misleading. Recommend

(a) Dredging the basin clean before starting.

(b) Using consistent instrumentation and method to survey the basin.

(c) Carefully establishing datum control.

(d) Obtaining cores at various locations to be analyzed for bulk density profiles.

(e) Spacing sounding ranges within the basin close enough together to be able to draw contours.

(f) Repeating surveys at 2-month intervals for 1 year.

(2) A numerical model should be used to calculate trapping efficiency precisely as filling occurs. A two-dimensional (2-D) laterally averaged model will suffice, but a three-dimensional (3-D) model is ideal.

(3) A numerical model of the entire system is also needed to evaluate overall sedimentation rates under various conditions and plans and to examine how basin changes will alter shoaling elsewhere.

b. *Salinity intrusion.* The model used for sediment transport will have to include salinity transport also, so it can be used for both purposes. It should have its upstream boundary located far enough away to capture the low salt zone around the refuge. Use the model to test a range of freshwater flows, depths of channel, and size of basin for the existing condition. Also test putting the gate back into operation and opening New Cut. Tests should be conducted to determine if a gate operating procedure can be developed that would achieve the desired salinity levels and distribution. Operating the wildlife refuge intakes in concert with freshwater release management could help solve that problem.

c. *Dredging management.* Management of the disposal areas should be examined to be sure everything appropriate is being done. For example, proper drainage is absolutely necessary both to maximize disposal site capacity and to ensure that sediment is not reintroduced to the channel. Moving the inflow point will also help. Batch mode filling could also be attractive.

34. During the discussion of these points, the following comments were made:

a. *Mr. Vann:* Agitation dredging by slip users may contribute to the problems, and the amount should be defined. The LTMS study should address all aspects of dredging, including that. A literature review of pre-tide gate conditions might provide some clues. He concurred with the recommendation to examine disposal site management fully, noting that the technology is available to maximize site capacity. Surface area is critical. From the presentations it sounds as if those managing dredging may be separated organizationally from those managing the disposal sites. Computer analysis of hydrographic data will be invaluable, providing much more than just sediment volumes by zone. Sediment bed densities are essential.

b. *Mr. McAnally:* Nuclear density profiling equipment, including drop probes and the newly developed WES-DRP sled for fluid mud, can provide hard information about sediment density in the fluff zones. The ocean may be a sediment source also, since estuaries in this area have large coastal marshes that accumulate and supply fine sediments to the coastal zone. (Dr. Krone: They can supplement cores, but highly resolved density profiles from cores are needed.) A 2-D laterally averaged model will suffice as a screening tool for plans and sensitivity studies, but satisfying the resource agencies with any project change predictions will require a full 3-D model with marsh wetting and drying.

c. *Mr. Jaime R. Merino, South Pacific Division:* There are tremendous discrepancies in the numbers for mass balance of sediments. There must be another source (other than upland) of sediments to account for the 7 million cubic yards of dredging. (Drs. Krone and Pritchard: Yes, back calculation leads to upstream concentrations of 100-300 ppm, but the data supplied by District suggest only 40 ppm. Additional information on input solids concentration is needed.) Wicks in the dredged material containment area might help reduce the volume. (Mr. Vann: Only if the pore pressure is high enough. Thus pore pressure measurements should be considered.)

d. *Mr. Herrmann:* Jim Neiheisel studied sediments in several estuaries of the region. His reports may contain useful information. The numerical model can address the optimum configuration of the sediment basin entrance channel.

e. *Mr. Powell:* Making the sediment basin deeper would increase its efficiency. The need for modeling and hydrographic surveys includes defining the "without-project" condition for the

next proposed channel enlargement. The study of the gate must include consideration of both the wildlife refuge and striped bass effects. Cores should be coordinated with the District geotechnical staff to ensure their needs are met. WES HL work with acoustic Doppler current profiler (ADCP) measurement of sediment flux will be valuable here.

f. Mr. Combe: The sediment basin is now too shallow at 38 ft. Evaluation of changes should start at 60 ft. Analysis of sedimentation rates by channel reach may reveal that more variable advance maintenance will create in-channel sedimentation basins. That will be particularly helpful if the existing sediment basin can't be made as effective as it we need it to be.

g. Mr. C. J. Wener, New England Division: The tide gate structure constricts Back River, since it has only 25 percent of the cross-sectional area of the river.

h. Dr. Pritchard: One alternative to the wildlife refuge problem would be to divert nearly all the freshwater flow into Back River above the refuge, leaving Front River as a saline port. The concept has potential problems that must be addressed, but it's worth looking at in the model.

i. Mr. H. Lee Butler, WES: Remember that we have more than one customer in the case—the port, the City of Savannah, fish and wildlife community, and so on. A joint agency effort to define project goals is needed.

j. Mr. Reindl: The field data collection to support modeling should be done with WES oversight and participation.

35. **Grays Harbor.** The draft Grays Harbor Subcommittee Report on the Grays Harbor breach was summarized by Dr. Krone. Major points were discussed and Dr. Krone requested that all comments be to him by the end of the week.

36. **Indian River Inlet Report.** Mr. Herrmann said that the report on the CTH analysis of Indian River Inlet has been published as an unnumbered report. Ms. Ginny Pankow, Water Resources Support Center; Dr. Pritchard; Mr. Lincoln C. Blake, Charleston District; and Mr. Merino did not receive copies.

37. **ESTEX Experimental Facility.** Mr. McAnally gave a brief update on the ESTEX experimental facility. The initial phase, a 400- by 60-ft basin, has been constructed for vessel effects testing. The construction of the rest of the facility is planned for 1997.

38. **Cohesive Sediments Research Newsletter.** Mr. McAnally reported that the newsletter has 212 subscribers, 112 in the Corps of Engineers, 39 other Federal government, 28 university or private U.S., and 33 international. Mr. William L. Boyt of WES is the newsletter editor.

39. **Tidal Hydraulics Bibliography.** Mr. Herrmann said that Volume 11 of the bibliography, which will be the final bound version, is ready for printing. The digital database form, demonstrated at the 102nd meeting, is ready to begin operation pending funding. Mr. Powell suggested that the on-line bibliography be combined with electronic mail services, and that the Committee consider an Estuarine News Network.

40. The concept of an electronic network was supported by several members. Mr. Merino noted that the Committee's White Paper on research and development (R&D) had recommended that the

R&D Directorate sponsor such a net, but that nothing had been set up so far. Mr. Wener said that the Water Quality Committee planned to set up an electronic bulletin board using Water Operations Technical Support (WOTS) funds.

41. **White Paper on R&D.** Mr. McAnally reported that the HQUSACE R&D Directorate had reportedly taken action on some of the Committee's May 1992 White Paper recommendations, but that no formal response has been received.

42. Mr. Powell said that the missing link in achieving the R&D objectives espoused by the CTH is setting up a tidal hydraulics research program. Mr. Herrmann noted that a strong HQUSACE Hydraulics and Hydrology Branch proponency is essential to creation of a program under General Investigations funding. Mr. Merino suggested that a linkage to LTMS for dredged material is appropriate, since so many tidal hydraulics problems are key to success in those studies. Mr. Vann said that the LTMS process is now driven by the HQUSACE Planning Directorate.

43. Dr. Krone said that tidal hydraulics R&D is split among many mission-oriented agencies, so that each person in the agencies sees only a small part of the overall problem. Fears for environmental damage arise from a fear of change, and we need to show how R&D can alleviate those fears.

44. Mr. Vann recommended that the CTH sponsor a workshop of field and laboratory people to define the problems. Mr. Powell endorsed the idea and recommended that a CTH subcommittee follow up the workshop by working up a specific niche program for Hydraulics and Hydrology to advocate. He offered Jay Lockhart's (HQUSACE) services to assist.

45. Mr. Combe noted that he attends many program reviews and often he was the only Engineering Division person present. Field Review Groups need a mix of disciplines.

46. Dr. Krone recommended that the program be proposed as a sequence of related efforts that will lead to useful products, even if some of the intermediate results are not directly useful to the field.

47. **Election of Officers.** Mr. Powell chaired the election of CTH officers for 1995. Mr. Combe nominated Mr. McAnally for Executive Secretary, Mr. Merino seconded the nomination, and Mr. McAnally was elected. Mr. Butler nominated Mr. Herrmann for Chairman, Mr. Merino seconded the nomination, and Mr. Herrmann was elected.

48. **New Members.** Mr. Herrmann read a letter of resignation from Dr. John Harrison, WES, who has accepted a new position in Washington. Nomination of a member to replace him was discussed.

49. **Next Meeting.** Possible invitations for the next meeting were mentioned for San Francisco and New Orleans.

50. **Other Business.** The excellent efforts of Mr. Seyle in organizing the meeting were gratefully acknowledged, and the Committee members expressed their appreciation to him, Ms. Durden, Ms. Dodd, and Mr. Reynolds for their presentations. Mr. Simmons' absence was keenly felt, and the membership extended their wishes for a rapid recovery.

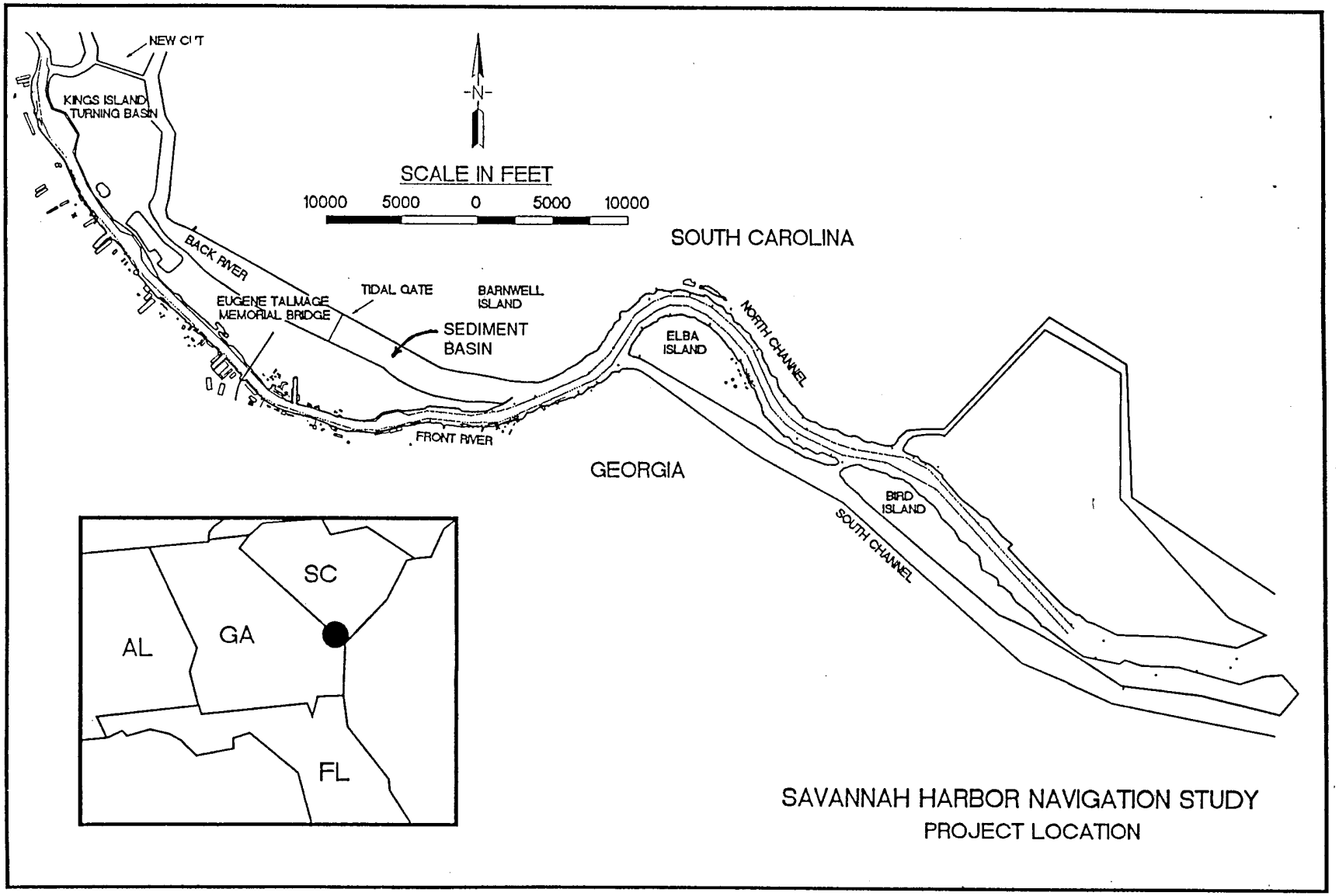
51. **Consultants Comments:**

a. Dr. Krone. Dr. Krone said that he was delighted to attend here in Savannah and hear of the harbor project. He worked on a CTH harbor study in 1972, and it's nice to see the District continuing the work. He expressed mixed feelings about the tide gate situation. The basin and gate combination was an innovative, successful solution that has been taken out of operation for seemingly vague benefits. The situation should be reevaluated and each agency involved should be responsible for their decisions and comments. The problems posed by the District for Savannah Harbor are manageable and solutions are straightforward; they must be addressed carefully and with WES help. He noted that work in Charleston Harbor showed that the crucible method of suspended sediment analysis gives the wrong result. Millipore filters are the only highly accurate method.

b. Dr. Pritchard. Dr. Pritchard said he always learns something at CTH meetings. It has been his longest running, most rewarding activity. Of the Savannah Harbor questions, he said it is disappointing that decisions made at the top of the agencies seem not to be based on sound knowledge. The Corps of Engineers, Environmental Protection Agency, National Oceanic and Atmospheric Administration, and others are able to work these kinds of problems out. He supported Dr. Krone's observation that the measured sediment fluxes at Clyo are too small in that they yield orders of magnitude lower sediment supply than the dredging records show. Accurate measurement of sediment loadings is essential.

52. **Adjournment.** Having no other business before it, the 103rd Meeting was officially adjourned by Mr. Herrmann at 1200 hours on 22 September 1994.

7 Enclosures
1. Savannah Harbor Navigation Study project location
2. Savannah Harbor project depths
3. Savannah Harbor annual shoaling rates
4. Savannah Harbor average discharge
5. USGS sediment sampling at the Clyo gage
6. Dimensions of sediment basin
7. Map of sediment basin


NEW CUT
KINGS ISLAND TURNING BASIN
BACK RIVER
EUGENE TALMAGE MEMORIAL BRIDGE
TIDAL GATE
BARNWELL ISLAND
SEDIMENT BASIN
FRONT RIVER
-N-
SCALE IN FEET
10000 5000 0 5000 10000
SOUTH CAROLINA
GEORGIA
ELBA ISLAND
NORTH CHANNEL
SOUTH CHANNEL
BIRD ISLAND
SC
AL
GA
FL
SAVANNAH HARBOR NAVIGATION STUDY
PROJECT LOCATION

Enclosure 1

SAVANNAH HARBOR PROJECT DEPTHS

STATIONS	AUTHORIZED PROJECT DEPTH	ADVANCE MAINTENANCE DEPTH
0+000		
	42	2
24+000		
	42	4
70+000		
	42	2
79+000		
	42	0
100+000		
	42	2
102+000		
	42	0
103+000		
	36	2
105+500		
	30	2
112+500		

Enclosure 2

SAVANNAH HARBOR ANNUAL
SHOALING RATES

STATION	1972-1976 AVERAGE	1993-1994 ESTIMATED	PERCENT CHANGE
0+000			
	360,650	276,230	-23%
26+000			
	50,880	149,740	+294%
30+000			
	372,380	424,840	+114%
41+000			
	1,374,490	771,260	-56%
50+000			
	1,355,590	716,560	-53%
61+000			
	1,127,030	686,600	-61%
70+000			
	40,060	123,280	+308%
80+000			
	321,810	100,200	-69%
97+000			
	323,500	232,520	-28%
100+000			
	199,470	124,810	-37%
105+500			
	231,170	128,950	-44%
112+500			
TOTAL	5,757,030	3,734,990	-35%

Enclosure 3

Savannah River
Average Discharge

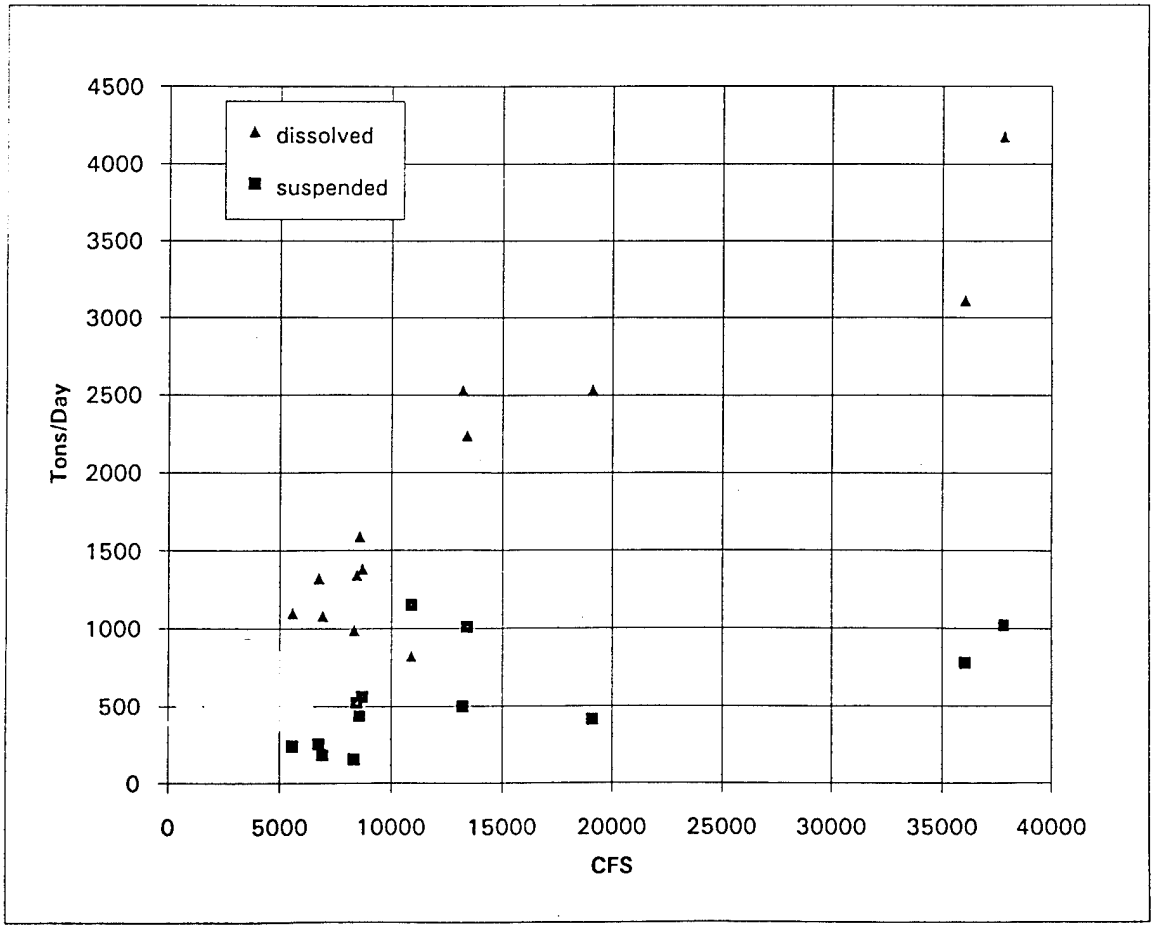
Location	Drainage Area	River Mile	Average Discharge (cfs) Period of Record		* WY1992
Thurmond Dam	6144 sq.mi.	238	(1954-93)	7857	6530
Augusta	7508	203	(1884-1993)	9970	7660
Jackson	8650	157		**	8360
Millhaven	8650	129	(1939-93)	10220	8740
Clyo	9850	65	(1930-93)	11740	9190
Savannah	10550	14			

* - Note: Since differing periods-of-record affect data comparison, 1992 is shown as a typical year.

** - Note: Jackson gage not defined above 22,000 cfs

USGS Sediment Sampling - Clyo Gage
Savannah River, Mile 65
1991-1993 (3-5 x per year)

		sediment, tons/day	
	cfs	dissolved	suspended
1991	8660	1380	561
	6900	1080	186
	8310	987	157
	10900	824	1150
	19100	2530	413
1992	6720	1320	254
	13200	2530	499
	13400	2240	1010
1993	8550	1590	439
	37800	4180	1020
	36000	3110	778
	8420	1340	523
	5560	1100	240

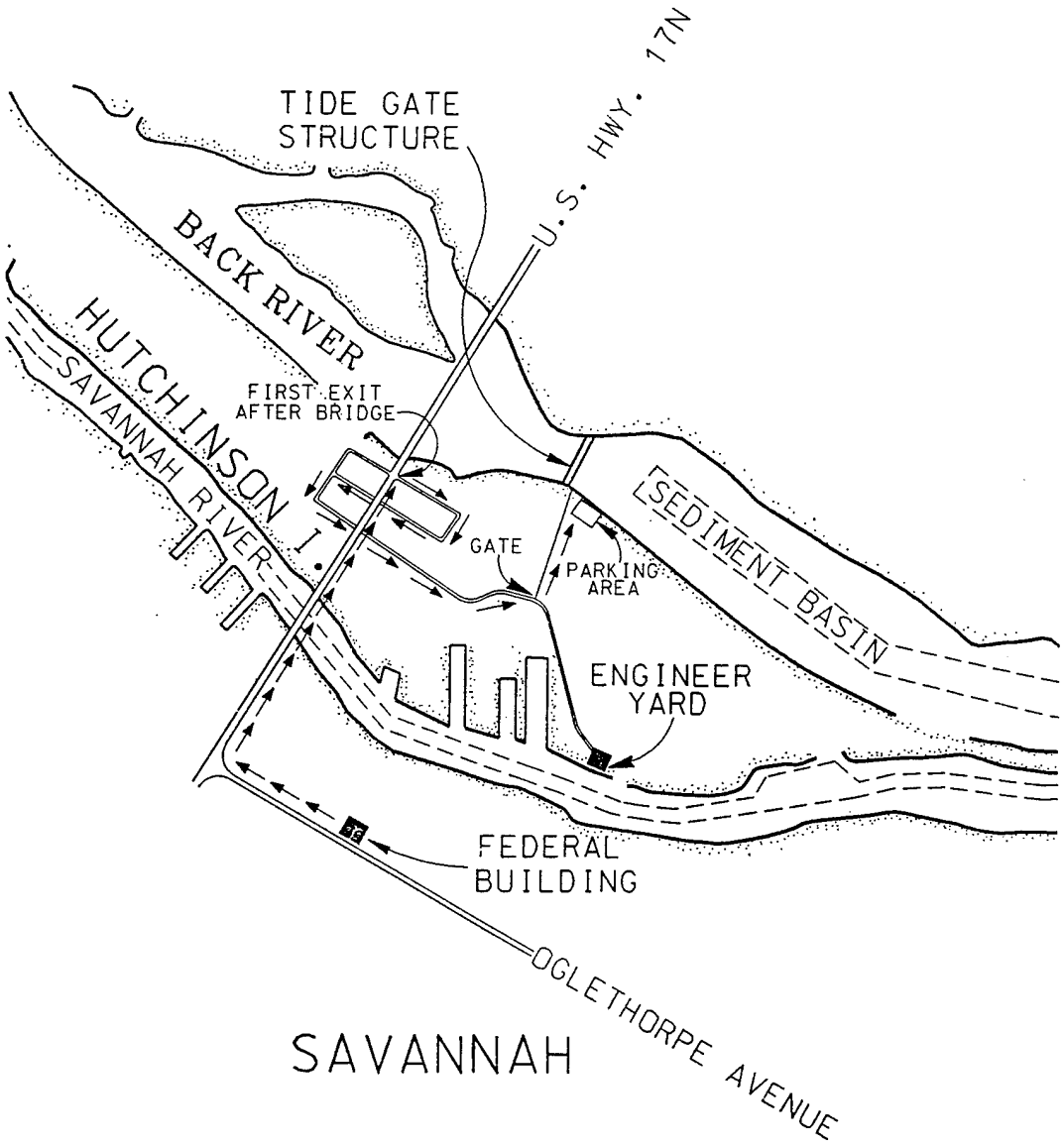


MONITORING COMPLETED COASTAL PROJECT
NOMINATION

SAVANNAH DISTRICT

SEDIMENT BASIN

	STATION	LENGTH Feet	WIDTH Feet	DEPTH Feet
Throat	0+500 to 2,000	1,500	300	38
Basin	to 13,300	11,300	600	40


TIDE GATE
STRUCTURE
U.S. HWY. 17N
BACK RIVER
HUTCHINSON I.
SAVANNAH RIVER
FIRST EXIT
AFTER BRIDGE
GATE
PARKING
AREA
SEDIMENT BASIN
ENGINEER
YARD
FEDERAL
BUILDING
OGLETHORPE AVENUE
SAVANNAH

Enclosure 7