SHIP NAVIGATION SIMULATOR STUDY
SACRAMENTO RIVER DEEPWATER SHIP CHANNEL
PROJECT, SACRAMENTO, CALIFORNIA

Report 1
PHASE I

Volume II
Appendixes B and C

by
Rosalyn HoangThi Nguyen, Larry L. Daggett
Hydraulics Laboratory
DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

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Report 1 of a Series

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Nguyen, Rosalyn Hoang Thi; Daggett, Larry L.

The tests showed that there was little difference between navigation of ships.

A real-time ship simulation investigation of the proposed design for deepening the man-made canal portion of the Sacramento Deepwater Ship Channel, Sacramento, CA, was conducted. The purpose of this study was to determine if the navigation channel could be deepened from 30 to 35 ft without widening from the existing channel width of 200 ft or if the channel would require widening to 250 ft, as authorized. A numeric model of the existing channel from about channel mile 35 to the Sacramento Harbor was developed. This model was verified by a member of the San Francisco Bar Pilots Association. Numeric models of two plan conditions were also developed, one with the existing channel deepened to 35 ft and the other with the channel widened by 50 ft and deepened to 35 ft. Both plans the two bends were widened by 50 ft. Tests were run on the WES ship simulator in which six pilots from the San Francisco Bar Pilots Association conned the simulated ship through the three simulated channel conditions.

Copies of this report and Appendices B and C are available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.
19. ABSTRACT (Continued).

In the existing channel and in the proposed channel which was deepened but not widened in the straight reaches. Slightly but consistently better control evident in the proposed channel. Larger bank clearances were evident with the 50-ft widening. Also, control of the ship appeared to be easier. The wider channel would provide more allowance for error, drift, and wind effects on the ships; however, the existing channel is not considered a navigation problem.

Appendix B presents track plots of each pilot's runs and Appendix C presents bar charts of statistical parameters in comparison format in addition to those discussed in the main text.

It is recommended that when the Sacramento Deepwater Ship Channel from mile 18.6 to the Sacramento Harbor is deepened by 5 ft (from 30 to 35 ft), the straight sections can remain 200 ft wide and the turns should be widened to 250 ft.

Keywords: Water channel test facilities; Ship models; Hydraulic models; Test/evaluation; Banks/waterways; Channels/waterways; Deep water channels. (MM)
APPENDIX B

LOWER SACRAMENTO TRACK LINES
PILOT TRACK PLOTS
AREA A

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 7
PILOT TRACK PLOTS
AREA B

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 1
PILOT TRACK PLOTS
AREA B

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 2
PILOT TRACK: PLOTS
AREA B

PLAN C
NO CURRENT / NO AIND
610 X 93 X 37
RUN E

PLATE B12
PILOT TRACK PLOTS
AREA B

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 4
PILOT TRACK PLOTS
AREA B

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 20
RUN 5

PLATE B14
PILOT TRACK PLOTS
AREA B

PLAN 0
NO CURRENT / NO WIND
610 x 93 x 30
RUN 6
PILOT TRACK PLOTS
AREA B

PLAN G
NO CURRENT / NO WIND
610 X 93 X 30
RUN 7
PILOT TRACK PLOTO
AREA B

PLAN 0
NO CURRENT / NO WIND
510 X 53 X 50
RUN 8

PLATE B17
PILOT TRACK PLOTS
AREA B

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 9
PILOT TRACK FLOTS
AREA C

PLAN C
NO CURRENT / NO WIND
610 X 93 X 30
RUN 1

PLATE B19
PILOT TRACK PLOTS
AREA C

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 2

PLATE B20
PILOT TRACK PLOTS
AREA C

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 3

PLATE B21
PILOT TRACK PLOTS

AREA C

PLAN 6
NO CURRENT / NO WIND
610 X 92 X 30
RUN 4

PLATE B27
PILOT TRACK PLOTS
AREA C

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 5
PILOT TRACK PLOTS
AREA C

PLANS
NO CURRENT - NO WIND
610 X 93 X 30
RUN 6

PLATE B24
PILOT TRACK PLOTS
AREA C

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 7
PILOT TRACK PLOTS
AREA C

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 8

PLATE B26
PILOT TRACK PLOTS
AREA C

PLAN 0
NO CURRENT / NO WIND
610 X 93 X 30
RUN 9

PLATE B27
PILOT TRACK PLOTS
AREA A
PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 2
PLATE B30

PILOT TRACK FLUTS

AREA A

FLAT 0

WICH CURRENT, NO WIND

10 X 93 X 30

RUN 3
PILOT TRACK PLOTS
AREA A

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 6
PILOT TRACK PLEITS
AREA A

PLAN 9
WITH CURRENT / WIND
60 X 90 X 30
POND A

PLATE B34
PILOT TRACK PLOTS

AREA A

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 10

PLATE 837
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 1
PILOT TRACK PLOTS

AREA B

PLAN 0
WITH CURRENT / NO WIND
610 x 93 x 36
RUN 2
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 3
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 4

PLATE 842
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 6

PLATE B43
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 7

PLATE B44
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 8
PILOT TRACK PLOTS
AREA B

PLAN D
WITH CURRENT / NO WIND
610 x 93 x 30
RUN 9

PLATE B46
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 10
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 11
PILOT TRACK PILOTS
AREA C

PLAN C
WITH CURRENT AND WIND
610 X 93 X 93
RUN 1

PLATE B49
PILOT TRACK FLOTTO
AREA C

PLAN 3
WITH CURRENT AND WIND
610 X 93 X 30
RUN 2

PLATE 850
PILOT TRACK FLIGHT
AREA C

PLAN C
WITH CURRENT AND NO WIND
610 X 93 X 21
RUN 3
PILOT TRACK PLOTS
AREA C

PLAN C
WITH CURRENT / NO WIND
610 x 93 x 30
PUN 4

PLATE B52
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 6

PLATE B53
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 7

PLATE B54
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 8
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 9

PLATE B56
PILOT TRACK FLETS
AREA C

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 10

PLATE B57
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / NO WIND
610 X 93 X 30
RUN 11

PLATE 858
PLATE B61
PILOT TRACK PLOTS
AREA A

PLAN 0
WITH CURRENT X WIND
610 X 93 X 30
PUN S

PLATE 863
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 1
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 2

PLATE B70
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 3
PILOT TRACK PLOTS
AREA B

PLAN D
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 4
PILOT TRACK PLOTS
AREA B

PLAN D
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 5
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT X WITH WIND
610 X 93 X 30
RUN 6
PILOT TRACK PLOTS
AREA B

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 7

PLATE B75
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / WITH WIND
610 x 93 x 30
RUN 1
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 2
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 3

PLATE B78
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN X

PLATE 881
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / WITH WIND
610 X 93 X 30
RUN 7
PILOT TRASK PLOTS
AREA C

PLAN 0
WITH CURRENT / WITH WIND
610 X 73 X 34
RUN 3

PLATE B84
PILOT TRACK PLOTS
AREA C

PLAN 0
WITH CURRENT / WITH WIND
610 x 93 x 30
PLT: 10

PLATE B85
PILOT TRACK PLOTS
AREA A

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 8

PLATE 893
PILOT TRACK PLOTS
AREA A

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 9
Pilot Track Plots
Area A

Plan 1
No Current, No Wind
610 x 93 x 35
Run 10
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 x 93 x 35
RUN 1

PLATE B96
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 2
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 3
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 4
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 5

PLATE B100
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 6

PLATE B101
PILOT TRACK PLOTS

AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 7

PLATE B102
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 8
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 5
Pilot Track Plots
Area B

Plan 1
No Current / No Wind
610 x 93 x 35
Run 10
PILOT TRACK PLOTS
AREA B

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
PUN II

PLATE B106
PILOT TRACK PLOTS
AREA C

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 1

PLATE B107
Pilot Track Plots
Area C

Plan 1
No Current / No Wind
610 x 93 x 35
Run 3

PLATE B109
PILOT TRACK PLOTS
AREA C

PLAN 1:
NO CURRENT / NO WIND
610 X 92 X 35
RUN 4
PILOT TRACK PLOTS
AREA C

PLAN I
NO CURRENT / NO WIND
510 X 33 X 35
RUN 6

PLATE B112
PILOT TRACK LANES
AREA C

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 7

PLATE B113
PILOT TRACK PLOTS
AREA C

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 8

PLATE B114
PILOT TRACK PLOTS

AREA C

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 9

PLATE B115
PILOT TRACK PLOTS
AREA C

PLAN 1
NO CURRENT / NO WIND
610 X 93 X 35
RUN 10
PILOT TRACK PLOTS
AREA A

PLAN 1
WITH CURRENT / NO WIND
610 X 93 X 35
RUN 6
PILOT TRACK PLOTS
AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN 1

PLATE B129
PILOT TRACK PLOTS
AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN 2
FILOT TRACK PLOTS

AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN 3
PILOT TRACK PLOTS
AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN 4
PILOT TRACK PLOTS

AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN 5

PLATE B133
PILOT TRACK PLOTS
AREA B

PLAN 1
WITH WIND / No WIND
610 X 93 X 35
RUN 6

PLATE B134
PILOT TRACK PLOTS

AREA B

PLAN 1
WITH WIND / NO WIND
612 X 93 X 35
RUN 7
PILOT TRACK PLOTS
AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN B

PLATE B136
PILOT TRACK PLOTS
AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN 10

PLATE B138
PILOT TRACK PLOTS
AREA B

PLAN 1
WITH WIND / NO WIND
610 X 93 X 35
RUN 11
PILOT TRACK PLOTS
AREA C

PLAN 1
WITH CURRENT / NO WIND
610 X 93 X 35
RUN 4

PLATE B143
PILOT TRACK PLOTS
AREA C

PLAN 1
WITH CURRENT / NO WIND
610 X 93 X 35
RUN 5

PLATE B144
PILOT TRACK PLANS
AREA C

PLAN 1
WITH CURRENT / NO WIND
610 X 93 X 35
RUN 6

PLATE B145
FLEET TRACK FLEET
AREA C
PLAN 3
WITH CURRENT FLEET
600 X 93 X 37
FLEET B

PLATE B147
PILOT TRACK FLIGHT
AREA C

PLAN 1
WITH CURRENT 
610 X 30 X 30
RUN 11

PLATE B15
Pilot Track Plan
Area C

Plan 1
With Current and Wind
410 x 93 x 25
Run 12

Plate B151
APPENDIX C

STATISTICAL ANALYSIS CHARTS
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA B - MEAN MAXIMUM PORT CLEARANCE

- MEAN MAXIMUM PORT CLEARANCE

NO CURRENT, NO WIND
WITH CURRENT, NO WIND
WITH CURRENT, WITH WIND

PLAN B    PLAN 1

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA B - MEAN MAXIMUM STARBOARD CLEARANCE

- MEAN MAXIMUM STARBOARD CLEARANCE

NO CURRENT, NO WIND
WITH CURRENT, NO WIND
WITH CURRENT, WITH WIND

PLAN B    PLAN 1

PLATE C2
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION

AREA A - MEAN MAXIMUM PORT CLEARANCE

Plan 0 Plan 1 Plan 2 Plan 2

No wind-no current: with 618 ft. bulk carrier
No wind-no current: with 855 ft. bulk carrier

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION

AREA A - MEAN MAXIMUM STBORD CLEARANCE

Plan 0 Plan 1 Plan 2 Plan 2

No wind-no current: with 618 ft. bulk carrier
No wind-no current: with 855 ft. bulk carrier

PLATE C4
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA B MEAN MAXIMUM PORT CLEARANCE

NO WIND - NO CURRENT; WITH 618 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA B MEAN MAXIMUM STARBOARD CLEARANCE

NO WIND - NO CURRENT; WITH 618 FT. BULK CARRIER
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN PORT MAXIMUM CLEARANCE

- NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN STARBOARD MAXIMUM CLEARANCE

- NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION PORT CLEARANCE

- NO CURRENT, NO WIND
- WITH CURRENT, NO WIND
- WITH CURRENT, WITH WIND

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION STARBOARD CLEARANCE

- NO CURRENT, NO WIND
- WITH CURRENT, NO WIND
- WITH CURRENT, WITH WIND

PLATE C8
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA B - STANDARD DEVIATION PORT CLEARANCE

<table>
<thead>
<tr>
<th>Condition</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Current, No Wind</td>
<td>12.5</td>
</tr>
<tr>
<td>With Current, No Wind</td>
<td>17.5</td>
</tr>
<tr>
<td>With Current, With Wind</td>
<td>12.5</td>
</tr>
</tbody>
</table>

PLAN B | PLAN 1

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA B - STANDARD DEVIATION STARBOARD CLEARANCE

<table>
<thead>
<tr>
<th>Condition</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Current, No Wind</td>
<td>12.5</td>
</tr>
<tr>
<td>With Current, No Wind</td>
<td>17.5</td>
</tr>
<tr>
<td>With Current, With Wind</td>
<td>12.5</td>
</tr>
</tbody>
</table>

PLAN B | PLAN 1

PLATE C10
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION PORT CLEARANCE

- No wind-no current; with 610 ft. bulk carrier
- No wind-no current; with 855 ft. bulk carrier

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION STARBOARD CLEARANCE

- No wind-no current; with 610 ft. bulk carrier
- No wind-no current; with 855 ft. bulk carrier

PLATE C14
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN PORT CLEARANCE

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN STARBOARD CLEARANCE

PLATE C17
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - STANDARD DEVIATION PORT CLEARANCE

- NO WIND-NO CURRENT: WITH 618 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - STANDARD DEVIATION STARBOARD CLEARANCE

- NO WIND-NO CURRENT: WITH 618 FT. BULK CARRIER

PLATE C18
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN DRIFT ANGLE

NO WIND-NO CURRENT; WITH 618 FT. BULK CARRIER

PLAN 0  PLAN 1  PLAN 2

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - STANDARD DEVIATION DRIFT ANGLE

NO WIND-NO CURRENT; WITH 618 FT. BULK CARRIER

PLAN 0  PLAN 1  PLAN 2
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - MEAN DRIFT ANGLE

- 1
- 0.75
- 0.5
- 0.25
- 0
- 0.25
- 0.5
- 0.75
- 1

PLAN 0 PLAN 1 PLAN 2 PLAN 2

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION DRIFT ANGLE

- 2.5
- 2
- 1.5
- 1
- 0.5
- 0

PLAN 0 PLAN 1 PLAN 2 PLAN 2

PLATE C20
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - MEAN RATE OF TURN

- NO WIND—NO CURRENT: WITH 610 FT. BULK CARRIER
- NO WIND—NO CURRENT: WITH 855 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION RATE OF TURN

- NO WIND—NO CURRENT: WITH 610 FT. BULK CARRIER
- NO WIND—NO CURRENT: WITH 855 FT. BULK CARRIER
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN RATE OF TURN

- NO WIND-HO CURRENT; WITH 618 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - STANDARD DEVIATION RATE OF TURN

- NO WIND-HO CURRENT; WITH 618 FT. BULK CARRIER
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - MEAN HEADING

- NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER
- NO WIND-NO CURRENT; WITH 855 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION HEADING

- NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER
- NO WIND-NO CURRENT; WITH 855 FT. BULK CARRIER
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN HEADING

NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - STANDARD DEVIATION HEADING

NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - MEAN RPM * RUDDER

NO WIND-NO CURRENT; WITH 618 FT. BULK CARRIER
NO WIND-NO CURRENT; WITH 855 FT. BULK CARRIER

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA A - STANDARD DEVIATION RPM * RUDDER

NO WIND-NO CURRENT; WITH 618 FT. BULK CARRIER
NO WIND-NO CURRENT; WITH 855 FT. BULK CARRIER

PLATE C27
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN RPM = RUD

NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER

MEAN RPM = RUD

PLAN 0  PLAN 1  PLAN 2

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - STANDARD DEVIATION RPM = RUD

NO WIND-NO CURRENT; WITH 610 FT. BULK CARRIER

STANDARD DEVIATION

PLAN 0  PLAN 1  PLAN 2

PLATE C28
SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - MEAN RPM & RUD

NO CURRENT, NO WIND
WITH CURRENT, NO WIND
WITH CURRENT, WITH WIND

PLAN 0

PLAN 1

SACRAMENTO DEEP WATER SHIP CHANNEL SIMULATION
AREA C - STANDARD DEVIATION RPM & RUD

NO CURRENT, NO WIND
WITH CURRENT, NO WIND
WITH CURRENT, WITH WIND

PLAN 0

PLAN 1

PLATE C32