FINAL FEASIBILITY REPORT
FOR
SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
SOUTHEAST TEXAS AND SOUTHWEST LOUISIANA

VOLUME I

ENGINEERING PLATES (APPENDIX 1)

ECONOMICS (APPENDIX 2)

BASELINE COST ESTIMATE (APPENDIX 3)

REAL ESTATE PLAN (APPENDIX 4)

PREPARED BY:

U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
SOUTHWESTERN DIVISION

March 2011

Appendix 1

Engineering Plates

Deep Draft Navigation Channel Improvements
Sabine Neches Waterway, Texas

ENGINEERING ADDENDUM
FOR
CHANNEL IMPROVEMENT STUDY
SABINE NECHES WATERWAY
48' PROJECT

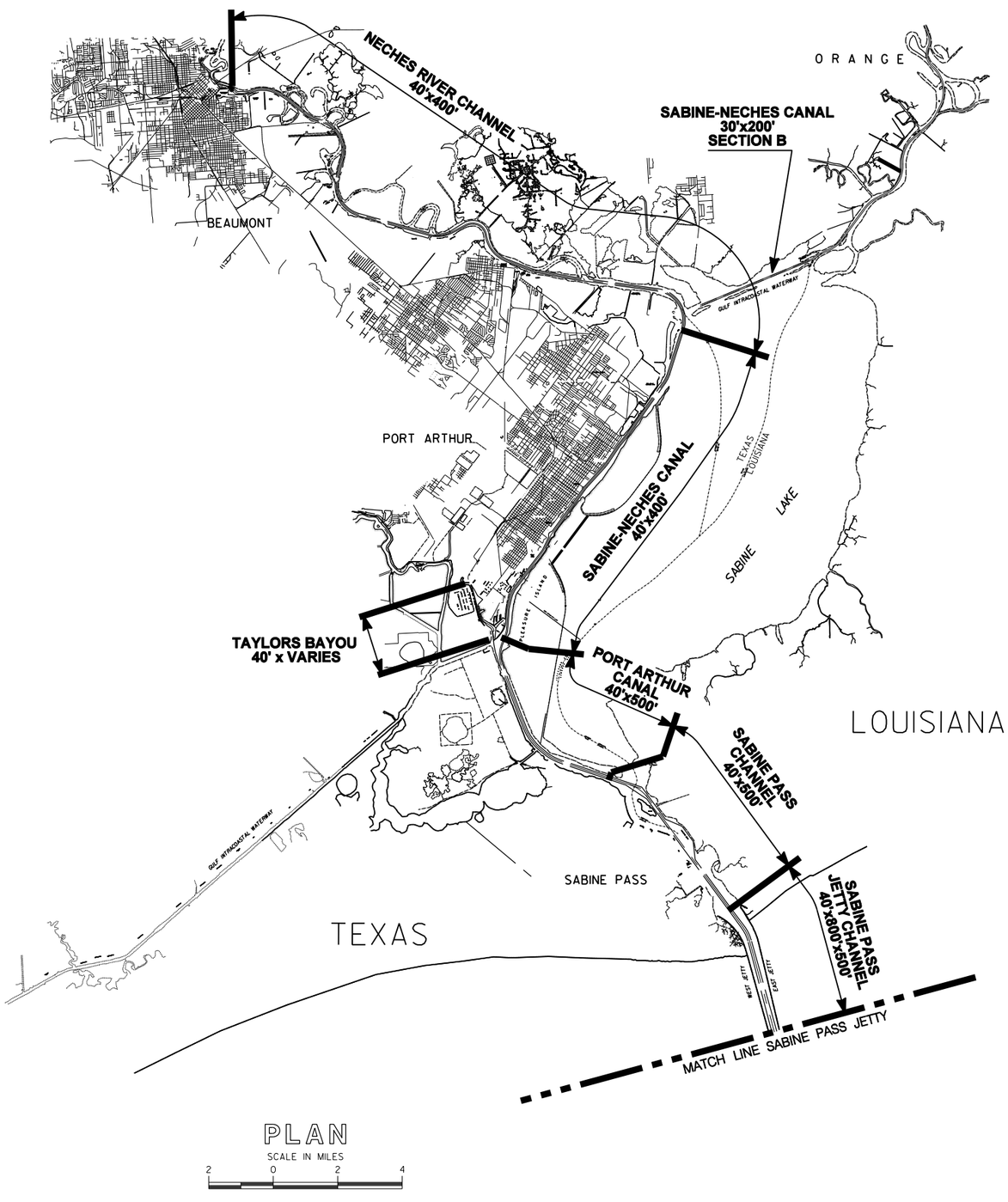
Center of Excellence

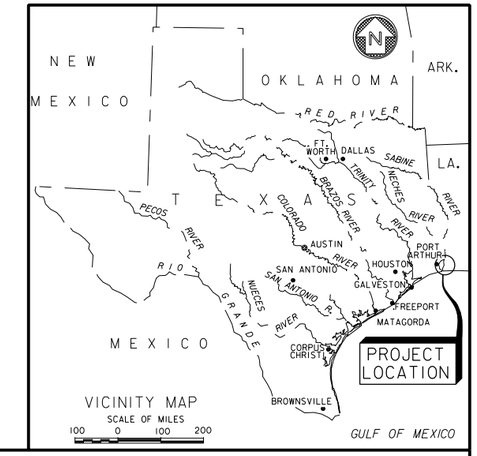
Coastal Navigation and Environmental Restoration

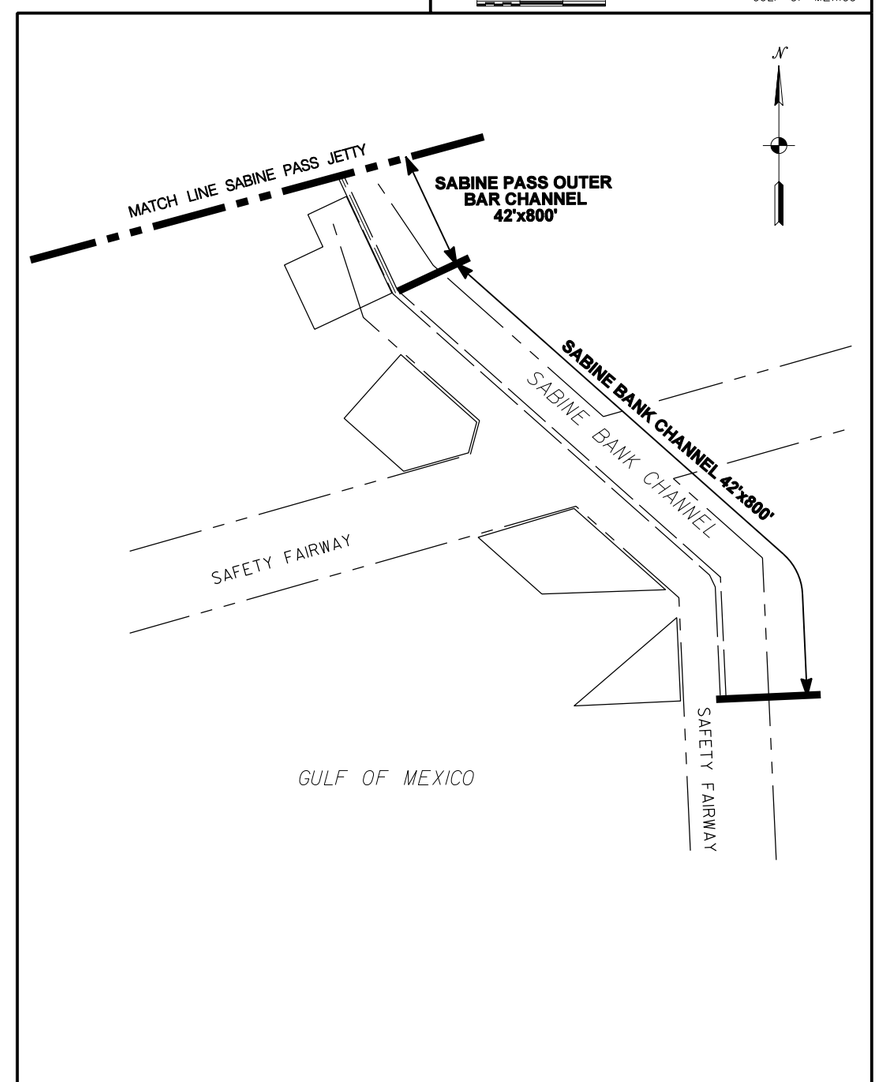
Office of the District Engineer
U. S. Army Engineer District, Galveston
Corps of Engineers
Galveston, Texas
Aug 2009

GALVESTON DISTRICT
TOTAL ARMY QUALITY

PRINTED ON RECYCLED PAPER







US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Geoengineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

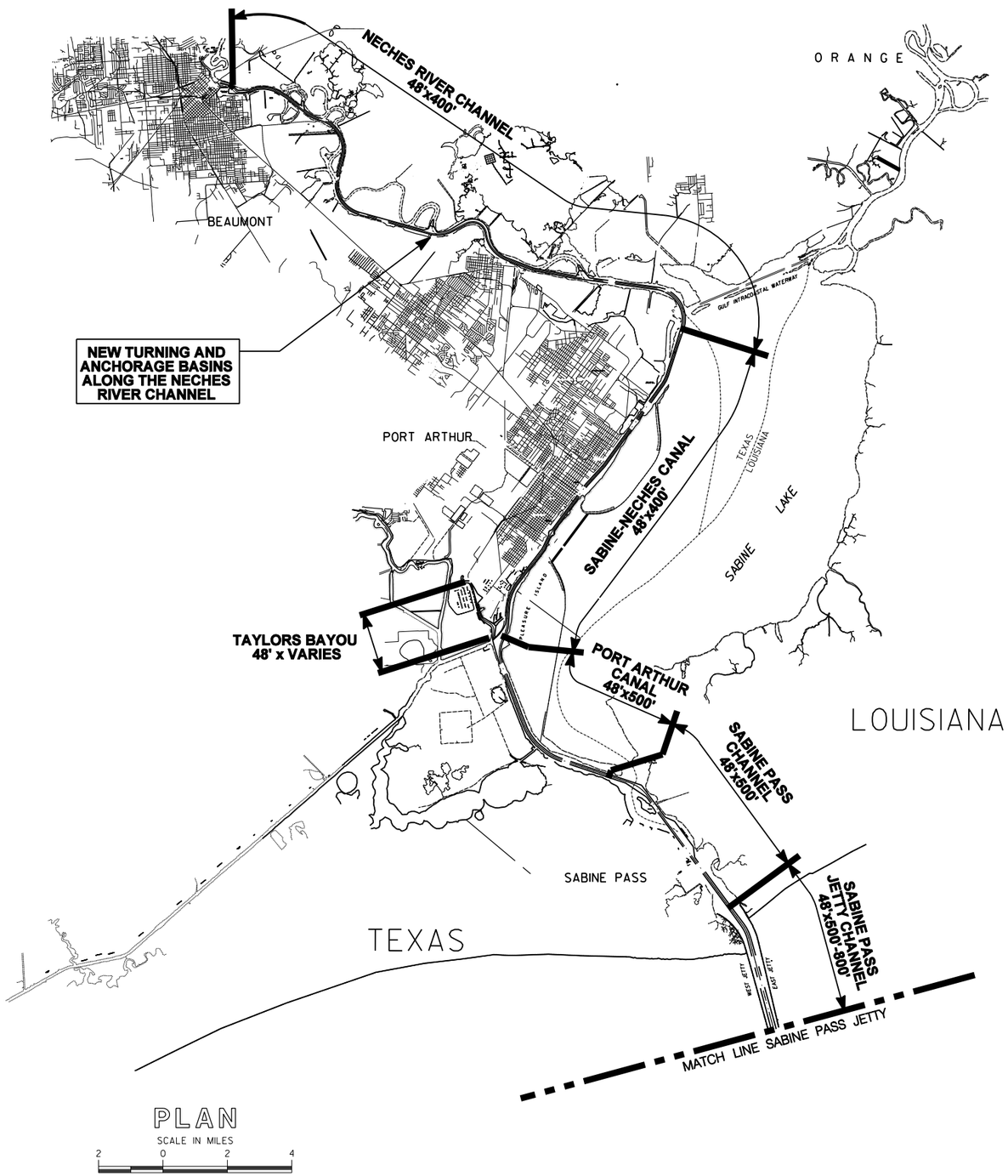
Date: MAY 2008
Rev.
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

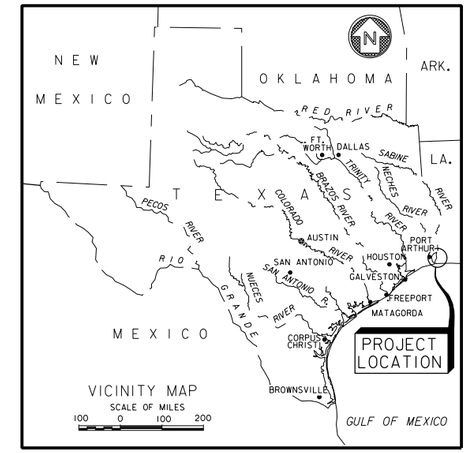
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

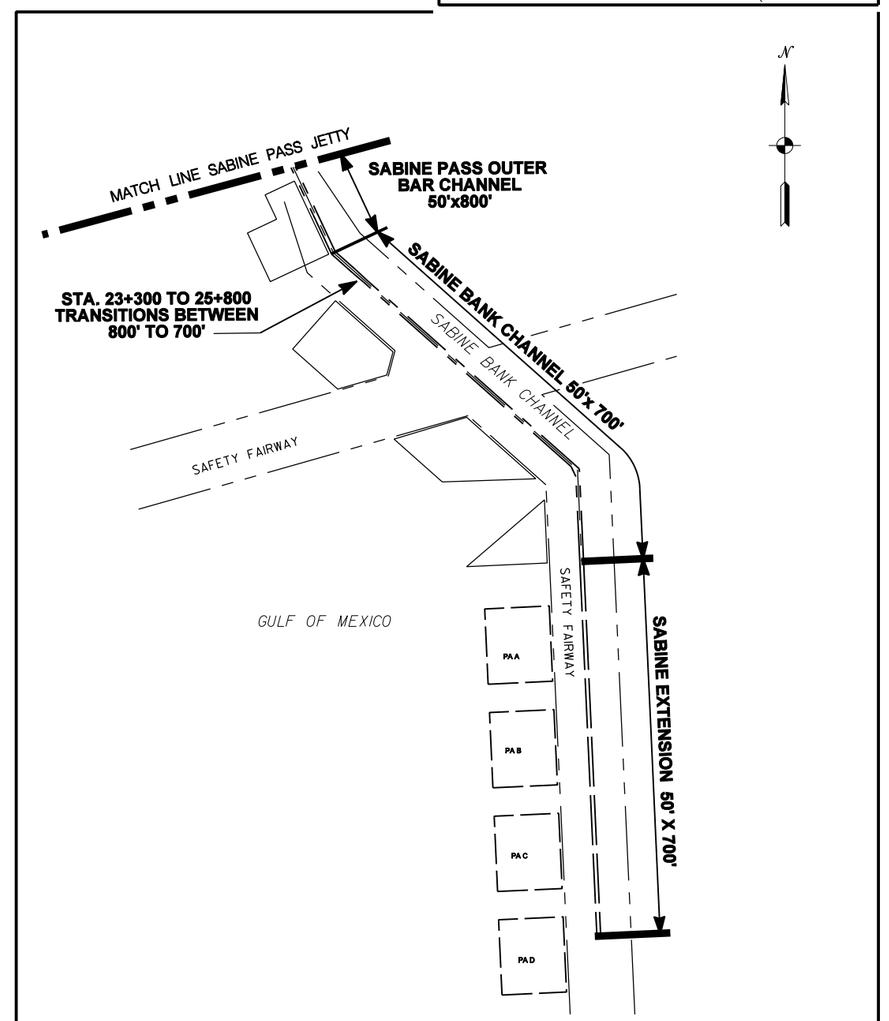
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOCATION PLAN
EXISTING WATERWAY

Drawing No.:
G-01







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GALVESTON, TEXAS

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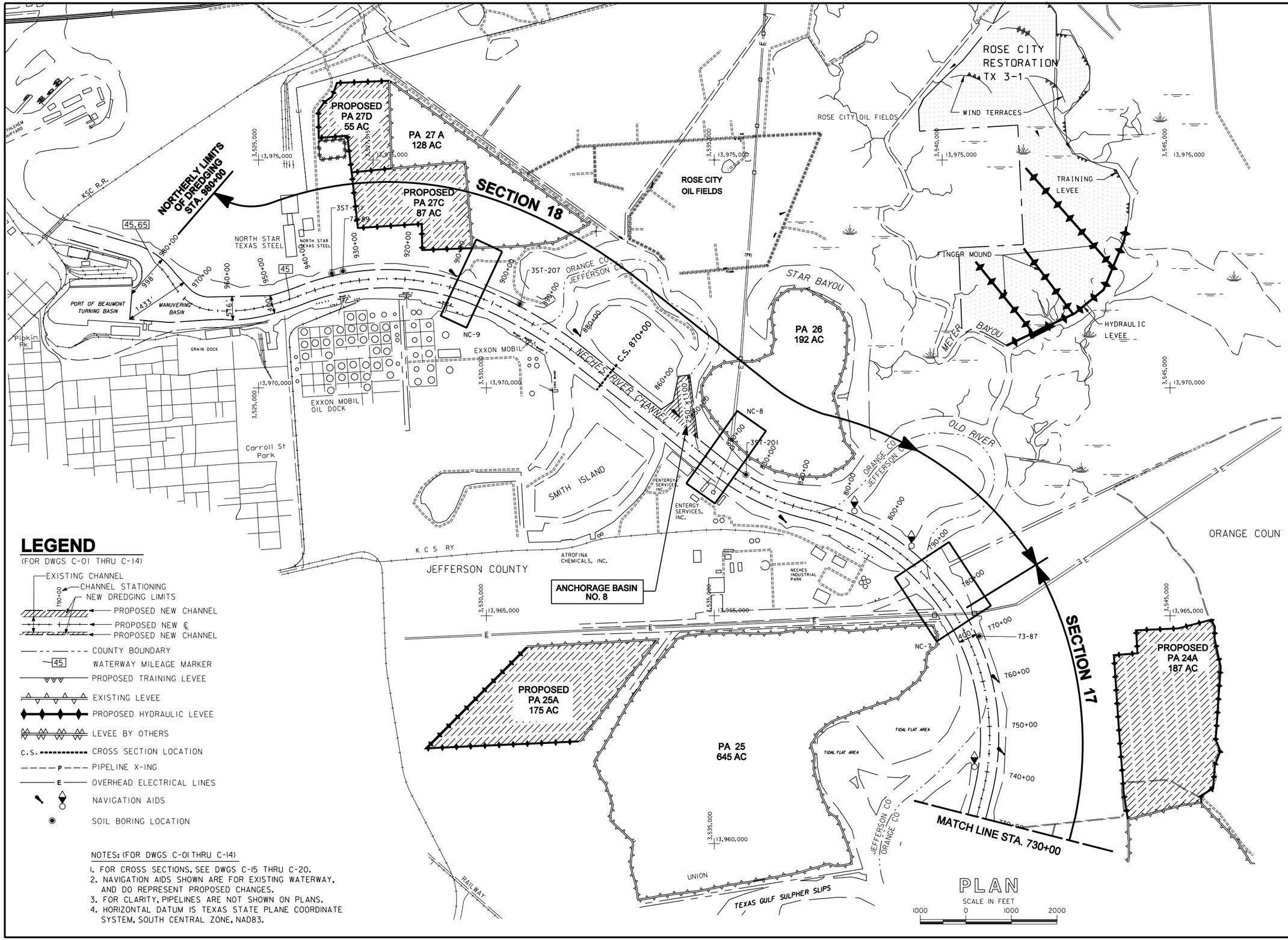
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOCATION PLAN
PROPOSED WATERWAY

Drawing No.:
G-02R



LEGEND

(FOR DWGS C-01 THRU C-14)

- EXISTING CHANNEL
- CHANNEL STATIONING (790+00)
- NEW DREDGING LIMITS
- PROPOSED NEW CHANNEL
- PROPOSED NEW ℄
- PROPOSED NEW CHANNEL
- COUNTY BOUNDARY
- WATERWAY MILEAGE MARKER (45)
- PROPOSED TRAINING LEVEE
- EXISTING LEVEE
- PROPOSED HYDRAULIC LEVEE
- LEVEE BY OTHERS
- C.S. CROSS SECTION LOCATION
- P PIPELINE X-ING
- E OVERHEAD ELECTRICAL LINES
- NAVIGATION AIDS
- SOIL BORING LOCATION

NOTES: (FOR DWGS C-01 THRU C-14)

1. FOR CROSS SECTIONS, SEE DWGS C-15 THRU C-20.
2. NAVIGATION AIDS SHOWN ARE FOR EXISTING WATERWAY, AND DO REPRESENT PROPOSED CHANGES.
3. FOR CLARITY, PIPELINES ARE NOT SHOWN ON PLANS.
4. HORIZONTAL DATUM IS TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83.

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Galveston District

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CORPS OF ENGINEERS
GALVESTON, TEXAS

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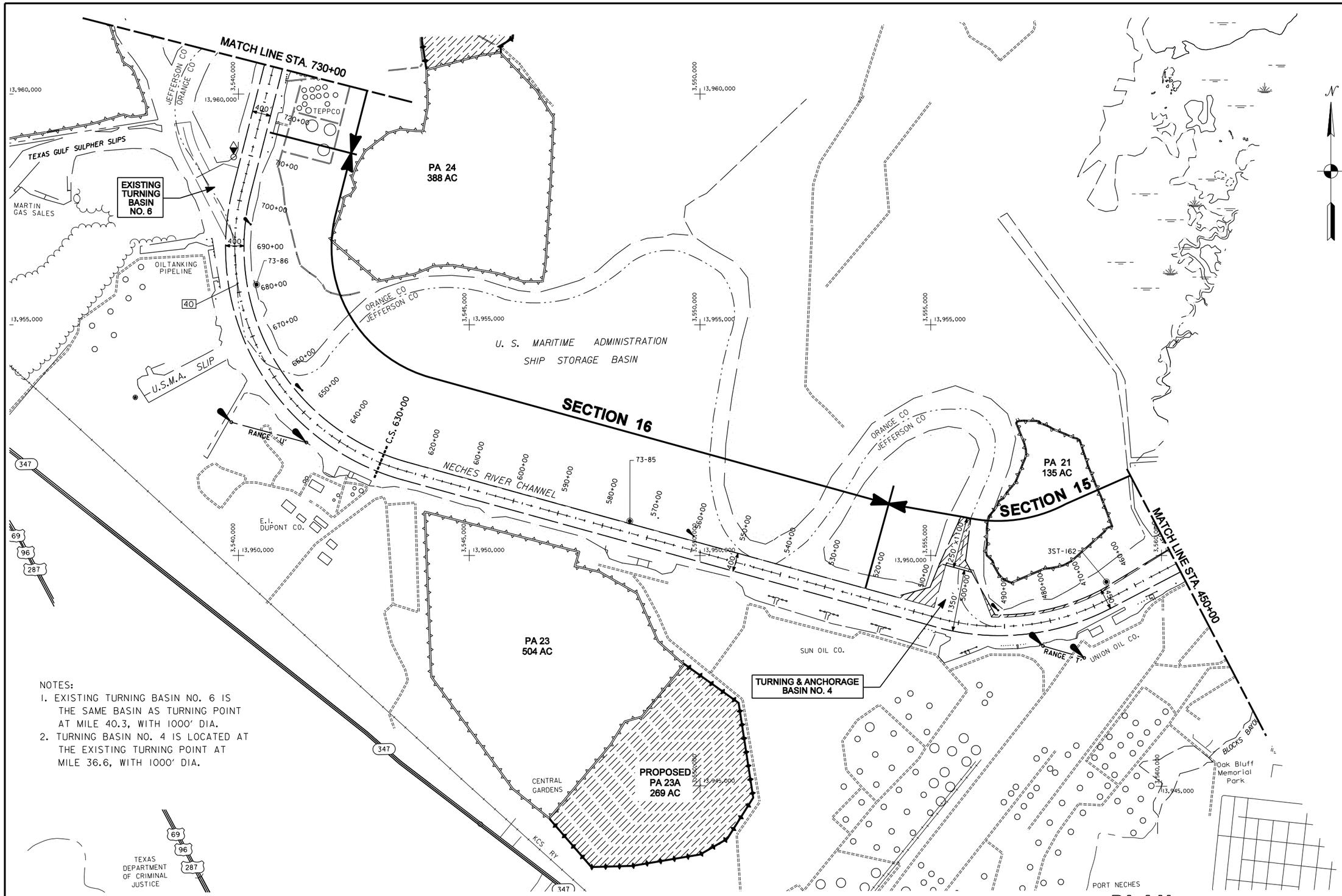
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
NECHES RIVER CHANNEL
STA. 980+00 TO STA. 730+00

Drawing No.:
C-01.R



NOTES:

1. EXISTING TURNING BASIN NO. 6 IS THE SAME BASIN AS TURNING POINT AT MILE 40.3, WITH 1000' DIA.
2. TURNING BASIN NO. 4 IS LOCATED AT THE EXISTING TURNING POINT AT MILE 36.6, WITH 1000' DIA.

PLAN

SCALE IN FEET

1000 0 1000 2000

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Sewerdrainage Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: AUG 2009
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U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

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DAVID C. WESTON, COL., C.E.,
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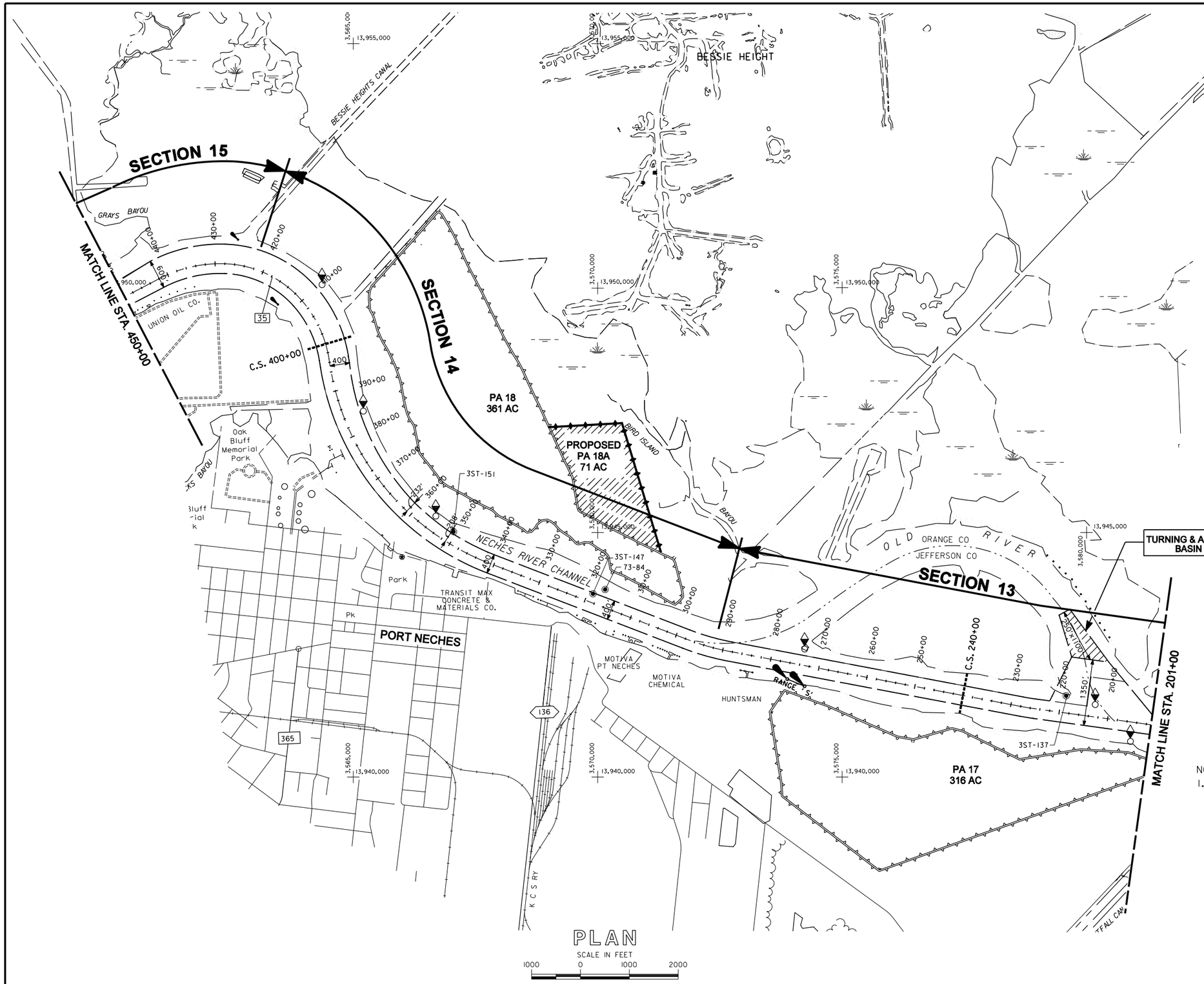
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
NECHES RIVER CHANNEL
STA. 730+00 TO STA. 450+00

Drawing No.:
C-02R



PLAN

SCALE IN FEET

1000 0 1000 2000

NOTE:

1. TURNING BASIN NO. 1 IS THE SAME AS EXISTING TURNING POINT AT MILE 31.1, WITH 1000' DIA.

US Army Corps of Engineers
Galveston District

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Drawn by: NCY	Date: AUG 2009
Designed by: NCY	Rev.
Checked by: MD	Scales: AS SHOWN
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Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division	

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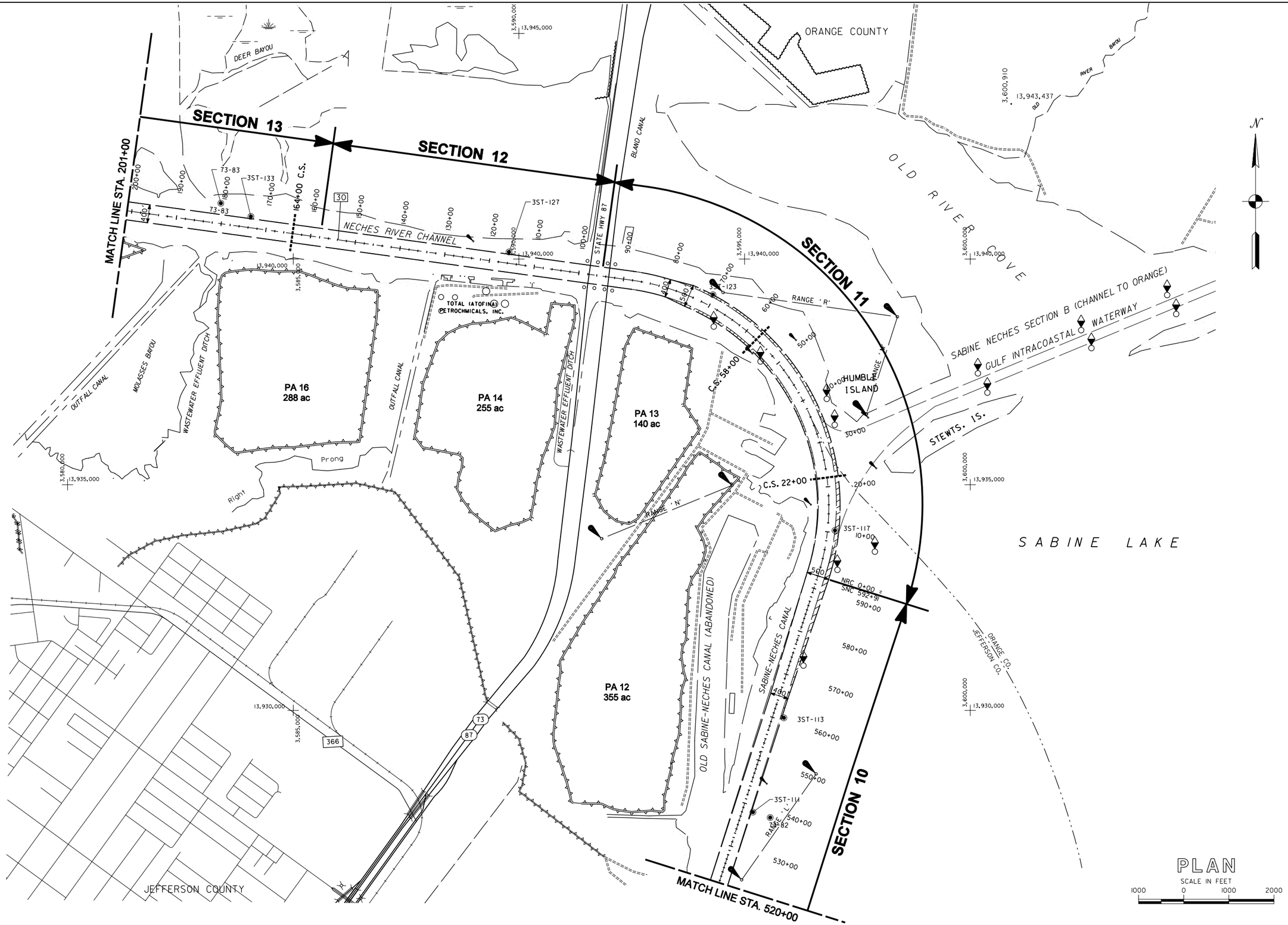
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
NECHES RIVER CHANNEL
STA. 450+00 TO STA. 201+00

Drawing No.:

C-03R



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SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
NRC STA. 201+00 TO
SNC STA. 520+00

Drawing No.:
C-04

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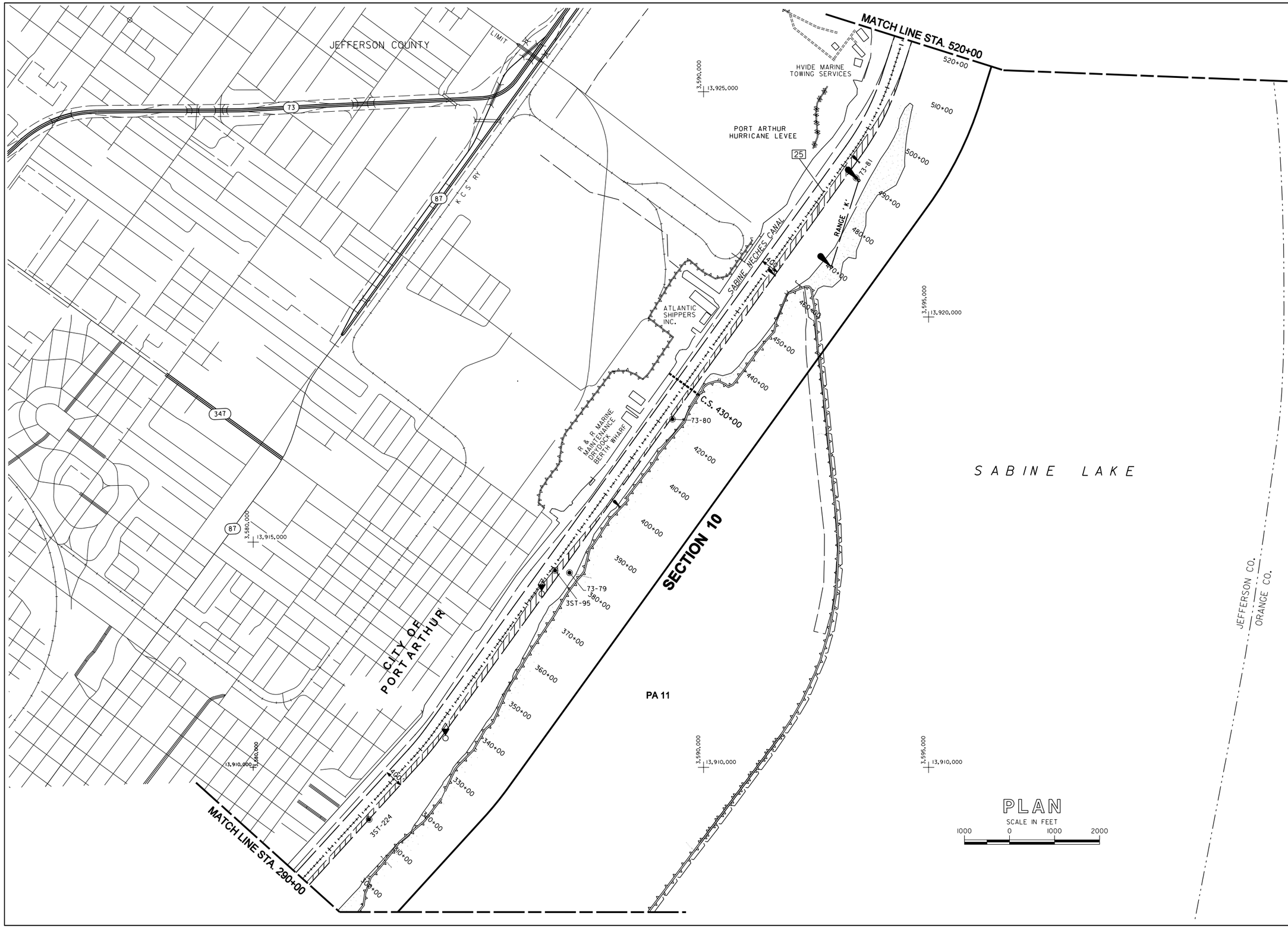

PLAN

SCALE IN FEET

1000 0 1000 2000

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GALVESTON, TEXAS

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Designed by: NCY
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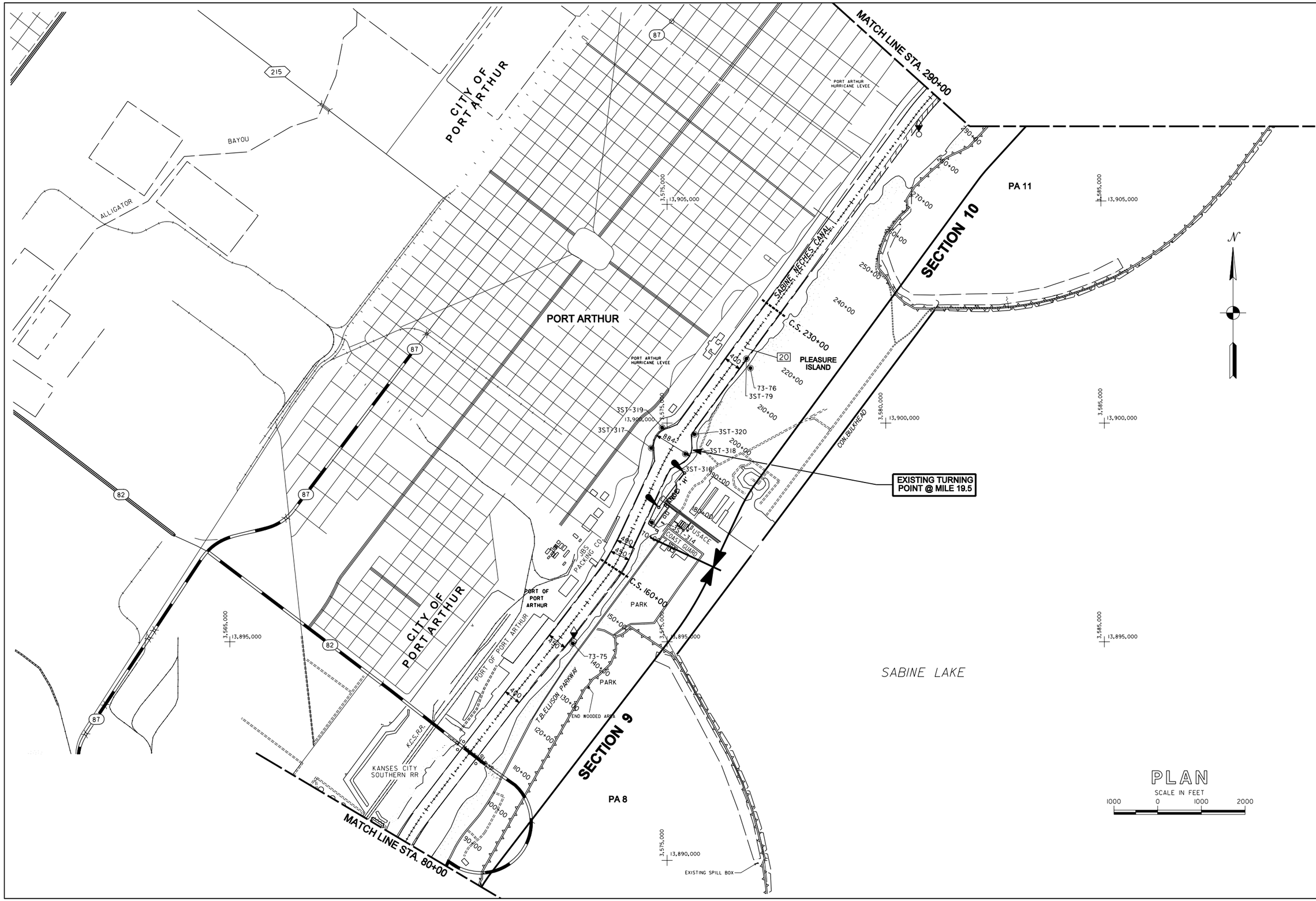
Submitted by:
DAVID R. BROWN, P.E.
Chief, Generalbgineering Section
Approved by:
PETE G. PEREZ, P.E.
Chief, Engineering and Construction Division

Date: MAY 2008
Rev.
Scale: AS SHOWN
Approval Recommended:
HARRISON T. SUTCLIFF, PE
Chief, Engineering Branch

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
SABINE NECHES CANAL
STA. 520+00 TO. STA. 290+00

Drawing No.:
C-05



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GALVESTON, TEXAS

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Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Rev.
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
SABINE NECHES CANAL
STA. 290+00 TO STA. 80+00

Drawing No.:
C-06

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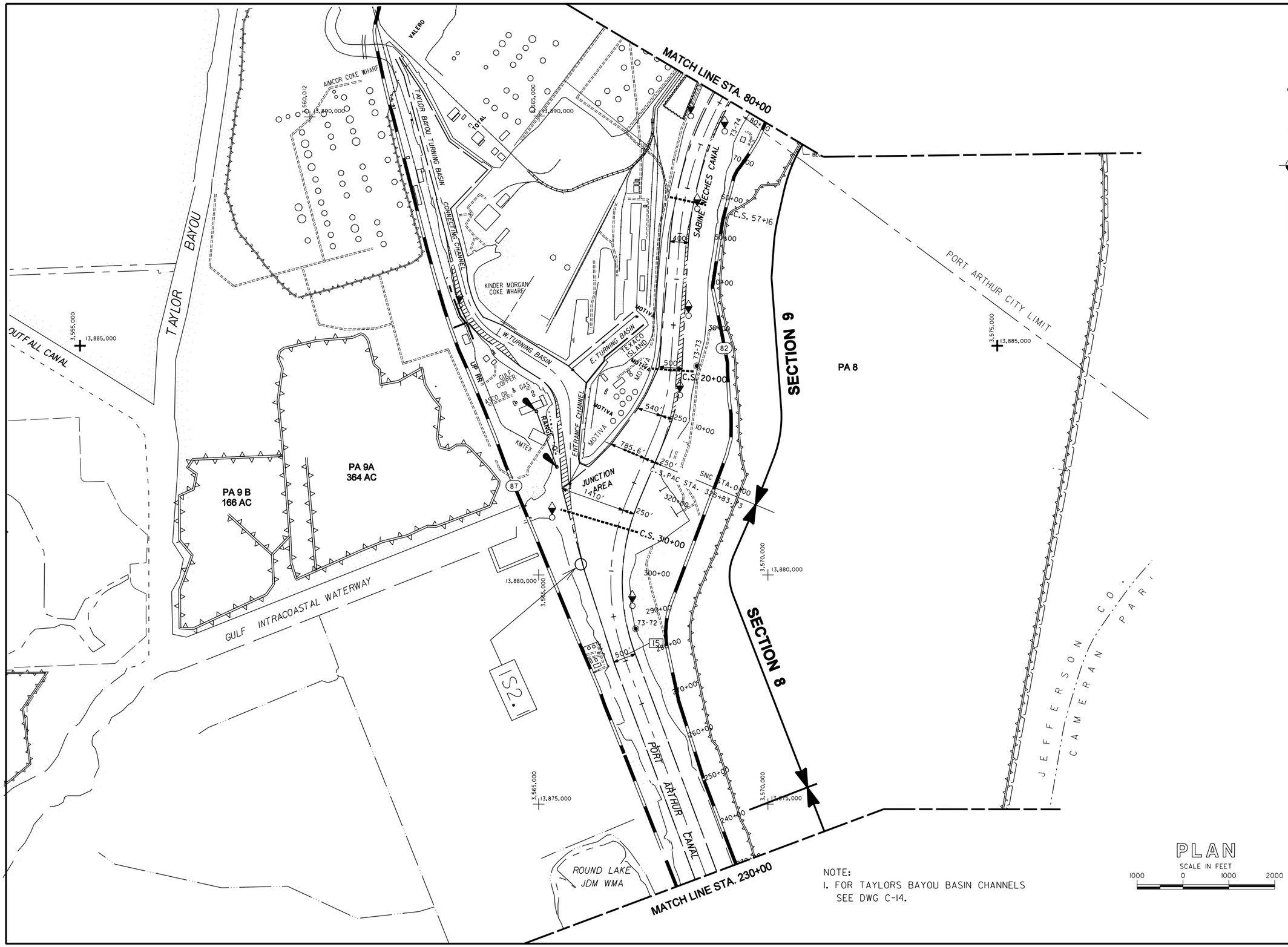

NOTE:
1. FOR TAYLORS BAYOU BASIN CHANNELS SEE DWG C-14.

PLAN
SCALE IN FEET
1000 0 1000 2000

US Army Corps of Engineers
Galveston District

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U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

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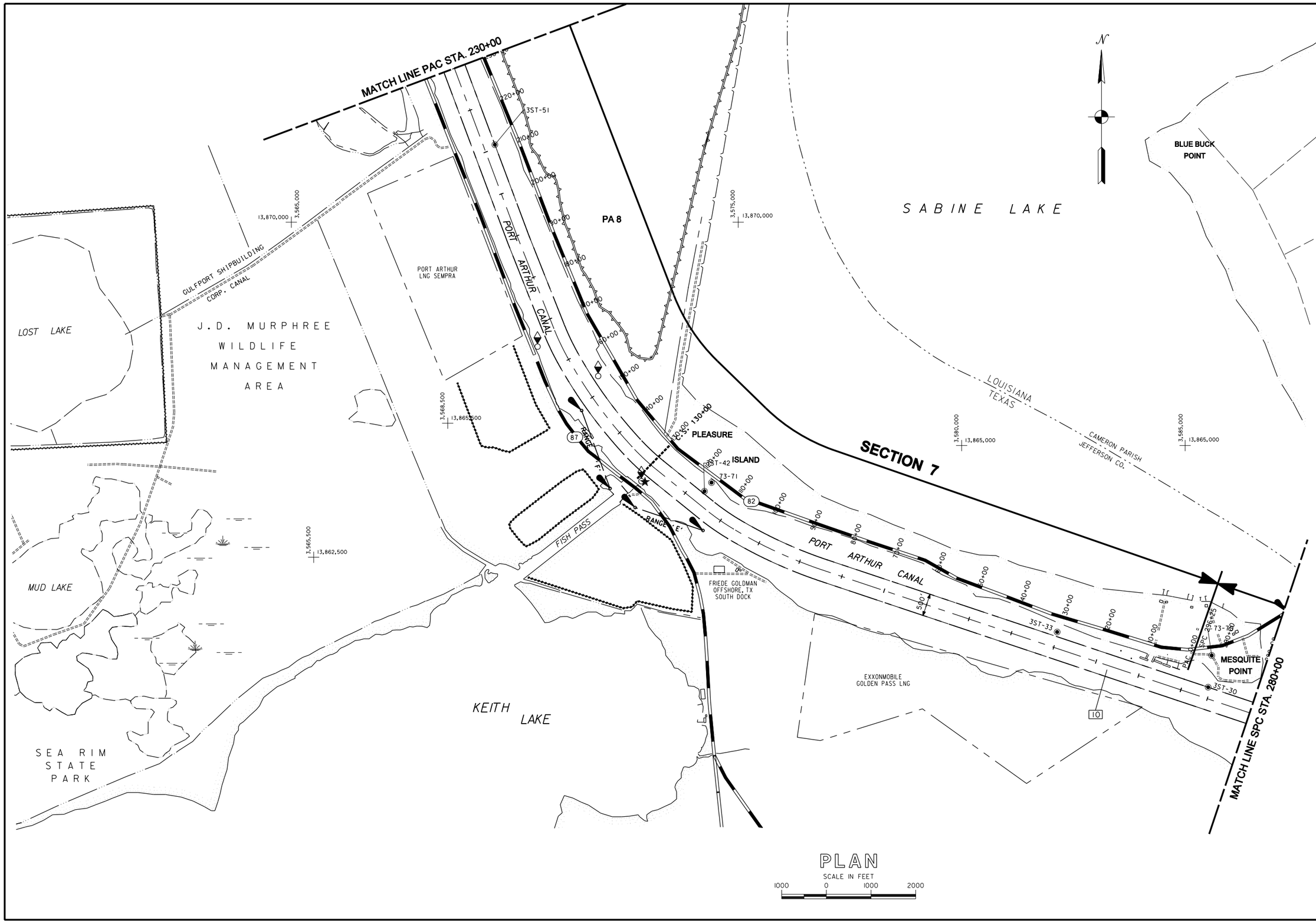
Submitted by: DAVID R. BROWN, P.E. Chief, General Engineering Section
Date: AUG 2009
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
SNC STA. 80+00
TO PAC STA. 230+00

Drawing No.:
C-07R



US Army Corps of Engineers
Galveston District

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U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
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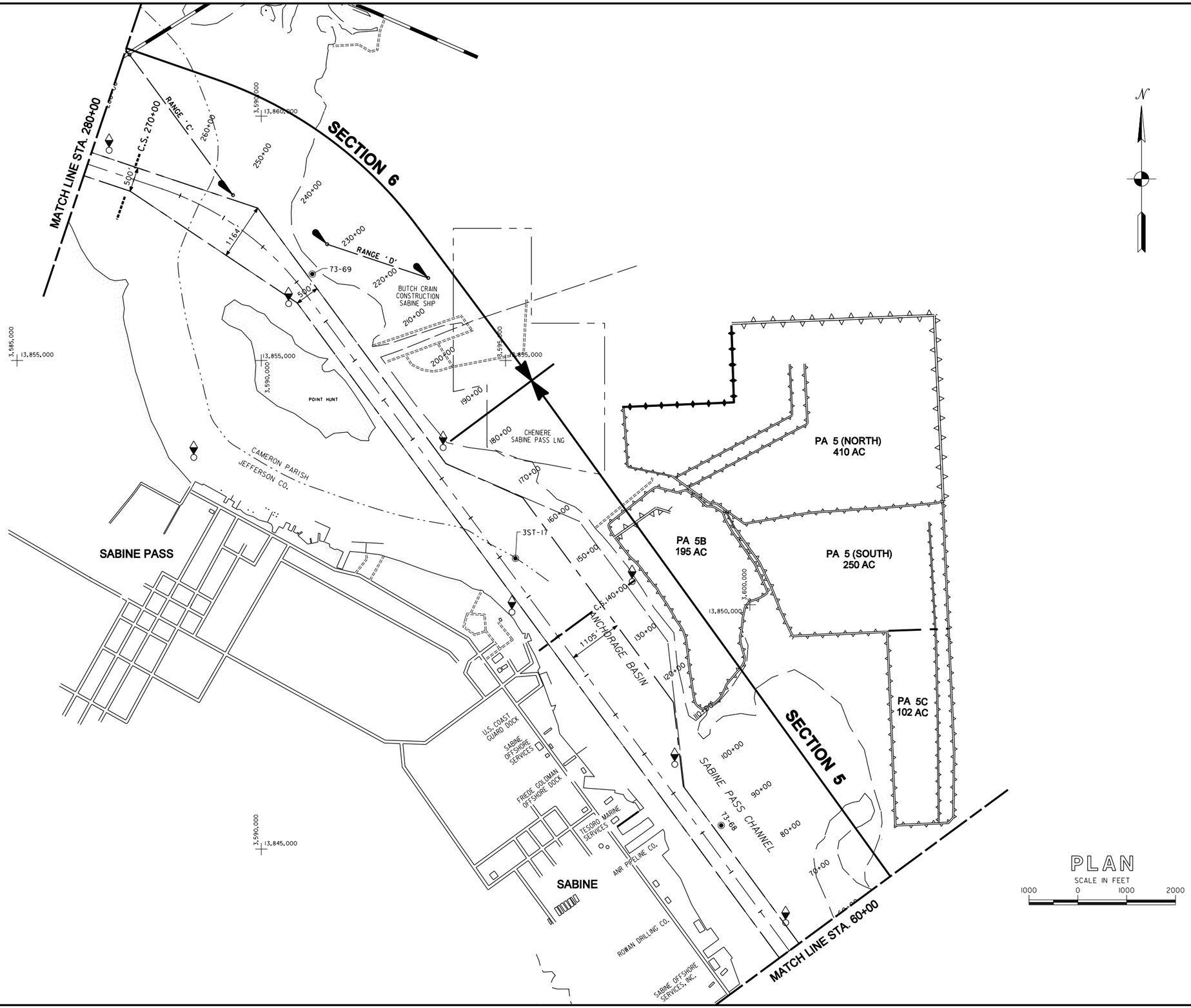
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
PAC STA. 230+00
TO SPC STA. 280+00

Drawing No.:
C-08R



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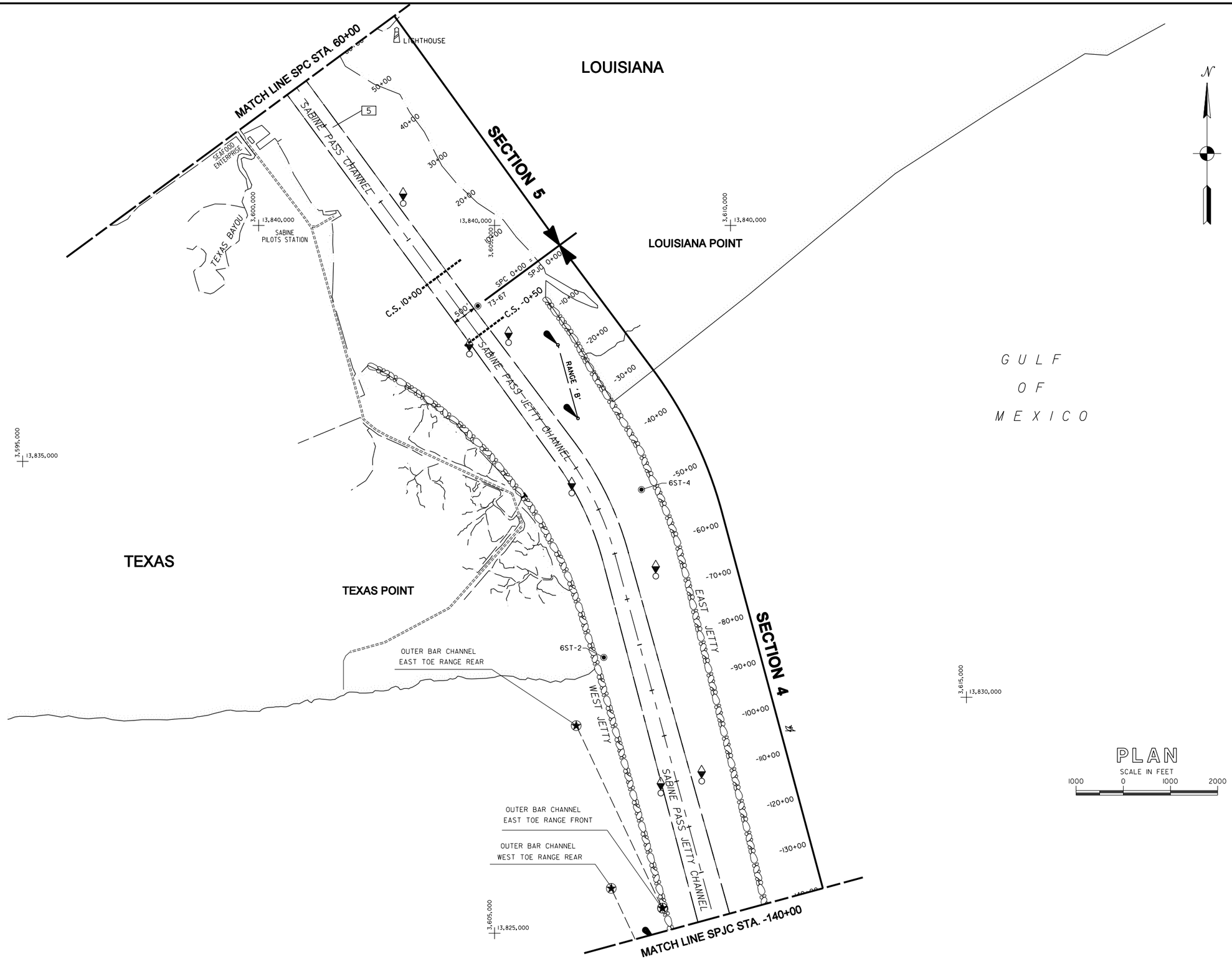
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
SABINE PASS CHANNEL
STA. 280+00 TO STA. 60+00

Drawing No.:
C-09R



PLAN

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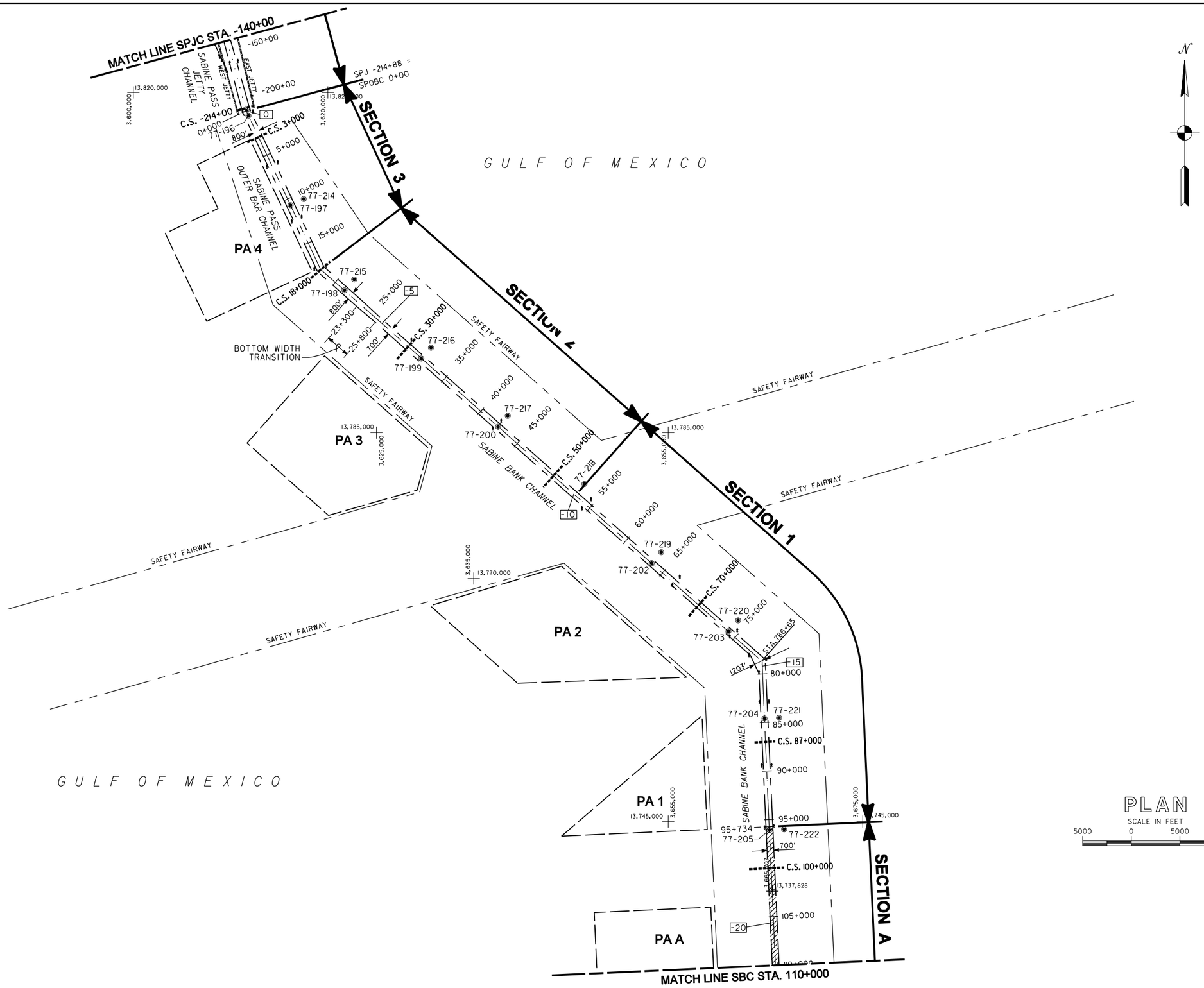
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
SPC STA. 60+00
TO SPJC STA. -140+00

Drawing No.:
C-10R



PLAN

SCALE IN FEET

5000 0 5000 10,000

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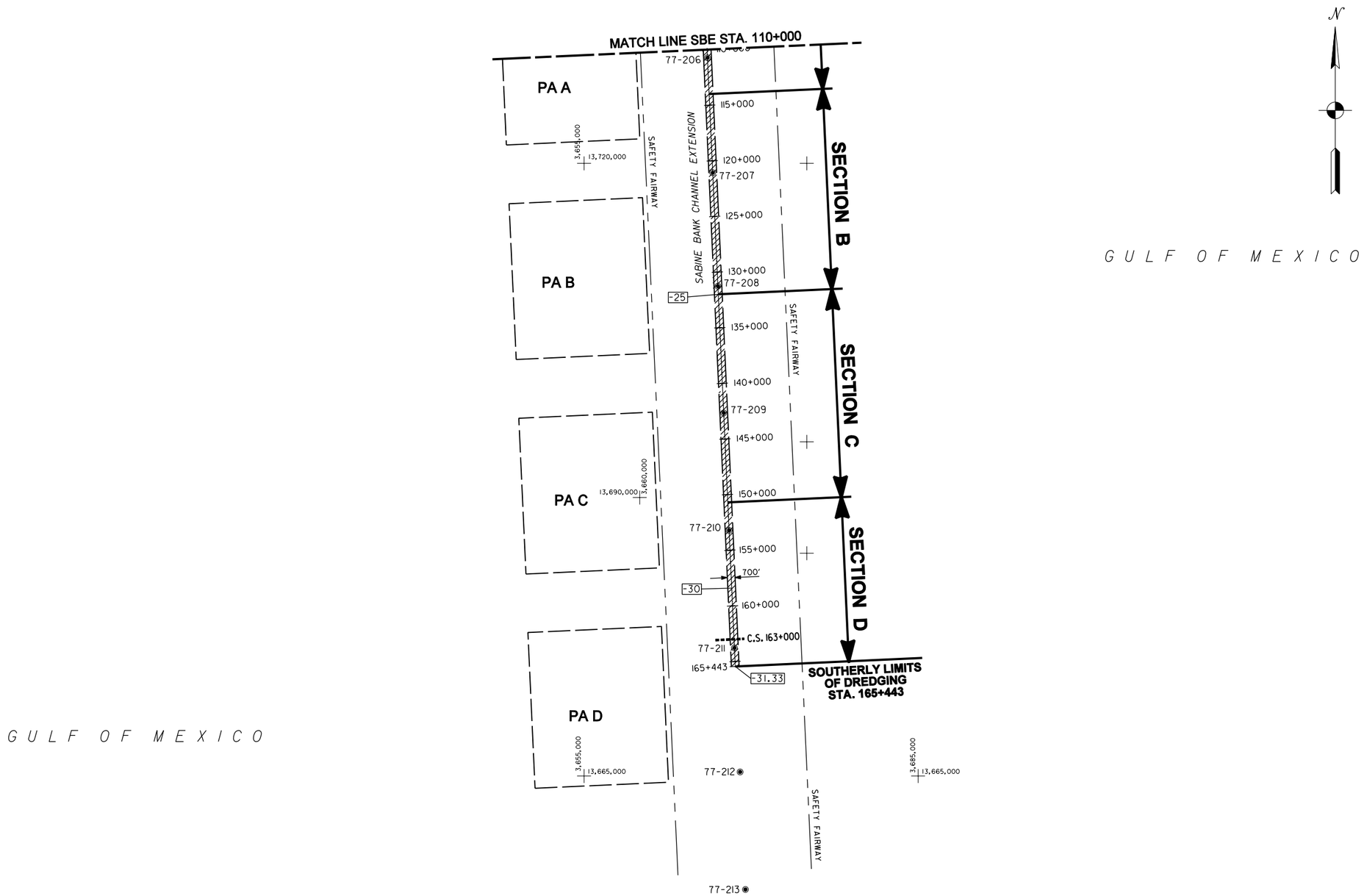
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
SPJC STA. -140+00
TO SBC STA. 110+000

Drawing No.:
C-11R



PLAN

SCALE IN FEET

5000 0 5000 10,000

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Approval Recommended: HARRISON T. SUTCLIFF, PE

U.S. ARMY ENGINEER DISTRICT, GALVESTON
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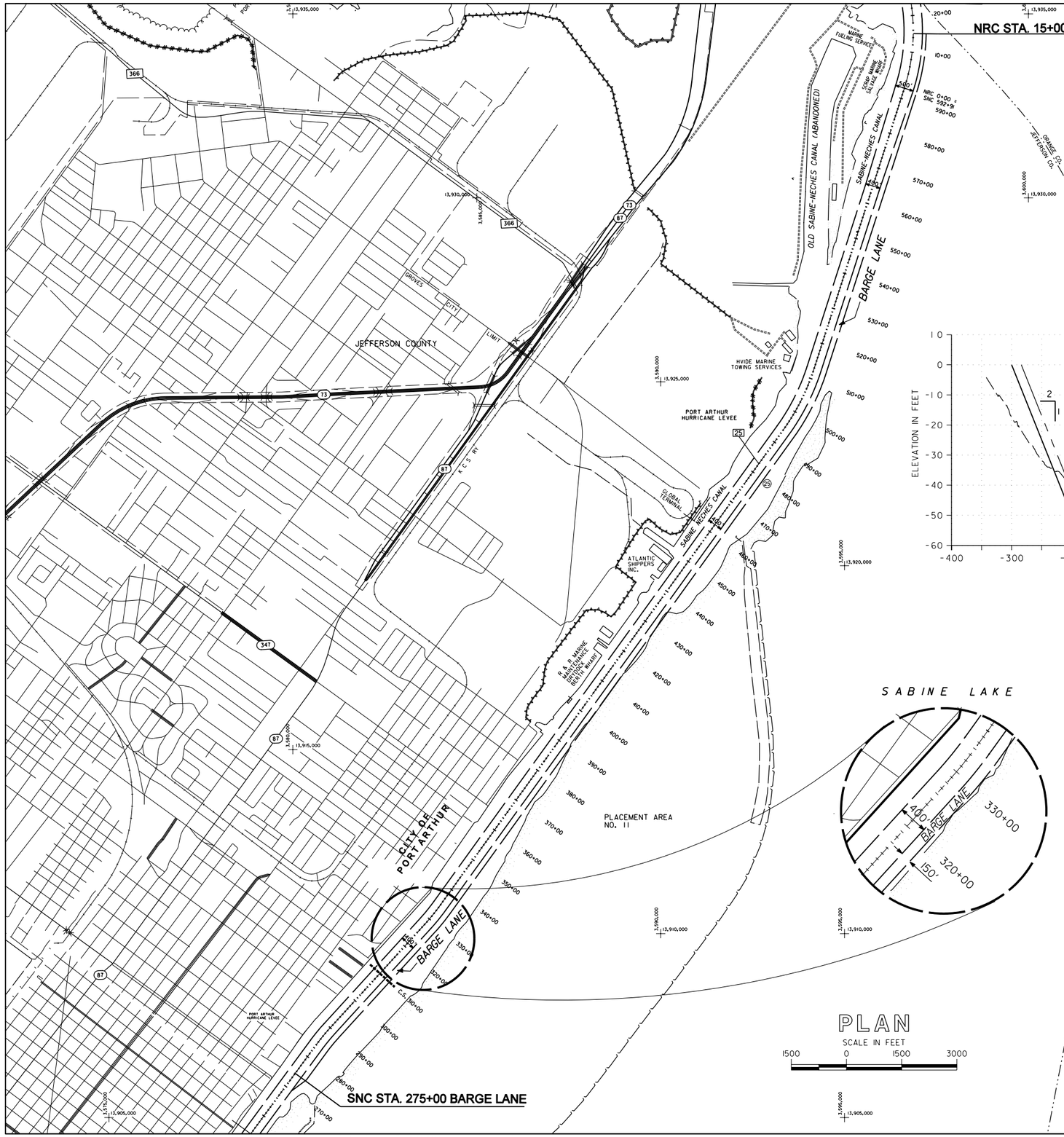
GALVESTON, TEXAS

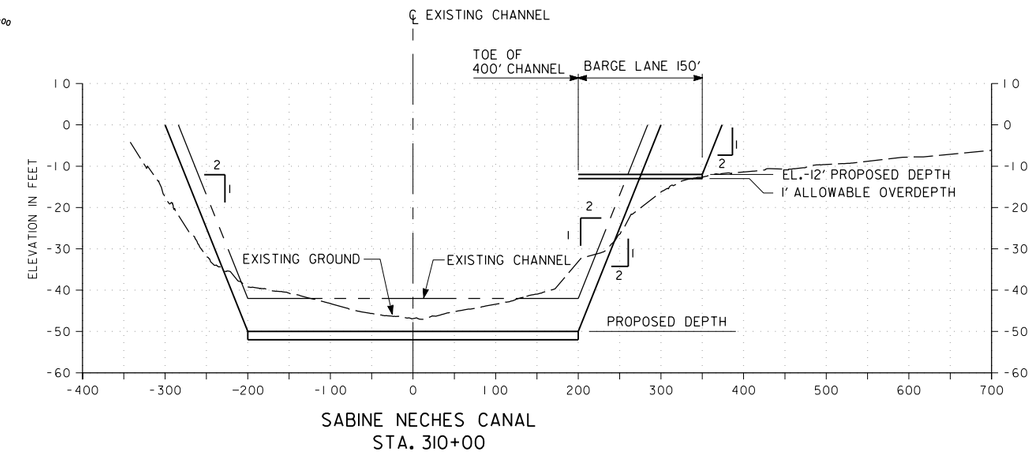
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DREDGING PLAN
SABINE BANK CHANNEL EXTENSION
STA. 110+000 TO STA. 165+000

Drawing No.:
C-12





NOTE: THE BARGE LANE WAS REJECTED AND IS NOT A FEATURE OF THE NED PLAN.

US Army Corps of Engineers
Galveston District

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U.S. ARMY ENGINEER DISTRICT, GALVESTON
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Approval Recommended: HARRISON T. SUTCLIFF, PE
Chief, Engineering Branch

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

BARGE LANE PLAN
& CROSS SECTION

Drawing No.:
C-13

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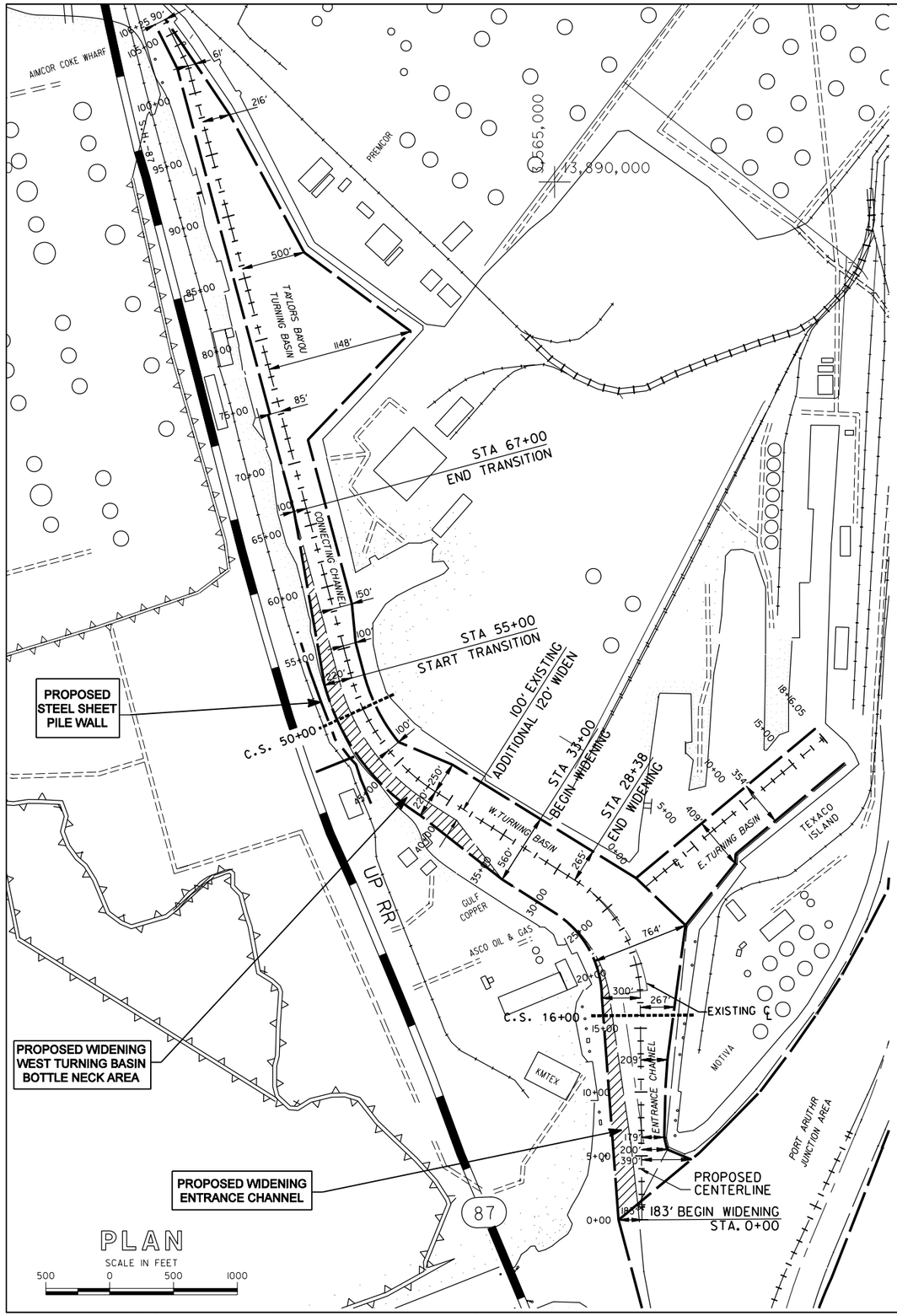
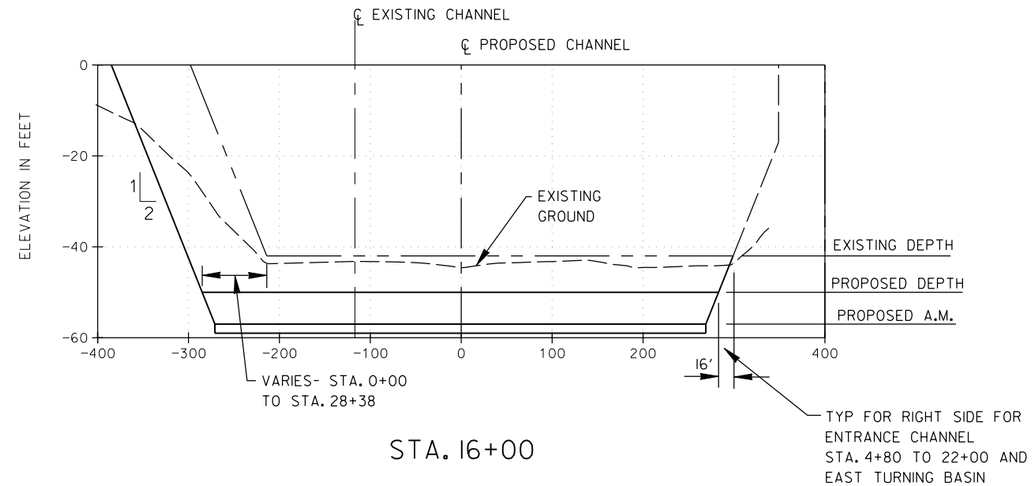
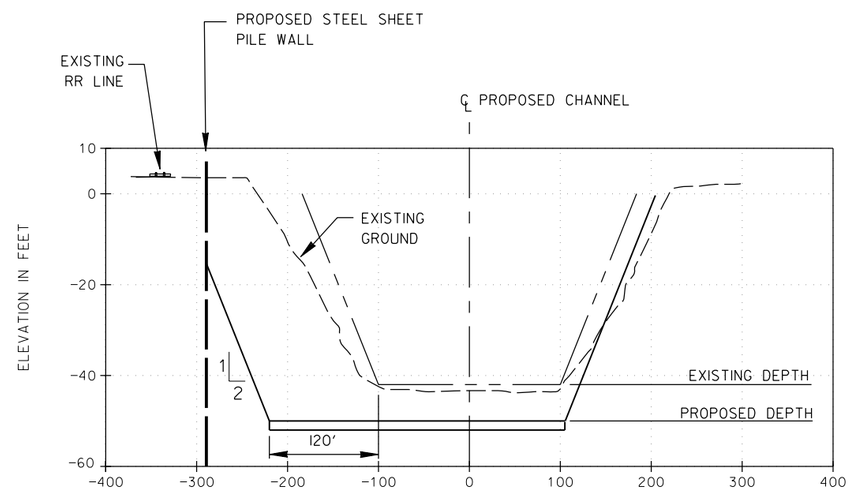




STA. 16+00



STA. 50+00

NOTES:
1. NEW STATIONING WITH NEW ALIGNMENT. WILL NOT MATCH EXISTING CHANNEL STATIONING.
2. EXISTING GROUND AS SHOWN IS APPROXIMATE.
3. CHANNEL SIDE SLOPES REMAIN THE SAME.
4. FOR ADVANCE MAINTENANCE DETAILS, SEE DWG C-21.
5. REFER TO DWG C-01 FOR LEGEND.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, General Engineering Section
Approved by: FRED E. PETTE, G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Scale: AS SHOWN
Rev.
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

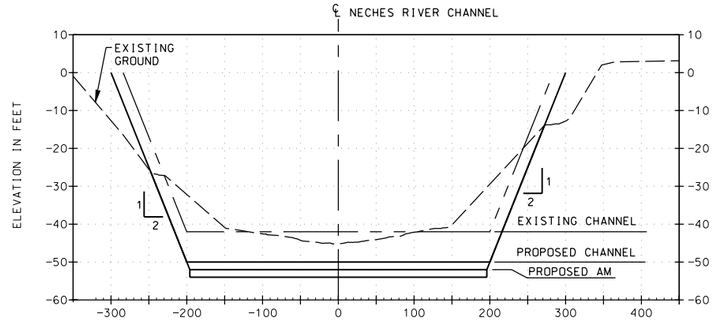
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL, C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

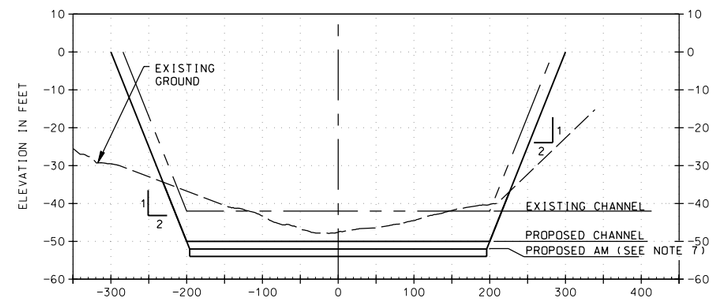
TAYLORS BAYOU
PROPOSED CURVE
AND MOUTH WIDENING

Drawing No.:
C-14

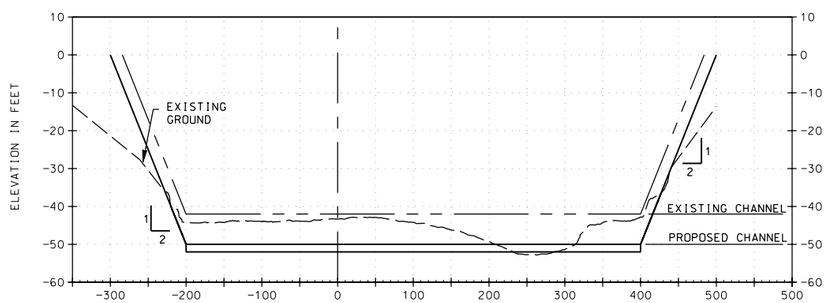
5/14/2008 12:23:51 PM w:\cadd\projects\sn\snww feas\plates\ea pl\c14 83 tb plan.dgn



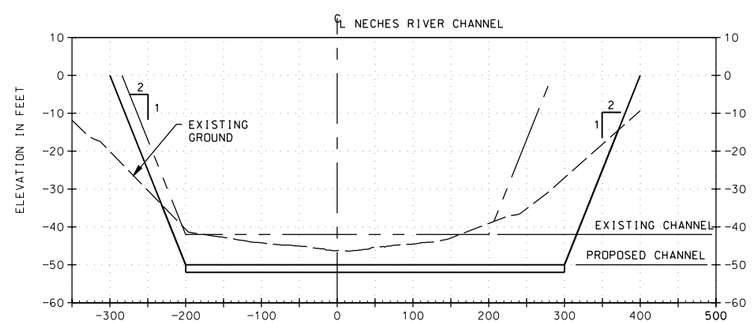
NRC STA. 870+00



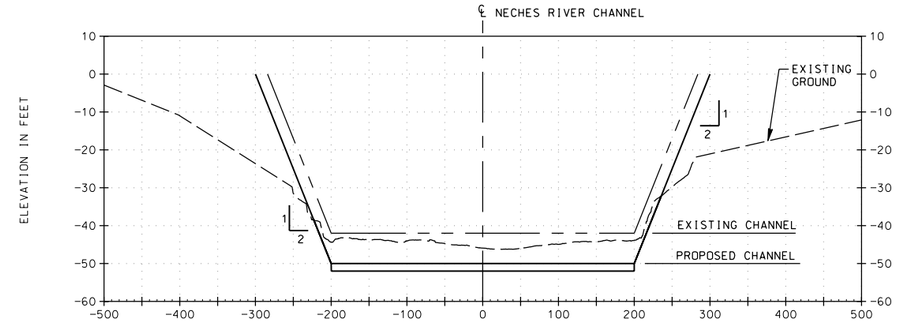
NRC STA. 630+00



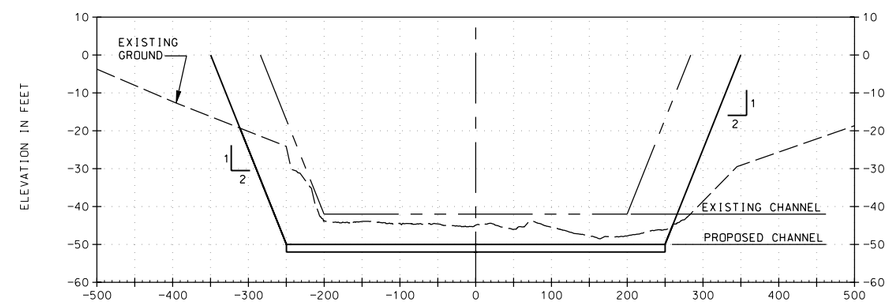
NRC STA. 400+00



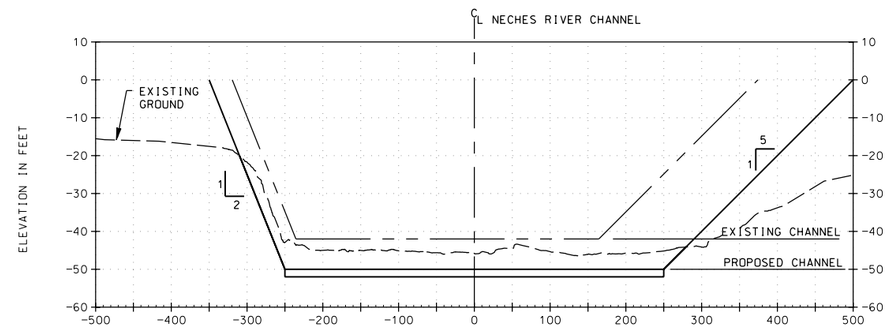
NRC STA. 240+00



NRC STA. 164+00



NRC STA. 58+00



NRC STA. 22+00

NOTES: (FOR DWGS C-13 THRU C-20)

1. EXISTING GROUND IS REPRESENTATIVE OF ACTUAL CONDITIONS AFTER DREDGING UP TO -30 ELEVATION.
2. CROSS SECTIONS WERE GENERATED FROM A DIGITAL TERRAIN MODEL (DTM) AND MAY NOT REFLECT ACTUAL BANK TOPO ABOVE -30 ELEVATION.
3. CROSS SECTIONS ARE SHOWN LOOKING UPSTREAM AND ARE PERPENDICULAR TO CENTERLINE.
4. REFER TO PLAN VIEWS FOR CROSS SECTION LOCATIONS.
5. CENTERLINE SHOWN IS FOR PROPOSED CHANNEL AND DOES NOT ALWAYS MATCH WITH EXISTING CHANNEL CENTERLINE.
6. VERTICAL DATUM SHOWN IS MEAN LOW TIDE (MLT).
7. THE FIRST TWO FEET OF ADVANCE MAINTENANCE IS INCLUDED WITHIN THE NEW TEMPLATE. ADDITIONAL REQUIRED ADVANCE MAINTENANCE IS BELOW THIS FIRST 2 FEET, AND IS CALCULATED TO BE DOWN THE SIDE SLOPE TO THE NEEDED DEPTH. THIS IS A TYPICAL APPLICATION FOR ALL CROSS SECTIONS WITH ADVANCE MAINTENANCE MORE THAN 2'.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, General Engineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Rev. --
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

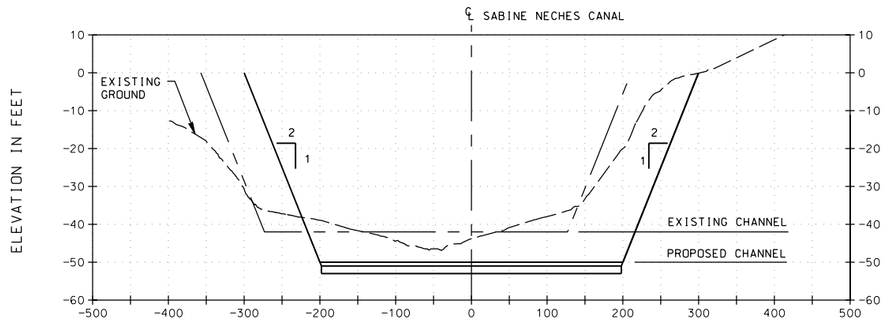
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

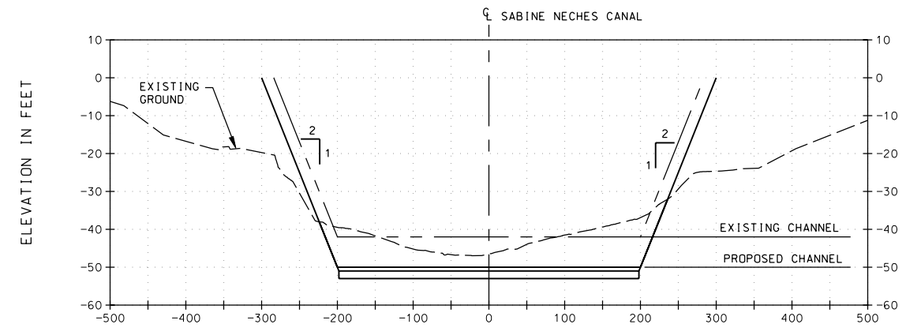
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

NECHES RIVER CHANNEL
CROSS SECTIONS

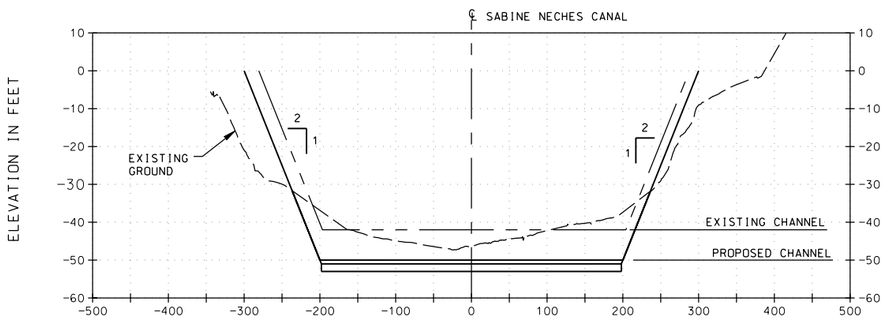
Drawing No.:
C-15



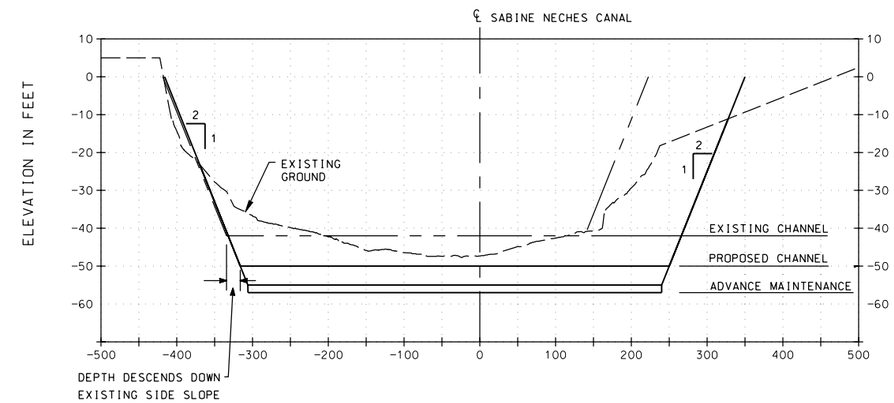
SNC STA. 430+00



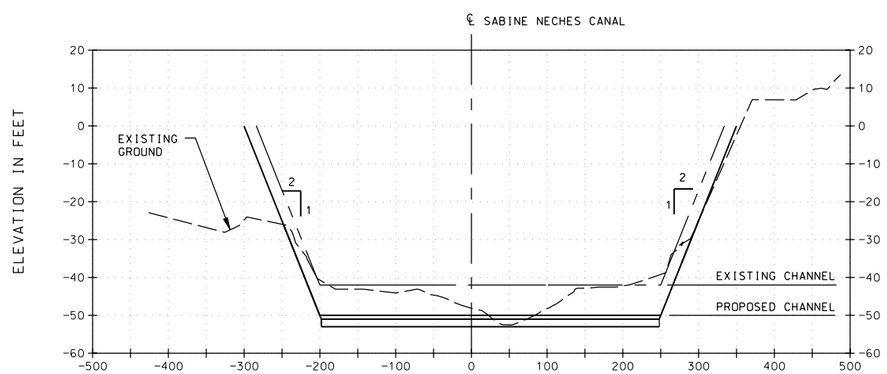
SNC STA. 57+16



SNC STA. 230+00



SNC STA. 20+00



SNC STA. 160+00

NOTES: (FOR DWGS C-16 THRU C-21)

1. THE FIRST TWO FEET OF ADVANCE MAINTENANCE IS INCLUDED WITHIN THE NEW TEMPLATE. ADDITIONAL REQUIRED ADVANCE MAINTENANCE IS BELOW THIS FIRST 2 FEET, AND IS CALCULATED TO BE DOWN THE SIDE SLOPE TO THE NEEDED DEPTH. THIS IS A TYPICAL APPLICATION FOR ALL CROSS SECTIONS WITH ADVANCE MAINTENANCE MORE THAN 2'.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

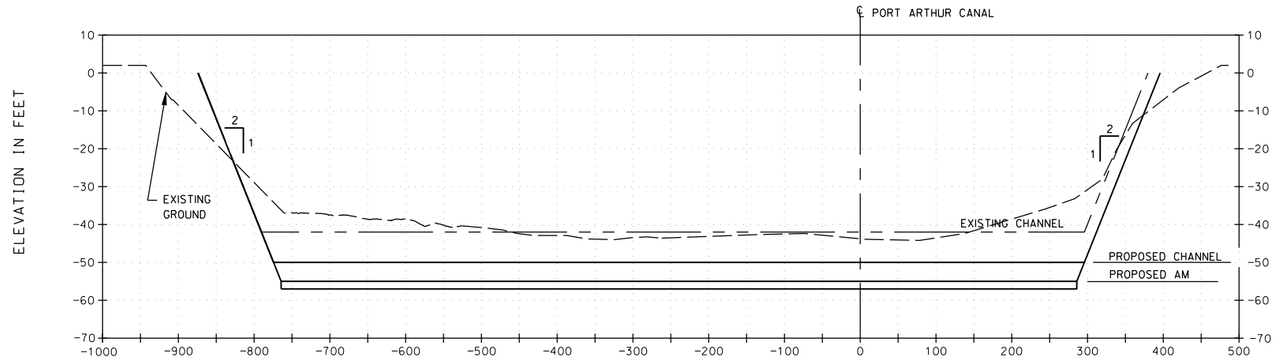
Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Geoengineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Rev. --
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

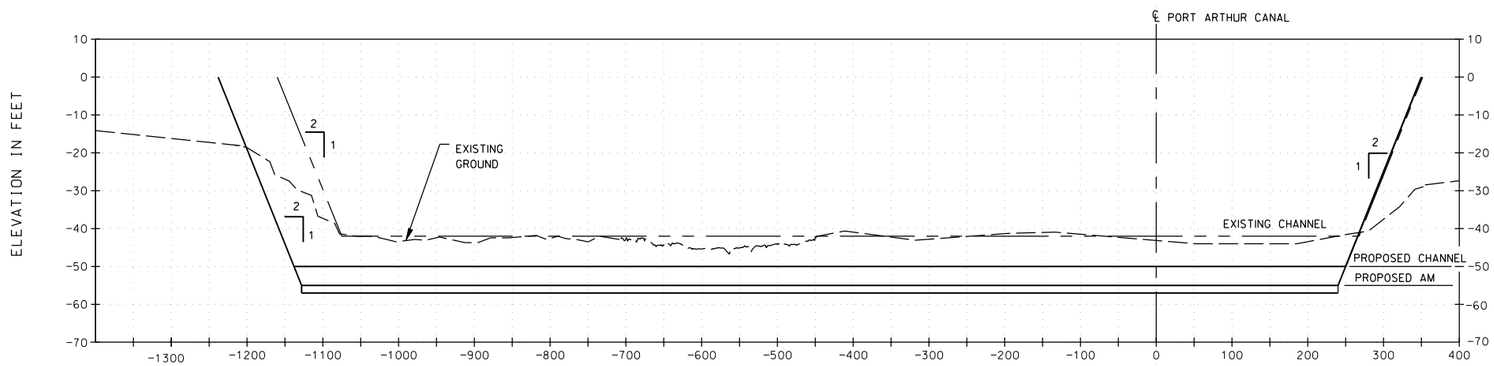
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

SABINE-NECHES CANAL
CROSS SECTIONS

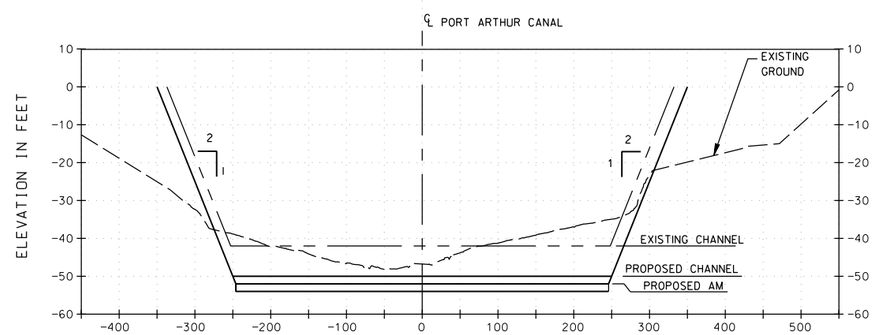
Drawing No.:
C-16



PAC STA. 325+83.73



PAC STA. 310+00



PAC STA. 130+00

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Geoengineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: AUG 2009
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Rev. --

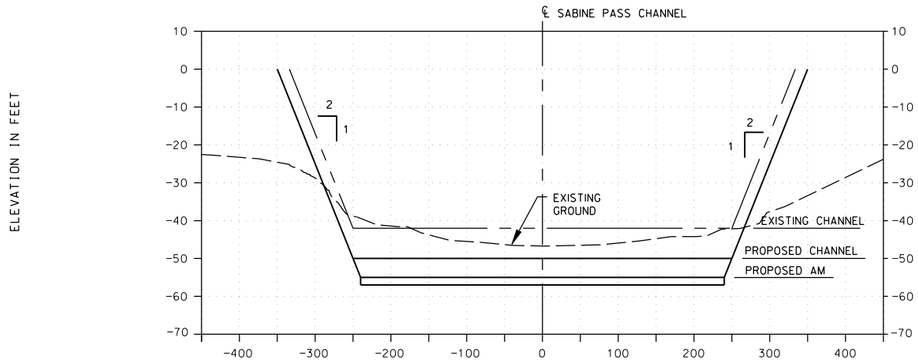
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

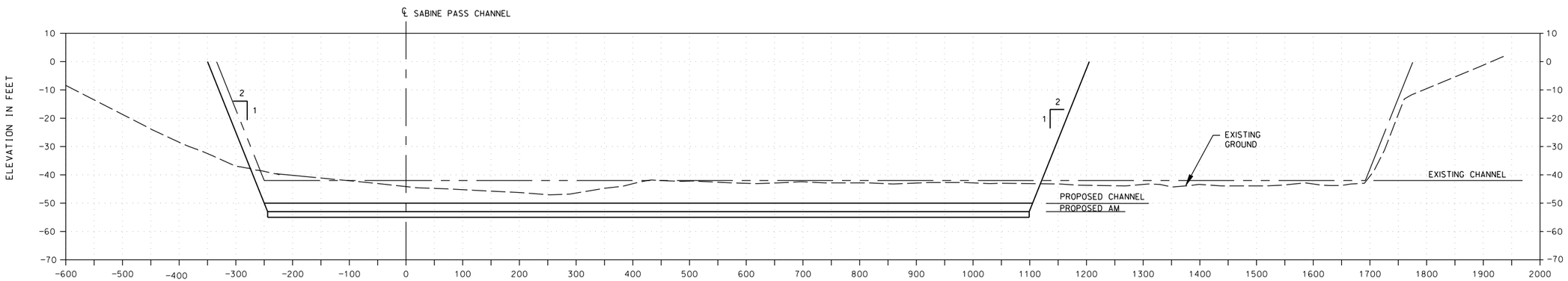
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

PORT ARTHUR CANAL
CROSS SECTIONS

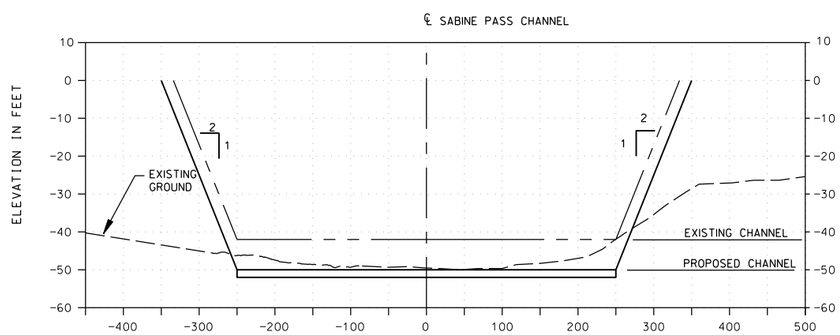
Drawing No.:
C-17R



SPC STA. 270+00



SPC STA. 140+00



SPC STA. 10+00

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, General Engineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: AUG 2009
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Rev. --

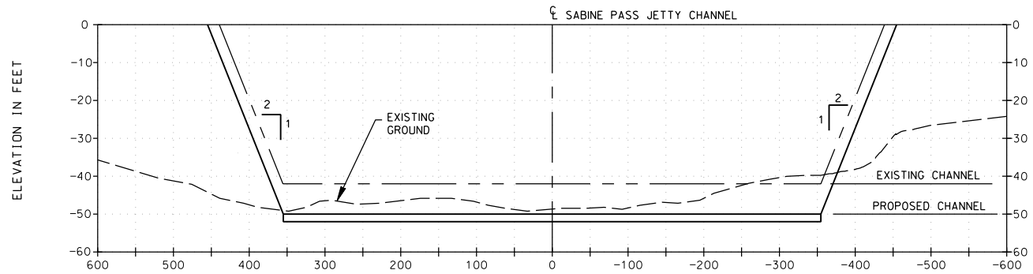
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

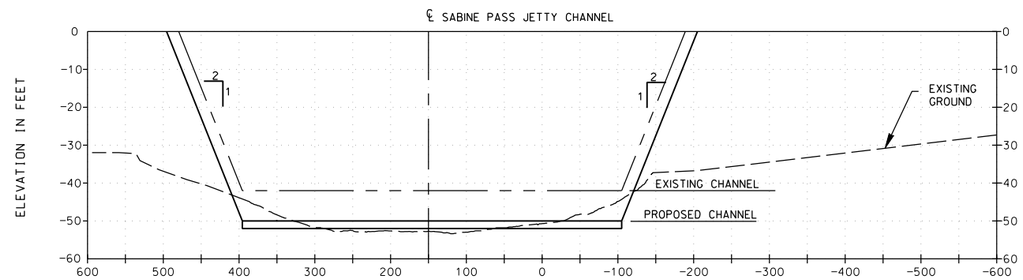
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

SABINE PASS CHANNEL
CROSS SECTIONS

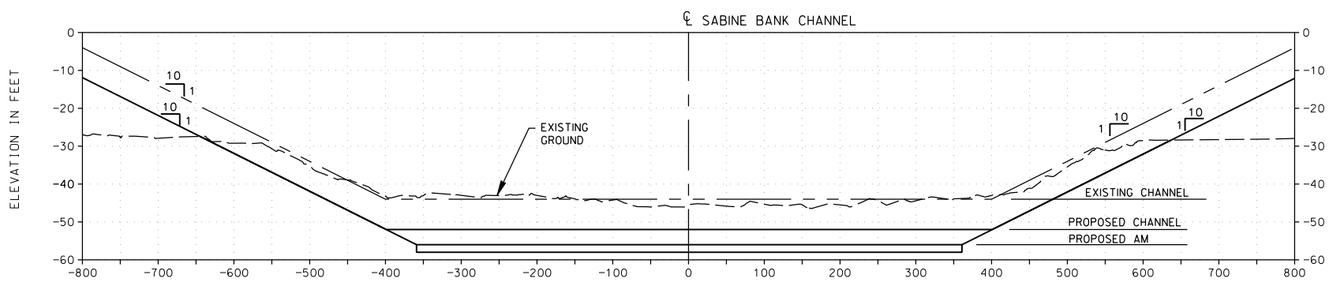
Drawing No.:
C-18R



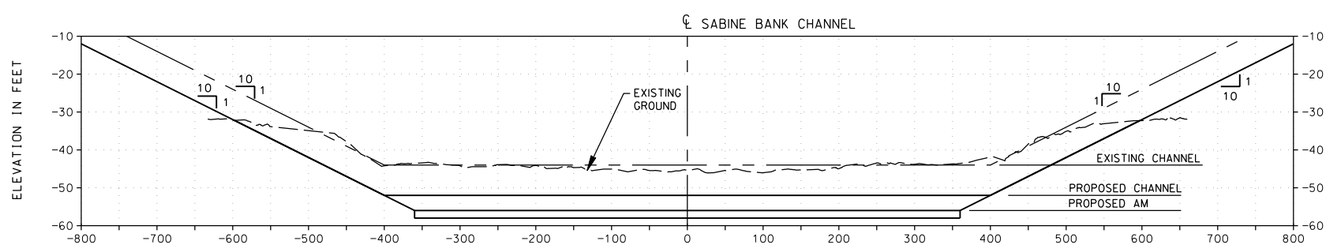
SPJ STA. -214+00



SPJ STA. -0+50



SABINE OUTER BAR STA. 3+000



SABINE OUTER BAR STA. 18+000

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

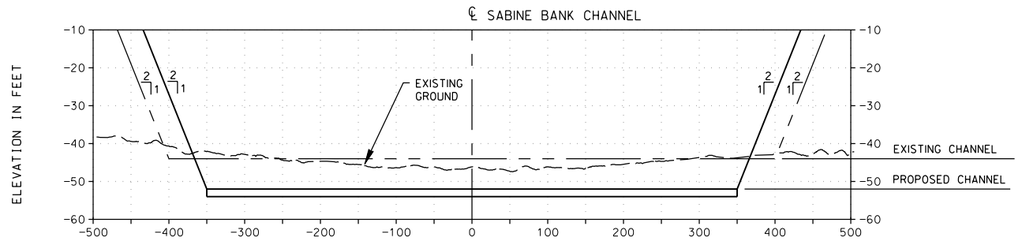
Drawn by: NCY
Designed by: NCY
Checked by: MD
Submitted by:
DAVID R. BROWN, P.E.
Chief, Engineering Section
Approved by:
PETE G. PEREZ, P.E.
Chief, Engineering and Construction Division

Date: AUG 2009
Scale: AS SHOWN
Rev. --
Approval Recommended:
HARRISON T. SUTCLIFF, PE
Chief, Engineering Branch

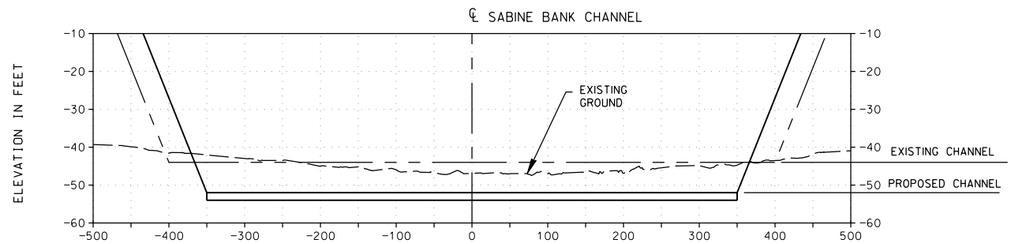
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

SABINE PASS JETTY &
SABINE PASS OUTER BAR CHANNELS
& CROSS SECTIONS

Drawing No.:
C-19R



SBC STA. 30+000



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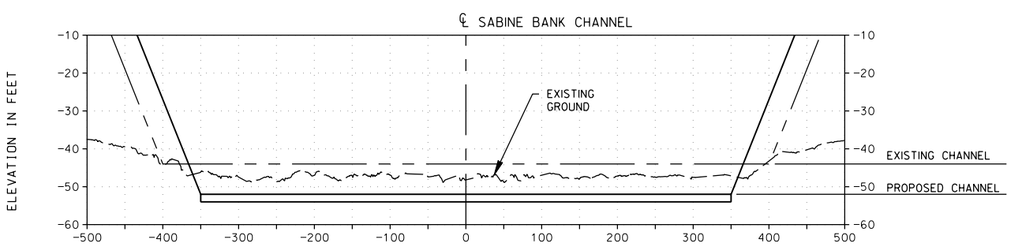
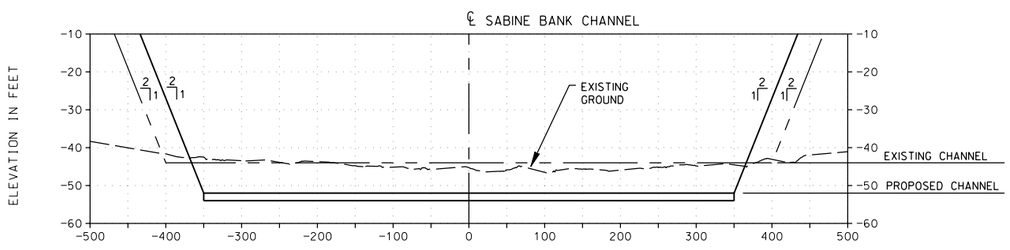
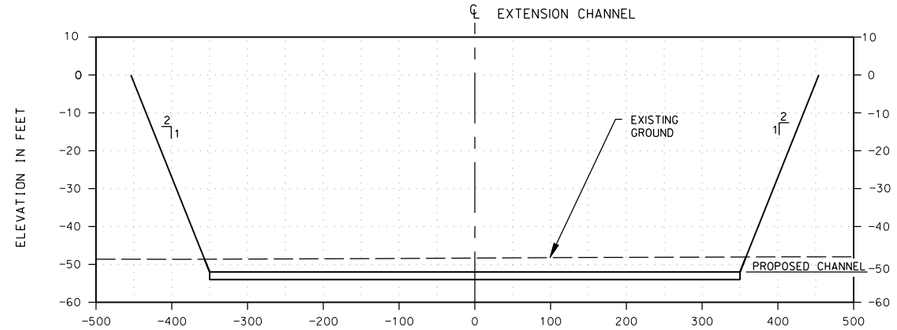


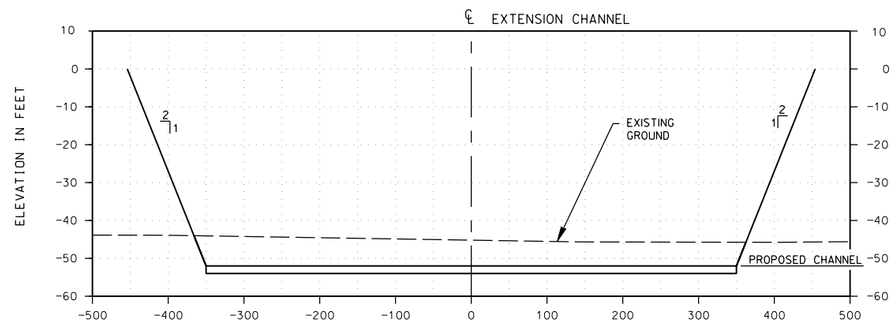
SBC STA. 70+000



SBC STA. 87+000



SNWW EXT STA. 163+000



SNWW EXT STA. 100+000

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Date: MAY 2008
Rev. --
Scale: AS SHOWN
Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Geotechnical Engineering Section
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

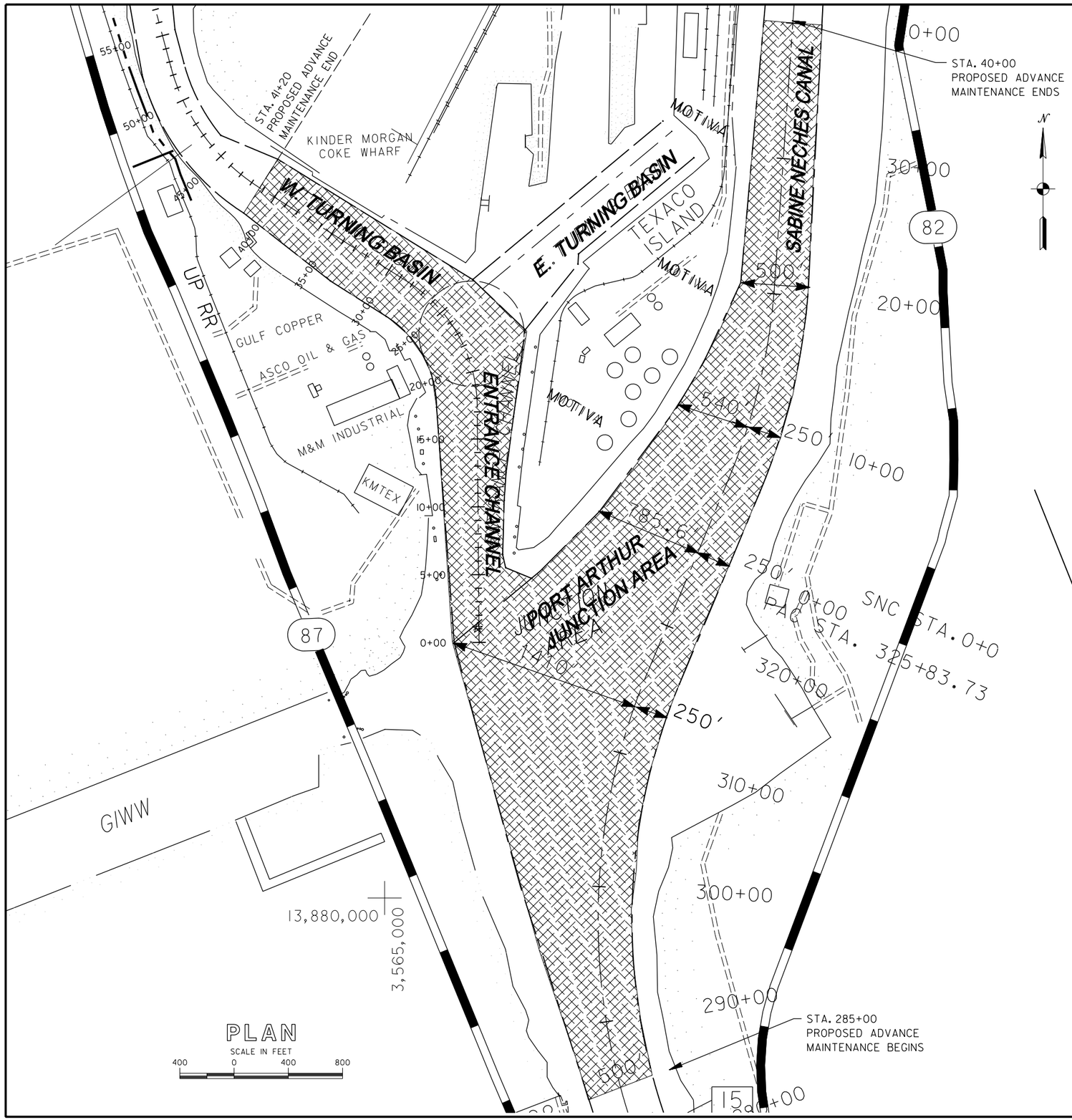
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

SABINE BANK
& EXTENSION CHANNELS
CROSS SECTIONS

Drawing No.:
C-20



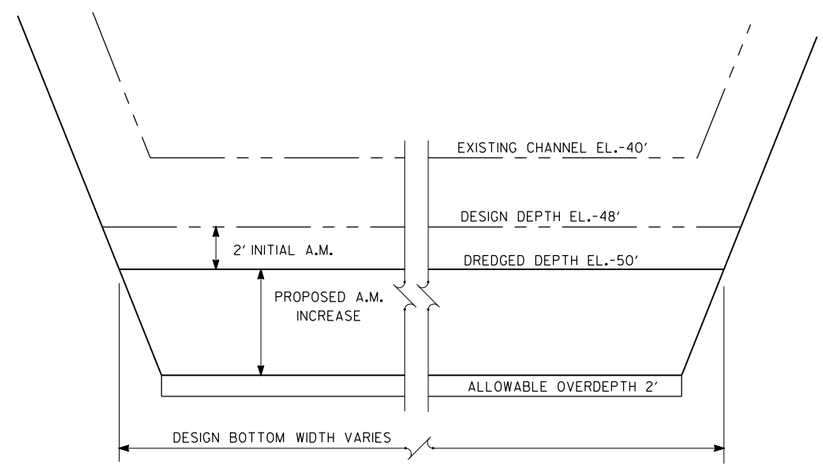
PLAN

SCALE IN FEET

400 0 400 800

NOTES:

1. NEW STATIONING WITH NEW ALIGNMENT, WILL NOT MATCH EXISTING CHANNEL STATIONING.
2. THE FIRST 2 FEET OF ADVANCE MAINTENANCE IS INCLUDED WITHIN THE NEW TEMPLATE. THIS IS A TYPICAL APPLICATION, AND STANDARD PRACTICE.
3. FOR ADVANCE MAINTENANCE OVER 2 FEET, THE DEPTH WILL DESCEND ALONG THE SIDE SLOPES, REDUCING THE BOTTOM CHANNEL WIDTH AS IT DESCENDS. THE PROPOSED CHANNEL WILL BE THE DESIGN WIDTH AT 50' DEPTH.
4. REFER TO PREVIOUS PLANS FOR LEGENDS.



TYPICAL SECTION DETAIL
NTS

PORT ARTHUR JUNCTION AREA
ADVANCE MAINTENANCE LIMITS

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

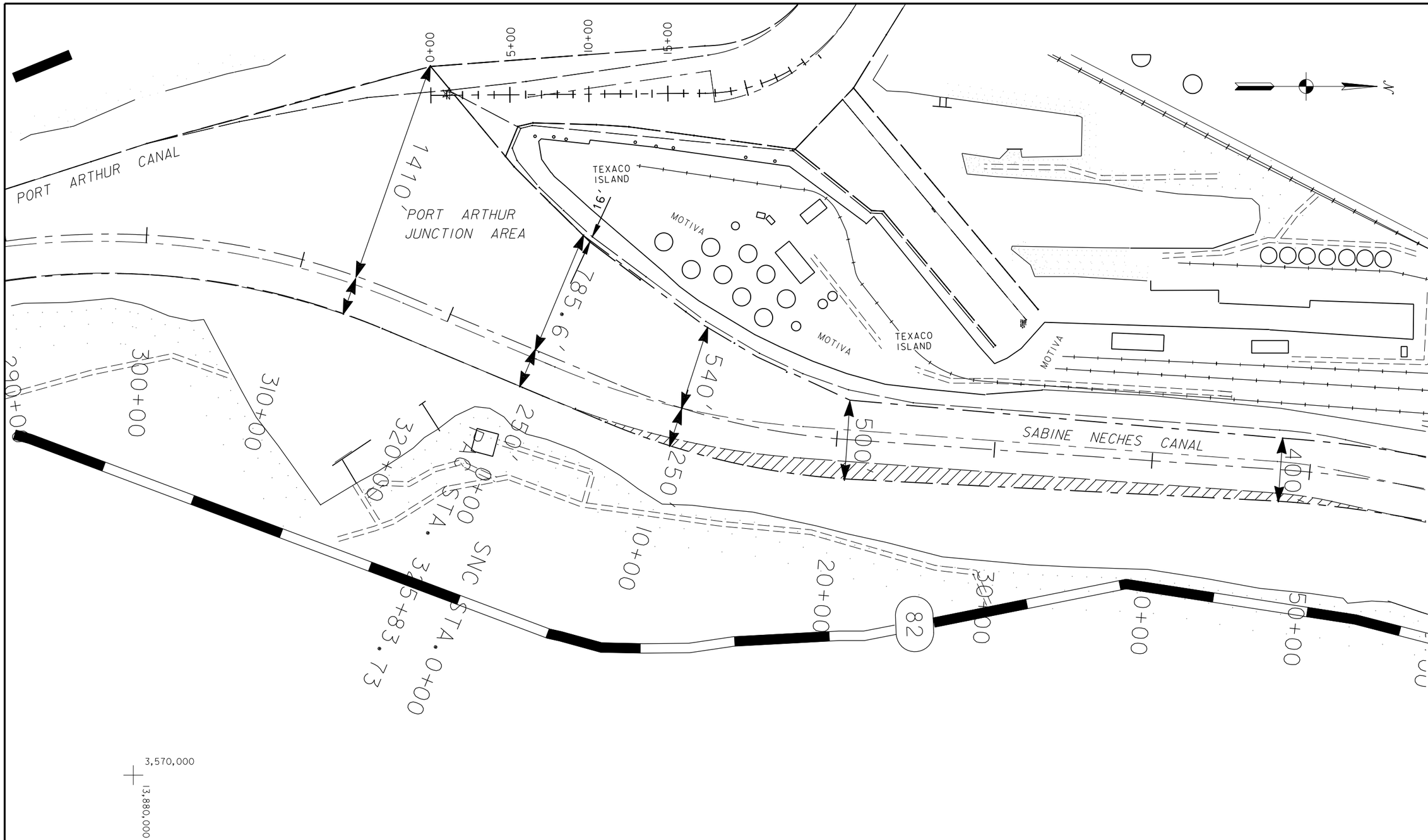
Drawn by: NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, General Engineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: AUG 2009
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Rev.

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

PORT ARTHUR JUNCTION AREA
PROPOSED ADVANCE
MAINTENANCE LIMITS

Drawing No.:
C-21R



3,570,000

13,880,000

PLAN

SCALE IN FEET

300 0 300 600

NOTES:

1. FOR LEGEND REFER TO DWG C-01.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: NCY
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Chief, General Engineering Section
Approved by: PETE G. PEREZ, P.E.
Chief, Engineering and Construction Division

Date: AUG 2009
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE
Chief, Engineering Branch

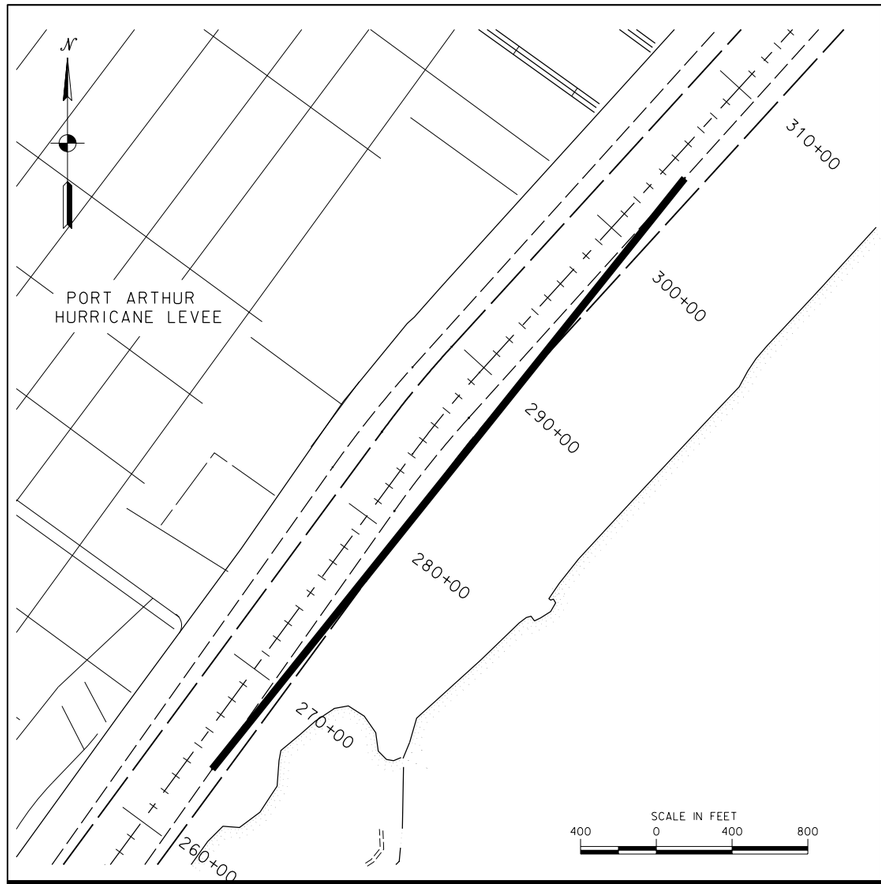
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

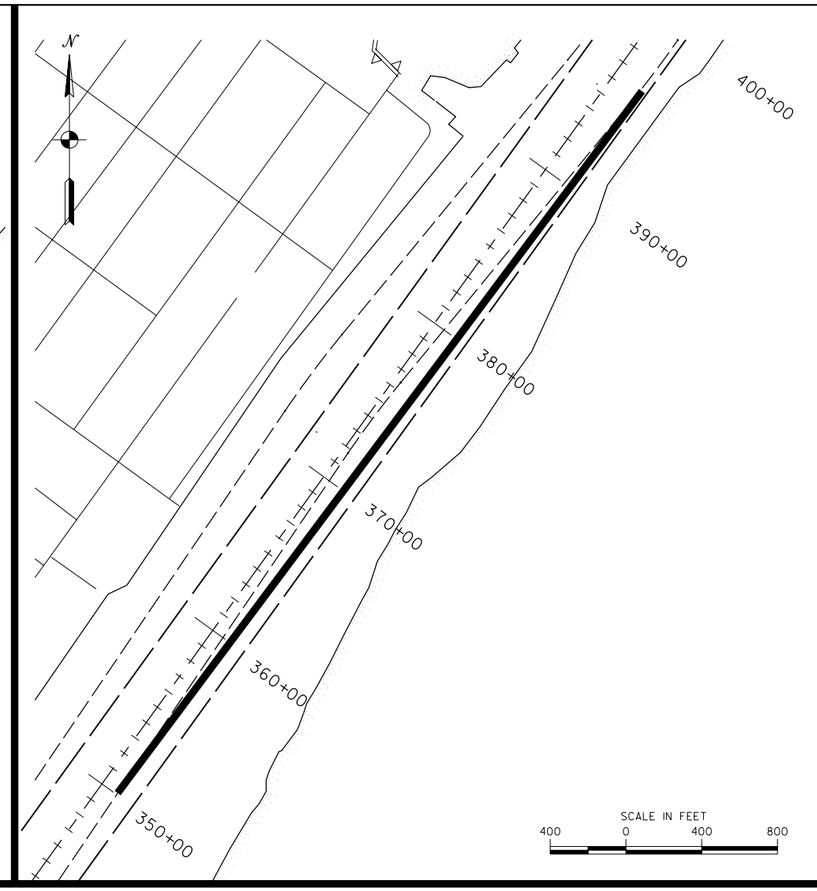
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

BEND EASING
PORT ARTHUR &
SABINE NECHES CANALS

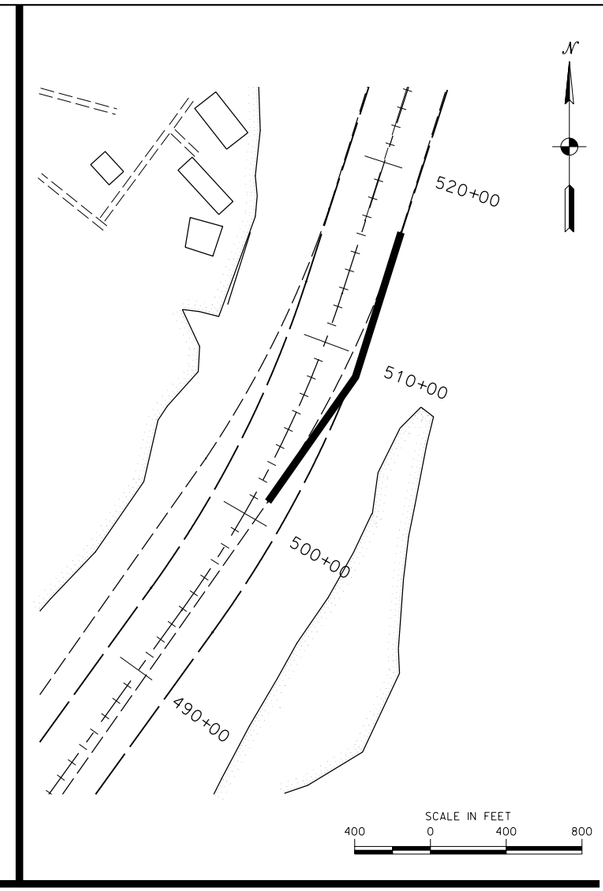
Drawing No.:
C-22R



SABINE NECHES CANAL
BEND EASING
STA. 260+00 TO STA. 350+00

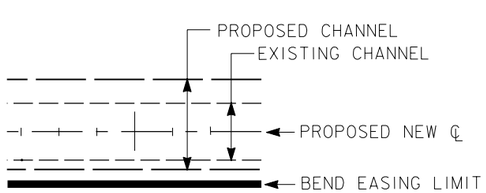


SABINE NECHES CANAL
BEND EASING
STA. 350+00 TO STA. 396+00



SABINE NECHES CANAL
BEND EASING
STA. 501+00 TO STA. 515+00

LEGEND



NOTE:
1. BEND EASING LIMITS RECOMMENDED BY ERDC. REFER TO SHIP SIMULATION REPORT.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Engineering Section
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Scale: AS SHOWN
Rev.

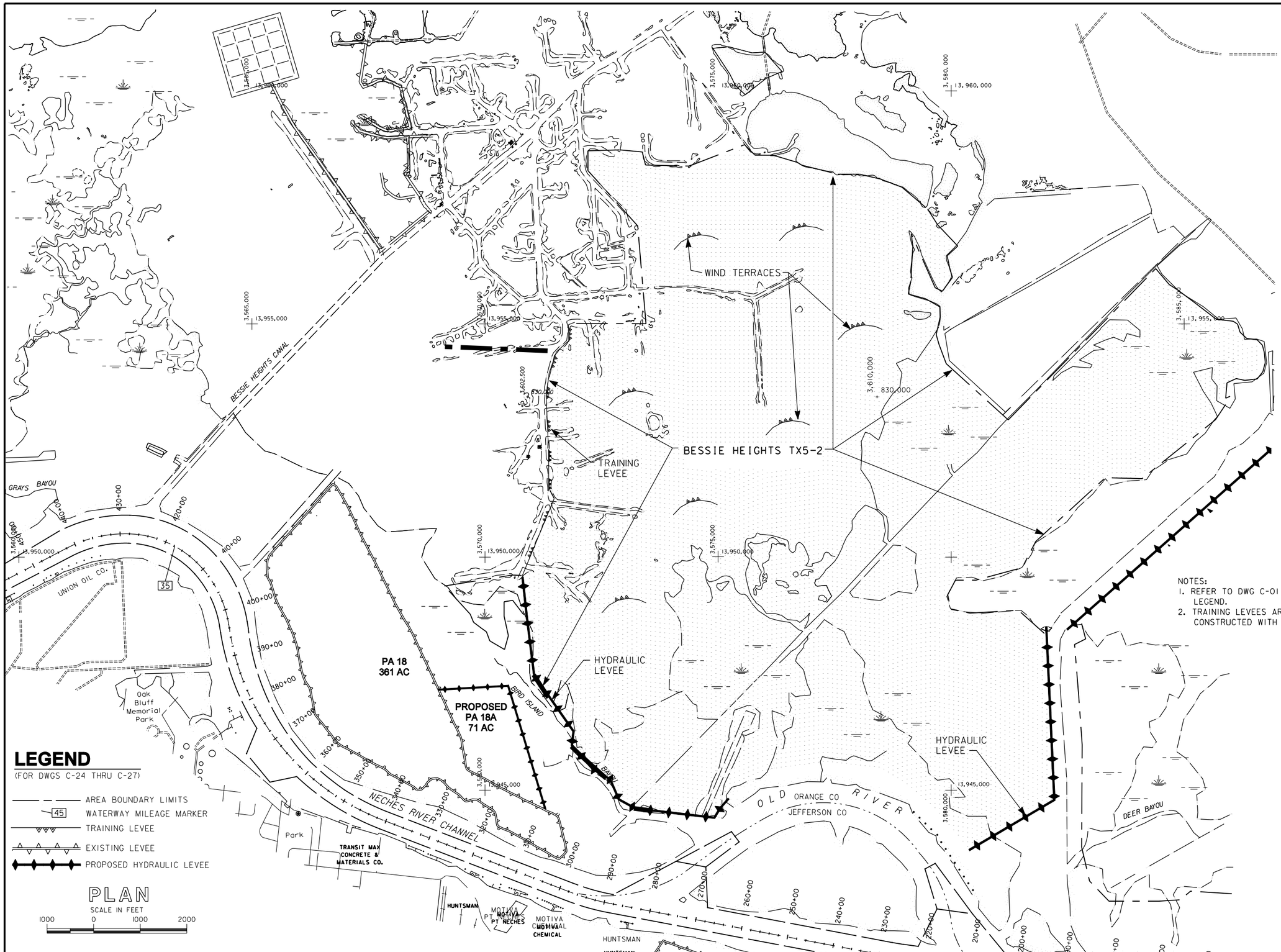
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

SABINE NECHES CANAL
BEND EASINGS

Drawing No.:
C-23



NOTES:
1. REFER TO DWG C-01 FOR ADDITIONAL LEGEND.
2. TRAINING LEVEES ARE MECHANICALLY CONSTRUCTED WITH SIDE BORROW MATERIAL.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Generalengineering Section
Dates: AUG 2009
Scales: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

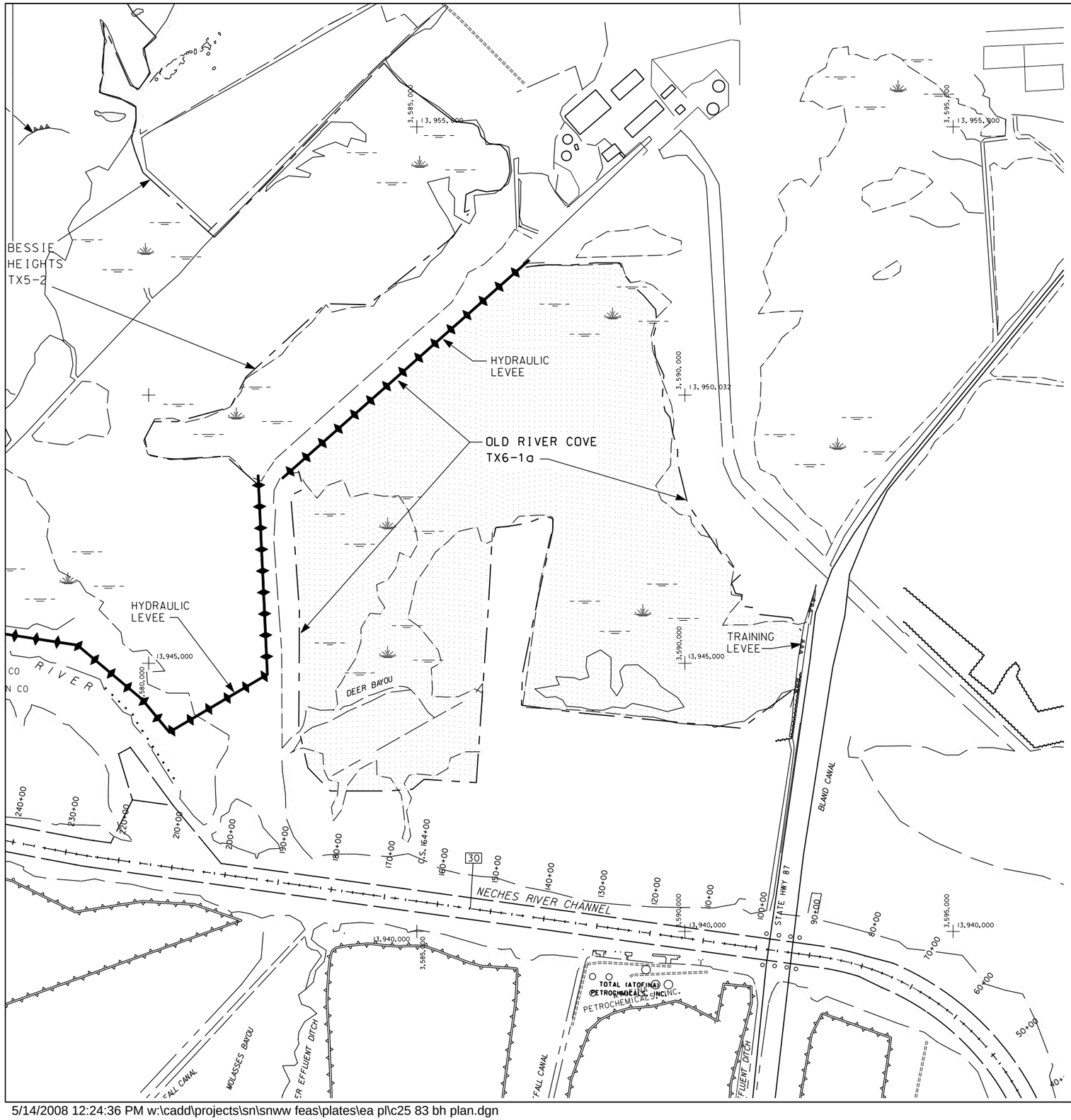
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

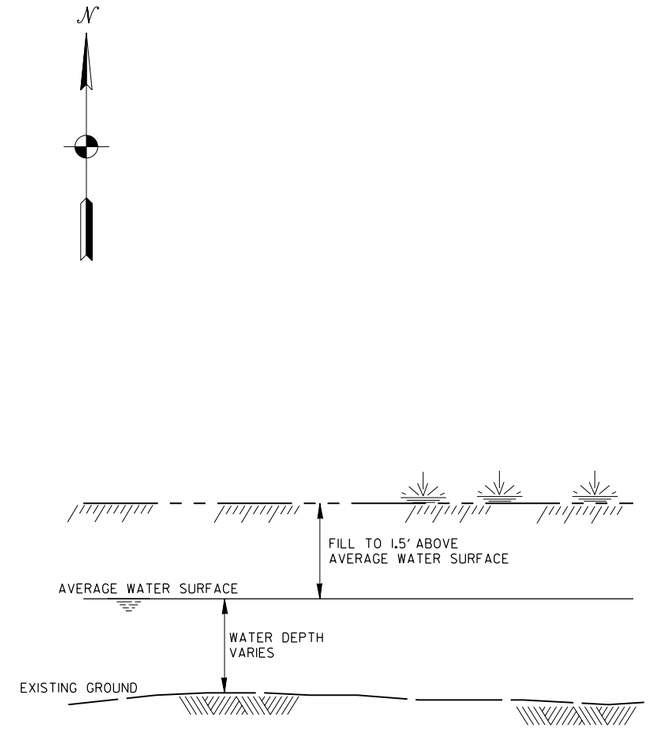
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL, C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

BESSIE HEIGHTS PLAN
TEXAS

Drawing No.:
C-24.R





TYPICAL MARSH RESTORATION SECTION

NOT TO SCALE

PLAN

SCALE IN FEET

1000 0 1000 2000

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, Generalist Engineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

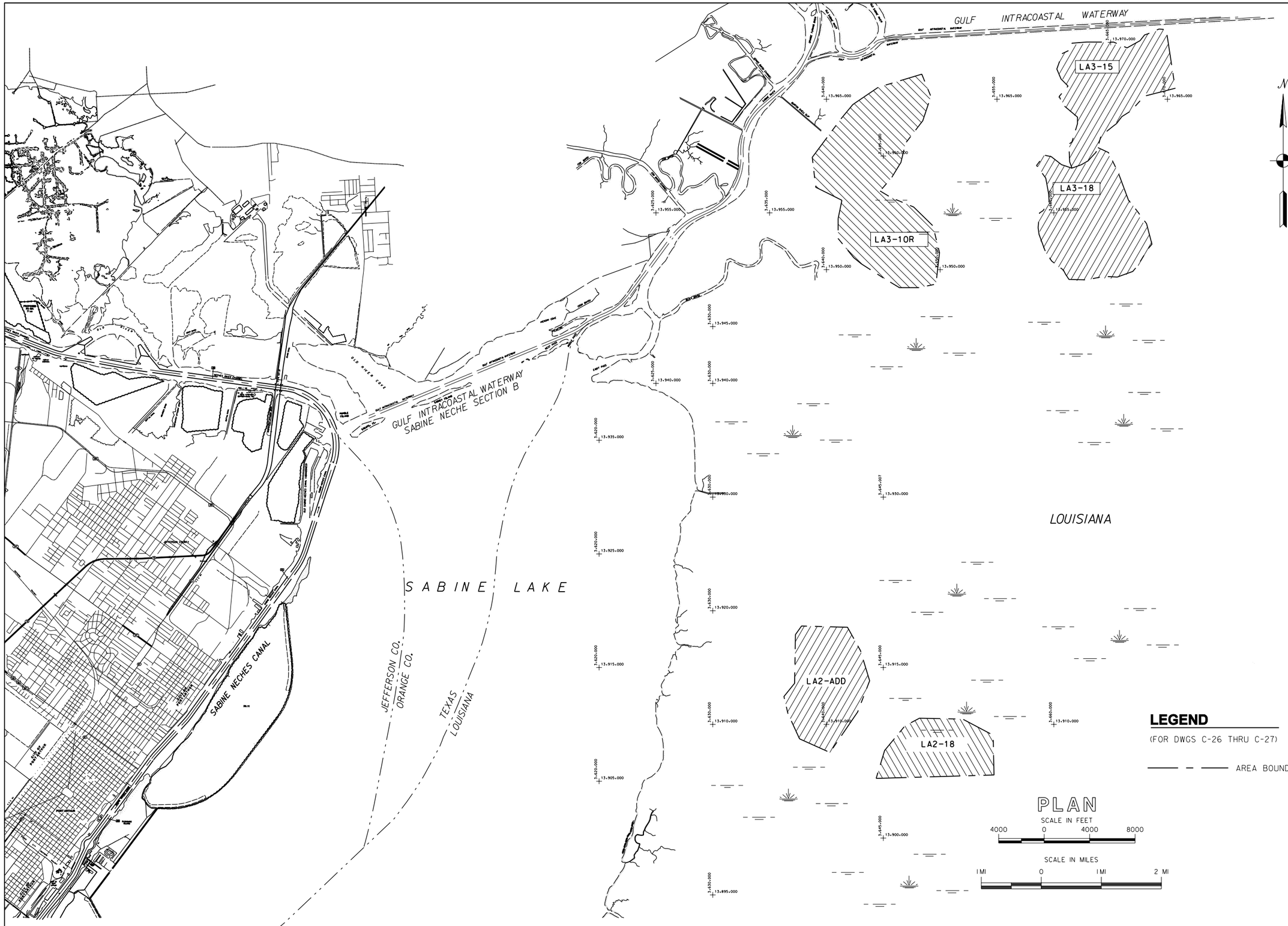
Date: MAY 2008
Rev.
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE

PREPARED UNDER THE DIRECTION OF DAVID C. WESTON, Col., C.E., DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

OLD RIVER COVE PLAN
TEXAS

Drawing No.:
C-25



US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: ESR/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Chief, General Engineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Scales: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

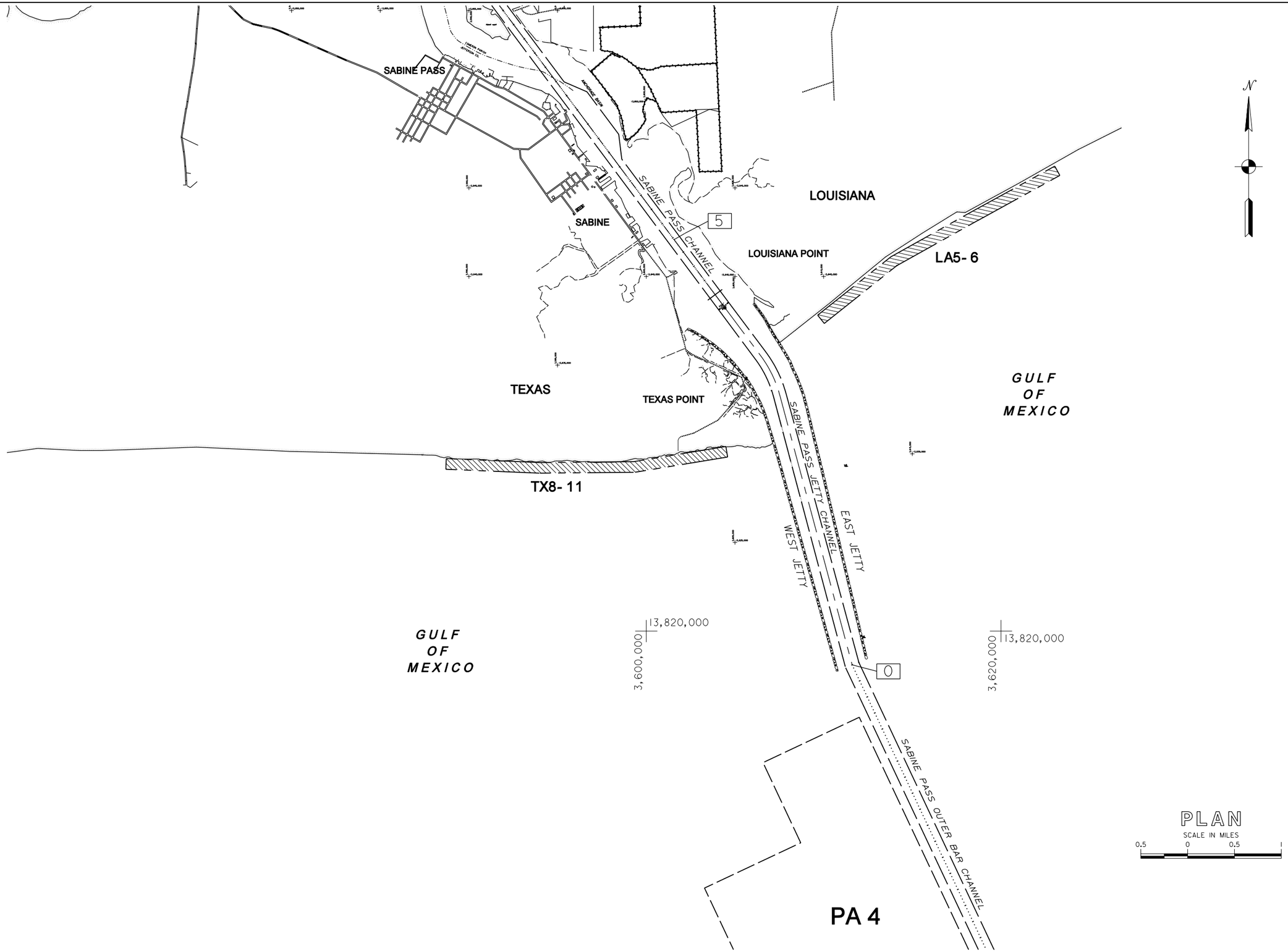
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOUISIANA PLAN

Drawing No.:
C-26



US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: ESK/NCY
Designed by: NCY
Checked by: MD
Submitted by: DAVID R. BROWN, P.E. Dist.Generalsgineering Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Rev.

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

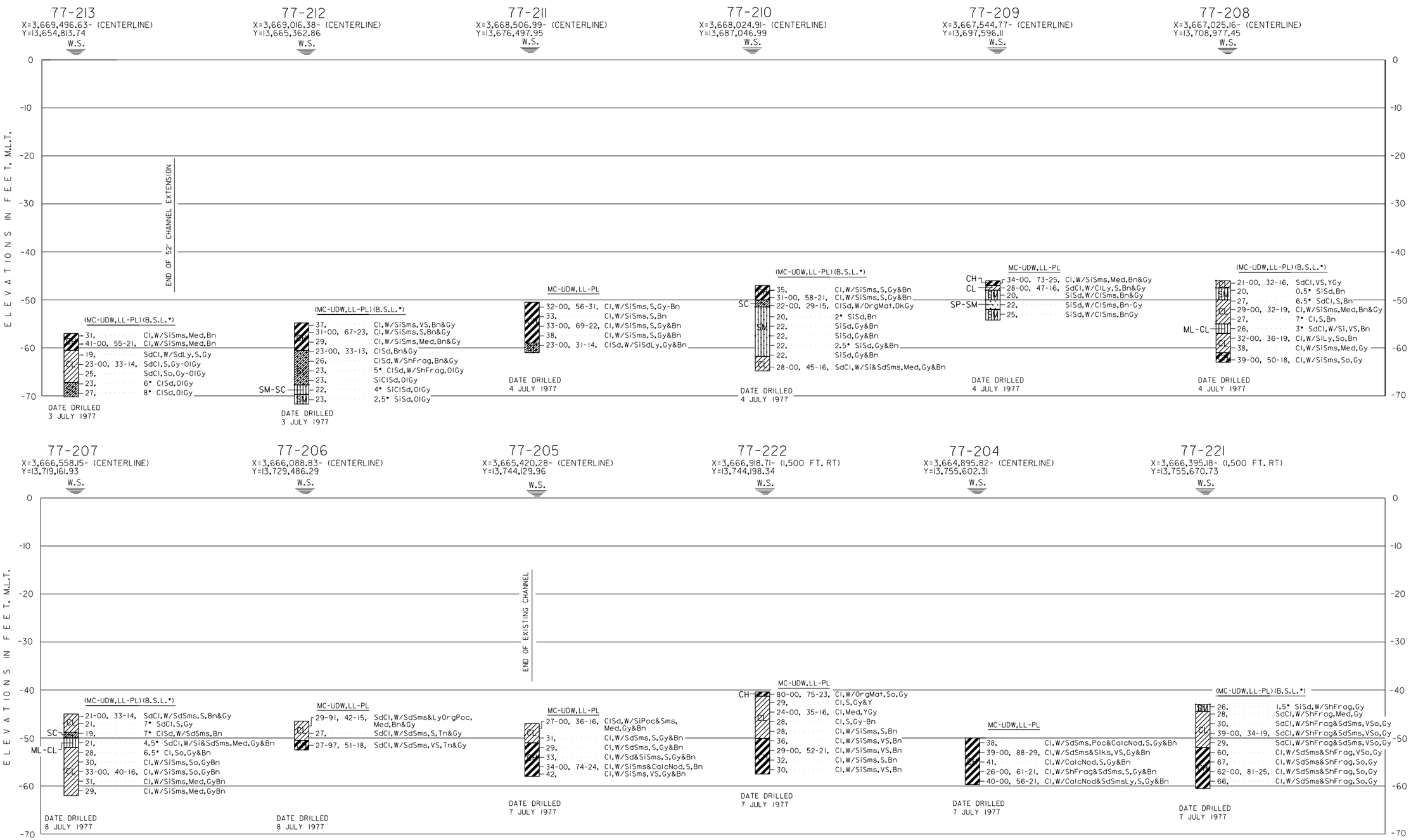
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

GULF SHORE
SHORELINE NOURISHMENT
PLAN

Drawing No.:
C-27

5/14/2008 12:24:59 PM w:\cadd\projects\sn\snww feas\plates\ea pl\c27 83 shoreln.dgn



NOTES: TO BORINGS

1. DIRECTIONS LEFT AND RIGHT OF CENTERLINE ARE AS VIEWED LOOKING UPSTREAM (TOWARD INCREASING STATION)
2. SEE DRAWING C-11 AND C-12 FOR BORING LOCATIONS.
3. SEE DRAWING F-6 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by:
Designed by: X
Checked by: X
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: FELIX C. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Rev.
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

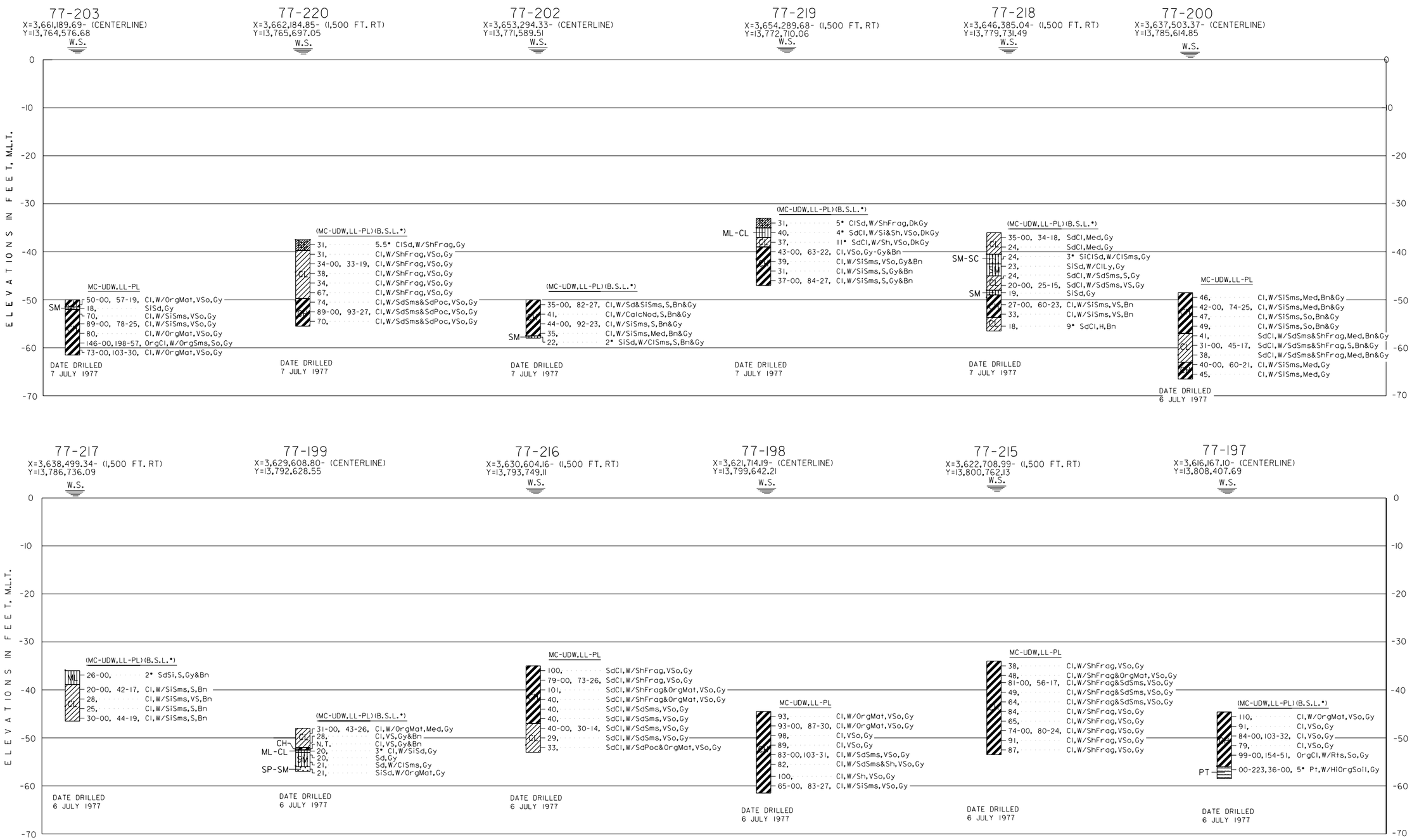
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOGS OF BORINGS
77-204 TO 77-222

Drawing No.:
F-1



NOTES: TO BORINGS

1. DIRECTIONS LEFT AND RIGHT OF CENTERLINE ARE AS VIEWED LOOKING UPSTREAM (TOWARD INCREASING STATION)
2. SEE DRAWING C-11 FOR BORING LOCATIONS.
3. SEE DRAWING F-6 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Date: MAY 2008 | Rev.
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Drawn by:
Designed by: X
Checked by: X
Submitted by: LORIK, THOMAS, P.E. Chief, Design/Structure Section
Approved by: PETER C. PEREZ, P.E. Chief, Engineering and Construction Division

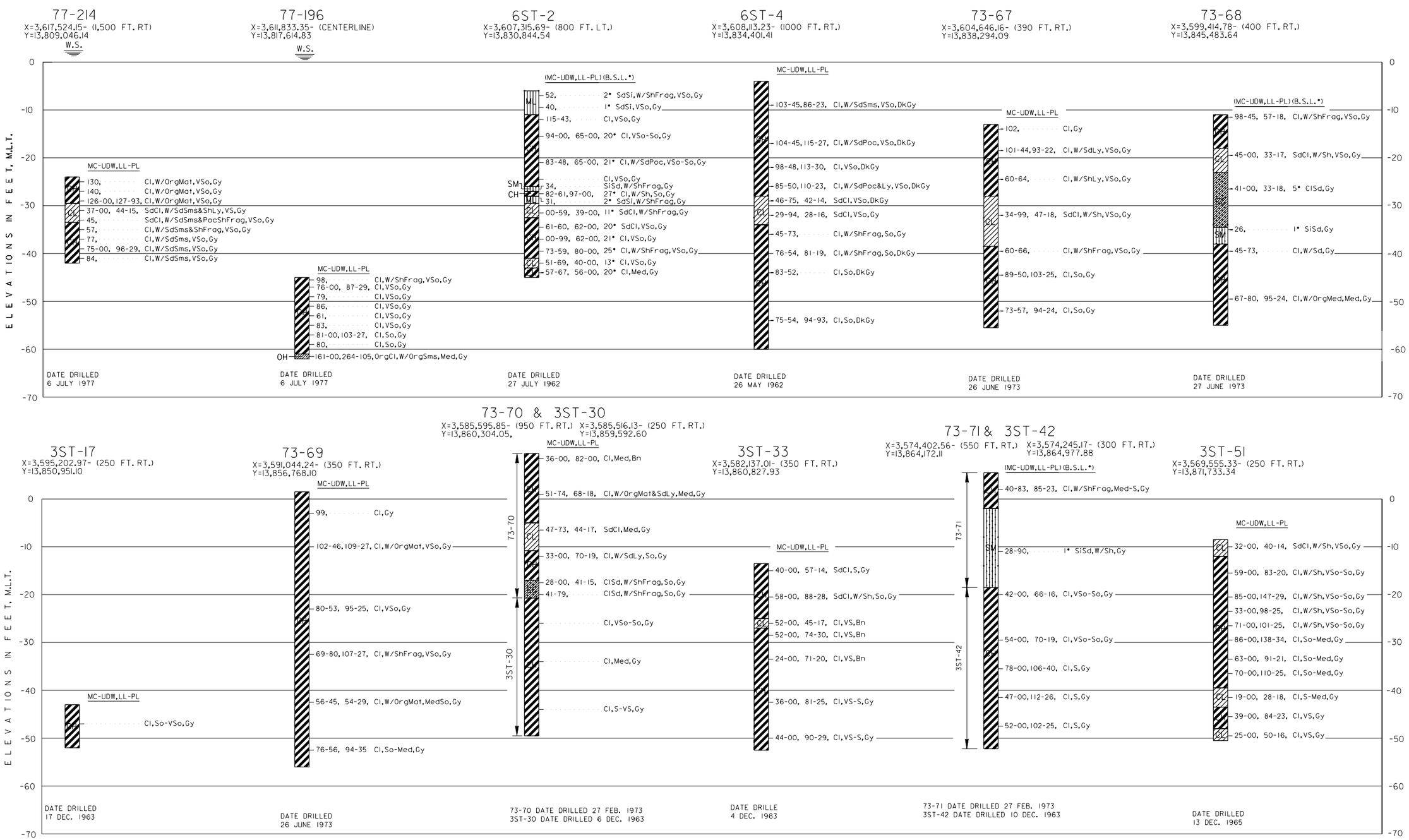
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL, C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOGS OF BORINGS
77-203 TO 77-197

Drawing No.:
F-2



NOTES: TO BORINGS

1. DIRECTIONS LEFT AND RIGHT OF CENTERLINE ARE AS VIEWED LOOKING UPSTREAM (TOWARD INCREASING STATION)
2. SEE DRAWINGS C-08, C-09, C-10 AND C-11 FOR BORING LOCATIONS.
3. SEE DRAWING F-6 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

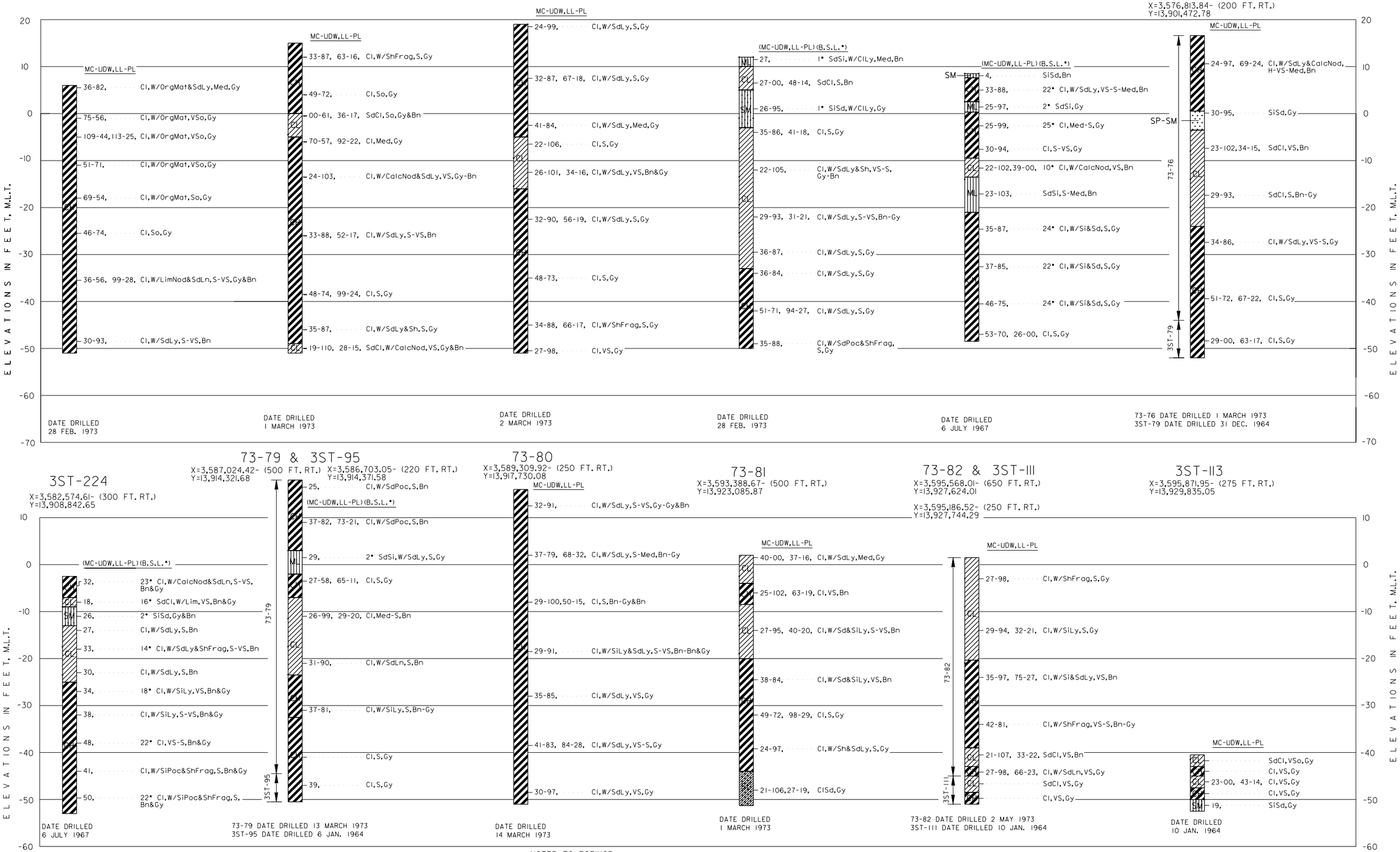
Rev.	Description	Date	By

Date: MAY 2008
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch
Drawn by:
Designed by: X
Checked by: X
Submitted by: LORIK, THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS
PREPARED UNDER THE DIRECTION OF DAVID C. WESTON, COL, C.E., DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOGS OF BORINGS
77-214 TO 3ST-51

Drawing No.:
F-3



NOTES: TO BORINGS

1. DIRECTIONS LEFT AND RIGHT OF CENTERLINE ARE AS VIEWED LOOKING UPSTREAM (TOWARD INCREASING STATION)
2. SEE DRAWINGS C-07, C-06, C-05 AND C-04 FOR BORING LOCATIONS.
3. SEE DRAWING F-6 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by:
Designed by: X
Checked by: X
Submitted by:
LORIK. THOMAS, P.E.
Chief, Geteech/Structure Section
Approved by:
RICHARD C. PEREZ, P.E.
Chief, Engineering and Construction Division

Date: MAY 2008
Rev.
Scale: AS SHOWN
Approval Recommended:
HARRISON T. SUTCLIFF, PE
Chief, Engineering Branch

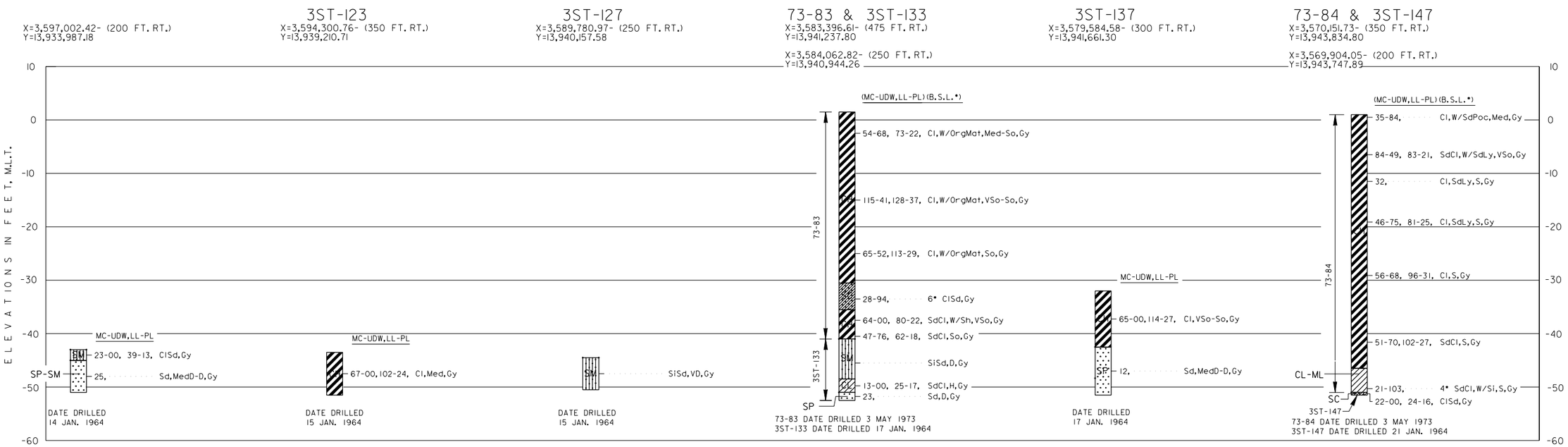
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

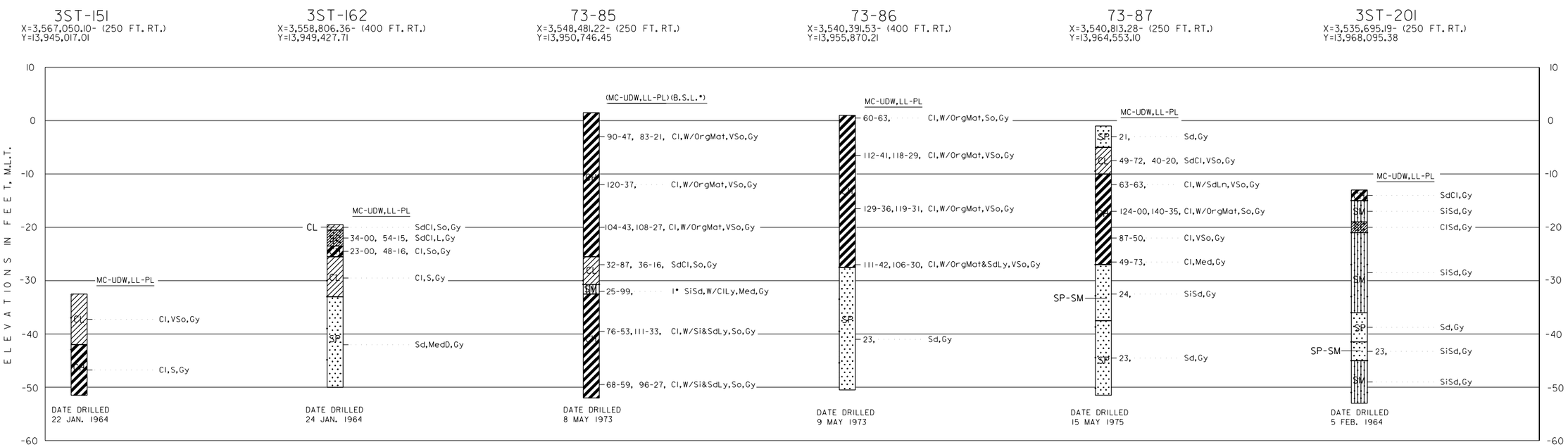
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOGS OF BORINGS
73-72 TO 3ST-113

Drawing No.:
F-4





NOTES: TO BORINGS

1. DIRECTIONS LEFT AND RIGHT OF CENTERLINE ARE AS VIEWED LOOKING UPSTREAM (TOWARD INCREASING STATION)
2. SEE DRAWINGS C-01, C-02, C-03 AND C-04 FOR BORING LOCATIONS.
3. SEE DRAWING F-6 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by:
Designed by: X
Checked by: X
Submitted by: LORIK, THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: PETER C. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL, C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOGS OF BORINGS
3ST-117 TO 3ST-201

Drawing No.:
F-5

LABORATORY CLASSIFICATION

- CH INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
- CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, LEAN CLAYS. CL-ML CLAY-SILT OF LOW PLASTICITY.
- ML INORGANIC SILTS AND VERY FINE SANDS, WITH SLIGHT PLASTICITY.
- SC CLAYEY SANDS, SAND-CLAY MIXTURES.
- SM SILTY SANDS, SAND-SILT MIXTURES.
- SP POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES. SP-SM POORLY-GRADED SAND W/SILT.
- OH ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
- PT PEAT AND OTHER HIGHLY ORGANIC SOILS.

NOTES;

1. SOILS HAVE BEEN CLASSIFIED IN ACCORDANCE WITH ASTM D-2487-93 "CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES (UNIFIED SOIL CLASSIFICATION SYSTEM) "." CONSISTENCY OF SOILS SUCH AS SOFT, MEDIUM, HARD, LOOSE, DENSE, ETC., ARE RELATIVE TERMS BASED ON ESTIMATED UNDISTURBED SHEAR STRENGTH OF THE MATERIAL AS DETERMINED BY VISUAL CLASSIFICATION POCKET PENETROMETER TESTS AND PENETRATION RESISTANCE DURING SAMPLING.
2. FIGURES TO THE RIGHT OF BORING LOGS ARE WATER CONTENTS IN IN PERCENT OF THE DRY WEIGHT, DRY DENSITY, LIQUID LIMIT, PLASTIC LIMIT AND BAR LINER SHRINKAGE. (MC-UDW,LL-PL) (B.L.S.*). FIGURES TO THE LEFT OF BORING LOGS ARE BLOWS PER FOOT PENETRATION FROM STANDARD PENETRATION TESTING.
3. BORINGS WERE DRILLED USING WET ROTARY DRILLING TECHNIQUES AND UNDISTURBED SAMPLES WHERE RECOVERED WITH A 3-INCH DIAMETER THIN WALL SAMPLER WHERE COHESIVE MATERIALS WERE ENCOUNTERED. WHERE COHESIONLESS MATERIALS WERE ENCOUNTERED, DISTURBED SAMPLES WERE TAKEN WITH A SPLIT SPOON SAMPLER DURING PERFORMANCE OF STANDARD PENETRATION TESTING.

VISUAL CLASSIFICATIONS

Bn Brown(ish)	Ly Layer(s)	Si Silty
Calc Calcareous	Mat Material	Slks Slicken Sides
Cl Clay(ey)	Med Medium	Sms Seams
D Dense	Nod Nodules	So Soft
Dk Dark	N.T. No Test	Soil Soils
Frag Fragment(s)	Ol Olive	S Stiff
Gy Gray(ish)	Org Organic	Tn Tan(nish)
H Hard	Prt Parting(s)	V Very
Hi Highly	PT Peat	W.S. Water Surface
Lim Limonites	Rts Root(s)	W With
L Loose	Sd Sand(y)	Y Yellow(ish)
Ln Lense(s)	Sh Shell(y)	

NOTES: TO BORINGS

1. DIRECTIONS LEFT AND RIGHT OF CENTERLINE ARE AS VIEWED LOOKING UPSTREAM (TOWARD INCREASING STATION)
2. SEE DRAWING C-01 FOR BORING LOCATIONS.
3. SEE DRAWING F-6 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by:
Designed by: X
Checked by: X
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: FELIX C. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Rev.
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

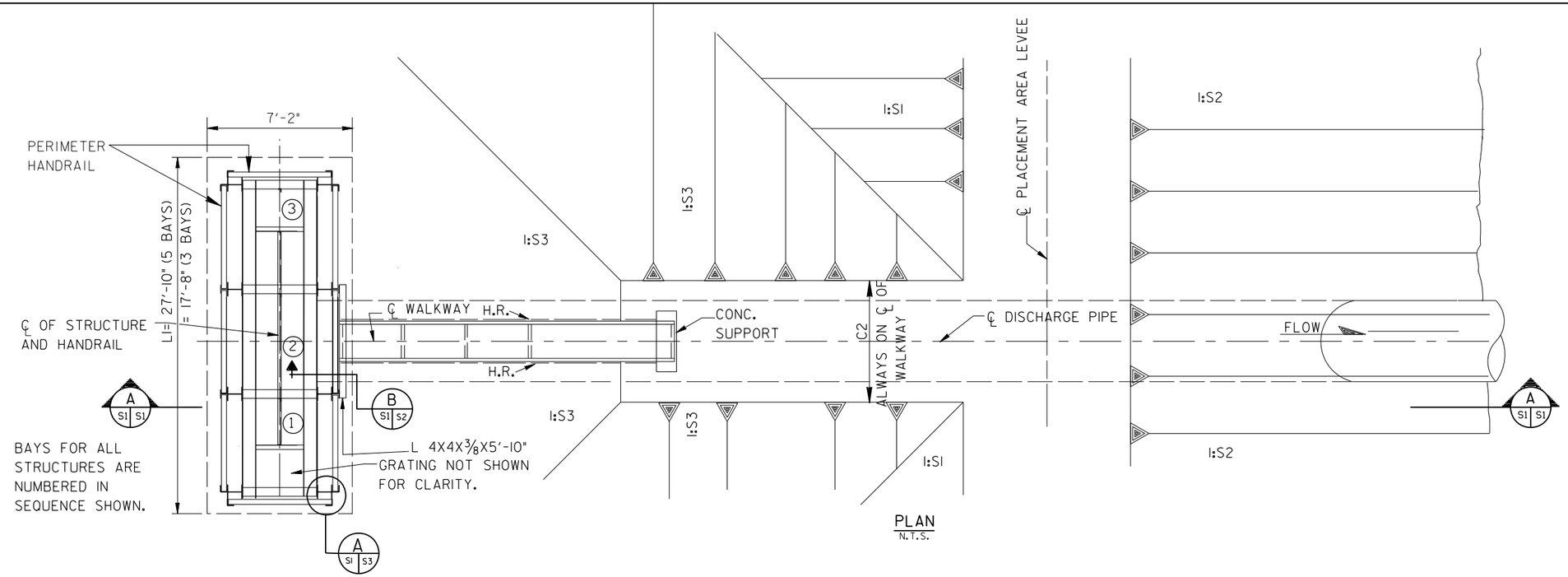
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL, C.E.
DISTRICT COMMANDER

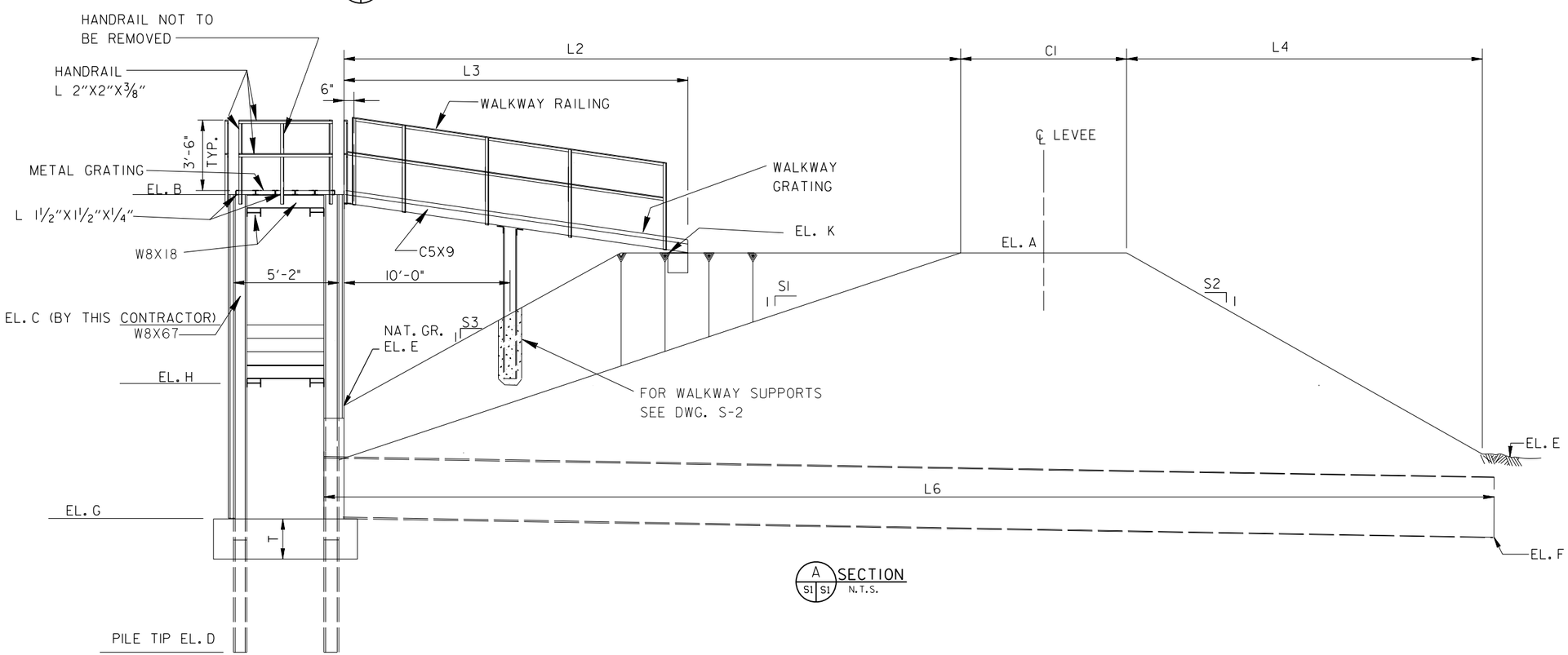
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

LOGS OF BORINGS
3ST-207 TO 3ST-211

Drawing No.:
F-6



PLAN
N.T.S.



SECTION
N.T.S.

REF: 7.1.7 MODIFICATIONS TO DROP-OUTLETS

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by:
Designed by: X
Checked by: X
Submitted by: LORIK, THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: ROBERT C. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Rev. --
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

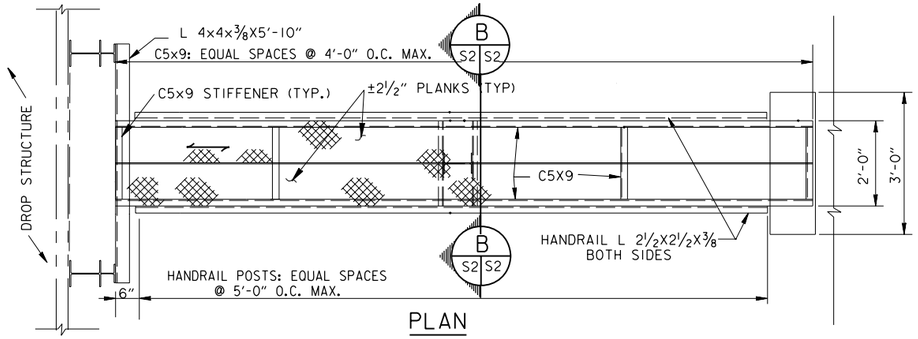
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL, C.E.
DISTRICT COMMANDER

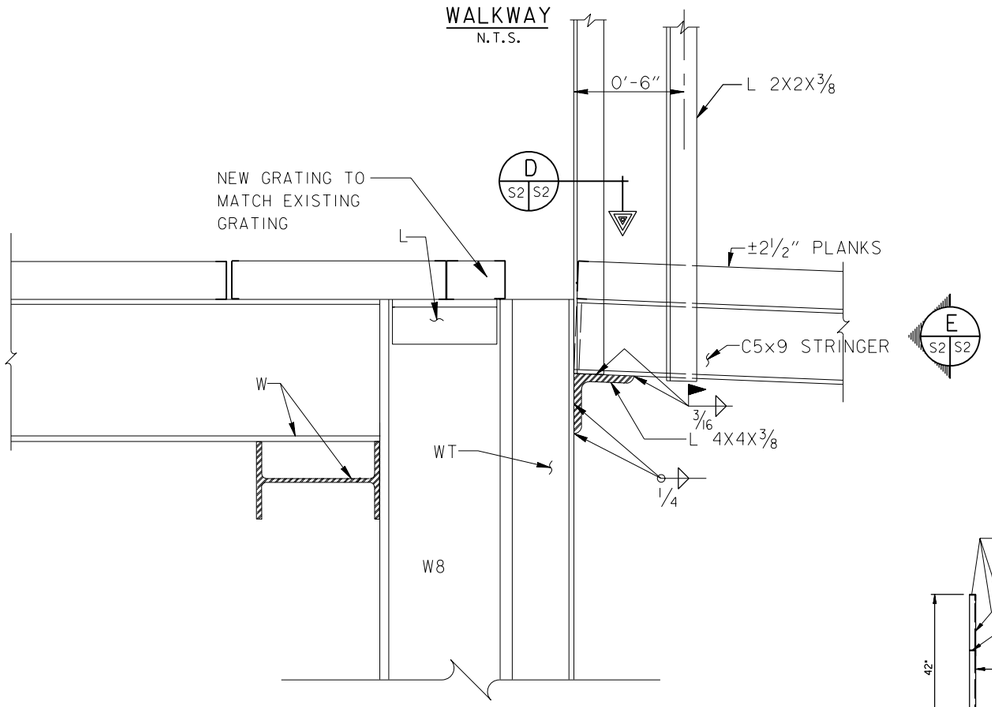
SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DROP OUTLET STRUCTURE
PLAN AND ELEVATION

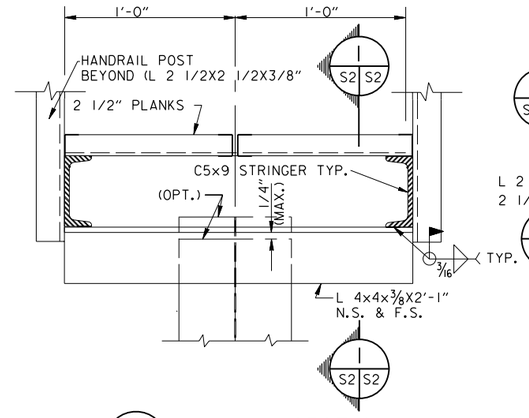
Drawing No.:
S-1



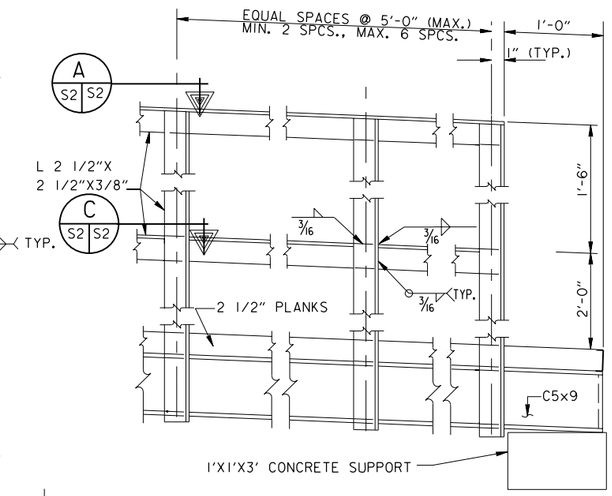
PLAN
WALKWAY
N.T.S.



B S1 S2 SECTION
N.T.S.

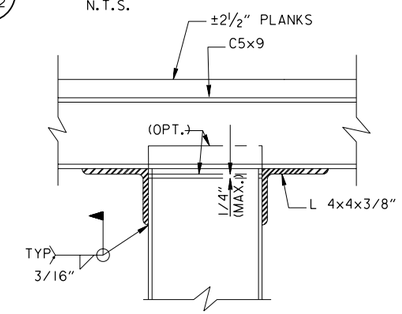


B S2 S2 WALKWAY SECTION
N.T.S.

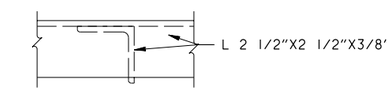


INTERMEDIATE POST END POST

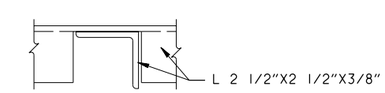
ELEVATION WALKWAY HANDRAIL
N.T.S.



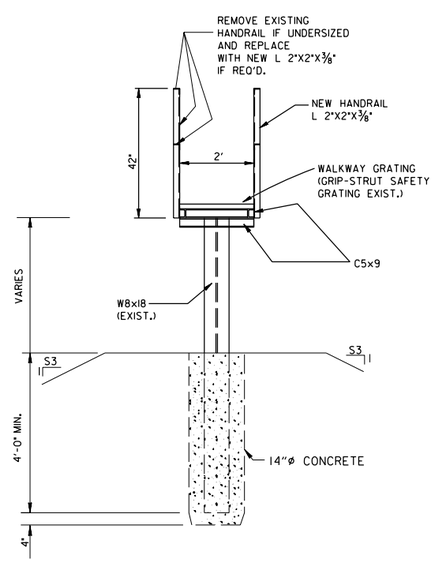
I S2 S2 SECTION
N.T.S.



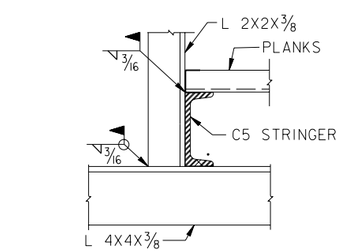
A S2 S2 SECTION
N.T.S.



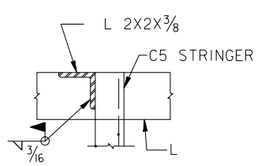
C S2 S2 SECTION
N.T.S.



WALKWAY SUPPORT SECTION
N.T.S.



E S2 S2 PLATFORM HANDRAIL @ WALKWAY CONNECTION
N.T.S.



D S2 S2 SECTION
N.T.S.

REF: 7.1.7 MODIFICATIONS TO DROP-OUTLETS

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by:
Designed by: X
Checked by: X
Submitted by: LORIK, THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: RITA C. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Scale: AS SHOWN
Rev. --
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

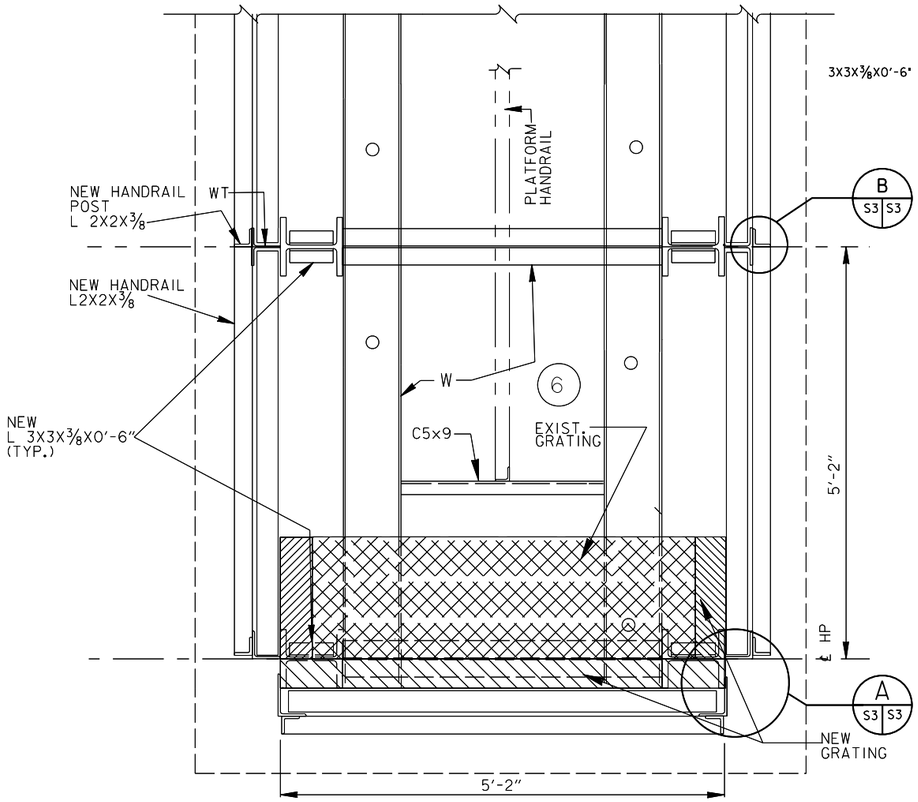
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL. C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DROP OUTLET STRUCTURE
DETAILS

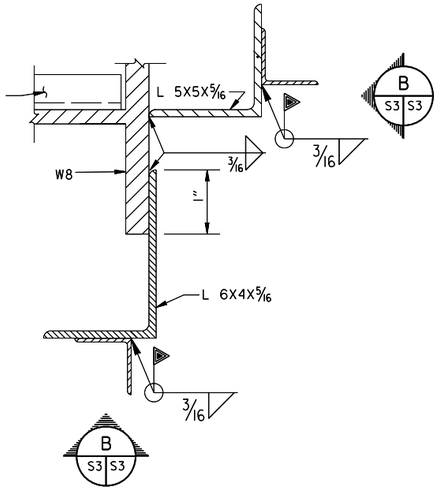
Drawing No.:
S-2



PARTIAL PLAN

N.T.S.

(WALKWAY NOT SHOWN)



A DETAIL

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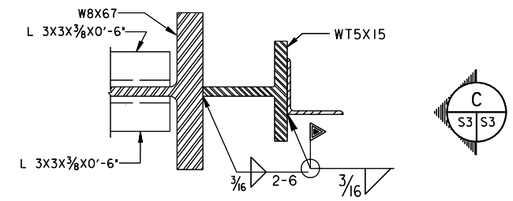
N.T.S.



B DETAIL

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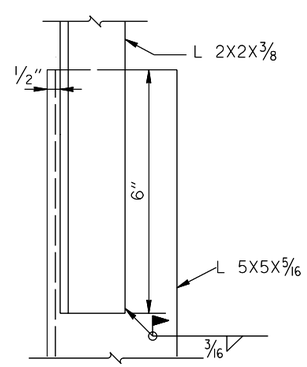

VIEW A

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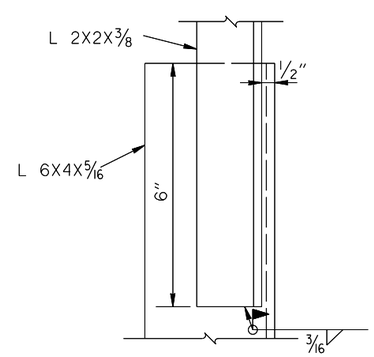

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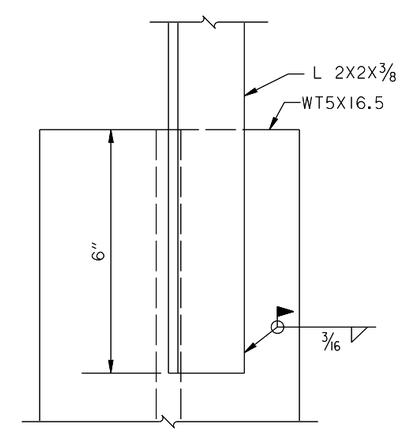

VIEW C

N.T.S. S3 S3

REF: 7.1.7 MODIFICATIONS TO DROP-OUTLETS

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by:
Designed by: X
Checked by: X
Submitted by: LORIK, THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: RAFE C. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MAY 2008
Rev. --
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFF, PE Chief, Engineering Branch

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL, C.E.,
DISTRICT COMMANDER

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DROP OUTLET STRUCTURES
DETAILS

Drawing No.:
S-3

TABLE I EXISTING/NEW STRUCTURES

REF. DWG. NOS.	C-09			C-07 C-08	C-07	C-06	C-04		C-04		C-04		C-03			C-02		C-01			C-01	
DESCRIPTION	EXIST. 5N	EXIST. 5S	EXIST. 5C	EXIST. 8	EXIST. 9, 9A	EXIST. 11	EXIST. 12	EXIST. 13	EXIST. 14	EXIST. 14A	EXIST. 16, 16A		EXIST. 18A	EXIST. 21	EXIST. 22	EXIST. 23A	EXIST. 24	EXIST. 25A	NEW 16A	NEW 24	NEW 24A	NEW 27D
NO. OF BAYS				5				5														
WALKWAY ℄ BAY				4				3														
WALKWAY BETWEEN BAYS																						
HEIGHT OF STRUCTURE				19′				11′														
PIPE(S) IN BAY NO(S)				2&3				2&4														
PIPE(S): NO./DIA.				2-48				2-36														
ELEVATIONS:																						
A				18.0				15.0														
B				23.0				18.0														
C																						
D								R														
E																						
F																						
G				4.0				7.0														
H																						
K																						
LENGTHS:																						
L 1				28.5′				28.5′														
L 2																						
L 3				40′				20′														
L 4																						
L 5																						
L 6																						
C 1																						
C 2																						
T																						
SLOPES:																						
S 1																						
S 2																						
S 3																						
COLUMNS				W8X58				W8X58														
STRUTS				W8X18				W8X18														
SUPPORTS				W8X58				W8X18														
WT SIZE				4X9				4X12														
TIMBER SIZE				3"				3"														

REF: 7.1.7 MODIFICATIONS TO DROP-OUTLETS

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, COL., C.E.
DISTRICT COMMANDER

Drawn by:
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Date: MAY 2008
Scale: AS SHOWN
Rev. --
Approval Recommended:
HARRISON T. SUTCLIFF, PE
Chief, Engineering Branch

SABINE NECHES WATERWAY, TEXAS
CHANNEL IMPROVEMENT STUDY
48' PROJECT

DROP OUTLET STRUCTURE
TABLE I

Drawing No.:
S-4

Appendix 2

Economic Appendix

APPENDIX 2
ECONOMIC APPENDIX
SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
SOUTHEAST TEXAS AND SOUTHWEST LOUISIANA

PREPARED BY:

U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
SOUTHWESTERN DIVISION

June 2010

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List of Acronyms

AEO	*Annual Energy Outlook*
AIS	Automatic Identification System
API	American Petroleum Institute
Bcf	billion cubic feet
Bcf/d	billion cubic feet per day
BCR	benefit to cost ratio
BOOT	Beaumont Offshore Oil Terminal
BOOTS	Bulk Oil Offshore Transfer System
BPD	barrel-per-day
DWT	dead weight tons
EGM	Economic Guidance Memorandum
EIA	U.S. Energy Information Administration
ERDC	Engineering Research and Development Center
FAO	Food and Agriculture Organization
FERC	Federal Energy Regulatory Commission
FY	fiscal year
GICA	Gulf Intracoastal Canal Association
GIWW	Gulf Intracoastal Waterway
IWR	Institute of Water Resources
LNG	Liquefied natural gas
LoLo	load-on/load off
LOOP	Louisiana Offshore Oil Port
LRS	Lloyd's Register-Fairplay of Ships
m^3	cubic meters
MSA	metropolitan statistical area
MSO	Marine Safety Office
MTBE	methyl tertiary-butyl ether
NDC	Navigation Data Center
PADD	Petroleum Administration Defense District
SB	Sabine Bar or the Sea Buoy
SETWAC	Southeast Texas Waterways Advisory Council
SNWW	Sabine-Neches Waterway
SPA	Sabine Pilots Association
SPR	Strategic Petroleum Reserve
Tcf	trillion cubic feet
TOPS	Texas Offshore Oil Port System
ULCC	Ultra Large Crude Carriers
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture

USDOE	U.S. Department of Energy
VLCCs	very large crude carriers
VTM	Vessel Traffic Management
VTS	vessel traffic service
WCSC	Waterborne Commerce Statistics Center

APPENDIX 2

ECONOMIC APPENDIX

1.0 GENERAL

This appendix presents the economic analysis for proposed modifications to the Sabine-Neches Waterway (SNWW). The SNWW project area and the general boundaries of its channel reaches are shown on Figure 1. The existing project is defined by a 40-foot project depth from the Gulf of Mexico offshore entrance channel to Port Arthur and Beaumont and a 30-foot project depth to the Port of Orange. Project alternatives were evaluated based on reductions in transportation costs generated from more-efficient vessel loading and from reductions in vessel delays due to channel deepening and widening. The benefits were calculated for a 2019–2069 period of analysis using Fiscal Year (FY) 2009 Federal Discount rate of 4.375 percent and the deep-draft vessel operating costs contained in the unpublished update to Economic Guidance Memorandum (EGM 08-04). The deepening benefits were calculated using a Microsoft Excel spreadsheet model. The widening benefits were calculated using the HarborSym model. The analyses and computations presented in this appendix are based on data and statistics obtained from personal interviews with industry officials and from analyses of historical data and published trends.

The appendix contains of nine sections. This first section presents general information on channel use and the results of the initial screening, and an overview of the historical traffic base. Section 2 presents evaluation of the major commodity groups. Section 3 presents existing vessel utilization trend data and a casualty assessment. Section 4 presents the commodity and fleet forecasts. Section 5 summarizes total tonnage. Section 6 presents the transportation savings benefit analysis. Section 7 presents a summary of the project benefits and the incremental analysis. Section 8 presents the sensitivity analyses. Section 9 presents an overview of regional economics.

The SNWW terminals include the public marine facilities owned by the ports of Beaumont, Port Arthur, and Orange, as well as the petroleum refineries, chemical plants, and general cargo terminals. Vessels and barges are used to transport crude oil, petroleum products, liquid and dry chemicals, and steel and dry bulk cargo. Deep-draft cargoes are transported from offshore through the Sabine Pass Channel. The Port of Port Arthur's general cargo facilities are located on the Sabine-Neches Canal near mile 32, and its crude petroleum and product terminals are in the Taylor Bayou basin. The Port of Beaumont's public and private docks are located on the Neches River Channel. The Channel to Orange intersects with the Gulf Intracoastal Waterway (GIWW) at the east end of the SNWW. Improvements to the Channel to Orange were not evaluated due to the expectation of low utilization of the existing project depth. In addition to its large volume of deep-draft traffic, the Sabine-Neches Canal serves as a through channel for the GIWW. The GIWW extends from Apalachee Bay, Florida, to Brownsville, Texas, and connects with the SNWW at approximately 3 miles below Orange and then follows the Sabine River and Sabine-Neches Canal to the head of the Port Arthur Canal where it exits the SNWW and continues westward to Galveston Bay. Distributions of SNWW's port-specific deep-draft and shallow-draft tonnage are displayed in Table 1.

Figure 1: Project Location

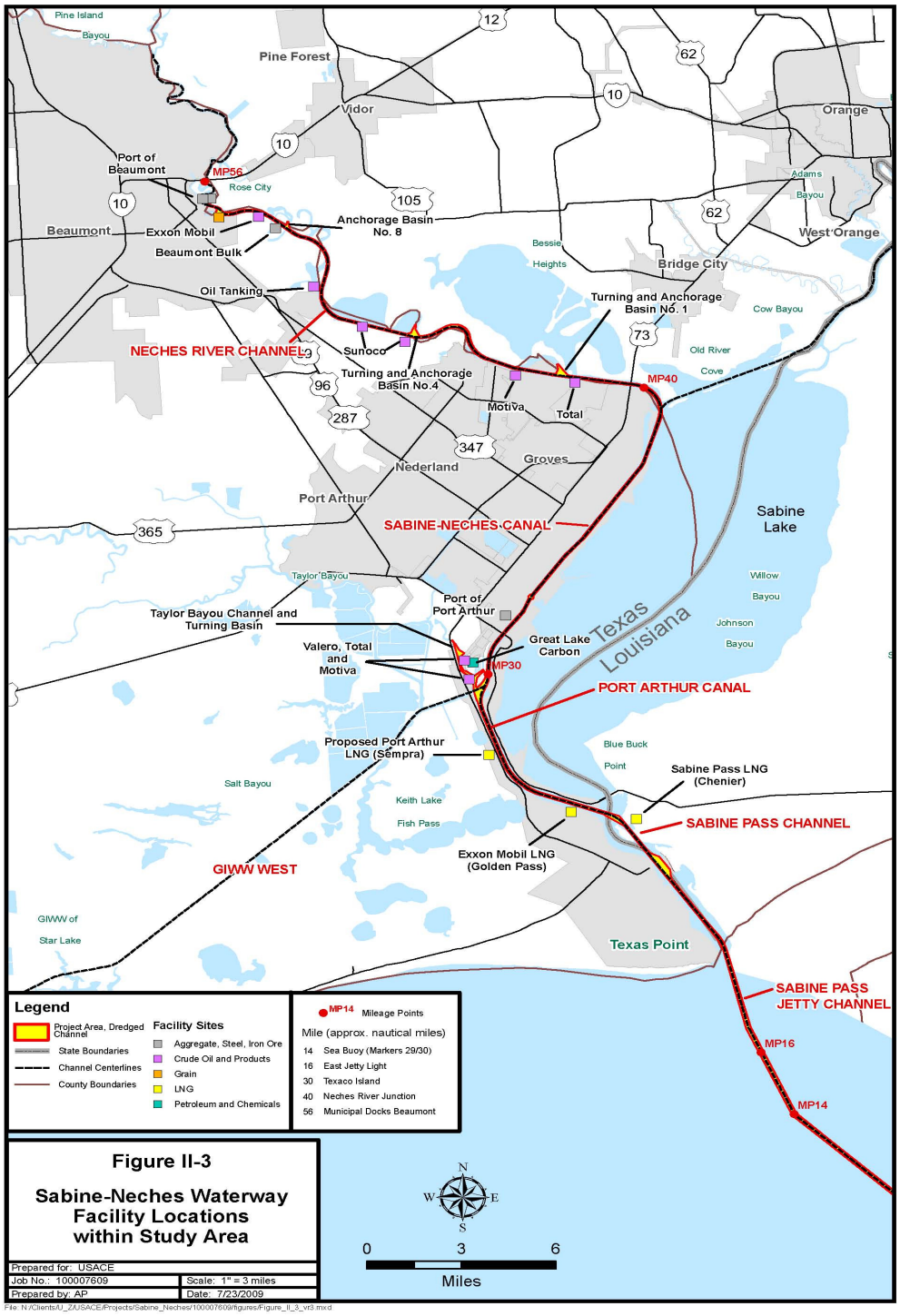


Table 1
SNWW Port Tonnage
(1,000s of Short Tons)

	Beaumont		Port Arthur		Orange		SNWW Port Totals a/	
Year	Deep-Draft	Shallow-Draft	Deep-Draft	Shallow-Draft	Deep-Draft	Shallow-Draft	Deep-Draft	Shallow-Draft
1999	69,655	12,997	13,730	7,657	0	681	83,385	21,335
2001	64,777	14,354	16,173	6,629	0	798	80,950	21,781
2002	70,441	15,470	16,640	6,036	5	759	87,086	22,265
2003	71,519	16,022	21,044	6,126	10	815	92,573	22,963
2004	74,065	17,632	20,758	6,812	3	606	94,826	25,050
2005	63,069	15,547	19,856	7,714	0	627	82,925	23,888
2006	60,431	18,784	20,990	7,413	3	718	81,424	26,915
2007	60,305	21,079	20,977	8,285	10	815	81,292	30,179

Source: U.S. Army Corps of Engineers (USACE), *Waterborne Commerce of the U.S., Part 2*, 1999–2007.
a/ Includes intraport movements.

An initial array of project alternatives was identified during the screening analysis. The screening results were presented at the May 2001 Feasibility Scoping Meeting. For the screening, channel-deepening benefits were calculated for 43, 45, 47, 48, 50, 52, and 55 feet. The results showed that the 50-foot channel depth produced the highest net excess benefits. The results also showed that the net excess benefits for 50 feet were only slightly higher than for 48 feet. Incorporation of later traffic data and improved cost estimates continued to indicate that the maximum net excess benefits were in the 48- to 50-foot range. Channel deepening was proposed by industry as a means to allow the existing fleet to be loaded more fully, reduce per ton transportation costs for vessels using the waterway, and allow for reductions in the number of annual vessel trips.

Identification of the channel-widening alternatives was driven by physical structures along the Neches River and Sabine-Neches Canal and the Port Arthur Hurricane Protection Levee in the Sabine-Neches Canal reach. Delays prompted by transit restrictions are a major concern under existing conditions and will continue to be a concern under the without-project future. As part of plan formulation, the Neches River anchorage basins were introduced as an alternative to widening of the Neches River Channel. The anchorages would be used to facilitate vessel passing. During the initial screening, extensive and intermittent widening was evaluated for the channel reaches from Sabine Pass Channel inland through the Neches River Channel. Widening of the Neches River was eliminated from consideration based on comparison of anticipated reductions in vessel delay costs and initial project construction cost estimates, and from the outputs of the Engineer Research and Development Center (ERDC) ship simulation modeling. Widening of the Neches River reach was found not be a cost-effective alternative due to the costs associated with dock relocations and extensive dredging. Additionally, intermittent widening of the Neches River Channel did not perform well during ERDC ship simulation modeling. In comparison, the Neches River anchorages and Sabine Pass Channel and Port Arthur Canal widening features performed

favorably. The results of the ERDC modeling showed that a minimum width of 700 feet through the Sabine Pass Channel and Port Arthur Canal would be necessary for the Suezmax and Aframax vessels presently using the waterway to meet smaller vessels in the Sabine Pass Channel and Port Arthur Canal. Aframax tankers characteristically range from 90,000 to 120,000 dead weight tons (DWT), and Suezmax tankers characteristically range from 135,000 to 175,000 DWT. The project design vessel is an 899-foot-long, 164-foot-wide 158,000 DWT Suezmax crude petroleum tanker. ERDC testing of a 600-foot channel width alternative showed that neither a loaded or ballast design vessel was successful in meeting a comparably sized vessel, nor could the design vessel and a smaller 110,000 DWT Aframax tanker meet. In 2007, there were over 2,000 piloted vessels. The largest sized vessels using the channel to Port Arthur are Aframax tankers. The largest sized vessels using the Neches River Channel to Beaumont are Suezmax tankers. Sixty percent of piloted vessels shipped or received cargo from docks on the Neches River. Of the remaining 40 percent, 39 percent were associated with Port Arthur and the remaining 1 percent with the Channel to Orange.

Table 2 shows the existing channel dimensions. Channel width inside of the Sabine Pass Jetty Channel ranges from 400 to 500 feet except for reaches containing turning basins. The without-project future will continue to be defined by the channel dimensions shown in Table 2.

Table 2
Existing SNWW Channel Dimensions

Channel Reach	Authorized Depth (feet)	Bottom Width (feet)	Length (miles)
Sabine Bank Channel	42	800	14.7
Sabine Pass Outer Bar Channel	42	800	3.4
Sabine Pass Jetty Channel	40	800–500	4.0
Sabine Pass Channel	40	500–1,133*	5.6
Port Arthur Canal	40	500–1,788*	6.2
Sabine-Neches Canal	40	400–1,060*	11.3
Neches River Channel	40	400	18.6
Channel to Orange	30	200	14.1

* This reach contains an existing turning basin.

The SNWW is currently subject to navigation constraints, including one-way and daylight-only sailing rules. The pilot rules are summarized in Table 3. The transit rules and associated restrictions are agreed upon by the shipping industry, supported by the U.S. Coast Guard (USCG) Captain of the Port Orders under the Ports and Waterways Safety Act of 1978, as amended, and administered by the Sabine Pilots Association (SPA). These voluntary rules were agreed upon by the Sabine shipping industries and the SPA, and supported by USCG Captain of the Port Orders under the Ports and Waterways Safety Act of 1978, as amended. The agreement, dated January 12, 1981, will remain in force until the Sabine shipping industries, SPA, and USCG agree to its revision or modification. Liquefied natural gas (LNG) vessels are subject to additional rules. LNG vessels using the SNWW would be subject to strict USCG regulations and to local pilot rules and, therefore, will not have the opportunity to meet other vessels or barges. The USCG regulations require that a safety zone is in place 2 miles ahead of a loaded LNG vessel and 1 mile astern of the vessel while transiting. LNG vessels using the SNWW would be subject to this rule. Even in the absence of the safety concerns inherent to LNG, the beams of LNG tankers would result in vessel-meeting restrictions; however, all LNG vessel movements will be subject to one-way traffic. Operation of the LNG terminals is part of the without-project future.

Table 3
SNWW Pilots Rules

General: Vessels 85,000 DWT or over, or greater than 875 feet in length and 125 feet in beam width will move during daylight hours only above the Texas Island intersection with the GIWW West. In the event that meeting situations are applicable but circumstances will not permit the utilization of turning basins, the following criteria will prevail:

1. Vessels with combined beam widths that equal or exceed one-half of the channel width will not meet day or night.
2. Vessels ≥85,000 DWT will not meet vessels of either ≥30,000 DWT or ≥2-foot draft above the Texas Island intersection.
3. Vessels ≥85,000 DWT will not meet vessels of either ≥30,000 DWT or ≥30-foot draft above buoys 29 and 30.
4. Vessels 48,000 metric DWT or more with a draft of 30 feet or more will not meet above buoys 29 and 30.
5. Vessels with a combined draft of 70 feet or more will not meet between the Neches River intersection and Day Beacon #40 (Smith Bluff) at night. Vessels with a combined draft of 65 feet or more will not meet above Day Beacon #40 at night.

Source: SPA (2008) http://www.sabinepilots.com/guidelines.htm.

Non-LNG vessels utilizing the waterway are wider than those using the channel even 5–10 years ago. Due to wider beams and the difficulty associated with handling an increasing number of larger vessels, the Sabine Pilots would not consider relaxing the transit rules without structural modifications of the channel. Widening the channel up to the Taylor Bayou junction will result in a relaxation of the pilot rules as vessels will have an additional 200 feet of channel (i.e., the existing channel width is 500 feet and the with-project width for the Sabine Pass Channel and Port Arthur Canal, which leads up to Taylor Bayou, will be 700 feet). The expectation for the with- and without-project future is that pilot rules will continue to limit the possibility of vessel-to-vessel and vessel-to-tow meetings in the Sabine-Neches Canal reach and that both vessel and shallow-draft tow movements will be scheduled through both vessel traffic service (VTS) and communication between vessel pilots.

An anticipated effect of the alternative that includes widening the Sabine Pass Channel and Port Arthur Canal to 700 feet would be to allow a higher percentage of vessels presently affected by the 50 percent combined beam rule in the 500-foot reach to meet in the proposed 700-foot reach. The pilots are uncertain as to the effect that widening will have on the other rules and are reluctant to speculate on how these rules might be relaxed if the channel was deepened and widened. For a "widening only alternative," rules 2 and 3 would be relaxed (see Table 3). For purposes of analysis, the only rule that would change if the channel were deepened and widened is the combined beam rule. The effect of relaxing the remaining two rules is expected if the channel was widened but not deepened. An increase in channel width to 700 feet would allow a higher percentage of vessels to meet in the proposed 700-foot reach. The effect of channel widening on Rule 1 would be that a larger number of wider beam vessels would be able to meet in the Sabine Pass Channel and Port Arthur Canal reaches. Rule 2 would not change meeting and passing restrictions in the Sabine-Neches Canal. The Sabine-Neches Canal is common to the GIWW. Safety concerns associated with the Sabine-Neches Canal reach provided the impetus for Port Arthur's selection as one of 28 ports selected for participation in the 1999 Vessel Traffic Management (VTM) workshops and the subsequent implementation of the VTM service in the early 2000s.

The screening analysis included assessment of nonstructural alternatives. Nonstructural alternatives include the existing Louisiana Offshore Oil Port (LOOP); reactivation of the Beaumont Offshore Oil Terminal (BOOT) permit; and participation in the August 2008 Texas Offshore Oil Port System (TOPS) initiative. The SNWW ports presently receive approximately 1 percent of daily refinery input through LOOP. Extensive pipeline expansions to LOOP would be necessary to accommodate a higher percentage of SNWW's crude petroleum throughput requirements, as SNWW's capacity is close to LOOP's capacity. Expansion is not under consideration by the LOOP stakeholders. While LOOP expansion was not considered for the SNWW without-project future base, the effect of a without-project future that includes utilization of offshore terminals was evaluated in the sensitivity section of this appendix (Section 8). The BOOTS project, which would be offshore from Beaumont, was announced in 2002. The BOOTS regulatory permit application is presently inactive, and the USCG has not received an update to the proposal since 2002. The TOPS initiative was announced in 2008. TOPS would be located offshore from Freeport (Texas) and would serve Port Arthur, Texas City, and Houston. Freeport is located on the Texas Coast southwest of the SNWW. As with BOOTS, TOPS would require construction of a pipeline from

offshore. The existing Seaway pipeline from Freeport to Texas City would be used as part of TOPS. The connection to Port Arthur from Texas City would necessitate a new pipeline extending approximately 95 miles. A March 2009 press release revealed that the Port Arthur participant, Motiva, put its participation on hold based on uncertainty associated with future crude petroleum import volumes and trade routes. The large fixed cost of offshore terminal construction requires high volumes of very large crude carriers (VLCCs) utilization in order to achieve a return on the investment. If constructed, industry indications are that TOPS and BOOTS would not serve as the exclusive supplies, just as LOOP is not the exclusive supplier for the Louisiana markets. The SNWW without-project future is based on the assumption that offshore port alternatives are not constructed. Current expectations are that regional crude oil imports will increase at lower rates in comparison to those experienced through the 1990s and into the early 2000s. The effect of a without-project future that includes utilization of offshore terminals is evaluated in the sensitivity section of this appendix.

An additional alternative is construction of a crude oil terminal in Port Arthur below Texas Island on the Sabine-Neches Canal, northeast of its junction with the GIWW. Port Arthur's existing petroleum terminals are located in the Taylor Bayou basin. The Taylor Bayou basin is immediately northwest of Texas Island. Construction of a new terminal in Port Arthur would divert crude petroleum import tonnage from the Neches River Channel to Beaumont. A new landside terminal on the Port Arthur Canal and the offshore alternatives remain uncertain; therefore, the effects of these alternatives on the 2019–2069 tonnage forecast was evaluated in the sensitivity section of this appendix.

The large volume of tow-barges using the Sabine-Neches Canal reach, along with a high flow of deep-draft traffic, compound congestion and prompted interest early in the study process of evaluation of a barge shelf through the canal reach between the east and west junction with the GIWW. Initial responses to the barge shelf alternative revealed large variance in expectations about its potential effects, with some tow operators questioning the usefulness of the proposed project feature. In 2005, the Gulf Intracoastal Canal Association (GICA) withdrew support for the barge shelf. While mixed concerns about the functionality of the proposed feature contributed to GICA's decision, the decision was primarily based on anticipated and continued success of the VTM as a nonstructural alternative. Additionally, and as part of the VTM initiatives, improved deep-draft and barge vessel communication initiated by the USCG and user safety board activities were noted by the USCG to have resulted in improved safety. Ongoing improvements to the VTM system are expected to result in accelerated safety and communication improvements. These nonstructural initiatives made by the USCG, Sabine Pilots Association, and GICA represent nonstructural alternatives to the barge shelf. The expectation for the with- and without-project future is that pilot rules will continue to limit the possibility of vessel-to-vessel and vessel-to-tow meetings in the Sabine-Neches Canal reach and that both vessel and shallow-draft tow movements in this reach will be scheduled through both VTM and communication between vessel pilots.

1.1 COMMODITY OVERVIEW

The SNWW tonnage experienced strong overall growth from the middle 1990s through 2007, with total tonnage increasing from an average of 108 million short tons for 1995–1997 to 138 million for 2005–2007. In 2007, tonnage totaled nearly 141 million short tons, and the waterway ranked 4th in the U.S. in terms of total tonnage and first in the Nation in crude oil imports. As individual ports, Beaumont ranked 5th in the nation with 81.4 million short tons. Port Arthur's 2007 tonnage totaled 29.3 million short tons with a national ranking of 28th. Channel to Orange tonnage totaled 682 thousand short tons in 2007. Tonnage for the three ports totaled approximately 111 million short tons. The remaining 30 million short tons of the 141-million-short-ton total consist of shallow-draft barge cargo. Table 4 presents SNWW 1970–2007 total tonnage and principal deep-draft movements. Approximately 60 percent of the SNWW tonnage consists of deep-draft movements. The remaining 40 percent consists of shallow-draft GIWW-related traffic. Table 5 displays Sabine-Neches Canal 1970–2007 shallow-draft GIWW tonnage section and the relative percentage of shallow-draft to total tonnage. In 2007, nearly 30 million short tons of the 59.7 million short tons of shallow-draft barge tonnage using the waterway were transported through SNWW port facilities. Beaumont's shallow-draft barge tonnage totaled 21.2 million short tons, Port Arthur's 8.3 million short tons, Orange's 0.7 million short tons, and Sabine Pass 0.9 million short tons. The remaining 30.3 million short tons of 2007 shallow-draft barge traffic consisted of "through movements" between ports such as those on the Lower Mississippi River, Houston, and the GIWW west of Houston. In reviewing trends for commodities presently or anticipated to be constrained, the initial focus was on the commodity groups displayed in Table 4.

Distributions of Port Arthur and Beaumont's 1999–2007 tonnages are displayed in tables 6 and 7. Port specific data for years prior to 1999 are not included in these tables due to U.S.Army Corps of Engineers (USACE) Navigation Data Center (NDC) reporting problems which resulted in a portion of Beaumont's tonnage being attributed to Port Arthur. Crude petroleum imports and petroleum and chemical product imports and exports comprised 80 percent of Port Arthur's 2007 total oceangoing tonnage. The 1999–2007 average was 83 percent. Port Arthur crude petroleum imports remained relatively flat since 2001 but steady. Port Arthur refinery capacity in 2009 is nearly 13 percent higher than in 2004, with additional expansions scheduled. Motiva announced plans for a 325,000 barrel-per-day (BPD) refinery expansion in Port Arthur in December 2007. Construction on the refinery expansion is presently taking place.

As shown in Table 6, Port Arthur's highest and most significant growth rates were for petroleum product exports and domestic coastwise, with overall tonnage growing at relatively steady rates. Analysis of the commodity-specific data showed that 81 percent of Port Arthur's 2005–2007 petroleum product exports were comprised of petroleum coke. Port Arthur's petroleum coke exports constitute 11 percent of the U.S. total, up from 3 percent for the early 1990s. Port Arthur's 2005–2007 chemical exports also experienced significant increases. Port Arthur's chemical export growth is attributable to significant gains in metallic salts and hydrocarbons exports. Twenty percent of U.S. 2005–2007 metallic salts exports were shipped from Port Arthur. Metallic salts and organic compounds are used in the production of paints and solvents, paper and wood products, cleaning products, and various chemical products, and more recently in the

production of nylon in Latin America and China. Increases in Port Arthur's metallic salt exports since 2004 are associated with the completion of a 266,000 metric-ton-per-year cyclohexane facility in the Taylor Bayou section of Port Arthur in early 2004.

Table 4
SNWW Total Tonnage and Major Commodity Tonnage
(1,000s of Short Tons)

Year	Total Tonnage	Total Deep-Draft Tonnage a/	Principal Deep-Draft Commodities						
			Crude Petroleum		Petroleum Products		Chemical Products		Bulk Grain Exports
			Imports	Coastwise	Imports	Exports	Imports	Exports	
1970	79,291	35,696	9	9,217	280	827	72	336	1,786
1975	79,296	41,134	13,820	3,102	177	256	42	310	2,926
1980	108,124	52,560	28,640	3,082	715	2,359	648	634	1,843
1985	70,239	39,169	22,627	1,835	2,516	1,514	267	707	1,642
1990	90,819	36,175	20,348	2,921	2,198	1,635	34	546	2,090
1993	95,418	46,990	32,639	81	2,656	3,260	25	537	3,471
1994	99,675	49,775	37,226	225	1,859	3,092	49	577	2,303
1995	103,254	52,959	38,743	187	1,304	4,258	33	725	1,712
1996	103,262	54,863	40,930	971	1,473	3,930	48	777	1,038
1997	116,012	67,553	51,142	81	2,470	4,595	33	1,101	1,370
1998	115,935	70,351	53,877	38	3,491	4,329	140	966	910
1999	114,393	69,259	53,834	86	3,627	3,307	449	753	936
2000	126,285	83,385	67,187	149	3,051	4,043	619	1,469	894
2001	128,944	80,950	64,226	127	2,734	5,120	754	1,296	858
2002	135,088	87,081	66,383	133	5,028	5,635	683	1,587	835
2003	143,923	92,563	70,158	195	5,187	6,573	434	1,555	1,125
2004	150,297	94,823	69,875	134	6,002	7,152	656	2,104	1,329
2005	134,695	82,925	59,691	165	5,349	6,354	1,084	1,891	1,081
2006	138,065	81,640	57,616	139	3,819	6,823	1,244	2,904	1,214
2007	140,967	81,282	56,088	217	3,744	6,608	955	3,169	1,632

Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1970–2007.
a/ Includes commodities in addition to what is shown.

Table 5
SNWW Shallow-Draft Port and GIWW Through Tonnage, Deep-Draft Total Tonnage, and Shallow-Draft Percentage of Total Tonnage (1,000s of Short Tons) a/

Year	Shallow-Draft Port Tonnage and GIWW Through Tonnage	Deep-Draft Tonnage	SNWW Total	Shallow-Draft Percent of Total Tonnage
1970	43,595	35,696	79,291	55
1975	38,162	41,134	79,296	48
1980	55,564	52,560	108,124	51
1985	31,070	39,169	70,239	44
1990	54,644	36,175	90,819	60
1995	50,295	52,959	103,254	49
1996	48,399	54,863	103,262	47
1997	48,459	67,553	116,012	42
1998	45,584	70,351	115,935	39
1999	45,134	69,259	114,393	39
2000	42,900	83,385	126,285	34
2001	47,902	81,998	128,944	37
2002	48,007	87,081	135,088	36
2003	51,360	92,563	143,923	36
2004	55,474	94,823	150,297	37
2005	51,770	82,925	134,695	38
2006	56,646	81,421	138,067	41
2007	59,685	81,282	140,967	42

Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1970–2007.
a/ Includes intra-port movements.

As shown in Table 6, Port Arthur's commodity movements other than petroleum and chemicals include crude materials, which consist of 513,000 short tons of limestone, sand, and gravel. For 1999–2007, crude material volumes averaged nearly 500,000 short tons annually. Port Arthur's crude material facilities are located on the Sabine-Neches Canal near mile 32, and its crude petroleum and product terminals are in the Taylor Bayou basin.

Port Arthur's steady volume of coastwise tonnage shown in Table 6 is associated with continuing shipments of gasoline, distillate fuel oil, and petroleum coke between Port Arthur and other deep-draft U.S. ports. Approximately 39 percent of tonnage is shipped to Florida's Atlantic Coast, 34 percent to Florida's Gulf Coast, 9 percent to Baton Rouge, 6 percent to Houston, 3 percent to Lake Charles, and 2 percent to Corpus Christi. The remaining 7 percent of destinations include Puerto Rico, the U.S. West Coast, and the Northeast.

Table 6
Port Arthur Total Tonnage and Major Commodity Tonnage
(1,000s of short tons)

Year	Total Tonnage	Total Deep-Draft	Total Coastwise	Crude Petroleum	Petroleum Products		Chemical Products		Crude Materials, Except Fuels		Primary Manufactured Goods		Major Group	% of Deep-
				Imports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Total	Draft
1999	18,308	12,073	659	7,977	604	1,136	5	349	566	21	617	107	12,041	100
2000	21,387	13,730	817	8,862	1,121	1,502	–	307	206	7	743	107	13,672	100
2001	22,802	16,173	1,043	11,064	641	2,327	25	136	131	–	665	101	16,133	100
2002	22,676	16,640	1,422	9,013	997	3,143	89	176	919	2	641	194	16,596	100
2003	27,170	21,044	2,577	11,987	1,152	3,734	60	210	481	20	557	128	20,906	99
2004	27,570	20,758	1,804	10,015	2,150	4,255	225	889	531	41	564	106	20,580	99
2005	26,385	19,856	1,803	9,320	2,205	3,858	194	998	558	14	710	84	19,744	99
2006	28,403	21,209	2,323	10,627	1,144	4,391	111	1,330	566	54	542	46	21,134	100
2007	29,067	20,977	3,330	10,334	792	3,978	97	1,525	513	64	122	35	20,790	99
Average Annual Growth Rate (1999-2007)														
	5.9%	7.1%	22.4%	3.3%	3.4%	17.0%	44.9%	20.2%	–1.2%	14.9%	–18.3%	–13.0%	7.1%	–0.1%

Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1999–2007.

Table 7
Beaumont Total Tonnage and Major Commodity Tonnage
(1,000s of short tons)

Year	Total Tonnage	Total Deep-Draft	Total Coastwise	Crude Petroleum Imports	Petroleum Products Imports	Petroleum Products Exports	Chemical Products Imports	Chemical Products Exports	Crude Materials, Except Fuels Imports	Crude Materials, Except Fuels Exports	Primary Manufactured Goods Imports	Primary Manufactured Goods Exports	Grain Exports	Major Group Total	% of Deep Draft
1999	69,406	57,186	3,330	45,857	3,023	2,170	444	404	115	446	281	8	936	57,014	100
2000	76,894	69,655	3,046	58,325	1,930	2,541	619	1,162	413	410	133	1	894	69,474	100
2001	79,131	64,777	2,793	53,162	2,093	2,793	729	1,160	622	165	103	6	858	64,484	100
2002	85,911	70,441	2,712	57,370	4,031	2,492	594	1,411	394	14	204	14	835	70,071	99
2003	87,541	71,519	2,732	58,171	4,035	2,839	374	1,345	583	73	115	36	1,125	71,428	100
2004	91,968	74,065	3,191	59,860	3,852	2,897	431	1,215	559	104	420	1	1,329	73,859	100
2005	78,887	63,069	2,967	50,371	3,144	2,496	890	893	624	106	471	12	1,082	63,056	100
2006	79,486	60,431	3,115	46,988	2,676	2,432	1,133	1,574	550	243	364	8	1,214	60,296	100
2007	80,062	60,305	3,261	45,776	2,952	2,713	858	1,644	617	421	173	86	1,632	60,133	100
Average Annual Growth Rate (1999-2007)															
	1.8%	0.7%	–0.3%	0.0%	–0.3%	2.8%	8.6%%	19.2%	23.4%	–0.7%	–5.9%	34.5%	7.2%	0.7%	0.0%

Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1999–2007.

Examination of Beaumont's tonnage (see Table 7) showed that crude petroleum imports and petrochemical imports and exports composed 89 percent of Beaumont's 2007 total oceangoing tonnage. Four percent of 2005–2007 U.S. fertilizer and fertilizer mixes were exported from Beaumont. For 2005–2007, the Beaumont share of potassic fertilizer exports increased to 12.5 percent of the U.S. fertilizer export total, up from 1 percent prior to 2001. Beaumont's other commodity movements include grain exports, coastwise shipments of gasoline and liquid sulphur, and imports and exports of crude materials and manufactured goods. The latter groups comprise approximately 7 percent of Beaumont's deep-draft tonnage. Beaumont's crude material imports, which include limestone, sand, and gravel, comprised 1 percent of the 2005–2007 average U.S. total. Beaumont's imports of manufactured goods for 2005–2007 consisted of 336,000 short tons of iron and steel products, representing 1 percent of the U.S. total. Coastwise shipments for 2005–2007 averaged 2.4 million short tons and included 1.3 million short tons of gasoline and 720,000 short tons of chemicals. Liquid sulphur composed 85 percent of coastwise chemical shipments. For the period 1998–2007, sulphur shipments ranged from a low of 506,000 short tons in 2004 to a high of 679,000 in 2001. In 2007, Beaumont's sulphur shipments totaled 553,000 short tons.

While the initial screening focused on crude petroleum imports, interest in channel deepening alternatives was found to include aggregate, bulk grain, chemicals, and LNG. During the early 2000s, LNG permits were approved for the Cheniere Sabine Pass, Golden Pass (Exxon Mobil), and Sempra terminals. Cheniere opened its terminal in April 2008. Receipt of "commissioning cargo," which is used to chill the tanks and keep the natural gas in its liquefied state, occurred in 2008. Since opening, throughput has been low due to increased demand in other parts of the world. The effect of competing demand drove up LNG prices on the world market, with other countries willing to pay more than we are for LNG, little is being shipped to the U.S.[1] Japan imported much higher than anticipated volumes of LNG to fuel peaking plants after the summer of 2008 earthquake shut down most of the country's nuclear power generation. Tentatively there are short-term plans to export LNG from the Sabine Pass LNG import terminal in Louisiana. In a July 2009 press release, the U.S. Energy Information Administration (EIA) noted that expectations in 2010–2012 are for prices to stabilize and shipments to the U.S. to increase. Cheniere presently has three storage tanks built and another two under construction. Construction of the Exxon Golden Pass LNG terminal is scheduled for completion in 2011. Its schedule was delayed due to ongoing Hurricane Ike cleanup activities along with the unexpected surge in Japanese demand for LNG. Construction of the third permitted facility, Sempra, is anticipated after 2012. The three LNG sites are located in the Sabine Pass Channel and Port Arthur Canal reaches; these reaches are presently 500 feet wide and will remain so under the without-project future

As indicated, the EIA raised its projections for liquefied natural gas imports in July 2009, citing falling long-term demand elsewhere as new global production comes online. The EIA noted that U.S. LNG imports are expected to increase from 350 billion cubic feet (Bcf) in 2008 to about 480 Bcf in 2009 and 650 Bcf in 2010.[2] It was also noted that the U.S. tends to be the LNG market of last resort as producers send LNG to the higher-paying Asian and European markets first, adding that global LNG demand and prices have began to decline 2009, potentially leaving more LNG for the U.S. whose extensive storage

[1] *Beaumont Enterprise*, "Sabine LNG Filing Tanks Up," June 28, 2009.
[2] USDOE, Short-Term Energy Outlook, EIA, June 9, 2009.

and pipeline network means it can absorb LNG even at times of low demand. Added effects expected to result in increases in U.S. LNG imports are new production projects coming online in Russia and Qatar late in 2009. Expectations through 2011 are for completion of projects in Yemen and Indonesia. The LNG projection is subject to considerable uncertainty, while noting that initial production from new liquefaction capacity has been slowed or delayed for extended periods.

The remainder of this section presents additional detail on breakbulk foreign imports and exports and coastwise commodities. SNWW's breakbulk commodities of wood products, iron ore, limestone, and rock fall within the classification of manufactured goods. Figure 2 displays SNWW's established base of import and export tonnage by major commodity group.[3] Petroleum and chemical product imports and exports, breakbulk imports and exports, and bulk grain exports are shown. Tonnage increased for all groups except grain. In spite of declines, grain exports have increased marginally since the middle 1990s, and Beaumont's 2005–2007 wheat exports represent 5 percent of total U.S. wheat exports. The U.S. Department of Agriculture (USDA) shows 909 million bushels of wheat exports for the 2006–2007 crop-year, and 1,150 million bushels for 2007–2008. The USDA forecasted a constant export level of 950 million bushels for 2008–2009 through 2017–2018.[4]

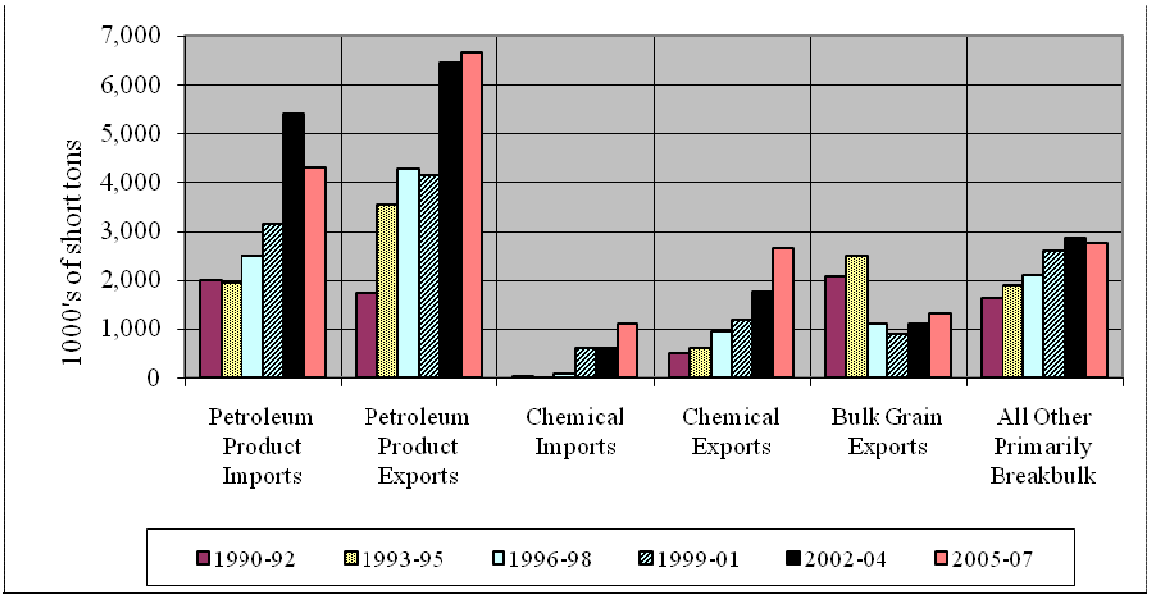
Figure 3 provides a detailed display of SNWW's major breakbulk tonnage. With the exception of wood and related product exports, which decreased at an average annual rate 9.5 percent, overall breakbulk volumes increased from 1990 to 1992 through 2005 to 2007. Iron and steel imports grew at an average annual rate of 8.8 percent. Limestone and rock imports increased at a rate of 6.3 percent. Wood product imports increased at an annual rate of 31.7 percent.[5] While 2005–2007 breakbulk volumes are up from the early nineties, 2007 tonnage was down. Approximately 60 percent of 2005–2007 combined imports and exports of breakbulk are transported through Port Arthur, and the remainder through Beaumont. Imports of iron and steel products and limestone and rock materials compose the majority of current breakbulk tonnage.

[3] Data for the years prior to 1999 are not presented for the individual ports. The Bureau of Census data contained in the *Waterborne Commerce of the United States* does not reflect correct allocation of Port Arthur and Beaumont traffic between the ports. Some of Beaumont's traffic was recorded under Port Arthur due to a Bureau of Census error. Total tonnage values were found to be correct for the SNWW, but the individual counts for years prior to 1999 were found to be unreliable.

[4] USDA, *USDA Agricultural Projections to 2017,* Long-term Projections Report OCE-2008-1, February 2008, p. 40.

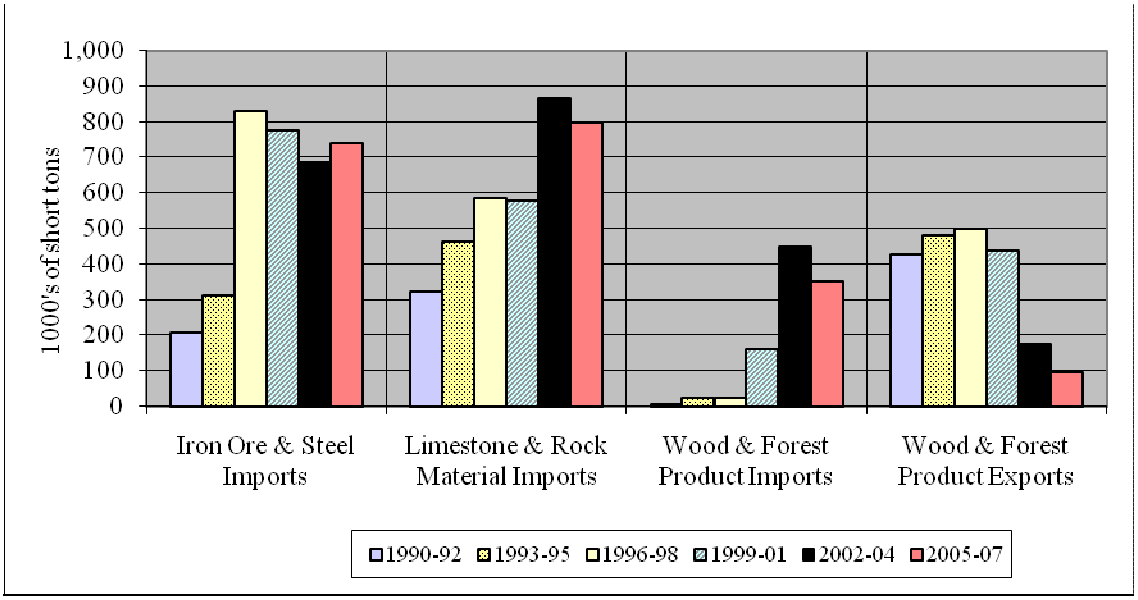
[5] The average annual growth rates for period such as 1990/1992 to 2005/2007 was calculated based on 15 years. The 1990/1992 to 2005/2007 averages were used as inputs.

Figure 2
SNWW Foreign Imports and Exports by Major Commodity Group
(Excluding Crude Petroleum)



Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1990–2007.

Figure 3
SNWW Breakbulk Imports and Exports
1989/1991 to 2004/2006 Distribution



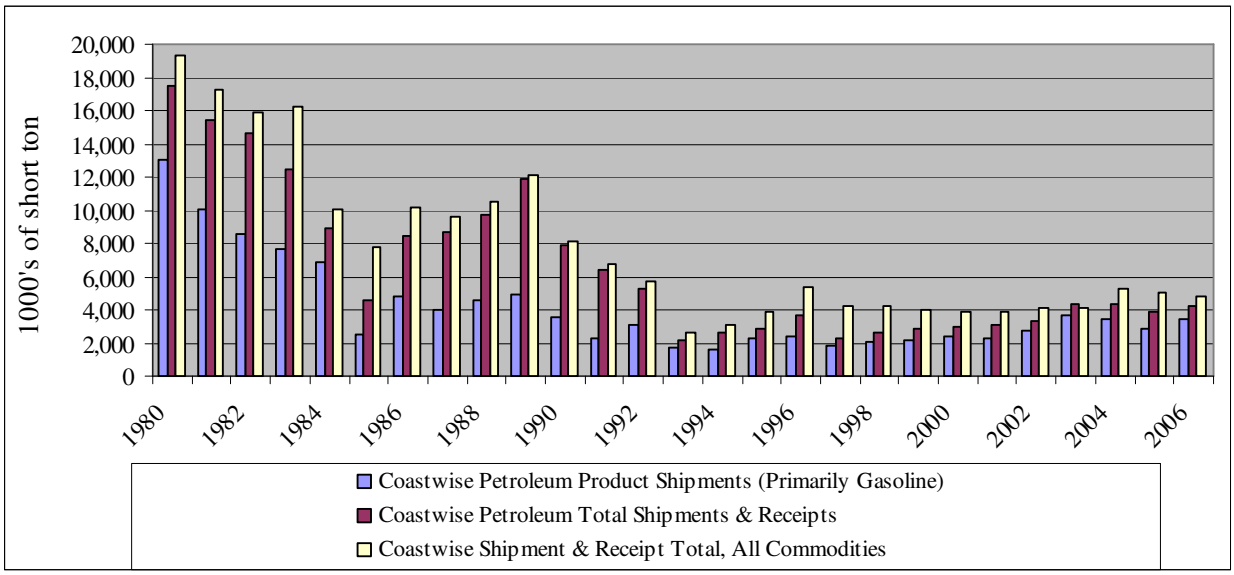
Source: USACE, Waterborne Commerce of the U.S., Part 2, 1990–2007.

Iron ore and rock materials increased dramatically from the early 1990s. Approximately 55 percent of 1999–2007 limestone and rock imports were shipped to Beaumont and the remainder to Port Arthur. SNWW aggregate tonnage primarily consists of imports of limestone, rock, and other raw building materials. For the period 2002–2007, 3.2 percent of U.S. limestone and rock imports were transported through the SNWW ports.

Approximately 62 percent of 1999–2007 iron and steel product imports were transported through Port Arthur and the remainder to Beaumont. While down in 2007, an average of 2.5 percent of 2002–2006 U.S. iron ore and steel slab imports were transported through the SNWW ports. For the period 2002–2007, imports ranged from a low of 240,000 short tons in 2007 and a high of 1.1 million short tons in 2005. SNWW wood and product imports primarily consist of pulp and waste paper, with the waterway importing 14 percent of 2005–2007 U.S. pulp and waste paper products.

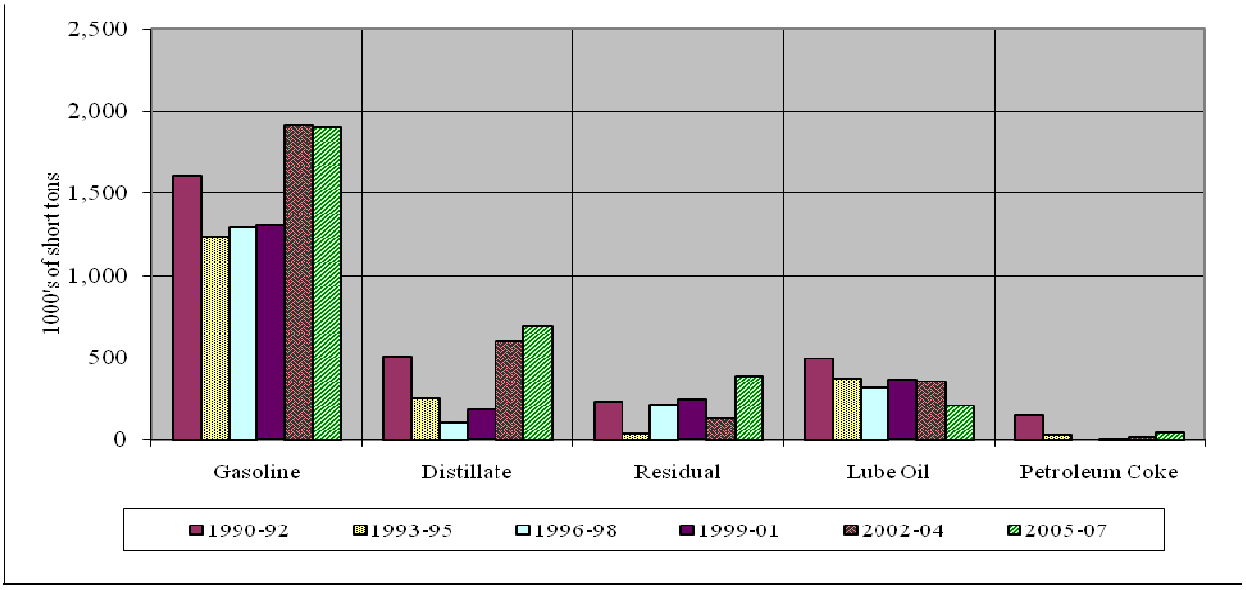
Coastwise tonnage consists almost exclusively of petroleum and chemical commodities. Figure 4 shows SNWW's 1980–2007 coastwise tonnage. The dramatic declines in coastwise product shipments experienced in the 1980s resulted from the transition from domestic production of crude petroleum to imports.

Figure 4
SNWW Coastwise Shipments and Receipts



Since the mid-1999s coastwise tonnage has been relatively steady, with some modest increases in recent years. Petroleum product shipments represented 67 percent of 2005–2007 tonnage, petroleum product receipts 22 percent, and the remaining 11 percent represented chemical shipments. Figure 5 displays SNWW's 1990–2007 coastwise petroleum product shipment averages by major commodity classification.

Figure 5
SNWW Coastwise Shipments and Receipts
by Major Commodity Group



Shipments consist of gasoline, distillate fuel oil, residual fuel oil, lube oil, and petroleum coke. Gasoline and products are shipped to the U.S. East Coast, specifically eastern Florida. Figure 6 displays Beaumont's and Port Arthur's petroleum product port shares for 1999–2007. As noted, 11 percent of SNWW coastwise tonnage consists of chemical shipments. Analysis of total chemical shipments showed that Beaumont shipped 95 percent of 1999–2007 chemical coastwise tonnage and Port Arthur the remaining 5 percent. Liquid sulphur constituted 75 percent of outbound shipments and contributed to a 95 percent increase in SNWW chemical shipments since the early 1990s. All of SNWW sulphur is shipped from Beaumont, with nearly all movements going to Florida. Figure 7 displays Beaumont's and Port Arthur's port shares for 1999–2007 chemical products.

Figure 6
Port Arthur and Beaumont
Outbound Coastwise Gasoline Shipments

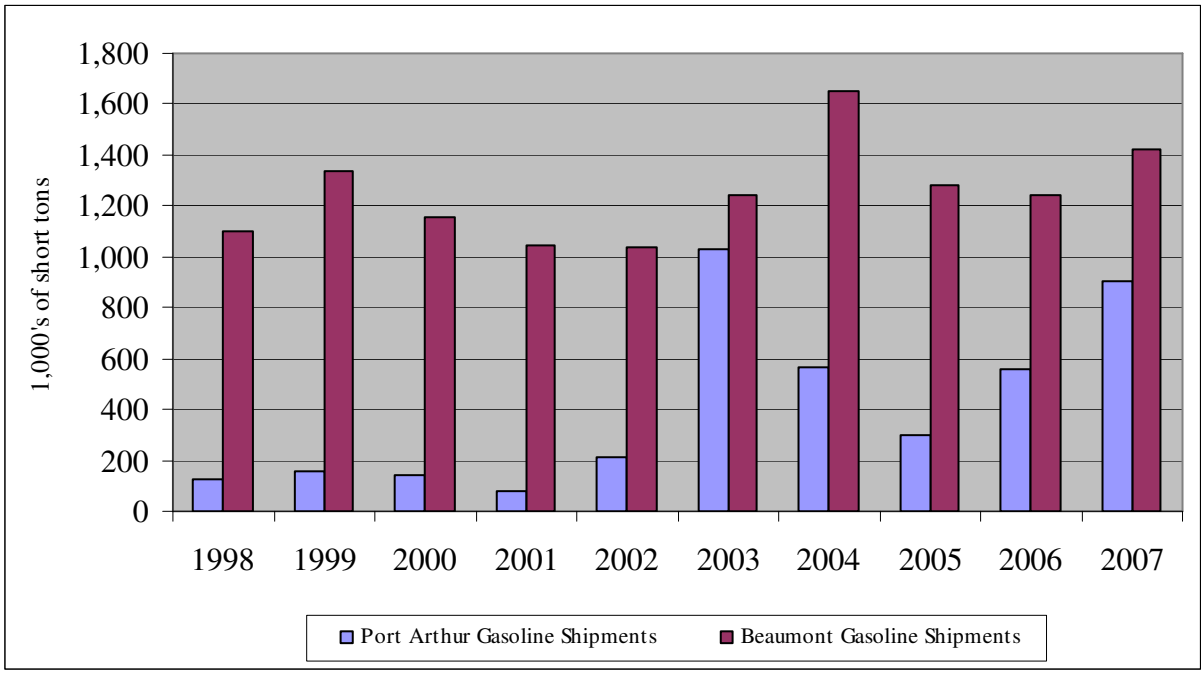
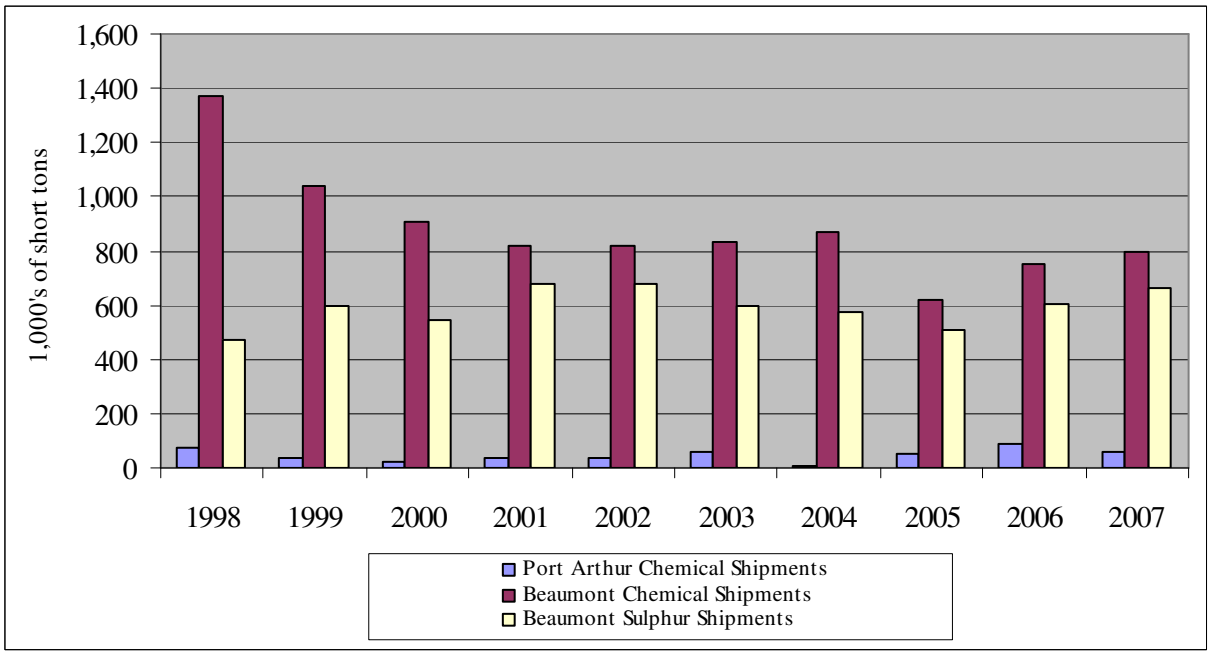


Figure 7
Port Arthur and Beaumont
Outbound Chemical Shipments



2.0 DETAILED COMMODITY ANALYSIS

This section presents detailed analyses of the major commodity groups currently or anticipated to be transported in larger vessels. Data obtained from vessel operators and ongoing analyses of SNWW trends and commodity-specific world and regional fleet data indicated that a portion of these commodities are limited by the constraints of the existing and the without-project future channel dimensions. The analyses address crude petroleum, petroleum products, chemical products, grain, aggregate, and LNG, with crude petroleum representing the most significant group.

2.1 CRUDE PETROLEUM

There are 20 waterfront facilities in Port Arthur and 27 in Beaumont that receive and/or ship crude petroleum or petroleum products. The SNWW refineries supply crude oil to the U.S. Department of Energy's (USDOE) "Big Hill Site" in Texas and the "Hackberry Site" in Louisiana Strategic Petroleum Reserve (SPR). The SNWW is the primary means of delivery for crude oil to four refineries in Beaumont and Port Arthur. Beaumont and Port Arthur each have two oil refineries, and the four refineries serve four terminals on the Neches River. Two of the Neches River terminals are connected by pipelines to the USDOE Strategic Petroleum Reserve underground storage units. The Motiva and Valero refineries are in Port Arthur in the Taylor Bayou basin. Motiva has a vessel terminal in the Taylor Bayou basin and another terminal on the Neches River. The Total Petrochemicals and ExxonMobil refineries are on the Neches River. Additional crude oil terminals located on the Neches River include BASF-Fina, Sun Oil, and Chevron-Phillips. The Neches River crude petroleum tankers accommodate Suezmax tankers.

The SNWW is contained in the U.S. Gulf Coast Petroleum Administration Defense District (PADD III). PADD III includes the states of Texas, Louisiana, Arkansas, Mississippi, Alabama, and New Mexico. SNWW's 2002–2006 crude petroleum waterborne imports composed 12 percent of U.S. and 18 percent of PADD III imports. Table 8 displays SNWW crude petroleum imports and the waterway's share of the national and regional totals for 1990–2007, and Table 9 displays the port-specific shares for 1998–2007.[6] Figure 8 shows the U.S. PADD boundaries. SNWW's crude petroleum imports represent 4 percent of the U.S. total and 7 percent of the U.S. Gulf Coast PADD III region. Figure 9 shows the regional SPR sites served by the SNWW terminals.

[6] Data for the years prior to 1998 are not presented for the individual ports. The Bureau of Census data contained in the *Waterborne Commerce of the United States* does not reflect correct allocation of Port Arthur and Beaumont traffic between the ports. Some of Beaumont's traffic was recorded under Port Arthur due to a Bureau of Census error. Total tonnage values were found to be correct for the SNWW, but the individual counts for years prior to 1999 were found to be unreliable.

SNWW's capacity represents six percent of the U.S. total. Specific capacity is 572,000 BPD for Port Arthur and 577,000 BPD for Beaumont. SNWW capacity levels for 2009 are presently 12 percent higher than in 2004 and 31 percent higher than in 1994. The Motiva expansion is presently under construction and will increase the refinery's crude oil throughput capacity to approximately 600,000 BPD, making it the largest refinery in the U.S. and one of the largest in the world. The ExxonMobil Beaumont refinery is presently the third largest refinery in the world. As a result of these additions, SNWW's combined capacity will represent the largest concentration in the State of Texas.

Table 8
Comparison of SNWW and Regional and National Totals
Crude Petroleum Imports (1000s of short tons)

Year	SNWW Imports	PADD III Imports	U.S. Total Imports
1990	20,348	178,052	322,433
1991	19,245	174,852	316,310
1992	23,613	184,871	333,666
1993	32,639	204,356	371,267
1994	37,226	221,020	386,381
1995	38,743	222,164	395,484
1996	40,930	237,708	411,824
1997	51,142	252,270	449,961
1998	53,877	267,175	476,231
1999	53,834	270,491	477,592
2000	67,187	281,170	497,547
2001	64,226	292,859	510,298
2002	66,383	282,226	499,999
2003	70,158	300,325	528,703
2004	69,875	316,402	553,337
2005	59,691	310,493	553,923
2006	57,615	309,399	553,489
2007	56,078	305,732	548,742
1990/1992 Average	21,069	179,258	324,136
2005/2007 Average	57,795	308,541	552,051
1990/1992 to 2005/2007 Compound Annual Growth (AAG) Rates			
	7.0%	3.7%	3.6%

Source: USACE and EIA, 1990–2007.

Table 9
Beaumont and Port Arthur Crude Petroleum Imports
(1,000s of Sort Tons)

Year	Beaumont	% of SNWW Total	Port Arthur	% of SNWW Total	SNWW Total	PADD III Total	SNWW % of PADD	U.S. Total	SNWW % of U.S.
1998	44,179	86.0	8,620	14.0	53,877	267,175	20.2	476,231	11.3
1999	45,857	85.2	7,977	14.8	53,834	270,491	19.9	477,592	11.3
2000	58,325	86.8	8,862	13.2	67,187	281,170	23.9	497,547	13.5
2001	53,162	82.8	11,064	17.2	64,226	292,859	21.9	510,298	12.6
2002	57,370	86.4	9,013	13.6	66,383	282,226	23.5	499,999	13.3
2003	58,171	82.9	11,987	17.1	70,158	300,325	23.4	528,703	13.3
2004	59,860	85.7	10,015	14.3	69,875	316,402	22.1	553,337	12.6
2005	50,371	84.4	9,320	15.6	59,691	310,493	19.2	553,923	10.8
2006	46,989	81.6	10,627	18.4	57,616	309,399	18.6	553,489	10.4
2007	45,766	81.6	10,312	18.4	56,078	305,732	18.3	548,742	10.2

Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1998–2007.

Figure 8
U.S. Petroleum Administration Defense Districts

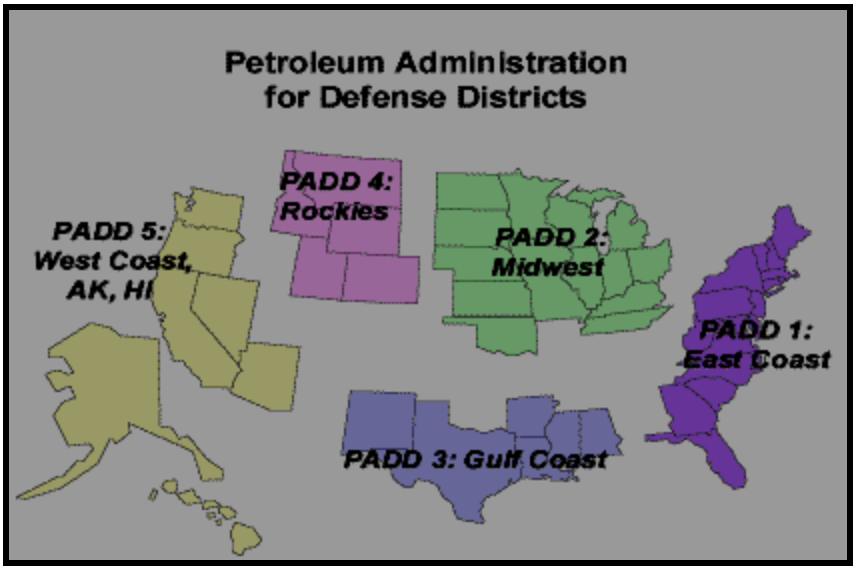


Figure 9
U.S. Strategic Petroleum Reserves Gulf Coast Sites

The amount of crude petroleum imported into the SNWW is largely dependent upon the area's capacity to refine crude and/or deliver pipeline by to other refining complexes. Table 10 displays regional crude petroleum refinery capacity data. In addition to supplying oil to two the USDOE SPR sites, the SNWW system delivers crude to refineries in Texas, Louisiana, Oklahoma, Ohio, Arkansas, and Kentucky. Examination of the refinery capacity data presented in Table 10 shows that the SNWW's 2002–2007 crude petroleum import volumes do not exceed crude petroleum refining capacity. Recent refinery expansions and anticipated new refinery construction prior to 2020 indicates that added capacity will be sufficient to meet anticipate crude petroleum import volumes.

Table 10
SNWW Atmospheric Crude Oil Distillation Capacity
(1,000s of Barrels Per Calendar Day)

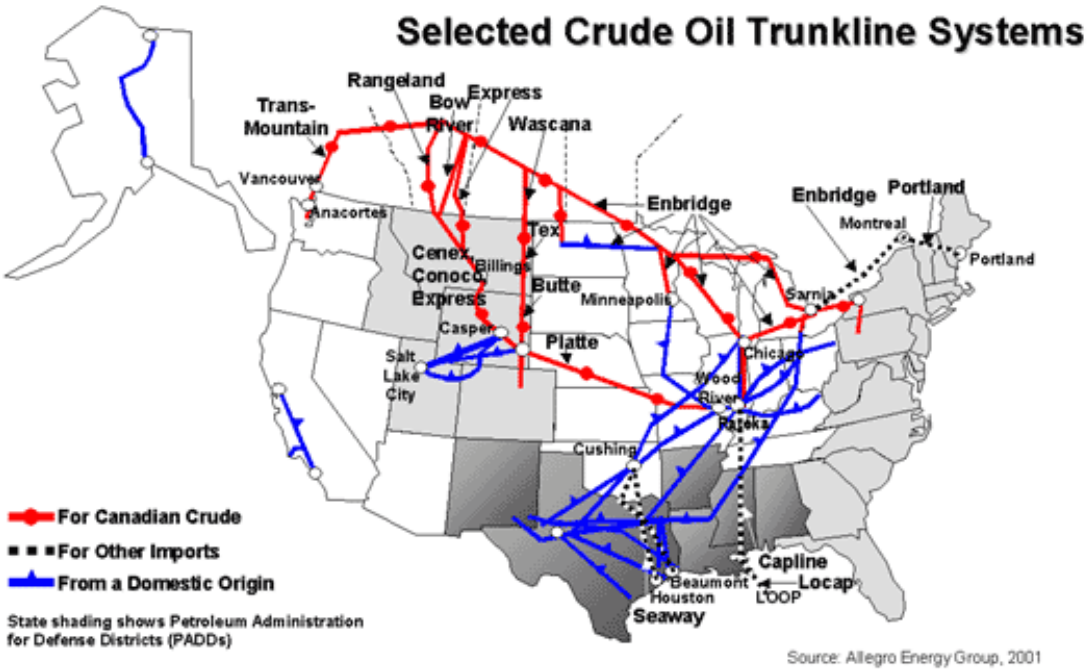
Period	Beaumont	Port Arthur	Percent of Texas	Percent of U.S.	U.S. Total
1994	420.5	454.0	19.6	5.8	15,034
1999	438.5	513.5	22.7	5.9	16,261
2000	450.0	523.0	23.0	5.9	16,512
2001	500.0	521.0	23.8	6.2	16,595
2002	500.0	527.0	22.9	6.1	16,785
2003	510.0	523.6	23.8	6.1	16,757
2004	505.0	523.6	22.9	6.1	16,974
2005	540.0	582.0	24.2	6.5	17,196
2006	545.0	580.5	24.0	6.5	17,383
2007	545.0	590.5	24.0	6.5	17,436
2008	574.0	576.5	24.0	6.5	17,436
2009	572.0	576.5	24.0	6.5	17,436

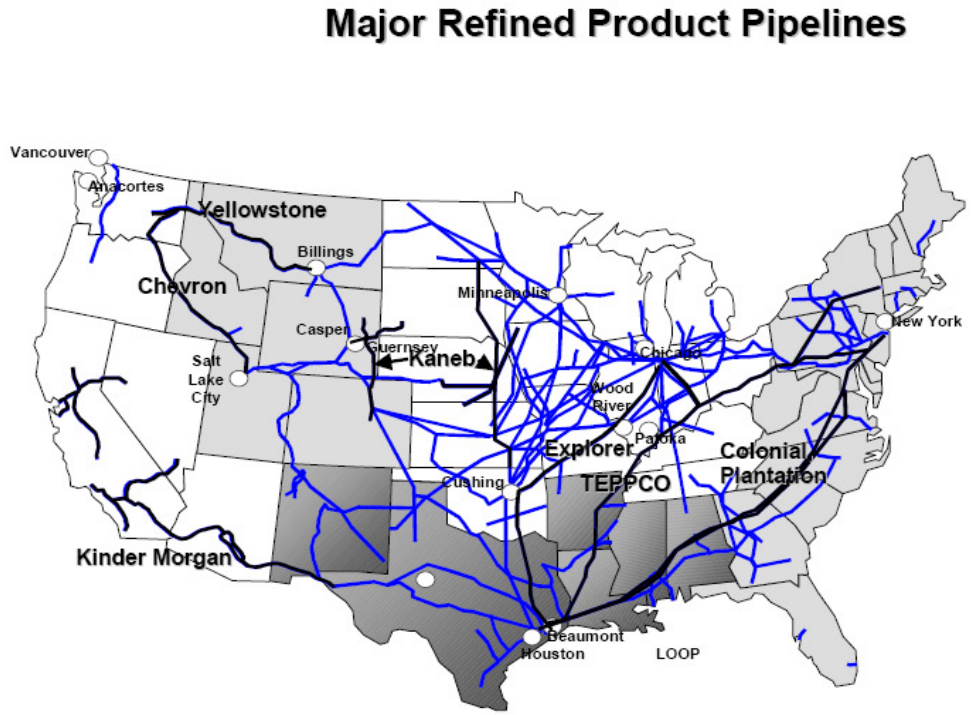
Source: U.S. Department of Energy (USDOE), EIA, 1994–2009.
* Variations occur in annual volumes due to temporary shutdowns and routine maintenance.

The Port Arthur and Beaumont terminals transport 400,000 barrels per day of waterborne crude oil via pipelines to inland refineries including refineries in Texas, Louisiana, Oklahoma, Ohio, Arkansas, and Kentucky.[7] Colonial Product Pipeline delivers over 2 million BPD of refined products via pipeline serving Louisiana, Alabama, Mississippi, Georgia, Tennessee, South Carolina, North Carolina, Virginia, Maryland, Delaware, and New Jersey. Explorer Product Pipeline delivers 650,000 BPD of refined products via pipeline serving Texas, Oklahoma, Missouri, Illinois, and Indiana. Products, such as gasoline, heating oil, diesel, and jet fuel, are transported from the Gulf Coast to the East Coast and the Midwest through existing pipeline networks. Product traffic also moves between U.S. ports by coastwise tankers and inland waterway barges. The SNWW refineries supply 15 percent of the product on Colonial's system and 13 percent of the product on Explorer's system. The pipeline maps shown on Figure 10 illustrate the distribution that includes the SNWW ports.

[7] Martin Associates. 2006. Economic Impacts of the Sabine-Neches Waterway and Economic benefits of Maintenance Dredging of the Waterway. Martin Associates, Lancaster, Pennsylvania.

Figure 10
Major U.S. Crude Petroleum and Product Pipelines





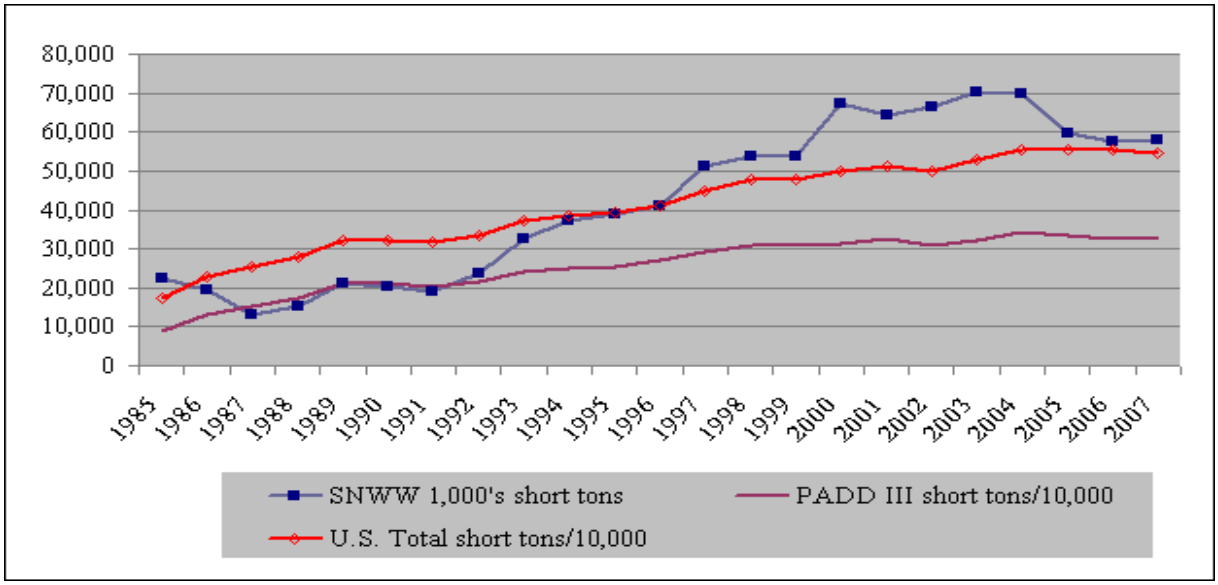
Source: Allegro Energy Group: How Pipelines Make the Oil Market Work, Their Networks, Operations, and Regulation, A Memorandum Prepared for the Association of Oil Pipelines and the American Petroleum Institute's Committee, December 2001.

Since the 1970s, overall SNWW and U.S. crude petroleum import volumes rose as U.S. crude production fell and was replaced by foreign imports of crude. The U.S. Gulf Coast leads the Nation in refinery capacity, with 41 percent of the Nation's crude oil distillation capacity, and one-half of the Gulf Coast refinery capacity is in Texas and the remainder is in Louisiana. The Gulf Coast is also the Nation's leading supplier in refined products. Figure 11 displays SNWW's 1985–2007 crude petroleum imports and SNWW's share of the national and regional totals. Although SNWW tonnage exhibits more variance than the region and the Nation, long-term expectations are that SNWW imports will grow at rates comparable to or higher than regional and national trends. These expectations are based on analysis of long-term historical trends and the study area's established infrastructure of regional and national pipeline distribution links. Declines in 2005–2007 imports are largely attributable to supply disruptions associated with Hurricane Rita, which devastated the SNWW region in September 2005.[8] The hurricane surge resulting from Rita resulted in sand bars at the offshore Entrance Channel and silting of the Neches River Channel to Beaumont. Silting of the Neches River Channel severely limited transit of the upper reaches for several months and resulted in tonnage diversions to other ports due to loaded-draft limitations. Aside from pipeline movements and events such as hurricanes, analysis of SNWW's crude petroleum and product tonnages and discussions with industry revealed that the effect of planned maintenance contributes to annual variances. U.S. imports declined marginally in 2006–2007.

While SNWW's 2005–2007 import volumes are down, Figure 11 shows that SNWW imports from 1992 through 2004 grew at higher rates than the region or the Nation. In comparison to other Texas Gulf Coast ports, SNWW 2000–2004 crude petroleum imports volumes exceeded other ports by nearly 35 percent. Additionally, recent increases in SNWW refinery capacity indicate the region will regain an increasing share of U.S. and PADD III totals. As noted, the Motiva expansion is presently under construction and will increase the refinery's crude oil throughput capacity to approximately 600,000 BPD, making it the largest refinery in the U.S. and one of the largest in the world, and the ExxonMobil Beaumont refinery is presently the third largest refinery in the world. The effect of Motiva expansion will result in SNWW's capacity representing the largest concentration in the State of Texas.

[8] Personal communication, ExxonMobil, Beaumont Office.

Figure 11
U.S. and Sabine-Neches Crude Oil Imports, 1985–2007



2.2 PETROLEUM PRODUCT IMPORTS

Table 11 presents SNWW and the U.S. 1990–2007 petroleum product imports. SNWW imports consist primarily of gasoline, distillate fuel oil, residual fuel oil, and naphtha. Figure 12 displays a comparison of the SNWW and U.S. trendlines. Comparison of the SNWW and U.S. totals indicates a strong level of correlation between the study area and the Nation; however, product types show significant variability. Variability in product volumes is noted to be a function of the demand and the supply of the relative types of crude oil supplied. The SNWW refineries have the capability to refine both high-sulfur and low-sulfur crude oil. The EIA notes that the average sulfur content of U.S. crude oil imports increased from 0.9 percent in 1985 to 1.4 percent in 2005. Future expectations are for increasing volumes of high-sulfur crude. Import of a range of crude oil types and spot-market sales result in dynamic market conditions and annual fluctuation in the product imports. For SNWW, high variability is noted for SNWW naphtha and distillate fuel oil. Naphtha is produced as an intermediate project from the distillation of crude oil and is primarily used as feedstock for producing high-octane gasoline. It is also used by the chemical industry for producing olefins in steam crackers. Distillate fuel oil is also a by-product of the refining process, but like naphtha, it is also imported. Variability is also reflected in the distribution of the U.S. products types, which is also characterized by annual fluctuations prompted by conditions where outputs fall short or are preempted by other market drivers.

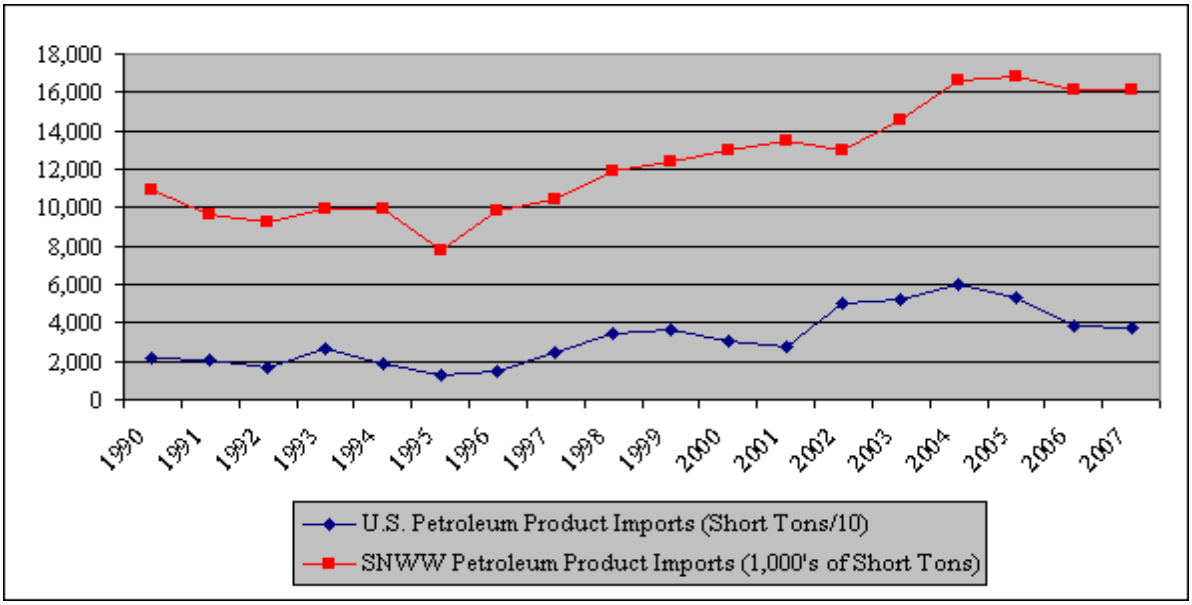
Table 11
SNWW and U.S. Petroleum Product Imports by Commodity Classification
1,000s of Short Tons

	SNWW Petroleum Product Imports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	–	–	–		–	–	37	32	62	551	1,613	1,800	1,678	1,096
Distillate Fuel Oil	74	12	126	210	102	230	1,047	572	566	1,337	2,008	1,728	1,268	1,872
Residual Fuel Oil	1,035	72	137	115	57	49	319	25	541	56	728	804	351	355
Lube Oil	8	690	597	1,262	2,140	2,009	52	700	1,039	1,301	619	50	71	2
Naphtha	813	155	267	450	808	900	1,326	1,138	2,074	1,650	780	595	367	139
Petroleum Coke	12	241	185	245	250	308	270	266	746	290	256	365	84	276
Other	254	134	160	188	134	70	–	1	–	2	–	7	–	4
SNWW Total Imports	2,196	1,304	1,472	2,470	3,491	3,626	3,051	2,734	5,028	5,187	6,003	5,349	3,819	3,744
% of U.S. Total	2.0	1.7	1.5	2.4	2.9	2.9	2.3	2.0	3.9	3.6	3.6	3.3	2.4	2.3

	U.S. Petroleum Product Imports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	18,054	10,789	19,561	19,374	17,381	18,404	24,157	27,732	29,282	32,294	50,746	63,022	64,261	58,574
Distillate Fuel Oil	13,644	12,915	16,155	16,619	13,592	15,278	21,111	20,589	19,936	29,115	53,876	52,679	53,670	55,627
Residual Fuel Oil	41,502	25,914	28,121	29,198	23,291	25,781	40,361	40,891	35,411	31,330	13,955	13,757	9,723	10,771
Lube Oil	12,533	9,558	8,869	11,144	35,327	35,229	9,040	10,353	8,606	10,653	10,148	515	666	383
Naphtha	13,277	9,916	14,085	13,825	12,736	10,901	17,844	15,718	16,227	17,405	7,994	8,634	7,109	7,146
Petroleum Coke	297	1,930	2,651	4,020	4,163	4,244	2,926	3,180	7,354	4,608	5,170	5,262	4,950	3,961
Liquid Natural Gas	5,321	3,027	4,292	4,303	5,306	6,312	6,694	8,364	7,671	15,556	22,192	16,566	18,618	21,238
Other	4,842	4,117	670	707	6,870	7,900	7,899	7,480	5,483	4,831	2,169	2,044	2,413	3,460
Total	107,470	78,166	98,316	104,167	118,666	124,049	130,032	134,307	129.970	145,792	166,250	162,479	161,410	161,160

Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Figure 12
SNWW and U.S. Total Petroleum Product Imports
1990–2007

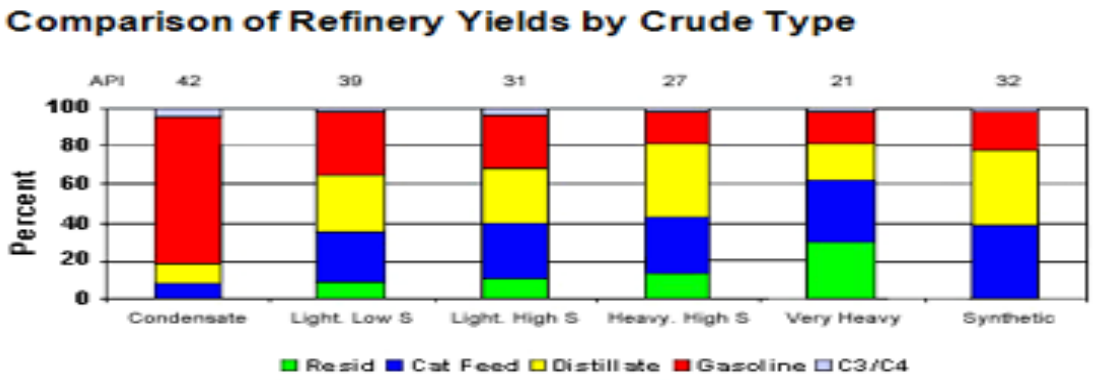


Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Figure 13 displays the product yield for six typical types of crude oil. The figure shows both light and heavy crudes as well as sweet and sour crude oils and the associated American Petroleum Institute (API) gravity. The chart provides a comparison of the different output when each crude type is processed in a simple distillation refinery. The chart includes five main product groups: gasoline; propane and butane (C3/C4); Cat feed (a partially processed material that requires further refining to make usable products); distillate (which includes diesel oil and furnace oil); and residual fuel (the heaviest and lowest-valued part of the product output, used to make heavy fuel oil and asphalt).

Table 12 displays Port Arthur and Beaumont petroleum products by major commodity group. Distillate fuel oil represents 50 percent of Port Arthur's 2005–2007 imports, up by approximately 250 percent from the early 2000s. Residual fuel presently represents 23 percent of Port Arthur's product total, with overall imports increasing but to a smaller degree than distillate. The remainder of 2005–2007 imports consists of naphtha (4 percent), gasoline (7 percent), and petroleum coke (10 percent). Port Arthur's product imports dropped in 2006 and again in 2007. These downturns are partially attributable to hurricane-induced channel damages and refinery expansion.

Figure 13



Source: Natural Resources Canada, "Refinery Economics," January 1, 2009.

Table 12
Petroleum Product Imports by Port and Commodity Classification

	Port Arthur Petroleum Product Imports (1,000s of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	0	0	0	17	0	28	91	181	101	36
Distillate Fuel Oil	9	1	522	177	127	643	1,096	1,019	658	414
Residual Fuel Oil	57	0	97	25	340	0	659	631	300	24
Lube Oil	56	0	0	49	168	52	0	0	0	2
Naphtha	337	216	232	106	37	140	90	109	0	0
Petroleum Coke	250	308	270	266	325	290	214	265	84	40
Other	18	78	0	0	0	0	0	0	1	0
Port Arthur Imports	727	603	1,121	640	997	1,153	2,150	2,205	1,144	792
% of U.S. Total	0.6	0.5	0.9	0.5	0.8	0.8	1.3	1.4	0.7	0.5
	Beaumont Petroleum Product Imports (1,000s of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	0	0	37	15	62	525	1,520	1,619	1,577	1,060
Distillate Fuel Oil	93	229	526	395	439	694	912	709	610	1,458
Residual Fuel Oil	0	49	222	0	201	56	69	173	51	331
Lube Oil	2,084	2,009	52	651	871	1,250	619	50	71	0
Naphtha	470	684	1,094	1,032	2,037	1,510	690	486	367	99
Petroleum Coke	0	0	0	0	421	0	42	100	0	0
Other	118	52	0	0	0	0	0	7	0	4
Beaumont Imports	2,765	3,023	1,931	2,093	4,031	4,035	3,852	3,144	2,676	2,630
% of U.S. Total	2.3	2.4	1.5	1.6	3.1	2.8	2.3	1.9	1.7	1.8

Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1998–2007.

Beaumont's product imports are dominated by gasoline. Gasoline represents 43 percent of Beaumont's 2005–2007 total product import total. Imports totaled nearly 1.1 million short tons in 2007, up from zero in the late 1990s. Beaumont's remaining imports consisted primarily of distillate fuel oil and naphtha. Beaumont's other imports consist of lube oil, residual, and naphtha, with annual volumes exhibiting relatively high degrees of variation.

2.3 PETROLEUM PRODUCT EXPORTS

Table 13 displays SNWW 1990–2007 petroleum product exports. SNWW petroleum product exports primarily consist of petroleum coke, gasoline, and distillate fuel oil. Overall exports increased since the 1990s at a generally steady rate, with exports exceeding 6 million short tons since 2003. Petroleum coke exports dominate total exports and represented 63 percent of 2005–2007 and 14.1 percent of U.S. total petroleum coke exports. Gasoline represented 11 percent of the SNWW total and 16.7 percent of U.S. gasoline exports. Distillate fuel oil represented 5 percent of SNWW total exports and 1.6 percent of U.S. distillate exports. The remaining 21 percent of SNWW exports consisted of lube oil, naphtha, residual fuel oil, and general products. Analysis of the SNWW and national totals indicated a strong level of correlation between the study area and the Nation, with regional growth generally exhibiting higher annual growth rates. Figure 14 provides a comparison of the SNWW and U.S. trendlines, and Figure 15 provides a comparison of regional and national petroleum coke exports.

Table 14 presents Port Arthur and Beaumont product exports by major commodity group. Port Arthur's product imports averaged 4.1 million short tons in 2005–2007. Petroleum coke represented 81 percent of Port Arthur's 2005–2007 exports, with its 2007 share nearly 90 percent. Gasoline represented 11 percent of Port Arthur's 2005–2007 product exports, and distillate 7 percent. The remaining 9 percent consisted of relatively small amounts of lube oil, naphtha, residual fuel oil, and general products. Port Arthur's relative shares of gasoline and distillate fuel oil exports increased over the last 8 years. Port Arthur's 2005–2007 petroleum coke export volumes represented 11 percent of the U.S. petroleum coke total. Overall demand for petroleum coke has been noted to be increasing due to growing use of heavy crude oil. It was noted that the cumulative effect of increasing product demand, tightening crude oil supplies, heavier and coarser crude oil, and constrained refinery capacity has contributed to the need for additional coking capacity.[9]

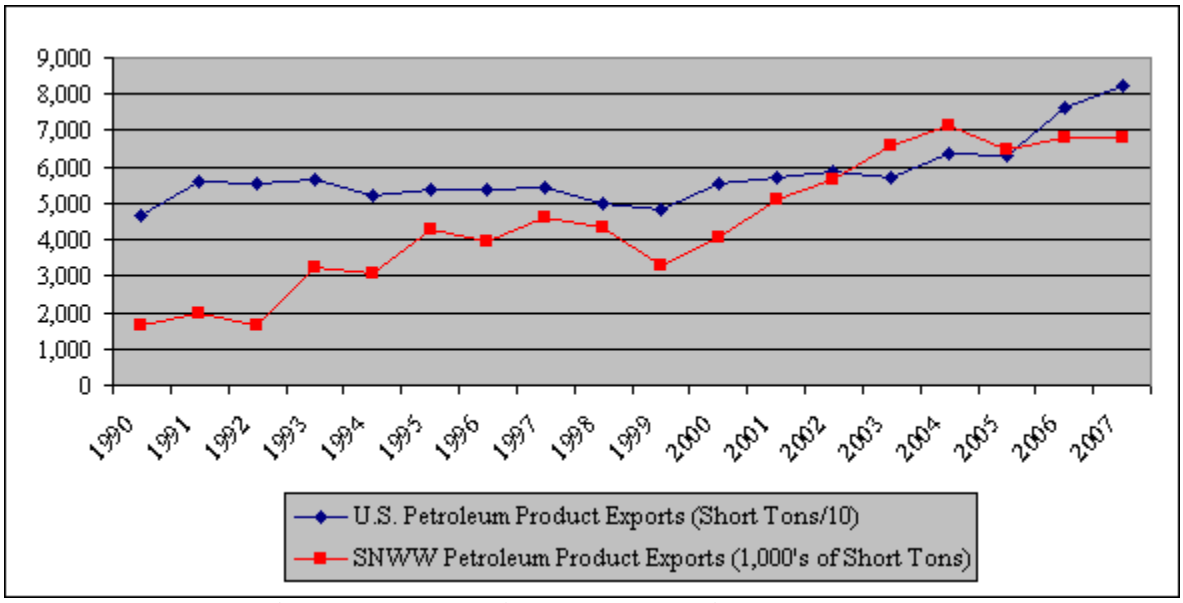
[9] Barnes and Clark, "Refining Perspectives," November 2005.

Table 13
SNWW and U.S. Total Petroleum Product Exports by Commodity Classification
1,000s of Short Tons

	SNWW Petroleum Product Exports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	39	518	676	1,412	1,376	826	1,474	1,258	1,344	1,578	1,950	1,755	1,777	1,970
Distillate Fuel Oil	192	8	263	604	620	333	9	179	228	401	449	546	371	345
Residual Fuel Oil	417	160	228	136	206	125	42	9	17	-	-	-	68	-
Lube Oil	113	46	76	24	41	20	115	55	37	70	39	33	117	99
Naphtha	29	23	23	-	-	23	0	46	14	14	8	39	94	58
Petroleum Coke	724	3,435	2,578	2,185	1,622	1,473	2,235	3,447	3,777	4,426	4,689	3,903	4,362	4,210
Other	121	68	85	234	464	507	168	128	219	84	17	78	34	215
SNWW Total Exports	1,635	4,258	3,929	4,258	4,329	3,307	4043	5,122	218	6,573	7,152	6,354	6,823	6,607
SNWW % of U.S.	3.5	7.9	7.3	8.4	8.7	6.9	7.3	9.0	9.6	11.5	11.2	10.1	8.9	8.9
	U.S. Petroleum Product Exports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	2,405	3,849	4,265	5,786	4,828	4,140	6,434	6,906	6,726	6,630	11,053	9,564	10,661	12,704
Kerosene	2,408	1,307	2,338	1,642	893	994	1,497	1,078	1,075	767	55	615	546	434
Distillate Fuel Oil	5,349	6,625	6,227	5,879	4,591	4,148	4,953	4,982	5,861	7,046	16,202	15,642	26,249	27,068
Residual Fuel Oil	13,191	10,141	9,062	8,519	9,282	10,030	12,693	14,032	12,129	9,420	1,269	3,501	2,538	5,426
Lube Oil	2,555	1,803	2,028	1,662	1,410	1,583	1,595	1,191	1,302	1,240	263	287	829	881
Naphtha	2,079	3,712	3,636	3,473	3,877	4,263	1,896	2,598	2,180	2,146	1,577	2,426	2,285	2,683
Asphalt, Tar and Pitch	1,232	3,364	3,565	3,960	3,340	2,693	58	32	81	365	291	279	474	555
Petroleum Coke	15,798	20,199	20,581	21,239	19,298	17,926	23,508	23,859	26,520	26,904	30,588	28,676	30,202	30,290
Liquid Natural Gas	1,421	2,257	2,172	2,170	2,144	2,197	2,842	2,150	2,757	2,327	2,251	1,889	2,441	2,104
Other	515	684	119	115	77	78	157	120	90	106	115	80	113	172
U.S. Total Exports	46,953	53,941	53,993	54,445	49,740	48,052	55,633	56,948	58,721	56,951	63,664	62,959	76,338	82,317

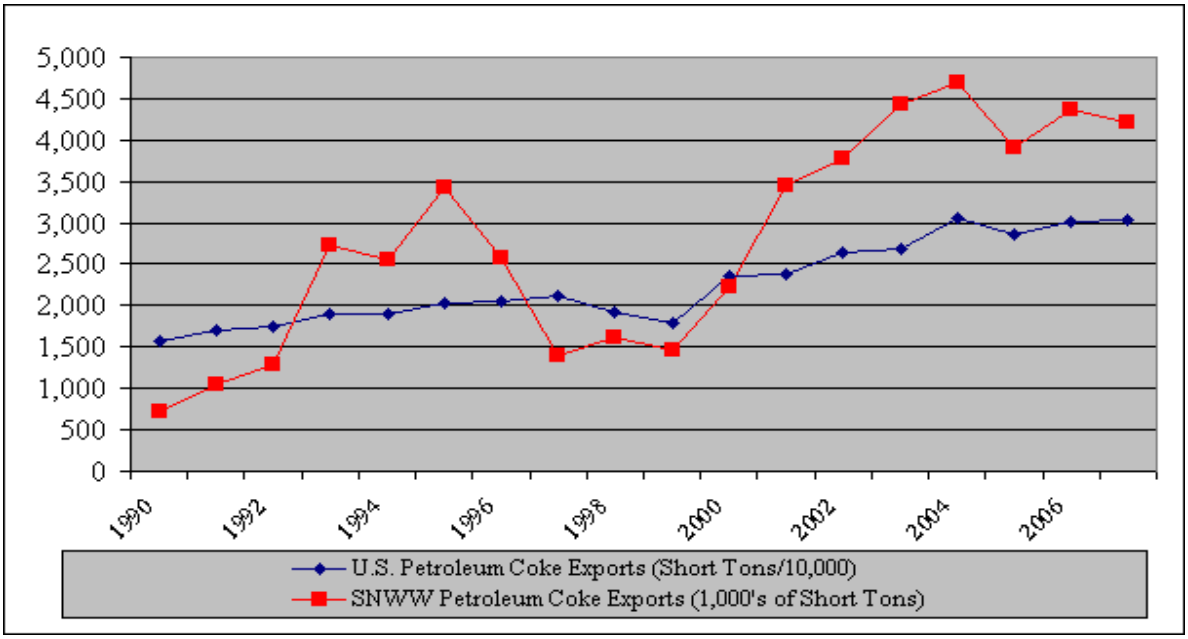
Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Figure 14
U.S. and SNWW Total Petroleum Product Exports
1990–2007



Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Figure 15
U.S. and SNWW Total Petroleum Coke Exports
1990–2007



Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Table 14
Petroleum Product Exports by Port and Commodity Classification

	Port Arthur Petroleum Product Exports (1,000 of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	105	2	123	51	0	158	290	558	492	324
Distillate Fuel Oil	82	66	0	96	213	238	389	444	262	117
Residual Fuel Oil	131	–	–	–	–	–	–	–	–	–
Naphtha	–	23	0	46	14	14	8	39	58	–
Petroleum Coke	1,112	1,038	1,274	2,125	2,754	3,319	3,550	2,812	3,545	3,530
Other	55	6	105	11	162	5	18	5	35	6
Port Arthur Exports	1,485	1,135	1,502	2,329	3,143	3,734	4,255	3,858	4,392	3,977
% of U.S. Exports	3.0	2.4	2.7	4.1	5.4	6.6	6.7	6.1	5.8	4.8
	Beaumont Petroleum Product Exports (1,000s of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	1,271	824	1,351	1,207	1,344	1,420	1,660	1,197	1,286	1,704
Distillate Fuel Oil	538	267	9	83	15	163	60	102	109	169
Residual Fuel Oil	75	125	42	9	17	–	–	–	51	22
Lube Oil	31	20	115	55	37	70	39	33	99	55
Petroleum Coke	510	435	961	1,322	1,023	1,107	1,139	1,091	817	679
Other	418	498	63	117	55	78	–	73	70	84
Beaumont Exports	2,843	2,169	2,541	2,793	2,491	2,838	2,898	2,496	2,432	2,713
% of U.S. Exports	5.7	4.5	4.6	4.9	4.2	5.0	4.6	4.0	3.2	3.2

Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1998–2007.

Large volumes of excess petroleum coke, specifically calcined coke, have historically been exported from Port Arthur existing facilities. Calcined coke is used in production of plastics, as feedstock for continuous particle thermal desulfurization, and for special low-sulfur carbon raiser in steel production.[10] Seven countries received more than 59 percent of U.S. coke exports in 2002. The major importer is Japan, which imports nearly 100 percent green coke and a trace of premium coke. The seven top importing countries use the green fuel-grade coke in their processing industries and as boiler fuel.[11] As indicated, world light sweet crude oil supplies are declining, and the refining of heavy oils is becoming a necessity. The refining of these heavy oils dramatically increases the amounts of petroleum waste product that are produced

The Port Arthur coker is used to convert heavy oil at the refinery directly to light products, in a process more typical of the refining process for conventional oils. Chief among methods of conversion is thermal coking, in which heavy oil from a vacuum distillation unit is fed to a heating unit (coker) that splits off lighter hydrocarbon chains and routes them to the traditional refinery units. The almost pure carbon remaining is a coal-like substance known as petroleum coke. The accumulated coke can be removed from

[10] Ellis, Paul J. and Christopher A. Paul, "Tutorial: Delayed Coking Fundamentals," Great Lakes Carbon Corporation, Port Arthur, Texas, March 8, 1998.

[11] *Petroleum Coke*, Pacific Mountain Energy Center I-1, September 12, 2006.

the coking vessels during an off cycle and either sold, primarily as a fuel for electricity generation, or used in gasification units to provide power, steam, and/or hydrogen for the refinery. Plans for a new 45,000 BPD "delayed coker" in Port Arthur were announced in February 2008, with construction anticipated to be complete by 2011.[12] Delayed cokers are used to convert residual oils into gasoline and diesel oil. Delayed coker feed originates from the crude oil, and the effect of new construction will be used to produce residual fuel and other products.

Beaumont product exports consist primarily of gasoline and also petroleum coke, with Beaumont gasoline exports representing 13 percent of U.S. total gasoline exports. Beaumont petroleum coke exports represented 3 percent of the U.S. total petroleum coke exports. Beaumont product exports remained relatively steady from 1998 through 2007, with growth exhibited for both gasoline and petroleum coke. Gasoline represented over 55 percent of 2005–2007 Beaumont product exports and petroleum coke approximately 34 percent. The remaining 11 percent of product exports consisted of distillate fuel oil, lube oil, residual fuel oil, and general products.

2.4 CHEMICAL PRODUCT IMPORTS

Table 15 displays 1990–2007 commodity-specific import totals for the SNWW. Distribution of Port Arthur's and Beaumont's 1999–2006 chemical imports by major commodity group is shown in Table 16. Examination of Port Arthur's and Beaumont's 1999–2006 chemical product shares showed that while Port Arthur's imports increased, overall tonnage remains relatively low in comparison to Beaumont's. Beaumont's 2005–2007 chemical imports averaged nearly 1 million. Increase in Beaumont's tonnage is primarily attributable to alcohols (methanol or methyl alcohol) and ammonia. For 2005–2007, imports of these two groups averaged 822,000 short tons and represented 83 percent of Beaumont chemical imports. Beaumont imported 16 percent of U.S. alcohol and 6 percent of U.S. ammonia.

[12] *Port Arthur News*, "Valero Expansion Expands Community Opportunities," February 29, 2008.

Table 15
SNWW and U.S. Chemical Imports by Commodity Classification

	SNWW Chemical Product Imports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Acyclic and Other Hydrocarbons	1	26	8	2	0	7	27	16	11	8	6	3	–	4
Benzene and Toluene	4	–	30	4	2	–	20	52	37	26	58	7	98	84
Alcohols (Methyl Alcohol)	22	–	–	6	20	199	189	195	169	74	22	477	460	374
Sulphuric Acid	–	–	–	–	0	6	158	0	100	71	131	124	147	6
Ammonia	–	–	–	21	100	234	174	361	221	173	401	469	425	684
Inorganic Elements	–	–	–	–	0	–	–	2	–	–	–	–	–	–
Chemical Products	–	–	–	–	0	–	45	–	129	74	17	4	–	–
Other	7	7	10	–	25	3	6	128	16	8	21	–	3	43
SNWW Import Total	34	33	48	33	147	449	619	754	683	434	656	1,084	1,133	955
% of U.S. Total	0.2	0.1	0.2	0.1	0.5	1.6	1.6	1.7	1.7	1.0	1.5	2.4	2.6	2.0
	U.S. Chemical Product Imports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Acyclic and Other Hydrocarbons	337	434	328	431	440	489	695	571	465	1,112	882	639	927	1,428
Benzene and Toluene	278	311	563	292	513	584	1,603	1,260	1,224	1,378	1,883	1,874	2,473	2,443
Alcohols (Methyl Alcohol)	1,718	2,745	3,398	3,587	3,806	4,626	5,794	7,091	6,950	6,236	7,218	8,348	10,653	8,882
Sulphuric Acid	800	502	835	799	841	799	1,155	1,220	1,008	601	773	563	474	187
Ammonia	2,495	3,803	3,499	3,381	3,517	3,811	4,284	5,974	5,396	6,630	6,809	7,433	7,083	7,569
Inorganic Elements	435	869	664	766	838	1,051	2,153	1,305	3,046	2,288	2,981	2,134	2,625	1,404
Chemical Products	225	368	323	387	402	444	1,458	1,359	2,012	2,364	1,756	866	1,084	1,451
Plastics	1,120	1,332	1,411	1,694	1,776	2,074	2,227	2,034	2,282	2,626	2,954	3,646	3,850	3,224
Organic Compounds	351	3,315	3,640	4,049	4,733	4,742	4,882	4,965	4,300	3,053	2,438	1,858	1,087	487
Agricultural Chemicals	7,165	9,252	8,682	8,014	8,953	8,490	12,405	17,494	11,826	15,538	14,707	17,469	15,588	18,238
Other	1,017	1,138	1,254	1,654	1,624	1,031	1,821	560	1,063	184	1,409	687	2,169	1,568
U.S. Import Total	15,943	24,069	24,597	25,054	27,443	28,141	38,477	43,833	39,572	42,010	43,810	45,517	48,013	46,881

Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Table 16
Chemical Product Imports by Port and Commodity Classification

	Port Arthur Chemical Imports (1,000s of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Acrylic and Other Hydrocarbons	2	3	–	3	7	–	–	–	0	4
Benzene and Toluene	–	–	–	22	4	–	–	–	27	73
Alcohols	13	–	–	–	–	8	–	37	–	–
Sulphuric Acid	–	–	–	–	34	31	73	12	–	–
Ammonia	6	–	–	–	38	21	152	146	35	18
Chemical Products		–	–	–	5	–	–	–	–	–
Other	23	2	–	–	1	–	–	–	49	2
Port Arthur Imports	44	5	–	25	89	60	225	195	111	97
	Beaumont Chemical Imports (1,000s of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Acrylic and Other Hydrocarbons	–	4	27	13	4	8	6	3	–	4
Benzene and Toluene	–	–	20	30	33	26	58	7	98	84
Alcohols	7	199	189	195	169	66	22	440	460	374
Sulphuric Acid	–	6	158	–	66	40	58	112	147	6
Ammonia	88	234	174	361	183	152	249	323	425	444
Chemical Products	–	–	45	0	124	74	17	4	–	–
Other	1	1	6	130	15	8	21	–	3	43
Beaumont Imports	96	444	619	729	594	374	431	889	1,133	955

Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1998–2007.

The USDA noted that the volatile and upward trend in U.S. natural gas prices from 2000 to 2006 has led to a 17 percent decline in the Nation's annual aggregate supply of ammonia. During the period, U.S. ammonia production declined 44 percent, while U.S. ammonia imports increased 115 percent. Also, the share of U.S.-produced ammonia in the U.S. aggregate supply of ammonia dropped from 80 to 55 percent, while the share from imports increased from 15 percent to 42 percent. Meanwhile, ammonia prices paid by farmers increased from $227 per ton in 2000 to $521 per ton in 2006, an increase of 130 percent. Natural gas is the main input used to produce ammonia. Additional increases in U.S. natural gas prices could lead to a further decline in domestic ammonia production and an even greater rise in ammonia imports.

Increases in SNWW methyl alcohol imports are also attributable to global market shifts. Methyl alcohol is used in the industrial production of many synthetic organic compounds and is a constituent of many commercially available solvents; it is noted that, when used as a gasoline additive, it lowers the carbon monoxide emissions but increases hydrocarbon emissions. Information published by SDI Consulting notes that a major shift in regional methanol capacity and production has occurred over the last two

decades.[13] Countries with large reserves of natural gas and limited domestic consumption have built world-scale methanol facilities to monetize their low-cost natural gas. The largest producing region in 2006 was Central and South America, whereas in 2011, China (northeast Asia) and the Middle East will be the largest producing regions in terms of both capacity and expected production. Overall, world demand for methanol is projected to grow at an average annual rate of just over 5.6 percent from 2006 to 2011, with lower growth expected in the industrialized areas of the world where the markets are mature. As expected, the largest consuming region for methanol in 2011 will be northeast Asia (Japan, China, Republic of Korea, and Taiwan), with 44 percent of world methanol consumption. China will consume 76 percent of northeast Asia's share. As a reflection of its growth potential, it is interesting to note that in spite of its projected methanol capacity in 2011, China will still remain a net importer.

Worldwide, formaldehyde production is the largest consumer of methanol, with 34 percent of world methanol demand in 2007. This demand is driven by the construction industry since formaldehyde is used primarily to produce adhesives for the manufacture of various construction board products. Historically, the major end product has been plywood, but in developed countries, demand is also driven by the expanding use of engineering board products such as OSB (oriented strandboard).

It was noted that the second-largest market for methanol worldwide is methyl tertiary-butyl ether (MTBE). In the U.S., consumption of MTBE increased substantially when the Clean Air Act Amendments of 1990 mandated that oxygenated compounds be added to gasoline as one aspect of a program to alleviate air pollution. In recent years, MTBE use has decreased due to groundwater contamination issues. SDI noted that California, formerly the leading consumer of MTBE, banned the use of MTBE at the end of 2003, and several states followed suit. Methanol use in U.S. MTBE production is cited to have declined since 1999 and according to the EIA will likely decline further to a steady level, supported only by export-driven demand.

Eighty-nine percent of SNWW methyl alcohol imports come from Trinidad, 8 percent come from Chile, and the remaining 3 percent from Venezuela. The Trinidad plant represents the world's largest methanol production plant and is capable of producing 5,000 tons per day. The plant located in Punta Arenas, Chile, plans to triple its methanol production capacity by the end of 2008. Additionally, new plants are planned in West Africa and the Middle East, with those locations presently serving markets other than the SNWW.

Ammonia is the main input source for all nitrogen fertilizers. Increases in ammonia imports are attributable to rising price of natural gas.[14] From 2000 to 2006, the increase in natural gas prices decreased the producers' gross return margins (the difference between the cost of natural gas to produce 1 ton of ammonia and the ammonia price [in the Gulf region] received by ammonia producers). The low average gross return margins in 2000–2003 suggest that, on average, ammonia production in these 3 years was less profitable than in 1992–1998, a period of high average gross return margins. Low profitability is

[13] SDI Consulting, Guillermo A. Saade, Abstract, July 2007.

[14] USDA, Impact of Rising Natural Gas Prices on U.S. Ammonia Supply, A Report from the Economic Research Service by Wen-yuan Huang, WRS-07-02, August 2007.

cited to have resulted in a significant number of ammonia producers ceasing production or merging with other producers. The USDA noted that U.S. net imports of ammonia maintained a relatively constant level from 1991 to 2000. Since 2001, however, with the decline of domestic ammonia production, imported ammonia has become increasingly important to the U.S. ammonia supply. From 2000 to 2006, annual U.S. imports of ammonia increased from 3.9 to 8.4 million tons, an increase of 115 percent, while ammonia exports remained constant. During that period, most SNWW ammonia imports came from Trinidad and Tobago, Canada, Russia, and Ukraine. In 2006, Trinidad and Tobago accounted for 57 percent of U.S. ammonia imports. North Dakota and Montana were the main entry ports for ammonia imports from Canada, while the Gulf States were the main entry ports for ammonia shipped from Trinidad and Tobago, Russia, and Ukraine. SNWW's points of origin for ammonia are Trinidad and Tobago, Russia, and Ukraine.

2.5 CHEMICAL PRODUCT EXPORTS

Table 17 shows SNWW and U.S. totals by commodity for 1990–2007. Table 18 presents Port Arthur's and Beaumont's 1998–2007 chemical exports by major commodity group. Port Arthur and Beaumont exports increased dramatically. Comparison of 1998–2000 with 2005–2007 data shows a 279 percent increase in Port Arthur's tonnage and a 107 percent increase in Beaumont's. Port Arthur's chemical exports consist primarily of metallic salts, which composed 73 percent of 2005–2007 tonnage and 91 percent of 2007 tonnage. The remainder of Port Arthur recent tonnage consists of hydrocarbons and organic compounds. For 2005–2007, 20 percent of U.S. metallic salts were exported from Port Arthur. Figure 16 shows the 1990–2007 U.S. and SNWW metallic salts trendline, and Figure 17 shows the distribution of these exports between Port Arthur and Beaumont. Approximately 60 percent of 2005–2007 metallic salt exports are shipped to the countries of Brazil, Argentina, Venezuela, Colombia, and Ecuador. The remaining 40 percent are shipped to Europe and South Africa. Metallic salts are included in the SIC classification of cyclohexane. The increase in Port Arthur's metallic salt exports experienced since 2004 is associated with the completion of a 266,000 metric-ton-per-year cyclohexane facility in Port Arthur. While most cyclohexane goes into the production of intermediates for nylon, it is also used as a solvent in chemical and industrial processes and recently has been substituted for benzene in many applications. The more general category of metallic salts and organic compounds is associated with the production of paints and solvents, paper and wood products, cleaning products, and various chemical products. It was noted in the September 2006 *Chemical Industry Newsletter* that by 2010, global demand for cyclohexane is anticipated to increase to 6 million metric tons, representing an average annual growth rate of 3 percent during 2005–2010.[15] Two percent of the 2005–2010 growth is attributed to China, with the associated demand driven mainly by nylon. As previously noted, nearly 60 percent of Port Arthur's 2005–2007 exports is shipped to South America. Of the six producers noted to account for 50 percent of world capacity for cyclohexane, five have operations on the SNWW. The six producers include ExxonMobil, Chevron Phillips, Huntsman, Deutsche BP Aktiengesellschaft, ConocoPhillips, and Idemitsu Kosan.

[15] Tefera, Ngan, Chemical Industry Newsletter, Cyclohexane (an abstract contained in Chemical Economics Handbook) p. 2, September 2006.

Table 17
SNWW and U.S. Chemical Exports by Commodity Classification

	SNWW Chemical Exports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Nitrogenous Fertilizer	–	–	–	–	–	–	–	–	–	–	8	3	23	23
Potassic Fertilizer	–	–	–	–	–	–	18	328	315	293	274	196	483	373
Fertilizers and Mixes	–	12	10	69	11	11	11	90	30	69	81	111	119	187
Hydrocarbons	40	148	231	510	340	209	564	300	541	513	617	407	523	343
Alcohols	76	100	70	73	3	32	85	15	9	68	66	52	11	16
Organic Compounds	–	22	97	104	207	96	218	207	225	91	127	145	653	706
Metallic Salts	386	430	338	294	368	335	376	257	347	379	812	909	1,027	1,412
Plastics	1	–	3	–	7	15	56	30	82	91	47	–	–	–
Chemical Additives	–	1	17	41	43	44	80	44	11	38	71	44	19	26
Other	44	11	10	10	–	11	61	25	27	13	1	24	42	83
SNWW Total Exports	547	724	776	1101	979	753	1,469	1,296	1,587	1,555	2,104	1,891	2,905	3,169
% of U.S. Total	1.4	1.5	1.6	2.2	1.9	1.4	2.5	2.4	2.9	2.9	3.5	3.4	4.9	5.3

	U.S. Chemical Exports (1,000s of Short Tons)													
Commodity	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Nitrogenous Fertilizer	2,498	1,934	2,397	1,983	1,980	2,099	1,739	1,442	1,907	1,689	1,588	1,330	1,732	1,012
Phosphatic Fertilizer	901	776	741	757	689	749	744	750	627	580	397	286	120	5
Potassic Fertilizer	1,062	1,394	1,024	1,256	2,645	2,852	2,535	2,380	2,119	2,190	2,231	2,522	2,413	3,452
Fertilizers and Mixes	9,150	12,203	10,167	12,034	12,504	13,256	8,518	9,005	8,593	8,419	9,196	8,845	7,899	6,522
Hydrocarbons	4,046	5,915	5,916	5,735	5,601	6,430	7,533	5,731	6,090	7,197	8,251	6,584	5,947	6,978
Alcohols	2,085	2,565	2,337	2,814	2,143	2,090	2,649	2,617	2,604	2,726	2,763	2,261	2,828	2,910
Organic Compounds	891	1,192	1,405	1,361	2,019	1,905	2,226	2,233	2,454	2,099	2,342	2,597	4,182	4,546
Metallic Salts	3,424	4,643	4,836	4,908	4,468	4,221	5,751	5,389	5,204	5,195	5,926	5,431	5,457	5,842
Plastics	4,471	5,626	5,710	6,046	5,774	5,376	6,883	6,568	6,268	5,971	7,868	7,255	7,767	10,124
Sodium Hydroxide	2,505	3,242	3,219	2,950	3,102	3,219	4,384	3,379	3,631	3,422	3,892	3,795	3,776	4,265
Inorganic Elements	2,078	1,568	1,148	1,136	1,158	993	3,322	2,959	3,301	2,518	4,369	4,486	5,325	2,587
Paint, Varnish, and Related Products	4,918	6,189	6,260	6,727	6,431	6,017	7,456	7,188	6,871	6,532	8,596	7,879	8,636	10,784
Other	2,390	2,219	2,316	2,831	2,829	2,992	4,146	5,105	5,292	5,037	3,315	3,042	2,617	2,617
U.S. Total Exports	40,419	49,466	47,476	50,538	51,343	52,199	57,886	54,746	54,961	53,575	60,734	56,313	58,699	60,188

Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Table 18
Chemical Product Exports by Port and Commodity Classification

	Port Arthur Chemical Exports (1,000s of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Nitrogenous Fertilizer	–	–	–	–	–	–	–	–	–	–
Potassic Fertilizer	–	–	–	4	18	3	–	–	5	–
Fertilizer and Mixes	11	11	4	–	–	–	–	–	3	–
Hydrocarbons	109	46	116	52	94	20	95	90	208	116
Alcohols	3	–	7	0	–	22	3	6	–	6
Organic Compounds	38	–	14	1	3	1	–	–	65	7
Metallic Salts	353	268	87	60	61	160	787	902	1,027	1,385
Plastics	0	0	4	17	–	3	–	–	0	–
Chemical Additives and Products	31	22	73	2	–	–	–	–	18	–
Other	1	2	2	–	–	1	4	–	5	6
Port Arthur Exports	546	349	307	136	176	210	889	998	1,331	1,521
	Beaumont Chemical Exports (1,000s of Short Tons)									
Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Nitrogenous Fertilizer	–	–	–	–	–	–	8	3	23	23
Potassic Fertilizer	–	–	18	324	297	290	274	196	478	373
Fertilizer and Mixes	–	–	7	90	30	69	81	111	115	177
Hydrocarbons	221	163	448	248	447	493	585	317	315	239
Alcohols	–	32	78	15	9	46	63	46	11	10
Organic Compounds	169	96	204	206	222	90	124	145	588	699
Metallic Salts	11	67	289	197	286	219	25	7	–	27
Plastics	7	15	52	13	82	88	47	6	–	–
Chemical Additives and Products	12	22	7	42	11	38	0	–	19	26
Other	0	9	59	25	27	12	8	65	48	–
Beaumont Exports	420	404	1,162	1,160	1,411	1,345	1,215	893	1,574	1,644

Source: USACE, *Waterborne Commerce of the U.S., Parts 2 and 5*, 1990–2007.

Beaumont's 2004–2006 chemical exports primarily consist of potassic fertilizers and mixes (33 percent), organic compounds (32 percent), and hydrocarbons (23 percent). These three groups represented 88 percent of 2004–2006 exports, up from 66 percent for 1999–2001. For 2004–2006, 10 percent of U.S. nitrogenous, potassic, and fertilizer mixes was exported from Beaumont. In 2006, the Beaumont share increased to 14.8 percent. Nearly 80 percent of 2004–2006 exports was shipped to Mexico and Central and South America. The remaining 20 percent was shipped to Japan.

Figure 16
U.S. and SNWW Metallic Salt Exports

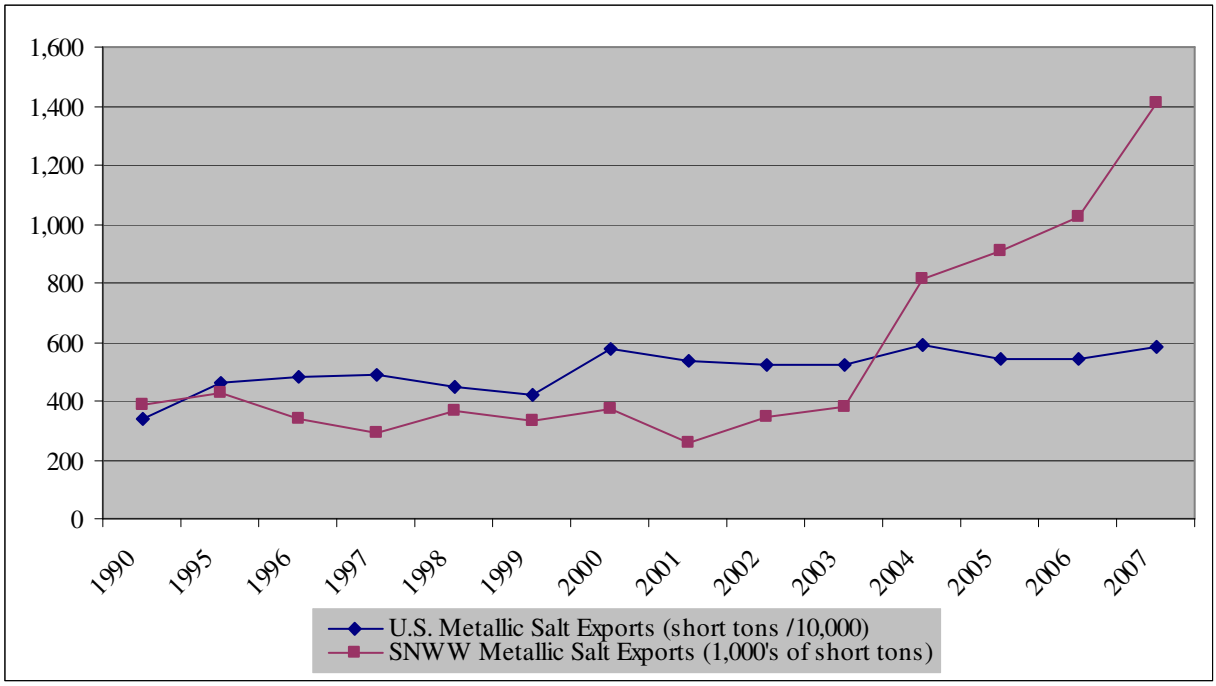
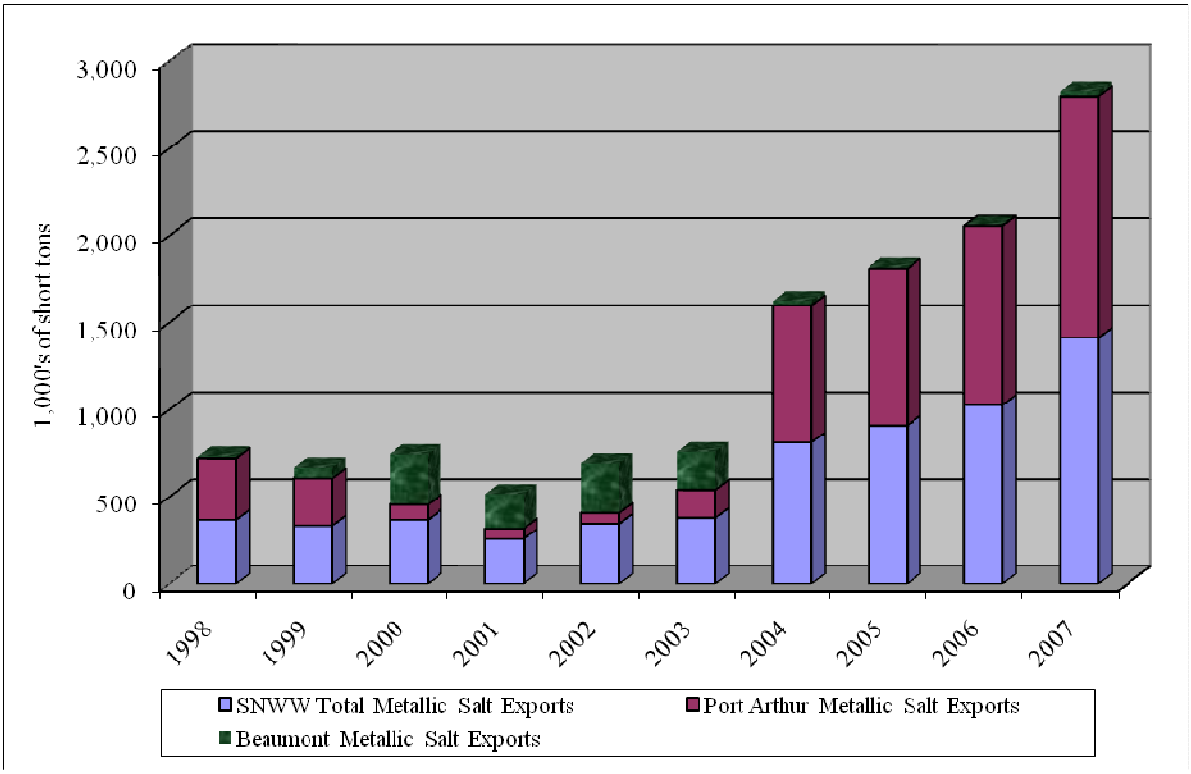


Figure 17
SNWW Total and Port Arthur Metallic Salt Exports



The Food and Agriculture Organization (FAO) of the United Nations (U.N.) notes that world fertilizer consumption is expected to increase at an annual rate of about 1.7 percent from 2007/2008 to 2011/2012, equivalent to an increment of about 15 million tons.[16] Approximately 70 percent of growth is anticipated to take place in Asia and 19 percent in America, primarily Latin America. Total fertilizer consumption in Latin America is forecast to increase at an annual rate of 2.7 percent from 2007/2008 levels. Increased demand is expected to be concentrated mainly in Brazil and Argentina where there has been a rapid response to increased crop prices partly resulting from increased sugar cane plantings for ethanol production. Future production increases are expected to come from a combination of a larger cultivated area and higher yields, which will help Latin America further increase its share of global agricultural markets.

North American consumption of nitrogen, phosphate, and potash fertilizer is forecasted to grow by 0.3 percent, 0.5 percent, and 0.7 percent, respectively. It is noted that significant gains in nitrogen use efficiency over the past 2 decades, combined with greater recycling of organic nutrient sources, are likely to mitigate increased fertilizer demand resulting from expanding bioethanol production. Asian demand is forecasted to increase by 2.1 percent annually from 2007/2008 levels through 2011/2012. The respective growth rates by fertilizer types are 1.6 percent for nitrogen, 2.4 percent for phosphate, and 3.5 percent for potash. The U.N. expects that Asia will move from a small deficit to a considerable surplus of nitrogen and will reduce its dependency on imported phosphate, but will increase the volume of its potash imports.

World demand forecast for potash fertilizers is to increase at an annual average rate of about 2.4 percent, equivalent to an increment of 3.6 million. About 68 percent of this growth will occur in Asia and 21 percent in Latin America, 5 percent in North America, 6 percent in Eastern and Central Europe, and the remainder in Western Europe. World demand for nitrogen fertilizers is expect to increase at an annual rate of 1.4 percent, with about 69 percent of growth taking place in Asia, 10 percent in Latin America, 3 percent in North America, and 7 percent in Africa, and the remainder in Eastern and Central Europe. The expected annual growth rate in world demand for phosphate fertilizers is about 2.0 percent. According to the report, about 71 percent of this growth will take place in Asia and 18 percent in America, 3 percent in North America, and the remaining 7 percent in Eastern and Central Europe.

Review of SNWW 1990–2007 (see Table 17) shows that regional potassic fertilizer exports represent 12.5 percent of U.S. total exports. SNWW fertilizer exports are nearly all associated with Beaumont (see Table 18). In general, Beaumont's chemical exports consist of a wide range of products, with fertilizer exports exhibiting notable overall increases since 2000.

2.6 GRAIN EXPORTS

Grain is exported from the Beaumont elevator located just below the Port of Beaumont main turning basin. Wheat presently represents 100 percent of Beaumont's grain exports for the most recent 4-year

[16] Food and Agriculture Organization of the United Nations, "Current World Fertilizer Trends and Outlook to 2011/12," FAO, Rome, 2008.

period. During earlier years, wheat represented 85 percent, sorghum 10 percent, and corn 5 percent. Table 19 displays Beaumont's 2001–2007 grain export tonnage by grain type.

Table 19
Beaumont Bulk Grain Export
Distribution of Tonnage by Grain Type

	2001	2002	2003	2004	2005	2006	2007
Bulk Grain Export Totals by Year (Short Tons)							
Beaumont Exports	831,000	835,000	1,125,000	1,329,000	1,080,639	1,214,010	1,632,000
% by Grain Type							
Wheat	79.0	88.8	100.0	100.0	100.0	100.0	100.0
Corn	6.5	8.4	0.0	0.0	0.0	0.0	0.0
Sorghum	14.5	2.8	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Beaumont's Exports as a % of the U.S. Total						
	2.5	2.4	2.8	4.3	4.1	4.0	5.1

Source: USACE, Waterborne Commerce Database, 2001–2007.

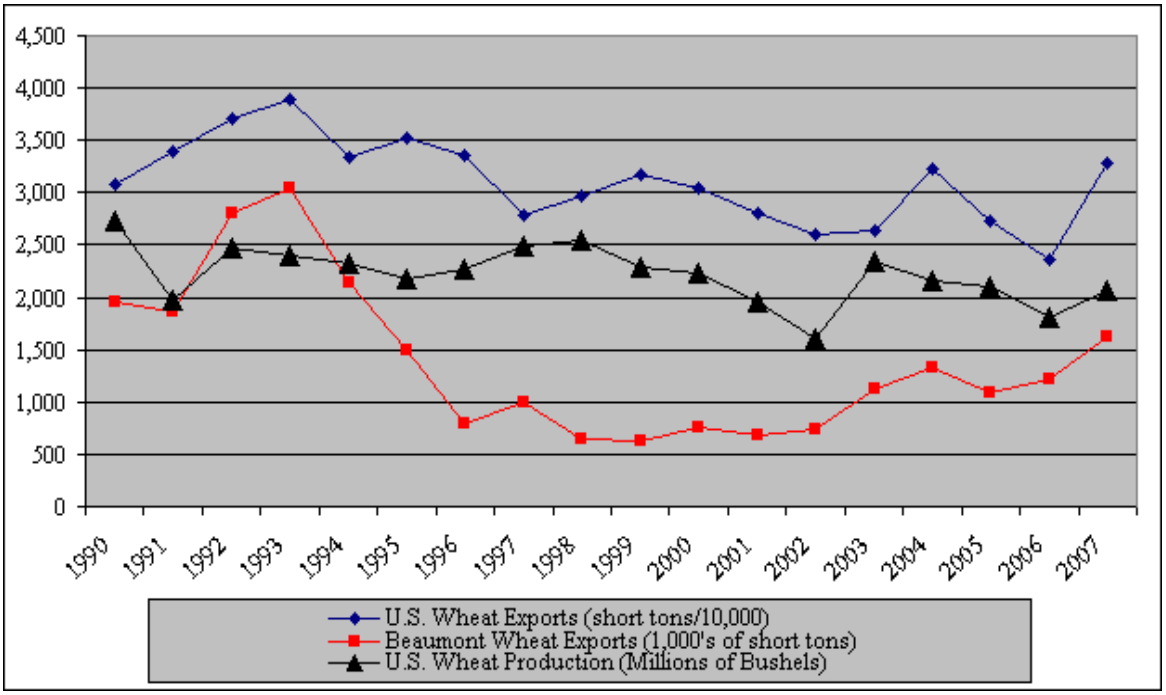
In 2007, Beaumont's wheat exports totaled 1.6 million short tons. While exports have exceeded 1 million short tons since 2003, recent volumes are less than one-half the 1993 peak volume of 3.5 million short tons. Beaumont exports are very low in comparison to the Pacific Northwest and the Lower Mississippi, but the port has maintained a 1.4 to 1.7 percent share of the U.S. waterborne bulk grain export market. Beaumont's 2006 wheat exports composed 5 percent of the U.S. wheat export total. Figure 18 displays comparison of Beaumont exports and U.S. exports and production levels for 1990–2007.

2.7 EXPANSION OF THE DEEP-DRAFT TRAFFIC BASE

In addition to its large existing base of crude petroleum, petroleum and chemical products, and dry bulk deep-draft cargoes, the without-project future includes operation of up to three LNG terminals. As noted, the Cheniere terminal is presently operational. Construction on the Golden Pass terminal will be complete by 2011. The LNG terminals are located below Texas Island in the portion of the waterway below the western GIWW intersection with the SNWW near Taylor Bayou.

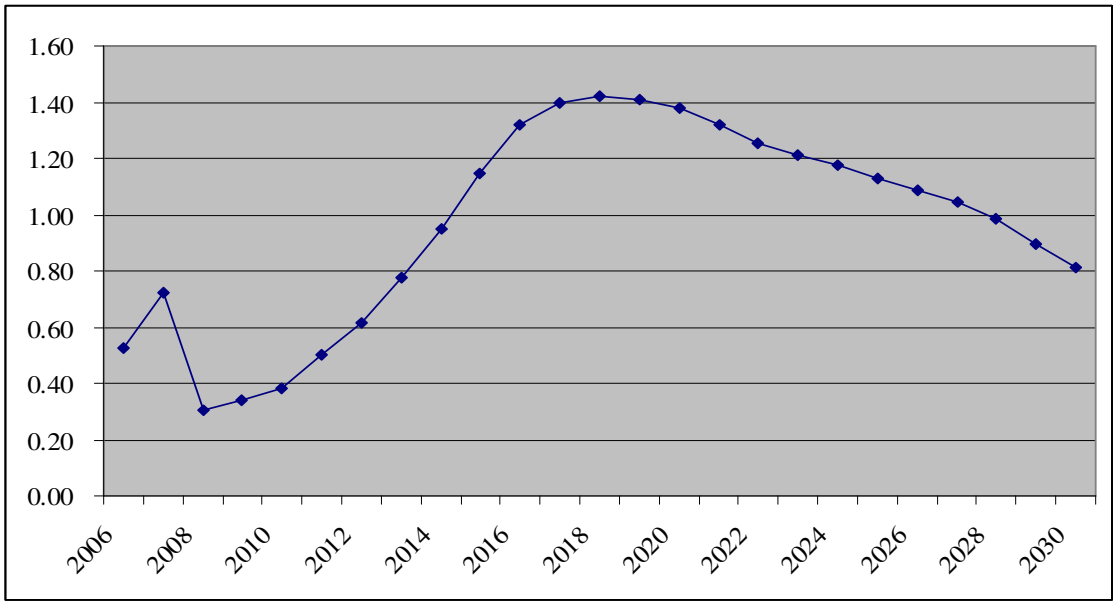
LNG is expected to play an increasingly important role in the natural gas industry and global energy markets in the next several years and in the long-term future due to the combination of higher natural gas prices, lower LNG costs, and rising gas import demand. Figure 19 shows the USDOE's 2006–2030 U.S. LNG import forecast.

Figure 18
U.S. and SNWW Bulk Grain Statistics
1990–2007



Source: USACE, Waterborne Commerce Database, 1990–2007, Parts 2 and 5, and USDA, Economic Research Service, July 2009.

Figure 19
U.S. LNG Imports 2006–2030
Trillion Cubic Feet



Source: USDOE, Updated Annual Energy Outlook 2009 Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook, Table 13, SR/OIAF/2009-03.

The SNWW LNG facilities are located in the Sabine Pass Channel and Port Arthur Canal reaches; these reaches presently have an authorized channel width of 500 feet. LNG vessels using the SNWW will be subject to strict USCG regulations and to local pilot rules and, therefore, will not have the opportunity to meet other vessels or barges. The USCG regulations require that a safety zone is in place 2 miles ahead of a loaded LNG vessel and 1 mile astern of the vessel while transiting. LNG vessels using the SNWW would be subject to this rule. Even in absence of the safety concerns inherent to LNG, the beams of LNG tankers would result in vessel-meeting restrictions; however, all LNG vessel movements will be subject to one-way traffic. Operation of the LNG terminals is part of the without-project future.

3.0 VESSEL FLEET ANALYSIS

This section presents vessel fleet data, examines vessel utilization, outlines existing and future constraints associated with the commodity groups discussed in the previous sections, and also includes discussion of vessel casualty records and nonstructural project alternatives initiated by the USCG and industry. The outputs of the commodity and fleet analyses provided the basis for helping to identify the commodities expected to utilize vessels loaded to channel depths over 40 feet. The commodity-specific discussions include the existing commodity groups such as petroleum, chemicals, grain, and breakbulk, and the introduction of LNG. The introduction of LNG and the SNWW's already large concentration of deep-draft tankers and barge traffic highlights safety concerns. The first part of this section presents discussion of vessel safety and accident records.

3.1 SNWW VESSEL CASUALTIES

The large volume of deep- and shallow-draft vessels using the SNWW provided the initial basis for evaluation of waterway improvements. While the implementation of the VTM system significantly improved safety, an evaluation of safety and casualties was reevaluated in 2008 due to the opening of the Cheniere LNG Terminal and general interest in an updated assessment of navigation safety since implementation of the VTM system. As part of this evaluation, SNWW historical casualty records were updated and the circumstances associated with marine casualties were discussed with the USCG's Port Arthur Marine Safety Office (MSO), the SPA, and the GICA in 2008.

Vessel casualties are classified by three general types including vessel grounding, vessel collisions with stationary objects (called allisions), and collision of two or more moving vessels. The Port Arthur MSO noted that marine casualties are caused by a variety of reasons including strong winds, fog, pilot error, bank forecast, traffic mix, and a variety of other circumstances. Distribution of SNWW 2006 casualty rates by vessel type is shown in Table 20.

The USCG and the SPA were asked for input on the effects of the SNWW project alternatives on casualty rates. In response to this inquiry, the MSO representatives noted that factors such as reductions in deep-draft vessel traffic and channel widening would serve to reduce the probability of casualties. While recognizing that widening would reduce the probability of casualties, the MSO emphasized that casualty occurrences in the Sabine Pass Channel and Port Arthur Canal are rare and that the proposal to widening those reaches would not have a discernible effect on the net change in casualty rates.

Table 20
SNWW Casualty Incident Rates, 2006

Transit Type a/	Transits	Incidents	Ratio of Incidents Per Transit
Tanker Transits	3,139	4	0.1%
Freighter Transits	913	4	0.4%
Tow Transits	41,793	42	0.1%
Other	1,460	15	1.0%
Certain Dangerous Cargo Transits	1,570	0	0.0%
Tanker Transits	48,874	65	0.1%

Source: Compiled from USCG, MSO, Port Arthur, 28 January 2007, "State of the Waterway," Southeast Texas Waterways Advisory Council (SETWAC) Presentation.
a/ Includes inbound and outbound transits.

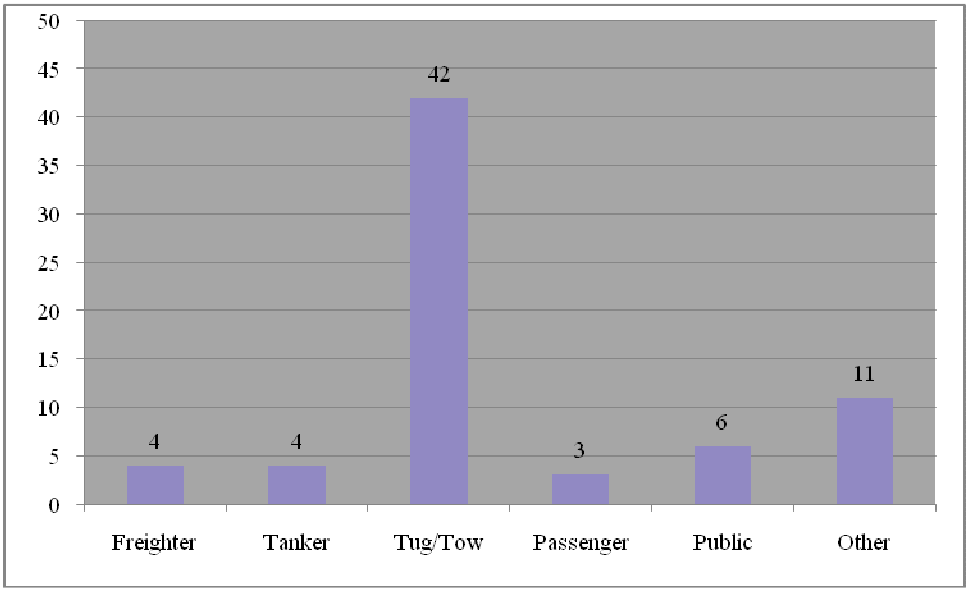
As noted, the Sabine Pass Channel and Port Arthur Canal reaches are used by oceangoing deep-draft vessels either coming in from or going out to the Gulf of Mexico. In discussing casualties with the Sabine Pilots, the pilots emphasized that the main effect of widening these reaches would be to reduce delays associated with one-way traffic restrictions.

Figure 20 contains distribution of 2006 SNWW casualties by vessel type, and Figure 21 displays the distribution of casualty incidents by nature of incident. The data indicate that 60 percent of casualties involve tows or tugs, 11 percent involve tankers and freighter, and the remaining 30 percent involve other vessel types as presented.

The MSO noted that nearly all casualties occur in the Sabine-Neches Canal reach, which, in addition to being used by all deep-draft vessels going to Port Arthur and Beaumont, serves as a through channel for the GIWW. Potential interaction between the diverse mix of vessels in this reach is presently scheduled, and scheduling will continue under the without- and with-project future conditions. As previously discussed, the large volume of tow-barges using the Sabine-Neches Canal, along with a high flow of deep-draft traffic, has the potential of compounding congestion that would increase casualty rates and probabilities and, therefore, prompted interest early in the study process for evaluation of a barge shelf through the canal reach between the east and west junctions with the GIWW. The USACE evaluation of the barge shelf coincided with the USCG efforts to evaluate the need for and plan future VTM projects, including installation and upgrades to VTS. The VTS was authorized by certain sections of the Port and Waterways Safety Act of 1972; the Oil Pollution Act of 1990 made participation mandatory in areas serviced by existing and future VTS.[17] The purpose of VTS is to provide active monitoring and navigational advice for vessels in particularly confined and busy waterways.

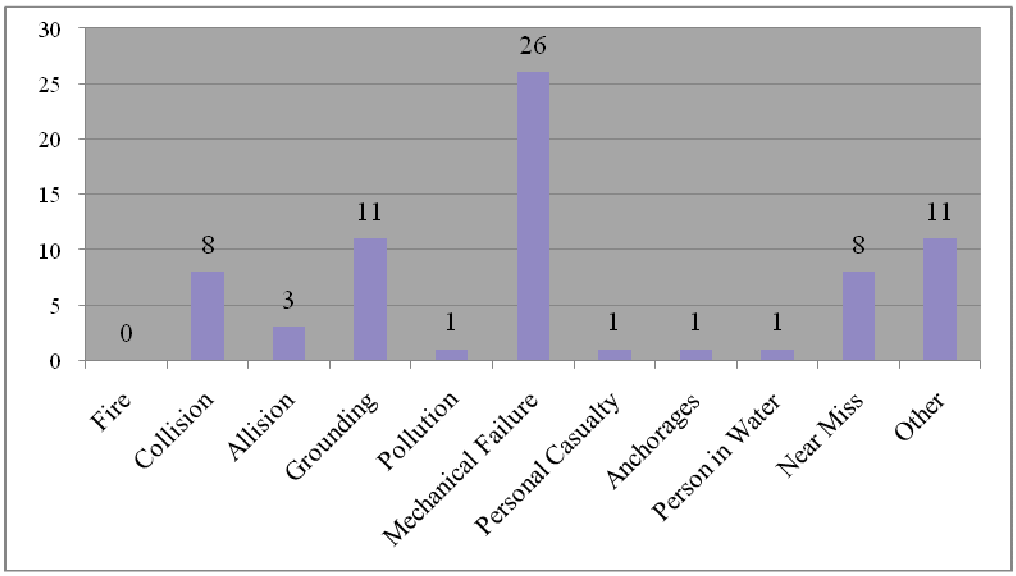
[17] USACE. 2008. Louisiana Coastal Protection and Restoration Draft Technical Report. USACE, New Orleans District.

Figure 20
SNWW Casualty Incidents (2006) by Vessel Type



Source: USCG, MSO, Port Arthur, "State of the Waterway" Presentation, January 28, 2007, USCG SETWAC Presentation, Slide 13.

Figure 21
SNWW Casualty Incidents (2006) by Casualty Type



Source: USCG, MSO, Port Arthur, "State of the Waterway" Presentation, January 28, 2007, USCG SETWAC Presentation, Slide 12.

The Port of Port Arthur and safety concerns associated with the Sabine-Neches Canal reach provided the impetus for Port Arthur's selection as one of 28 ports selected for participation in the 1999 VTM workshops. As part of the VTM study initiative, the USCG conducted a series of in-depth, user-focused workshops using their Port Risk Model to frame participant discussions and develop computer algorithms to translate expert opinions into quantified data.

For purposes of the Port Risk Model, risk is defined as a function of the probability of a casualty and its consequences. As part of the selection process, the input data used for port section included accident/incident history, the numbers and types of vessels using the port, weather conditions, waterway characteristics (e.g., configuration and complexity), and cargo types and volume. Each of those data elements was thought to bear some relationship to one or more of the risk factors included in the Port Risk Model. The model includes variables associated with both the causes and the effects of vessel casualties. The USCG classified 20 port safety risk factors that are grouped into one of six categories (Table 21).

As noted in USCG report documentation, the participants calibrated a risk measurement scale for each risk factor by assigning numbers to qualify risk levels. It is noted that the most important segment of the workshop consisted of discussions of port-specific problems relating to each Port Risk Model factor. The participants used the risk-measuring scales to numerically evaluate the risk levels in their port. The categories were ranked on a scale between 1 (low risk) and 9 (high risk). Discussion of existing risk mitigation strategies and appropriate ways to further reduce risk occurred next. The participants were asked to evaluate the efficacy and appropriateness of selection of VTM measures for addressing unmitigated risk, i.e., risk that was not well balanced by mitigation strategies already in place. Port Arthur's ratings are shown in Table 22.

Currently, VTS Port Arthur is a voluntary system operated in accordance with existing VTS regulations. VTS is designed to expedite ship movements, increase transportation system efficiency, improve all-weather operating capability, and enhance vessel safety and marine environmental protection.[18, 19] The VTS Center in Port Arthur monitors every ship, vessel, or boat that attempts to enter or leave the SNWW and the GIWW in the Port Arthur service area. Infrared cameras, along with radar, radio-telephone reports from vessel operators, and satellite surveillance sensors on towers along the SNWW allow VTS controllers to zoom-in on vessel activity at a moment's notice. The satellite-based Automatic Identification System (AIS), required by the Maritime Transportation Security Act of 2002, assists the VTS by determining exactly what a specific commercial vessel is carrying, along with its speed, dimensions, and destination.

[18] USACE. 2007. USCG, MSO, Port Arthur, "State of the Waterway" Presentation, January 28, 2007, USCG SETWAC Presentation, Slide 12.

[19] USCG. 2008. VTS Port Arthur Operating Procedures Guide. http://www.uscg.mil/d8/VTSPortArthur/Documents/VTS%20Port%20Arthur_Opertating-Guide.pdf (accessed March 9, 2008).

Table 21
Safety Risk Factors

Composition	Traffic Conditions	Navigational Conditions	Waterway Configuration	Immediate Consequences	Subsequent Consequences
Percentage of High Risk Deep Draft	Volume of Deep-Draft Vessels	Wind Conditions	Visibility Obstructions	Number of People on Waterway	Economic Impacts
Percentage of High Risk Shallow Draft	Volume of Shallow-Draft Vessels	Visibility Conditions	Channel Width	Volume of Petroleum Cargoes	Environmental Impacts
	Volume of Fishing and Pleasure Craft	Tide and River Currents	Bottom Type	Volume of Hazardous Chemical Cargoes	Health and Safety Impacts
	Traffic Density	Ice Conditions	Waterway Complexity		

Source: USCG, Ports and Waterways Safety Assessments (PAWSA) Final Report, p. 4, date is 2003-period. http://www.navcen.uscg.gov/mwv/projects/pawsa/PAWSA_FinalReports.htm.

Table 22
Port Arthur's Safety Risk Factors

Composition	Traffic Conditions	Navigational Conditions	Waterway Configuration	Immediate Consequences	Subsequent Consequences
Percentage of High Risk Deep Draft 4.1	Volume of Deep Draft Vessels 6.5	Wind Conditions 2.3	Visibility Obstructions 4.7	Volume of Passengers 1.4	Economic Impacts 4.3
Percentage of High Risk Shallow Draft 6.2	Volume of Shallow Draft Vessels 7.4	Visibility Conditions 2.8	Passing Arrangements 6.7	Volume of Petroleum Cargoes 9.0	Environmental Impacts 5.2
	Volume of Fishing and Pleasure Craft 2.8	Tide and River Currents 3.0	Bottom Type 3.0	Volume of Hazardous Chemical Cargoes 5.2	Health and Safety Impacts 3.4
	Traffic Density 6.7	Ice Conditions 1.0	Waterway Complexity 8.4		

Source: USCG, Port of Port Arthur, Texas, After Action Report, p. 6, date is 2003-period. http://www.navcen.uscg.gov/mwv/projects/pawsa/WorkshopReports/Port%20Arthur.pdf.

Most commercial vessels using the waterway were required to have AIS equipment installed by the end of 2004.[20] These include power-driven vessels 20 meters in length or longer; power-driven vessels of 100

[20] U.S. Coast Guard (USCG). 2004. Automatic Identification System Carriage Requirements. Available on the internet at http://www.navcen.uscg.gov/enav/ais/AIS_carriage_reqmts.htm.

gross tons or more carrying one or more passengers for hire; towing vessels 26 feet or longer while navigating, all dredges and floating plant likely to restrict or affect the navigation of other vessels; and all vessels required to participate in the Vessel Movement Reporting System. However, not all vessels are required to carry AIS; in particular, pleasure crafts, fishing boats, and warships are exempt. Until rules regarding VTS Port Arthur are published, vessels are exempt from all VTS and Vessel Movement Reporting System requirements, except the requirement for AIS continuous broadcasts. When VTS Port Arthur is included in the VTS regulation, participation will become mandatory. At that time, VTS Port Arthur will be authorized to designate temporary reporting points and procedures, impose vessel operating requirements or establish vessel traffic-routing schemes. During conditions of vessel congestion, restricted visibility, adverse weather or other hazardous circumstances, VTS may control or manage traffic by specifying times of entry, movement, or departure to, from, or within a VTS area. The existing VTS along the SNWW was evaluated as a nonstructural alternative. Although this service is managed by the USCG and thus is not within the jurisdiction of the USACE, it was evaluated because it appeared to be a potential alternative to structural plans and it was found to be a better alternative than the barge shelf proposal. While the VTS would help congestion and improve safety to some degree, the USCG's traffic management role is limited to specific circumstances when the SNWW is congested or experiencing hazardous conditions. The VTS assists vessel operators in making independent decisions regarding the safe navigation of their vessels, for which they retain complete responsibility. In this sense, VTS should be considered primarily a navigational aid, a tool for mariners to use along with numerous other tools to facilitate safe navigation,[21] and thus would not improve deep-draft navigation inefficiencies created by the need for lightering and associated vessel delays.

The effect of the channel indication from discussions with the industry is that channel widening and the Neches River anchorage basins will reduce the likelihood of accidents; however, the number of accidents remains small. The indication from discussion with the industry is increases in channel width, anchorages, and the VTS will all contribute to an overall reduction in accident probabilities. Most vessel accidents involve tows, and most of these occur in the Sabine-Neches Canal reach, with the majority being "intentional groundings."

There is not a historical record of vessel-tow accidents as the existing condition is avoidance. The USCG noted that while communication has always been good, improved deep-draft and barge vessel communication brought about through the USCG Southeast Texas Waterways Advisory Council (SETWAC) and the VTS activities have resulted in improved safety. The pilot rules place limitation on what vessels can meet where and when. For the without- and with-project future, the pilot rules will continue to limit the sizes of the vessels that can meet in each portion of the channel. Widening the channel up to the Taylor Bayou junction will result in a relaxation of the pilot rules as vessels will have an additional 200 feet of channel (i.e., the existing channel width is 500 feet and the with-project width for the Sabine Pass Channel and Port Arthur Canal, which leads up to Taylor Bayou, would be 700 feet. The expectation for the with- and without-project future is that pilot rules would continue to limit the possibility of vessel-to-

[21] USCG. 2008b. VTS Port Arthur Operating Procedures Guide. http://www.uscg.mil/d8/VTSPortArthur/Documents/VTS%20Port%20Arthur_Opertating-Guide.pdf (accessed March 9, 2008).

vessel and vessel-to-tow meetings in the Sabine-Neches Canal reach and that both vessel and shallow-draft tow movements would be scheduled through both VTS and communication between vessel pilots.

The relative impacts to tow-barge traffic are anticipated to generally be the same between the without- and with-project future. One difference is that for the with-project condition of channel deepening, there would be fewer oceangoing vessel trips and, therefore, an overall reduction in traffic density. The decision to forgo the barge shelf was made by the tow industry due to reconsideration of how vessels and barges would interact. The concern that was raised, and this was not physically modeled, was that the tow-barges could get pulled under or out into the channel as it either meet a deep-draft vessel or "held-up or idled" in the barge shelf. The tow operators originally thought that they wanted to shelf in case radio and/or other communication failed and a tow-barge could not clear the channel as a deep-draft vessel began its transit through the reach; however, the recent impact of the VTS has improved communication among vessel operators, and accident probabilities were not calculated for the without-project condition and benefits for reductions in casualties were not taken. The effect of the without-project condition is "avoidance behavior" in the form of "pilot rules."

3.2 OFFSHORE ALTERNATIVES

Offshore oil terminals were assessed as an alternative mode to landside port delivery of crude petroleum. Two offshore terminal alternatives were considered in the analysis, one existing and one proposed. The decision to use an offshore terminal instead of lightering or constructing a deeper channel is complicated but largely depends on the relative cost per ton, relative market volumes, and facility accessibility. While a detailed quantitative analysis of a LOOP alternative is beyond the scope of USACE's planning study, the overall infrastructure requirements were examined to the extent possible. Pipeline capacities and necessary expansions were identified, and the reasons for current and past choices were evaluated as were expectations about future interest.

The existing offshore terminal, the LOOP, is America's first and only deepwater port. LOOP is presently operating at capacity and has been since 2005. In addition to new customers brought on due to infrastructure damages associated with the 2005 hurricanes, recent increase in the LOOP is tied to utilization associated with domestic production in the U.S. Gulf. Access to LOOP for the SNWW market is periodically reviewed; however, actualization would require substantial investment as SNWW crude oil import volume nearly equals LOOP's capacity. LOOP's design capacity of 1.4 to 1.8 million barrels per day is only marginally higher than SNWW's 2003–2007 crude petroleum import volume which ranged from approximately 1.1 to 1.3 million barrels per day.[22]

While all of SNWW's crude oil could not currently transfer to LOOP, some tonnage could be diverted. The volume diverted depends upon various ranges of expansion of LOOP or construction of a new facility. The large fixed cost of expansion, and associated financing costs, necessitates participation by a

[22] The *Waterborne Commerce of the U.S.*, Part 2, Waterways and Harbors, Gulf Coast, Mississippi River System and Antilles shows crude petroleum imports of 60 million short tons in 2005 and 70 million in 2003 of crude oil imports for the SNWW. The standard conversion factor to put short tons per year to barrels per day is 0.0182. The link for the public website for waterborne commerce publications is shown below. Detailed vessel records are not contained in a public domain but can be provided upon request. http://www.iwr.usace.army.mil/ndc/wcsc/wcsc.htm.

consortium of companies. While LOOP is presently at capacity, the SNWW industries have not found the option of investing in LOOP, and the necessary associated infrastructure expansions, to be a cost-effective alternative to existing practices of either direct shipment or offshore lightering. The lack of incentive has remained since the 1970s. The SNWW users continue to consider LOOP along with other alternatives; however, continued practices suggest that LOOP is not a cost-effective alternative to the existing SNWW practice of its land-based ports. An additional variable pertinent to the current evaluation is that LOOP would appear to be a less attractive cost option when compared to lower shipping costs that the SNWW improvement project is expected to provide.

LOOP is located offshore of Grande Isle, Louisiana, in 110 feet of water. Grande Isle is 302 miles east of Port Arthur and Beaumont. LOOP was organized in 1972 as a Delaware corporation and converted to a limited liability company in 1996. Marathon Ashland Pipe Line LLC, Murphy Oil Corporation, and Shell Oil Company are LOOP's owners. LOOP is the only port in the U.S. capable of offloading deep-draft tankers known as Ultra Large Crude Carriers (ULCC) and VLCC. Along with offloading crude from VLCCs, LOOP also offloads smaller tankers. LOOP consists of three single-point mooring buoys used for the offloading of crude tankers and a marine terminal consisting of a two-level pumping platform and a three-level control platform.

A 48-inch-diameter pipeline connects the LOOP Marine Terminal located 23 miles offshore in the Gulf of Mexico to the Clovelly, Louisiana, storage facilities. Clovelly is approximately 260 miles east of the SNWW Port Arthur and Beaumont facilities. Four pipelines connect the onshore storage facility to refineries in Louisiana and along the Gulf Coast. The Clovelly facility provides interim storage for crude oil before it is delivered via connecting pipelines to refineries on the Gulf Coast and in the Midwest. The oil is stored in eight underground caverns leached out of a naturally occurring salt dome. In 1996, one cavern was dedicated to the production streams coming in from the deepwater Gulf of Mexico.

The domestic offshore crude oil system uses the same distribution system used by the foreign barrels. The caverns are capable of storing approximately 50 million barrels of crude oil (a barrel of oil is equal to 42 U.S. gallons). In addition, LOOP has an aboveground tank farm consisting of six 600,000-barrel tanks. LOOP operates the 53-mile, 48-inch LOCAP pipeline that connects LOOP to CAPLINE (Amoco Cushing-Chicago Pipeline Company) at St. James, Louisiana. CAPLINE is a 40-inch pipeline that transports crude oil to several Midwest refineries. St. James is 227 miles east of Port Arthur and Beaumont. LOOP is connected to over 50 percent of the U.S. refinery capacity and has offloaded over 7 billion barrels of foreign crude oil since its inception.

LOOP is designed to handle 1.4 million BPD, but depending on the sizes of ships being serviced, it can handle 1.8 million BPD. The variance relates to the pumping rates of the tankers using the facility. Larger tankers tend to have faster pumping rates with some capable of pumping 80,000 barrels per hour. Smaller tankers may only be able to pump 35,000 barrels per hour. When fully operational, LOOP is generally the largest point of entry for crude oil imports into the U.S. About 13 percent of all waterborne foreign imports pass through LOOP each day. Again, LOOP’s design capacity of 1.4 to 1.8 million BPD is only marginally higher than SNWW 2003–2007 crude petroleum import volume. Of SNWW’s over 1 million BPD import volume, terminals on the SNWW transport approximately 400,000 BPD of waterborne crude oil via pipelines to inland refineries including refineries in Texas, Louisiana, Oklahoma, Ohio, Arkansas,

and Kentucky.[23] In total, the SNWW delivers approximately 12–16 percent of the crude oil supplied to domestic refineries east of the Rockies. Refineries supplied via the Sabine-Neches provide transportation fuels and other products to consumers along the Gulf Coast, East Coast, and Midwest regions. The SNWW ports presently receive about 1 percent of their daily input through LOOP. Additional offshore and landside infrastructure would be necessary for an increase in volume to take place. Expansion of the infrastructure was discussed with industry and they periodically evaluate new proposals. It was noted two proposals were due in December 2007 and acceptance of the proposals depended on participation by a consortium of users. As of June 2010, there has not been any action on these proposals.

Although there are some competing markets, the SNWW and LOOP generally serve parallel markets, with LOOP consistently processing very large volumes and SNWW serving relatively smaller parcels. The sizes of the VLCCs using LOOP typically exceed 300,000 DWT, whereas the maximum-sized vessels using the SNWW are 175,000 DWT. The maximum design draft of these vessels is 55 feet or less. The minimum-sized crude oil tankers using SNWW are in the 70,000 to 80,000 DWT range and have design drafts between 40 and 48 feet. LOOP's foreign petroleum imports are from the Middle East, whereas SNWW's market consists of direct shipments from Mexico and Venezuela and lightened mother vessels and shuttles. It has been noted that the cost effectiveness of LOOP lessens for small vessel sizes. The SNWW has the ability to serve a more general market and range of users.

The most immediate obstacle to increased use of LOOP or a new offshore facility is lack of or major limitations for direct connection from LOOP to SNWW. A marginal increase in SNWW use of LOOP from its present 1 percent share would require LOOP pipeline connection modifications involving multiple pipelines and multiple companies. Such an investment may generate the necessity for higher throughput charges, which in turn may make access less cost effective than in the past. An industry analyst noted that to a large extent the companies demand that each segment, including pipeline transportation, stand on its own economically.[24] In discussions with local port and oil industry personnel, it is noted that LOOP and similar proposals serve crude petroleum but do not serve a full range of petroleum and bulk cargoes that use the SNWW. The long-term availability of LOOP since the 1970s and participation by SNWW companies indicate that LOOP and new offshore terminal proposal have not provided the market utilization incentives for significant shares of SNWW crude oil to shift towards these alternatives. The long-term trend is for domestic refining capacity to become more concentrated in regional centers and for imports of petroleum products to grow. This trend is evident with SNWW with crude oil import tonnage exceeding that of any other U.S. port and being equal to LOOP. Imports of refined products and partial refined crude oil have grown significantly as have the use of draft-constrained vessels for transporting these cargoes.

In 2001, construction of a new terminal (called the Bulk Oil Offshore Transfer System, or BOOTS) offshore of Sabine Pass, Texas, was proposed. The relatively long distance from LOOP to SNWW and the need for additional infrastructure suggest that a facility closer to SNWW would be an attractive alternative to LOOP for SNWW channel improvements. However, the BOOTS facility has not yet been constructed and the regulatory permit application is inactive. The USCG has had no update on the

[23] Martin Associates, Economic Benefits of Maintenance Dredging of the Waterway, July 6, 2006.

[24] Rabinow, Richard A., The Liquid Pipeline Industry in the United States, "Where It's Been, Where It's Going, a report for the Association of Oil Pie Lines, April 2004, p.14.

proposal and does not expect a submittal. At the present time, the potential user of the proposed project is the terminal proponent. They noted that their participation as sole supporter is not feasible financially. It was specifically noted that their feedstock needs were not sufficient to finance the expansions to LOOP.

The BOOTs project manager was contacted periodically, and it was found that a new location farther down the Texas Coast near Freeport is presently being considered. The Freeport, Texas, site is about 100 miles southwest of the BOOTS location. Access by the SNWW refineries to a Freeport site involves longer distances than the previous BOOTS location but it has advantages over LOOP. The Texas offshore terminal was reorganized as TOPS and announced plans for construction in August 2008. TOPS is a proposed offshore terminal project that would provide feedstock to Texas City, Houston, and Port Arthur. The Port Arthur Motiva refinery, which has terminals at Taylor Bayou and on the Neches River, was a major participant in TOPS. TOPS would connect from offshore Freeport to an existing landside pipeline from Freeport operated by Seaway Pipeline Company to Texas City. Connection to Port Arthur would necessitate a new pipeline from Texas City to Port Arthur, a distance of approximately 95 miles. TOPS was noted to serve as an addition and complement to existing methods of importing crude petroleum rather than a substitute for existing modes of shipment. A March 2009 press release revealed that the Port Arthur participant, Motiva, has put its participation on hold based on uncertainty associated with future crude petroleum import volumes and trade routes. Due to uncertainty, the use of an offshore alternative was evaluated as sensitivity (Section 8.2).

While recognizing potential diversion to the existing LOOP or to a new offshore terminal, an increase in the number of specially designed SNWW vessels was recently completed by one company and another has invested in Neches River dock modifications for the larger “Aframax” and “Suezmaz” vessels. The focus of immediate private sector petroleum vessel investments is concentrated on SNWW improvements rather than offshore or on the Sabine Pass Channel or Port Arthur Canal. Ongoing consultation with industry continues to show that commitments to offshore terminal investment have not materialized. During the 30 years since LOOP has become operational, several Texas Gulf Coast channel-improvement projects have been completed and the benefits have been accrued. Offshore terminals would not accommodate products other than crude oil, and a significant proportion of benefits for the SNWW project improvement are from refined petroleum products. The offshore terminal was found not to meet the efficiency objective for all waterway users as it addressed the needs of only one user and commodity (crude oil). For these reasons, this alternative was eliminated from further consideration. While crude petroleum represents a significant share of SNWW tonnage, use of draft-constrained vessels for dry bulk commodities such as iron ore, building stone, and chemicals prompted interest by the navigation district and port authorities in the channel deepening and widening alternatives.

In a general discussion with industry, a representative noted that offshore oil terminal projects surface periodically, but the cost of these alternatives keeps them from moving beyond the initial planning stage. It is noted that the attractiveness of offshore alternatives over existing use of the SNWW is diminished by its ability to only serve one commodity (i.e., crude petroleum). It was added that the various crude oil blends and grades of oil introduce a range of additional concerns that add to throughput costs.

As noted, a constraining or complicating issue is that the pipelines and associated infrastructure requirements vary between potential users, and mingling of products and grades of crude is complex and difficult to facilitate. The construction of an offshore terminal that can meet the needs of various users is a challenge with the costs to realize multiparty usage creating an impasse to these proposals moving beyond the initial planning stage. Recognition of the cost of multiple pipelines necessary to meet the needs of the large base of customers necessary to finance these project alternatives has resulted in a stalemate in the decision process. As noted, LOOP is an existing offshore alternative. Current use of LOOP by SNWW users is very limited, and future use would require extensive pipeline investment. The major users of LOOP consist of a few major companies with high throughput volumes. In addition to serving crude oil tankers delivering imports, LOOP is used to transport domestic crude produced in the Gulf of Mexico. When asked about LOOP, potential users on the SNWW noted that LOOP's availability is sometimes limited and SNWW imports are within 1 percent of LOOP's annual throughput. The investment necessary for LOOP to process SNWW's entire crude petroleum throughput would require a doubling of capacity. A new facility such as BOOTS requires substantial investment on the part of several oil companies. Present use of LOOP consists of Louisiana-based refineries and U.S. Gulf Coast state domestic offshore production interests. LOOP's existing base of customers uses it as one of several options for delivering crude oil to their Gulf Coast refineries.

3.3 VESSEL UTILIZATION AND OPERATING PRACTICES

Analysis of the vessel fleets and utilization, and existing and future constraints associated with crude petroleum, petrochemical products including LNG, grain, and aggregate products, such as iron ore, steel slab, limestone, and sand and gravel provided the basis for identifying the commodities expected to be transported in vessels loaded to channel depths over 40 feet and estimating specific percentage utilization for channel depths over 40 feet. Additional considerations were foreign port depths and constraints such as the Panama Canal. Completion of the Panama Canal expansion, from its present width restriction of 106 feet and approximate loaded draft limit of 39.6 feet, in the year 2014 will allow for more fully loaded vessel movements from deepwater ports in Western Mexico, South America, and the Far East. The canal expansion will accommodate maximum loaded drafts of 48 feet. Port depth, trade route, and historical vessel utilization data were used to identify the percentage of tonnage anticipated to benefit from the proposed SNWW depth increases.

Examination of the vessel sizes associated with the historic traffic base suggested that, if deeper depths were available, vessels used in the transport of crude petroleum and petroleum products could be loaded to drafts over 40 feet. In addition, but to a lesser extent, examination of the 1995–2007 vessels sizes, loaded drafts, design drafts, and parcel sizes indicated that some of the vessels used to transport grain, chemical products, and breakbulk cargo, such as iron ore, metal products, and limestone and other aggregate, warranted additional analysis. The existing 40-foot SNWW project depth was designed to efficiently and safely accommodate vessels of approximately 40,000 DWT with loaded drafts of 36 feet. Since the authorization of the existing project, the size and draft of vessels using the waterway increased to meet the competitive demand for more-efficient movements. Evaluation of SNWW's vessel utilization

patterns was initially made based on examination of historical trends. The historical trend analysis was followed-up with user interviews and trade route analyses.

Table 23 presents 1990–2007 vessel trips by loaded draft for deep-draft vessels. Analysis of the data showed that trips increased at an annual rate of 3.7 percent, with the highest rates of growth for 36 feet and greater. Total trips for drafts over 35 feet increased at an average annual rate of 7.3 percent, while trips for loaded drafts of 35 feet or less grew at 3.7 percent. For the period 1990–2007, total deep-draft tonnage grew at an average annual rate of 5.2 percent. SNWW's vessel utilization patterns were also reviewed in terms of the average tonnage per trip for 1965–2007. Figure 22 shows average tonnage per trip for oceangoing traffic. The graph shows trips increasing at a slightly decreasing rate and suggests an overall increase in average tonnage per trip. While the increases in the volume of tonnage per trip are primarily associated with crude petroleum and petrochemical products, larger vessels are being used for manufactured goods and crude materials. Since 1993, the volume of tonnage per vessel has increased as the variety of commodities using the waterway has diversified.

The largest vessels presently using the SNWW are crude petroleum tankers. Crude petroleum represents over 70 percent of 2007 deep-draft tonnage and 2005–2007 average deep-draft total. Trade routes, vessel sizes, and loaded drafts are of particular importance in calculating transportation costs. For the period 2005–2007, approximately 45 percent of SNWW crude petroleum imports were shipped from Mexico, Venezuela, Colombia, and Trinidad. Of the remaining 55 percent, 54.3 percent was shipped from the Middle East and Africa and 0.3 percent was shipped from Canada. In comparison to the Nation, the SNWW has a relatively higher share of imports from Mexico, the Caribbean, and South America, while also receiving relatively higher Middle East imports. The U.S. 2005–2007 distribution comprised 34 percent from Mexico, the Caribbean, and South America; 50 percent from the Middle East, Africa, and the North Sea; and 16 percent from Canada. In its Annual Energy Outlook, the EIA shows a 2030 U.S. distribution of 33 percent from Mexico, the Caribbean, and South America; 47 percent from the Middle East, Africa, and the North Sea; and 20 percent from Canada. Canadian imports include both ship and pipeline movements.

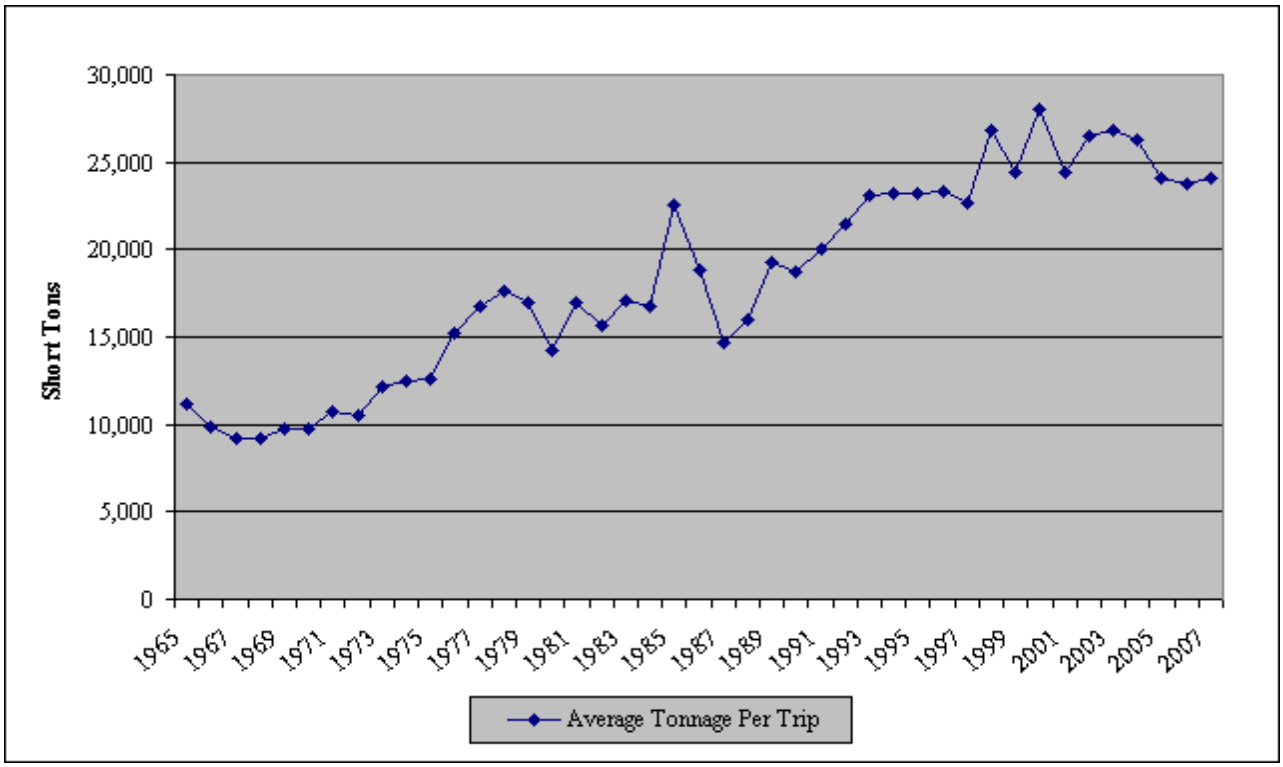
The following tables outline the distribution of tonnage by loaded vessel draft. Table 24 shows total import and export tonnage by loaded draft for select years. Table 25 shows the 1990–2007 distribution of SNWW's crude petroleum imports by loaded draft, respectively. Tables 26 and 27 present petroleum and chemical product imports and exports by loaded draft. Table 28 shows tonnage by loaded draft for groups other than petroleum and chemicals. Every effort was made to compile data for as many years as practical; however, the schedule of data releases results in some gaps. The purpose of the analyses associated with these presentations was to identify the existence of patterns and provide inputs for establishing base conditions. Based on this consideration, all relevant years are displayed.

Table 23
SNWW Trips by Loaded Draft (Includes Loaded and Light Vessels)

Year/feet	≥43	42	41	40	39	38	37	36	≤35	Total
SNWW Total Inbound and Outbound Trips by Loaded Draft (feet)										
1990	–	–	39	42	123	82	80	52	1,511	1,929
1993	2	–	–	115	77	214	209	155	1,261	2,033
1996	1	–	–	160	192	277	279	168	1,274	2,351
1999	–	1	–	117	139	276	142	172	1,987	2,834
2000	–	–	–	107	139	325	156	155	2,096	2,978
2001	1	–	–	124	168	324	175	173	2,090	3,055
2002	–	2	–	167	112	441	167	146	2,258	3,293
2003	1	–	1	289	114	347	158	175	2,364	3,449
2004	2	–	–	248	232	300	167	147	2,508	3,604
2005	–	–	–	206	154	312	189	178	2,410	3,449
2006	1	–	1	185	148	545	231	78	2,136	3,425
2007	–	–	2	178	271	263	136	143	2,380	3,373
Inbound Trips by Loaded Draft (feet)										
1990	–	–	14	38	102	69	55	33	610	921
1993	1	–	–	56	37	108	104	78	642	1026
1996	1	–	–	80	95	140	139	83	627	1,165
1999	–	–	–	101	121	250	126	135	657	1,390
2000	–	–	–	86	110	289	127	113	689	1,414
2001	–	–	–	101	147	301	147	114	646	1,456
2002	–	–	–	141	97	382	145	108	714	1,587
2003	–	–	–	254	102	289	130	121	746	1,642
2004	1	–	–	230	207	260	141	96	993	1,721
2005	–	–	–	181	141	280	164	104	762	1,632
2006	–	–	1	164	133	514	192	94	567	1,666
2007	–	–	2	148	252	209	107	73	869	1,660
Outbound Trips by Loaded Draft (feet)										
1990	–	–	25	4	21	13	25	19	901	1,008
1993	1	–	–	59	40	106	105	77	619	1,007
1996	–	–	–	80	97	137	140	85	647	1,186
1999	–	1	–	16	18	26	16	37	1,330	1,444
2000	–	0	–	21	29	36	29	42	1,407	1,564
2001	1	0	–	23	21	23	28	59	1,444	1,499
2002	–	2	–	26	15	59	22	38	1,544	1,706
2003	1	–	1	35	12	58	28	54	1,618	1,807
2004	1	–	–	18	25	40	26	51	1,515	1,883
2005	–	–	–	25	13	32	25	74	1,648	1,817
2006	–	–	–	21	15	31	39	84	1,569	1,759
2007	–	–	–	30	19	54	29	70	1,511	1,713

Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1990–2007.

Figure 22
Sabine-Neches Waterway
Average Tonnage Per Trip for Oceangoing Vessels



Source: USACE, *Waterborne Commerce of the U.S., Part 2*, 1965–2007.

Table 24
Total Imports and Exports by Year and Loaded Draft
(1,000s of short tons)

Year	≥40 feet	39 feet	38 feet	37 feet	36 feet	≤35 feet	Total
	Imports by Loaded Draft (feet)						
1990	2,586	6,641	4,540	3,155	1,119	4,909	22,950
1993	3,164	2,098	7,562	7,893	5,875	9,705	36,297
2002	10,851	7,185	28,404	10,902	7,149	9,901	74,393
2003	11,175	7,069	27,760	10,629	7,396	13,578	77,607
2004	17,486	15,353	19,282	10,086	5,505	11,201	78,914
2005	13,249	9,834	19,291	10,714	5,335	9,875	68,298
2006	12,321	9,448	14,279	12,638	4,238	11,920	64,845
2007	11,033	18,557	14,009	6,575	3,516	8,617	62,308
	Exports by Loaded Draft (feet)						
1990	1,205	370	194	204	252	2,943	5,168
1993	46	217	95	25	14	7,719	8,115
2002	1,104	375	1,285	465	764	4,647	8,640
2003	1,471	149	1,327	365	1,331	5,017	9,659
2004	656	885	1,316	404	1,179	6,478	10,918
2005	827	268	754	502	1,673	5,634	9,658
2006	641	434	858	956	2,109	6,359	11,357
2007	1,045	583	1,665	399	1,883	6,808	12,384
	% of Import and Export Tonnage by Loaded Draft (feet)						
1990	13.5	24.9	16.8	11.9	4.9	27.9	100.0
1993	8.7	5.8	20.8	21.7	16.2	26.7	100.0
2002	14.4	9.1	35.8	13.7	9.5	17.5	100.0
2003	14.5	8.3	33.3	12.6	10.0	21.3	100.0
2004	20.2	18.1	22.9	11.7	7.4	19.7	100.0
2005	18.1	13.0	25.7	14.4	9.0	19.9	100.0
2006	17.0	13.0	19.9	17.8	8.3	24.0	100.0
2007	16.2	25.6	21.0	9.3	7.2	20.7	100.0

Source: USACE, Navigation Data Center (NDC) detailed records, 1990–2007.

Table 25
Crude Petroleum Imports by Loaded Draft and Year

Year	≥40 feet	39 feet	38 feet	37 feet	36 feet	≤35 feet	Total
	1,000s of short tons Loaded Draft and Year						
1990	2,339	6,244	4,121	2,839	940	3,937	20,419
1993	2,655	1,648	7,317	7,672	5,739	7,609	32,639
1996	5,399	5,688	9,626	9,216	5,511	5,490	40,930
1997	7,691	8,863	13,782	10,142	5,800	4,793	51,070
1998	6,541	14,271	16,710	6,457	6,364	3,535	53,877
1999	8,605	8,496	17,284	7,032	6,676	5,741	53,834
2000	6,654	9,346	25,452	10,116	8,368	7,251	67,187
2001	6,744	10,730	21,743	11,196	7,465	6,349	64,226
2002	9,909	6,856	26,271	10,515	6,146	6,685	66,383
2003	18,703	7,620	20,308	8,771	7,817	6,939	70,158
2004	15,467	14,294	18,330	9,403	4,665	7,715	69,875
2005	11,945	9,207	18,391	9,706	4,346	6,097	59,691
2006	11,203	9,102	13,589	11,821	3,262	8,639	57,616
2007	9,856	18,265	13,477	6,072	2,689	5,729	56,088
	% Loaded Draft and Year						
1990	11.5	30.6	20.2	13.9	4.6	19.3	100.0
1993	8.1	5.0	22.4	23.5	17.6	23.3	100.0
1996	13.2	13.9	23.5	22.5	13.5	13.4	100.0
1997	15.1	17.4	27.0	19.9	11.4	9.4	100.0
1998	12.1	26.5	31.0	12.0	11.8	6.6	100.0
1999	16.0	15.8	32.1	13.1	12.4	10.7	100.0
2000	9.9	13.9	37.9	15.1	12.5	10.8	100.0
2001	10.5	16.7	33.9	17.4	11.6	9.9	100.0
2002	14.9	10.3	39.6	15.8	9.3	10.1	100.0
2003	26.7	10.9	28.9	12.5	11.1	9.9	100.0
2004	22.1	20.5	26.2	13.5	6.7	11.0	100.0
2005	20.0	15.4	30.8	16.3	7.3	10.2	100.0
2006	19.4	15.8	23.6	20.5	5.7	15.0	100.0
2007	17.6	32.6	24.0	10.8	4.8	10.2	100.0

Source: USACE, NDC detailed records, 1990–2007.

Table 26
Petroleum Product Imports and Exports by Loaded Draft

Year	40 feet	39 feet	38 feet	37 feet	36 feet	≤35 feet	Total
	Petroleum Product Imports (1,000s of Short Tons) by Loaded Draft (feet)						
1998	158	255	447	273	426	1,932	3,491
2002	732	500	1,935	715	475	671	5,028
2003	912	121	1,138	418	440	2,159	5,187
2004	1,543	937	529	391	412	2,190	6,002
2005	698	470	788	543	644	2,206	5,349
2006	356	117	508	544	640	1,655	3,820
2007	346	242	368	310	684	1,790	3,740
	Petroleum Product Exports (1,000s of Short Tons) by Loaded Draft (feet)						
1998	-	168	216	44	295	3,606	4,329
2002	891	181	1,221	448	620	2,273	5,635
2003	1,324	35	1,174	285	1,147	2,608	6,573
2004	521	687	1,231	340	1,081	3,291	7,152
2005	564	235	642	447	1,445	3,020	6,354
2006	541	319	488	659	1,521	3,295	6,823
2007	714	514	1,257	139	1,566	2,501	6,691
	Total Petroleum Product Imports and Exports by Loaded Draft (feet)						
1998	158	422	663	317	721	5,539	7,820
2002	1,623	681	3,156	1,163	1,095	2,944	10,663
2003	2,236	156	2,312	703	1,587	4,767	11,760
2004	2,064	1,624	1,760	731	1,493	5,482	13,154
2005	1,263	705	1,430	990	2,089	5,226	11,703
2006	897	436	996	1,203	2,161	4,950	10,643
2007	1,060	756	1,625	449	2,250	4,290	10,431
	% of Import and Export Tonnage by Loaded Draft (feet)						
1998	2.0	5.4	8.5	4.1	9.2	70.8	100.0
2002	15.2	6.4	29.6	10.9	10.3	27.6	100.0
2003	19.0	1.3	19.7	6.0	13.5	40.5	100.0
2004	15.7	12.3	13.4	5.6	11.4	41.7	100.0
2005	10.8	6.0	12.2	8.5	17.8	44.7	100.0
2006	8.4	4.1	9.4	11.3	20.3	46.5	100.0
2007	10.2	7.2	15.6	4.3	21.6	41.1	100.0

Source: USACE, NDC detailed records, 1998–2007.

Table 27
Chemical Product Imports and Exports by Loaded Draft

Year	40 feet	39 feet	38 feet	37 feet	36 feet	≤35 feet	Total
	Chemical Product Imports (1,000s of Short Tons) by Loaded Draft (feet)						
1998	–	0	–	–	8	132	140
2002	–	–	97	42	29	515	683
2003	–	63	8	–	–	363	434
2004	–	44	71	58	79	405	656
2005	40	62	–	41	109	831	1,084
2006	14	54	–	121	158	897	1,244
2007	–	1	9	15	163	768	955
	Chemical Product Exports (1,000s of Short Tons) by Loaded Draft (feet)						
1998	–	–	18	51	30	867	966
2002	25	28	62	17	66	1,388	1,587
2003	27	24	97	34	61	1,313	1,555
2004	11	13	36	67	44	1,933	2,104
2005	5	33	54	–	106	1,692	1,891
2006	5	5	68	95	305	2,426	2,904
2007	12	7	44	46	210	2,850	3,169
	Total Chemical Product Imports and Exports by Loaded Draft (feet)						
1998	–	–	18	51	30	867	966
2002	25	28	62	17	75	1,520	1,727
2003	27	24	194	75	90	1,828	2,238
2004	11	77	45	67	44	2,295	2,538
2005	5	77	125	58	185	2,097	2,547
2006	45	67	68	136	414	3,257	3,988
2007	25	61	44	167	369	3,747	4,413
	% of Import and Export Tonnage by Loaded Draft (feet)						
1998	0.0	0.0	1.9	5.3	3.1	89.7	100.0
2002	1.5	1.6	3.6	1.0	4.3	88.0	100.0
2003	1.2	1.1	8.7	3.4	4.0	81.7	100.0
2004	0.4	3.0	1.8	2.6	1.7	90.4	100.0
2005	0.2	3.0	4.9	2.3	7.3	82.3	100.0
2006	1.1	1.7	1.7	3.4	10.4	81.7	100.0
2007	0.6	1.4	1.0	3.8	8.4	84.9	100.0

Source: USACE, NDC detailed records, 1998–2007.

Table 28
Total Tonnage Excluding Petroleum and Chemicals by Loaded Draft

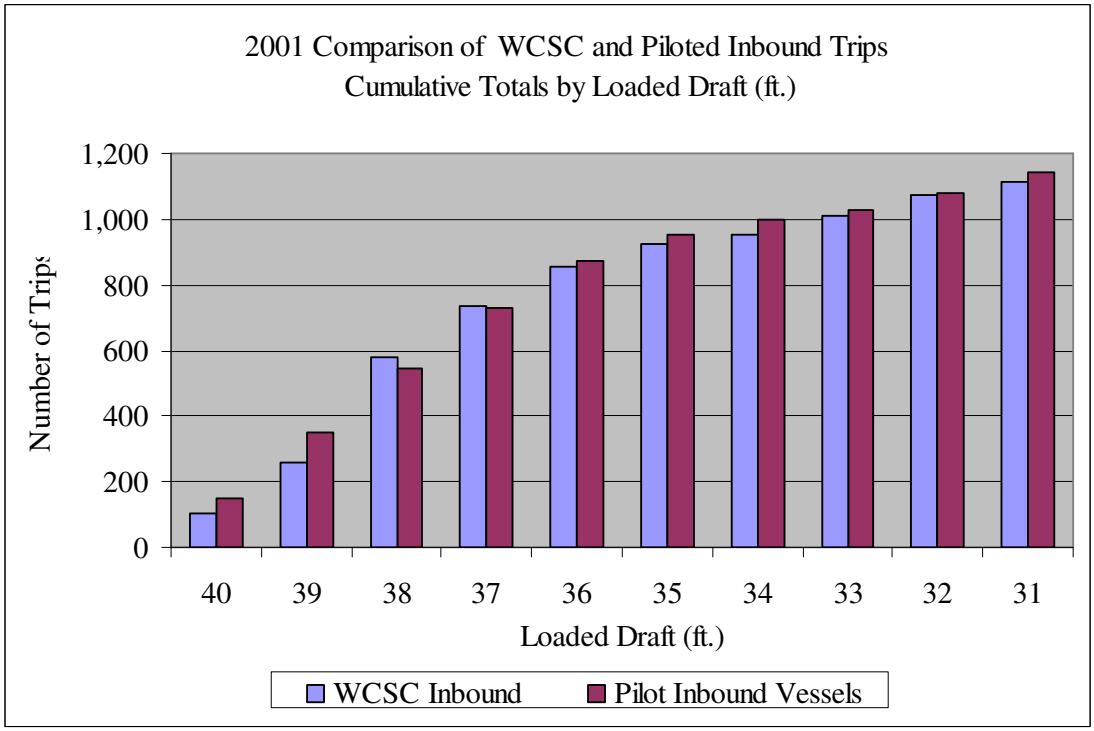
Year	40 feet	39 feet	38 feet	37 feet	36 feet	≤35 feet	Total
	Imports (1,000s of Short Tons) by Loaded Draft (feet)						
1990	0	0	0	0	0	2,532	2,532
1993	179	96	0	17	17	619	928
2002	306	16	951	91	220	636	2,219
2006	749	174	183	150	180	730	2,166
2007	834	46	89	68	47	423	1,506
	Exports (1,000s of Short Tons) by Loaded Draft (feet)						
1990	1,207	121	113	96	88	1,360	2,986
1993	47	153	1	25	0	4,094	4,319
2002	192	165	6	0	986	986	1,394
2006	97	111	305	204	295	618	1,630
2007	185	66	326	219	138	1,490	2,423
	Total Import and Export Tonnage by Loaded Draft (feet)						
1990	1,207	121	113	96	88	3,892	5,518
1993	226	249	1	42	17	4,713	5,247
2002	498	181	957	91	1,206	1,622	3,613
2006	846	285	488	354	475	1,348	3,796
2007	1,019	112	415	287	185	1,913	3,929
	% of Import and Export Tonnage by Loaded Draft (feet)						
1990	21.9	2.2	2.0	1.7	1.6	70.5	100.0
1993	4.3	4.7	0.0	0.8	0.3	89.8	100.0
2002	13.8	5.0	26.5	2.5	33.4	44.9	100.0
2006	21.6	7.3	12.5	9.0	12.1	34.4	100.0
2007	25.9	2.8	10.6	7.3	4.7	48.7	100.0

Source: USACE, NDC detailed records, 1990–2007.

The presentations show that a significant portion of crude petroleum imports and petroleum product imports and exports were transported in vessels with loaded drafts of 36 feet or more (see tables 25 and 26). The chemical import and export data presented in Table 27 show a more limited utilization of loaded drafts over 36 feet. Table 28 displays the distributions associated with "all other imports and exports." This group is largely comprised of bulk commodities.

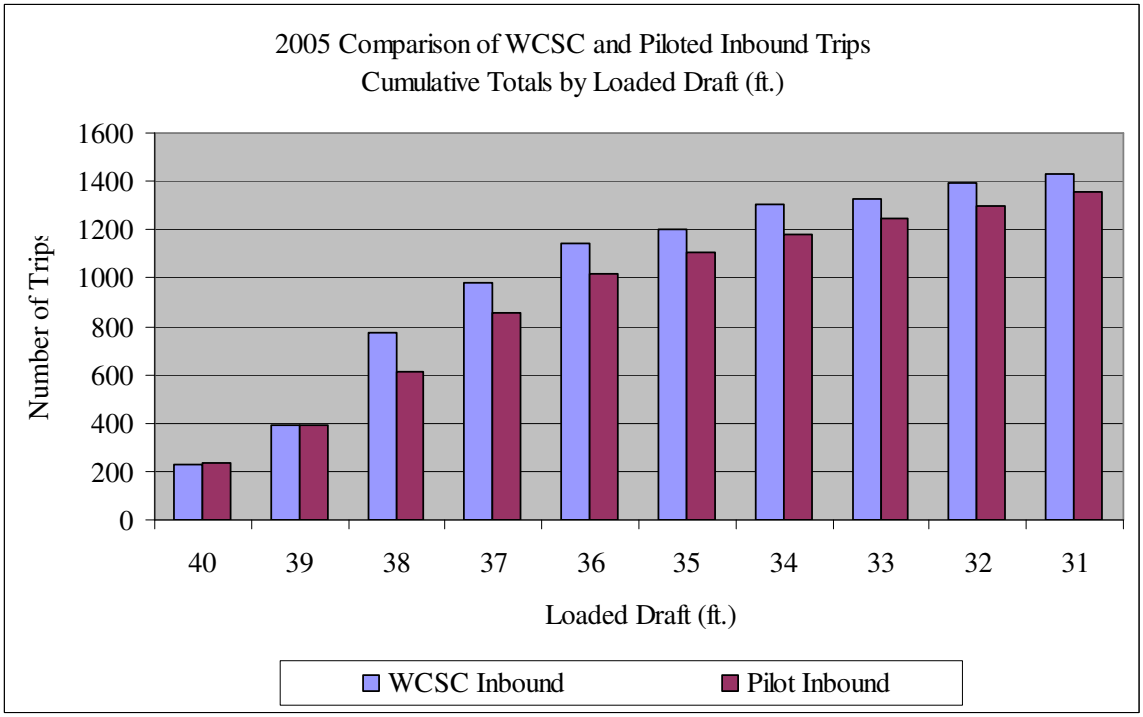
The data shown in tables 29–32 were compiled from the USACE foreign freight databases. A subsequent comparison of the loaded draft records from the USACE NDC databases with those in the pilots' records was made to identify differences in loaded drafts between the data sets. Comparisons of the data sets are displayed on figures 23 and 24.

Figure 23



WCSC=Waterborne Commerce Statistics Center

Figure 24



The primary use of the pilot data was to obtain specific information on trips by dock. Dock-specific information for foreign imports and exports is not available from the USACE databases. Dock-specific routings are available for SNWW domestic coastwise vessels; however, those routings were generally limited as domestic coastwise represented 5 percent of total trips in 2001 and 3.5 percent of 2005 total trips.

The trip comparisons displayed on figures 23 and 24 correspond to loaded drafts between 31 and 40 feet. While examination of the pilot data and the NDC foreign freight traffic data showed that the maximum loaded draft for inbound vessels was 40 feet, one U.S. outbound domestic coastwise vessel showed a loaded draft of 43 feet. Additionally, a few U.S. domestic coastwise 1996–2004 records show loaded drafts up to 43 feet. In comparison to the USACE records, the pilot records for 2001 and 2005 showed no vessels with sailing drafts over 40 feet. A sample of pilot data for April–May of 2002 did not contain any loaded drafts over 40 feet. Review of the 2004 and 2006 pilot data also showed no loaded drafts over 40 feet. Pilot data for years later than 2006 were not obtained.

For purposes of analysis, the pilot guidelines and the associated documentation of trips by draft are believed to be more accurate and consistent, if for no other reason than being collected by one entity using the same metrics. The expectation that the pilots' records are more accurate than the Waterborne Commerce Statistics Center (WCSC) records also relates to the risk associated with misreading a loaded draft, particularly during low tide or late in the dredging cycle. The pilots stated that they normally will not move any vessel if the loaded draft exceeds 40 feet fresh water. The restrictions are rigid due to insurance liability. It was noted that allowance of 40 feet fresh water assumes optimal weather and a well-maintained channel. One of the subject matter experts recognize that the USACE and pilot data are collected at different locations and in different metrics. For piloted vessels, a mandatory and consistent check of loaded drafts is made prior to departure from either the dock or the offshore pilot loading station. These recordings are in feet. The USACE WCSC records of imports and exports are not based on pilot logs but census data. The USACE detail contains counts of export trips by loaded draft. The U.S. Customs' manifest document is the most common source for inbound vessels but these records do not include a trip field. The domestic coastwise database includes a trip field. Loaded draft of inbound domestic vessels may be called in from the last port of call. For imports, the last port of call is generally outside of the U.S., and therefore draft information may be relayed in meters. It is interesting to note that comparison of the 1996–2007 inbound with the outbound records shown in Table 28 reveal that there are more outbound vessels with loaded drafts over 40 feet than inbound vessels. A reason cited for this difference is that the outbound vessels have the additional weight of bunker fuel. The indication is that vessels traveling from distant locations will burn bunker fuel in transit. The inclusion of bunker fuel will add approximately 1 foot of draft.[25] The result being that the arrival drafts may be different than the draft recorded in the manifest or other documentation.

The pilots noted that they are only aware of a few incidents when a draft over 40 feet was allowed and wondered if they were due to recording errors. It was also noted that a 3-foot minimum underkeel

[25] Personal communication with Institute of Water Resources (IWR) navigation analyst.

clearance requirement was issued by the USCG in the early 2000s. Exceptions to the 3-foot rule may only be made by a pilot master conference to discuss the specifics.

For the USACE's NED analysis, loaded draft is critical to the calculation of SNWW channel deepening benefits. Loaded draft is also a crucial analytical consideration for the widening analysis due to the fact that there are specific pilot rules restricting loaded drafts above a given threshold from meeting vessels of comparable loaded drafts, gross tonnage, beam width, or other specifications. The calculation of widening benefits is based on discrete loaded draft classes.

While the waterborne commerce records show a few vessels sailing at loaded drafts over 39 feet, discussion with the pilots and Galveston District's Operation Branch suggest that the dredging practice of 2 feet advance maintenance and 2 feet overdepth provides nearly all vessels at least 3 feet of underkeel clearance. Analysis of the pilots' policy application and examination of the number of trips with loaded drafts over 37 feet implies the availability of advance maintenance and overdepth. Comparison of the USACE data with the pilot records shows differences between recorded drafts, which are problematic. Review of the USACE data revealed that the USACE data come from several sources and are, therefore, more likely to reflect the introduction of recording discrepancies than the pilot data. Additionally, allowance of less than 3 feet underkeel clearance introduces insurance liability issues. Analysis of the data and pilot records showing recorded drafts over 37 feet implies the availability of at least 41 feet of still water. Water displacement due to vessel squat and trim implies the availability of additional depth in the Entrance Channel, where the existing authorized channel depth is 42 feet mean low tide. It has been noted in the past that the SNWW, like other Gulf Coast channels, has a relatively soft bottom. It has also been noted that the SNWW heavy traffic flows may work to help maintain the channel or slow the silting processes; however, discussions with the SPA and previous project studies also point towards an increasing concern about safety and a reduction in risk-taking behavior. In general, liability and personal responsibility concerns associated with potential casualties and actual vessel damages has become increasingly apparent due to incidents such as the *Exxon Valdez* oil spill off the coast of Alaska. On a much smaller scale, general reviews of USCG records for GIWW traffic has shown that casualties and oil spills occur on a less frequent basis than 10 to 20 years ago. The latter suggests a reduction in risk-taking behavior.

3.4 CRUDE PETROLEUM FLEET

This section contains discussion of SNWW's crude petroleum fleet and methods of shipment. Data through 2007 show an average of 80 percent of import tonnage shipped in vessels with loaded drafts of 30 feet or more, and over 40 percent of import tonnage was shipped in vessels with loaded drafts of 36 feet or more. The analysis also showed that over 75 percent of SNWW crude petroleum tonnage was shipped in 90,000 to 119,999 DWT tankers, up from 30 percent in 1990. The largest concentration of SNWW crude petroleum tonnage is in vessels between 100,000 and 119,999 DWT. Table 29 presents SNWW distributions of crude petroleum imports by vessel size for 1993, 1998, and 2002–2007. The DWT range from 90,000 to 119,000 represents the dominant class for all years shown. Comparison of the data for the

early 1990s with that for 2002–2007 shows a general decrease in the vessels less than 75,000 DWT and resurgence in the 75,000 to 85,000 DWT range.

Table 29
SNWW Crude Petroleum Imports,
Percentage of Imports by Vessel DWT
and Design Draft and Year Built

DWT 1,000s	1993	1998	2002	2003	2004	2005	2006	2007
<50	0.6	0.1	0.1	0.4	0.8	1.6	0.9	0.8
50–74.5	3.8	1.2	8.5	3.1	1.7	1.8	3.4	3.7
75–84.9	18.4	8.1	8.6	18.1	20.4	18.0	25.0	23.0
85–89.9	17.3	10.6	9.9	4.6	0.5	0.0	0.3	0.0
90–119.9	56.0	72.1	65.6	65.8	67.8	71.8	63.7	66.3
120–149.9	1.9	2.7	2.8	2.7	3.3	3.0	2.0	1.7
150–175	2.0	5.2	4.5	5.3	5.5	3.8	4.6	4.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, NDC unpublished data were used to compile the percentage distribution of tonnage by vessel size. The LRS were used to obtain the vessel DWT and associated characteristics.

Review of the annual vessel statistics and follow-up meetings with the ship pilots and terminal operators revealed that petroleum tankers beams have increased significantly in recent years, and that the vessel beam increase is compounding the effect of delays. Double-hulled tanker legislation was initiated under 46 USC§3703a after the *Exxon Valdez* oil spill. The U.S. Congress passed the Oil Pollution Act of 1990 requiring double-hull tankers now, but allowing the transportation companies until 2015 to replace existing tankers. Table 30 provides comparison of the beam widths associated with the 1981 and 2003 world tanker fleets. The table illustrates the transition in tanker sizes to wider beam vessels and also illustrates an increase in cargo-carrying capacity at less draft.

Table 30
1981 and 2003 World Tanker Fleet
Comparison of Vessel Beam by DWT and Design Draft

Beam Range (feet)	Median Beam (feet)	Median DWT	Design Draft (feet)
1981 World Tanker Fleet (sample): Average Vessel Age: 7 years			
120–124	122	87,800	44
125–129	127	88,058	46
130–139	135	128,439	54
140–158	145	156,000	58
160–175	169	228,054	66
World Fleet (Vessels Built Between 1991–2003): Average Vessel Age: 4 years			
120–124	120	49,999	35
125–129	125	84,999	46
130–139	138	105,000	48
140–158	149	114,980	48
160–175	164	158,982	52

Source: The 1981 fleet distribution was prepared based on a sample taken from Clarkson Research Studies, Ltd, The Tanker Register, London, 1981.

3.5 PORT ARTHUR AND BEAUMONT VESSEL FLEETS

Port Arthur's and Beaumont's specific distributions are shown in tables 31 and 32. Port Arthur's two petroleum refineries are located inside the Taylor Bayou complex. The existing width at the mouth of Taylor Bayou and the configuration of the docks within Taylor Bayou limit the allowable vessel size. Widening of the mouth of the bayou and the west turning basin bottleneck curve was evaluated as part of the current study. The result of widening the mouth would facilitate increased use of larger vessels that are presently restricted from using this portion of the channel. The most common crude oil tankers unloading at the Taylor Bayou terminals are 85,000 DWT, have design drafts of 45 feet, and beams of approximately 124 feet. It was found that the design drafts associated with the current fleet of 75,000 to 85,000 DWT vessels are slightly greater than in the earlier period. Several new tankers in this group were constructed in the early 2000s and are presently using the Port Arthur portion of the channel. The maximum size using the Taylor Bayou facilities is generally in the 110,000 to 116,000 DWT class. Widening of the mouth of the entrance to Taylor Bayou will occur under the with-project future and this will allow better vessel maneuverability. Widening of the mouth was recommended as a result of the ERDC vessel simulation modeling. The Taylor Bayou current fleet is specially designed for that project reach, and the vessels are characteristically wider and shorter than other tankers in the 80,000 to 90,000 DWT class. The Taylor Bayou configuration currently makes it difficult to maneuver longer vessels, and therefore, the design of the Taylor Bayou fleet reflects wider beams. Based on application of the pilot rules (see Table 3), inbound 124-foot beam Taylor Bayou vessels cannot meet common-beam-range outbound Neches River tankers of 135 to 145 feet. Present beam restrictions for the 500-foot-wide Sabine

Pass Channel and Port Arthur Canal reaches stipulate that the combined beam width of meeting vessels cannot exceed 50 percent of the channel width. The proposed increase to a project width of 700 feet would enable Taylor Bayou tankers to meet the relatively wider Neches River tankers in the channel reaches up to the Taylor Bayou junction.

Table 31
Port Arthur Crude Petroleum Imports
Percentage of Imports by Vessel DWT

DWT (1,000s)	2002	2003	2004	2005	2006	2007
≤50	0.1	0.7	0.7	1.5	0.0	0.9
50–74.5	55.5	6.2	3.0	3.1	4.5	7.9
75–84.9	14.5	75.8	93.7	66.0	93.1	82.2
85–89.9	5.3	0.7	0.0	0.0	0.0	0.0
90–119.9	21.9	15.2	2.6	26.0	2.4	4.4
120–149.9	0.8	0.0	0.0	0.8	0.0	1.0
150–175	1.9	1.4	0.0	2.6	0.0	3.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, *Waterborne Commerce of the U.S.*, 2002–2007. The LRS was used to obtain the vessel DWT and associated characteristics.

Table 32
Channel to Beaumont Crude Petroleum Imports
Percentage of Imports by Vessel DWT

DWT (1,000s)	2002	2003	2004	2005	2006	2007
≤50	0.6	0.4	0.8	1.6	1.1	0.7
50–74.5	2.3	2.5	1.5	1.6	3.2	2.8
75–84.9	8.1	6.2	8.2	9.1	9.6	9.7
85–89.9	9.8	5.4	0.5	0.0	0.4	0.0
90–119.9	71.2	76.2	78.8	80.2	77.6	80.2
120–149.9	2.9	3.3	3.9	3.5	2.5	1.9
150–175	5.2	6.1	6.5	4.0	5.7	4.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, *Waterborne Commerce of the U.S.*, 2002–2007. The LRS was used to obtain the vessel DWT and associated characteristics.

The maximum sized vessels using the Channel to Beaumont are in the 150,000 to 170,000 DWT range. The maximum length for that group is approximately 900 feet, with a corresponding beam width of 164 feet. One percent of Beaumont's crude petroleum imports are associated with this group. Table 33 presents fleet-specific data corresponding to Beaumont and Port Arthur. Table 34 displays Beaumont's and Port Arthur's distributions by loaded draft. The annual distributions of tonnage by loaded draft exhibit large variance and also show distinct differences between the two ports.

Table 33
Crude Petroleum Vessel Characteristics
Representative of the Existing Fleet Through 2006
Vessel Length, Beam, and Design Draft (feet) and Year Built

DWT (1,000s)	Port Arthur Taylor Bayou				Channel to Beaumont			
	LOA	Beam	Design Draft	Year Built	LOA	Beam	Design Draft	Year Built
≤50	580	102	36	1999	598	103	38	1998
50–74.5	748	106	45	2003	748	106	45	2002
75–84.9	758	124	45	2002	785	122	40	1988
85–89.9	800	131	43	1985	787	150	42	1992
90–119.9	810	138	45	1998	800	138	48	1998
120–149.9	892	150	56	2002	899	150	53	1996
150–175	899	158	52	2004	899	157	55	2003

Source: USACE, *Waterborne Commerce of the U.S.*, 2002–2006. The Fairplay/Lloyds Register of Ships (LRS) was used to obtain the vessel DWT and associated characteristics.

Table 34
SNWW Crude Petroleum 2002–2007 Imports by Loaded Draft

Loaded Draft (feet)	2002	2003	2004	2005	2006	2007
	Port Arthur Crude Petroleum Imports					
<35	7.6	2.6	0.3	9.5	5.0	4.6
35–37	10.5	8.6	0.0	47.6	56.7	19.0
>37	81.9	88.8	99.7	42.9	38.3	92.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
	Beaumont Crude Petroleum Imports					
<35	10.5	10.5	12.7	10.3	17.2	7.3
35–37	27.3	27.0	23.5	19.1	19.3	22.6
>37	62.2	62.5	63.8	70.6	63.5	70.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, *Waterborne Commerce of the U.S.*, 2002–2007. The LRS was used to obtain the vessel DWT and associated characteristics.

In comparison of Port Arthur and Beaumont relative port statistics, it was noted that for some years a greater percentage of crude tonnage is loaded to drafts of 38 feet or more for Port Arthur than for Beaumont. This is due to Port Arthur receiving a higher share of direct shipments from Mexico than Beaumont does. Generally, vessels will be loaded to deeper drafts for longer-distance direct routes. In comparison, Beaumont receives a higher share of lightered tonnage from both lightened mother vessels and shuttles. While there are cost incentives for loading to the maximum allowable depth, it was found that the average loaded drafts for the lightened mother vessels and shuttles were lighter than vessels associated with direct shipments. Deepening the Taylor Bayou reach would allow the present fleet of crude carriers to load to drafts over 40 feet; however, the transition to a larger DWT class is unlikely due to turning-area constraints. The turning-area constraints are unlikely to change even with channel deepening; however, industry representatives noted that a deeper channel will facilitate loading additional cargo on the existing range of vessels. While maximum vessel size ranges from 110,000 to 116,000 DWT, with design drafts of 49 feet, the most common crude oil tankers unloading at the Taylor Bayou terminals are 85,000 DWT and have design drafts of 43 feet. This common size is related to the entrance to Taylor Bayou for which widening was evaluated. A large portion of the vessels in the 85,000 and 110,000 to 116,000 DWT classes using Taylor Bayou were constructed in 2002–2003, which suggests that they will be utilized for another 20 years. The maximum beam width routinely allowed is 124 feet. Examination of vessel transits shows that the median and average beam for Taylor Bayou crude tankers is 124 feet and the maximum beam is 149 feet, with 92 percent of tonnage being transported in vessels with beam of 124 feet. The 124-foot beam corresponds to 85,000 DWT tankers, and the 149-foot beam corresponds to 116,000 DWT tankers. The maximum vessel length for Taylor Bayou vessels is approximately 758 feet. Vessels longer than 758 feet cannot easily be turned given Taylor Bayou boundaries and dimensions. For the Channel to Beaumont, 92 percent of tonnage is associated with beam widths over 130 feet. The vessel beams of both Port Arthur's and Beaumont's vessels causes them to be regularly impacted by the present 500-foot width of the Sabine Pass Jetty Channel and Port Arthur Canal.

3.5.1 Methods of Shipment for Crude Petroleum

The methods of shipping crude include direct, lightered, lightened, and transshipped. Direct shipment, as the name implies, is the transfer of tonnage by vessel between two coastal ports. Lightering is defined as the process involving ship-to-ship transfer of oil cargo, and it is extremely cost effective for long hauls. U.S. Gulf Coast lightering occurs in the international waters of the Gulf of Mexico and involves the transfer of tonnage from a larger vessel, called a VLCC, onto one or more shuttle vessels.

Figure 25 shows the U.S. Gulf offshore lightering zones. With lightering, the VLCC does not enter the coastal receiving port. A frequent alternative to either direct shipment or lightering is lightening. The term lightening describes the process where enough cargo is offloaded from a tanker to permit the light-loaded vessel to enter a confined channel system. The tanker sizes associated with lightening on the Texas Coast generally range from 120,000 to 175,000 DWT. Tankers larger than 175,000 DWT are normally lightered; however, there is a gap in the world tanker fleet between 175,000 and 250,000 DWT. The reason for the gap is that is not cost effective to use tankers significantly larger than 175,000 DWT for direct shipment even for channel depths of less than 55 feet. Analyses of the cost per ton transportation

costs also show that it is not cost effective to use vessels smaller than 250,000 DWT for lightering. An increase in channel depth to the SNWW would provide opportunity for these shuttles to be more fully loaded.

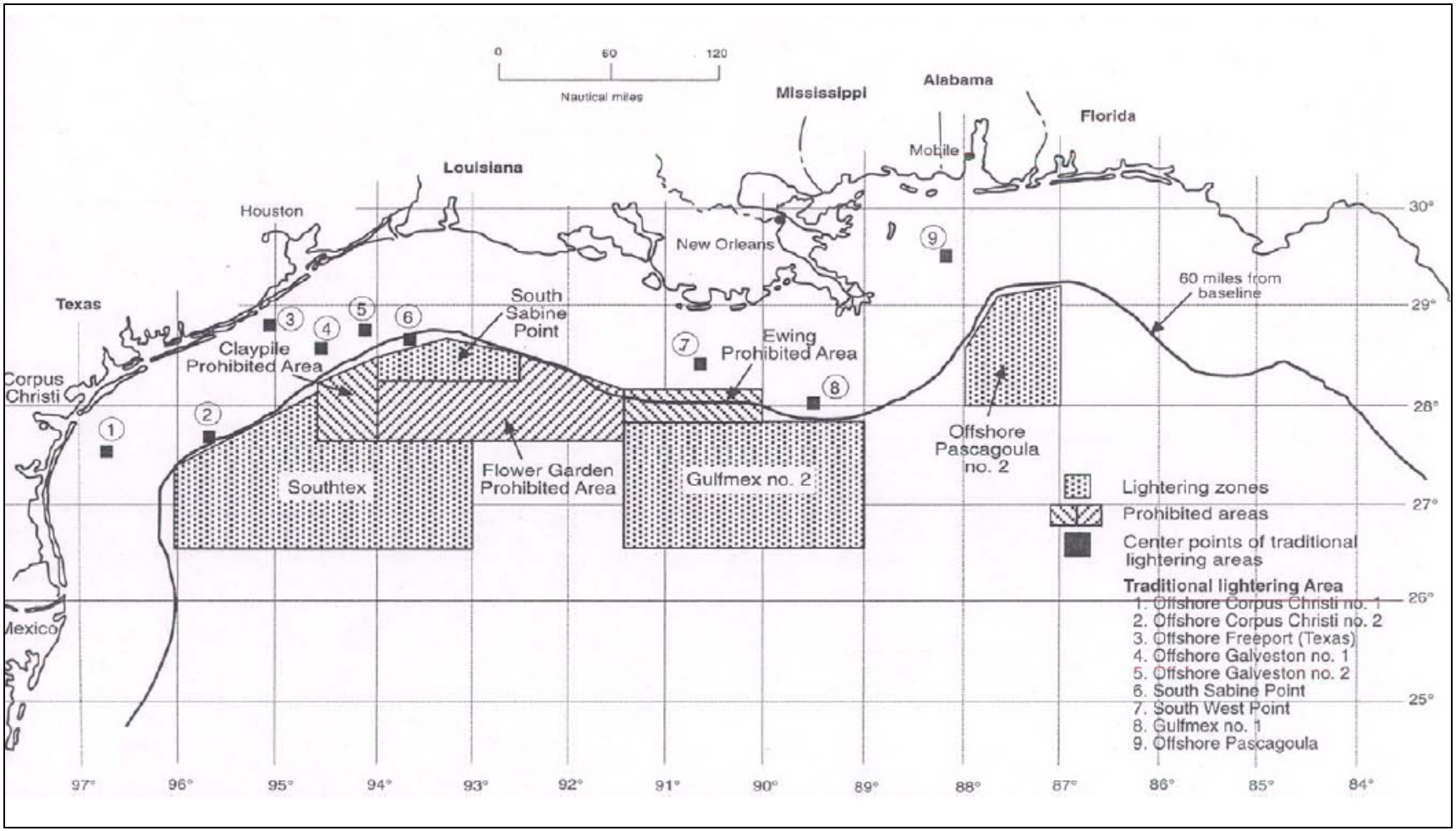
Africa, Mediterranean, and Europe movements are either lightened or shipped direct. The tanker sizes associated with lightening on the Texas Coast generally range from 120,000 to 175,000 DWT.[26] Tankers larger than 175,000 DWT are normally totally lightered offshore onto shuttles. Shipments from Africa, the Mediterranean, and Europe are usually transported in tankers between 90,000 and 175,000 DWT, with direct shipments generally using tankers between 90,000 and 120,000 DWT.

Transshipping is the fourth method of shipment. Crude oil is also transshipped through deepwater ports in the Caribbean. Crude is transported on VLCCs to the transshipped sites and later transferred to 90,000 to 114,000 DWT range shuttle tankers for shipment to the SNWW.

The primary sized vessel used on the Mexico/Eastern South America route for direct shipments into the SNWW is presently 90,000 to 114,000 DWT. Review of the 2007 *Fairplay Tanker Register* showed that the design drafts associated with tankers of 90,000 to 114,000 DWT generally range from 40 to 51 feet, with the average being 48 feet. An increase in channel depth to Port Arthur and Beaumont would provide opportunity for these shuttles to be more fully loaded. The size of the largest tankers using the SNWW in 2005–2007 on a regular basis is 169,146 DWT. The length, beam, and design draft for this vessel is 935x148x61 feet. In addition to transportation cost incentives, vessel selection is also related to the way crude petroleum is currently sold and how crude oil is shipped. Presently, parcels are generally sold in 500,000 to 650,000 barrels. A 500,000- to 650,000-barrel parcel converts to approximately 75,000 to 95,000 short tons. Many vessels arrive in the international waters of the Gulf of Mexico with double parcels. Cost analyses show that the most economical sized vessel for single parcels is between 75,000 and 100,000 DWT given the existing channel depth of 45 feet. For double parcels, the most efficient size is between 150,000 and 175,000 DWT.

[26] USACE, unpublished data.

Figure 25
U.S. Gulf Coast Crude Petroleum Lightering Zones



Source: Ellis, John, "Commonality of GoM [Gulf of Mexico] Lightering, Experience with GoM Shuttling", Floating Production, Storage and Offloading Global Workshop, September 25, 2002, http://lovie.org/pdf/John- Ellis.pdf.

Gulf Coast industry personnel indicated that parcel size and associated ship size are primarily a function of the existing channel dimensions. The indication suggests that an increase in channel dimensions would likely result in a shift to larger parcel sizes and larger vessels. Comparison of the parcel sizes associated from the early 1990s with 2007 crude oil imports revealed that the distribution of tonnage by parcel size increased for Texas ports where the channel operating depths increased from 40 to 45 feet. Comparison of crude oil import records from the early 1990s with 2007 records illustrates that larger parcels are being shipped today and suggests that the channel deepening from 40 to 45 feet facilitated this transition.

Lightening is a common alternative to either direct shipment or lightering for some routings, and it describes the process where enough cargo is offloaded from a tanker to permit the light-loaded mother vessel to enter a confined channel system. Africa, Mediterranean, and Europe movements are either lightened or shipped direct. The tanker sizes associated with lightening on the Texas Coast generally range from 120,000 to 175,000 DWT. Tankers larger than 175,000 DWT normally are totally lightered offshore onto shuttles. Shipments from Africa, the Mediterranean, and Europe are usually transported in tankers between 90,000 and 175,000 DWT, with direct shipments generally using tankers between 90,000 and 120,000 DWT.

Shipments from the Europe/North Sea/Africa trade route are usually transported in tankers between 90,000 and 175,000 DWT, with direct shipments generally using tankers between 90,000 and 120,000 DWT. Tankers larger than 175,000 DWT are normally lightered. The primary sized vessel used on the Mexico/Eastern South America route for shipments into the SNWW and other U.S. Gulf Coast ports is 90,000 to 114,000 DWT; however, vessels up to 120,000 DWT are not uncommon.[27] Review of the 2007 *Fairplay Tanker Register* showed that the design drafts associated with tankers of 90,000 to 114,000 DWT generally range from 40 to 51 feet, with the average being 48 feet. The limited volumes of direct shipments from the Middle East are usually shipped in vessels between 90,000 and 120,000 DWT; however, direct shipment of crude originating in the Middle East is not a cost-effective choice.

The logistics associated with offshore transfers introduce higher degrees of uncertainty than direct shipment and, therefore, generate large cost variances. Industry indicated that lower cost differences between direct versus offshore transfer costs may increase the likelihood of direct shipment. Industry personnel indicated that the number of days to completely lighter a VLCC normally ranges from 4 to 10 and that the average number of days to completely lighter 200,000 to 300,000 DWT vessels is 5.5; however, it was noted that 2 weeks is not uncommon. Five and one-half days equate to 1.5 times the in-port unloading rate. Utilization of the upper limit of 2 weeks appears to relate to a less than optimal number of shuttles and shuttle turnaround rate.

Identification of the number of days used for the SNWW analysis was based on inputs from industry including data outlined in the Skaugen PetroTrans' publication "Introduction to Lightering."[28] The mother vessels used for Gulf Coast lightering are generally in the 300,000 to 350,000 DWT range. The SNWW

[27] USACE, unpublished data.

[28] Skaugen Petro Trans Inc., Introduction to Lightering, October 25, 2006. http://www.teekay.com/PDFs/Lightering101.pdf.

cost calculations were based on a VLCC of 320,000 DWT, which is the largest tanker presented in the USACE's EGM. The Skaugen publication includes a graphic with three shuttle vessels taking 3 days to totally offload a VLCC. While not noted in that publication, the use of three shuttles implies a channel depth of 45 feet or more, as each shuttle would need to accommodate 100,000 tons of cargo in order to offload a 300,000 DWT mother vessel. The maximum cargo load that can be transported on tankers between 100,000 and 150,000 DWT, given a 40-foot channel depth, ranges from approximately 70,000 to 86,000 short tons (see Table 109). Given a channel depth of 40 feet, four shuttles are needed to totally offload a 300,000 DWT vessel. Identification of the number of shuttle vessels needed by channel depth is outlined later in this document (see Table 110).

Discussion with industry personnel, including Skaugen, revealed that unloading rates for crude oil would generally range from 4,038 to 5,250 short tons per hour. It was also noted that the rate of 4,038 would be representative for offshore operations; therefore, this rate was used for the SNWW offshore vessel calculations. Given an unloading rate of 4,038 short tons per hour, a 300,000 DWT vessel carrying a full load of 291,000 short tons would take 3 days, or 72 hours, to completely unload based on optimal logistics. Using the same unloading rate, a 350,000 DWT vessel carrying a full load of 339,500 short tons would take 84 hours, or 3.5 days, to completely unload. The SNWW lightering cost calculations are based on the mother vessel being offshore for 24 hours for each shuttle vessel used. Based on 24 hours, the mother vessel would be offshore for a total of 96 hours given four shuttles and 72 hours given three shuttles.

An increase in channel depth would reduce the number of shuttles. For instance, a three-shuttle operation would take 72 hours, down from 84 hours for a four-shuttle operation. The affect of using greater and lesser offshore times on channel depth optimization is evaluated in the sensitivity section (Section 8.6).

The mother vessels associated with lightening are generally in the 150,000 to 175,000 DWT range. Given an unloading rate of 4,038 short tons per hour, a 175,000 DWT vessel carrying a full load of 160,050 short tons would take 19.8 hours, or 0.8 day, to discharge one-half of its cargo. The lightening cost calculations are based on one day or 24 hours. The 24 hours includes a combination of unloading at sea and waiting at sea. Travel time to port was calculated as a separate line item as was unloading time in port. The effect of using greater and lesser times on channel depth optimization is evaluated in the sensitivity section (Section 8.3).

Comparison of direct shipment costs with those for lightering or lightening for the Africa, Mediterranean, and Europe route revealed that while the average cost for lightering or lightening is less than the average cost for shipping direct, the percentage difference between direct shipment costs and the offshore alternatives is considerably less than for either Mexico/South America or Middle East and Far East origins. The relative closeness in the costs between shipping methods for Africa, Mediterranean, and Europe tonnage and, in particular, the variance associated with the number of days necessary to complete the offshore transfer process contributes to a higher percentage of direct shipment for this route than optimal or than least-cost computations would suggest. A risk of delays, in association with the closeness in costs between shipping methods, contributes to a proportion of direct shipments that is higher than

what might occur if the variance associated with the cost of lightering did not overlap with the cost of shipping direct. Examination of the cost data suggests that an increase in channel dimensions would probably result in an increase in direct shipment movements for Africa, Mediterranean, and Europe shipments.

Comparison of the method of shipment costs for Eastern South America and the Persian Gulf did not show that channel depth increases over 50 feet provided cost incentives to switch from one method of shipment to another, given channel depth constraints between 43 and 48 feet. In general, lightening is not cost effective for tonnage on the Persian Gulf trade route because the economies of scale associated with existing practices result in a lower cost for lightering than what would be attained through lightening. The reason lightering is cheaper than lightening for Persian Gulf/Indian Subcontinent shipments is because the magnitude of the mileage component of the per ton cost is large enough to offset the relatively large fixed cost attributable to having the mother vessel remain offshore for 5.5 days. For similar reasons, the relatively short distance and high fixed costs associated with either lightening or lightering eliminates any incentive for Mexico/Eastern South America shipments to shift to lightening. Despite the clear lack of economic rationale for lightering Mexico/Eastern South America tonnage or shipping Persian Gulf/Indian Subcontinent tonnage direct, relatively inefficient shipping methods are used for some shipments on these trade routes. The decision to lighter Mexico/Eastern South America tonnage or ship Persian Gulf/Indian Subcontinent tonnage direct results from less than perfect world market conditions. For purposes of analysis, the least-cost practical alternative was assumed given existing technology and anticipated future innovations. Specifically, the cost calculations were made using direct shipment for the Americas; lightering for the Middle East and Far East; and lightening for Africa, Europe, and the Mediterranean for the 40-foot channel with a transition to direct shipment for increased channel depth alternatives based on transportation cost efficiencies.

Regardless of trade route, the vessel size utilized is sometimes related to the way crude petroleum is sold. Currently, crude petroleum is traditionally sold in parcels of 500,000 barrels. A 500,000-barrel parcel converts to approximately 75,000 short tons. The most economical size vessel for a 75,000-ton parcel is between 75,000 and 100,000 DWT. For 150,000-ton parcels, the most efficient size is between 150,000 and 175,000 DWT. Ninety-four percent of the 100,000 to 140,000 DWT vessels in the world fleet have design drafts in excess of 45 feet, and 32 percent of the vessels between 75,000 and 100,000 DWT have design drafts over 45 feet. The SNWW channel deepening alternatives were formulated assuming that the maximum ship size for both direct shipments and lightered vessels would be 175,000 DWT. Vessels over 100,000 DWT would continue to be light-loaded under the with-project condition; however, there would be a reduction in the number of feet light-loaded. U.S. Gulf Coast industry personnel indicated that parcel size and associated ship size is primarily a function of the existing channel dimensions and that an increase in channel dimensions would likely result in a shift to larger parcel sizes and larger vessels.

Evaluation of the percentage of SNWW tonnage transported in vessels anticipated to utilize depths over 40 feet was primarily based on the relative change in per ton transportation cost between the existing 40-foot channel depth and increased channel depths. Cost analysis suggested that nearly all vessels used to transport crude petroleum from Mexico, Venezuela, and Central and South America would be loaded to

depths over 45 feet. Expectations concerning the percentage of Middle East and Africa movements are subject to greater uncertainty. Nearly all Middle East tonnage is presently lightered. Lightering is also the least-cost alternative for Far East tonnage.

Table 35 presents Port Arthur and Beaumont crude petroleum imports by trade route. The format of the USACE's WCSC's shipping records obtained by the USACE through the Bureau of Census do not provide sufficient information to distinguish lightened tonnage from direct or lightered tonnage. Industry discussions revealed that lightened tonnage is primarily limited to shipments from Western Africa, and transportation cost analysis conducted by the USACE for SNWW confirmed this. While the port loading facilities in Western Africa do presently accommodate the VLCCs associated with lightering, this situation could change over the 50-year period of analysis, and the affect of changing this variable is evaluated in the sensitivity analysis.

The data presented in Table 35 include a "trade route classification" titled "lightered." The tonnage included under this classification includes shuttle vessels associated with lightering and lightening; however, it does not completely reflect the total volume of tonnage associated with the lightering or "offshore transfer" process. In particular, a large part of the tonnage included under West Africa, North Europe, and the Mediterranean, and, to some degree, the Middle East and Far East is partially offloaded onto shuttle vessels. The port classification noted in the Census data for these lightening mother vessels is the country of origin. The port of origin shown for all shuttle vessels is the "international waters of the Gulf of Mexico." Using the data provided, it is not possible to reconstruct the specific routing. For this reason, the costs associated with lightering and lightening need to be reconstructed to determine what the most efficient method of shipment is. While it is cost effective to lighten crude shipped from West Africa and it is cost effective to lighter VLCCs from the Middle East, some tonnage from these routes is presently shipped direct. Additionally, some tonnage from Mexico is lightered. While the method of shipment for all cargo may not represent the most cost effective means, the transportation cost calculations were prepared assuming that the most cost effective method of shipment would be chosen under the without- and with-project future.

Table 35
SNWW Percentage of Crude Petroleum Imports by Trade Route

	Port Arthur Imports by Trade Route					
Trade Route	2002	2003	2004	2005	2006	2007
Mexico	67.6	79.6	94.0	72.0	94.9	88.8
Central and South America and Caribbean	0.0	0.0	0.9	0.4	1.1	0.4
Venezuela and Colombia	3.6	4.2	1.7	9.2	0.0	1.1
Western South America	0.0	1.9	0.6	1.9	0.0	0.0
Northern Europe and Mediterranean	12.3	1.2	0.8	4.0	1.5	2.5
Western Africa	0.0	0.7	0.0	1.4	0.0	1.5
Middle East	11.1	0.0	0.0	4.1	0.5	0.7
Lightered	5.3	12.4	2.0	7.0	2.0	5.0
Port Arthur Total	100.0	100.0	100.0	100.0	100.0	100.0
	Beaumont Imports by Trade Route					
Canada	4.2	1.5	0.0	0.4	0.6	0.7
Mexico	32.6	23.0	21.8	24.4	22.6	22.4
Central and South America and Caribbean	0.5	1.4	1.8	2.7	2.3	2.5
Venezuela	6.1	10.7	7.8	8.7	7.1	8.4
Colombia	3.7	3.2	2.8	2.2	1.6	1.4
Brazil and Argentina	0.5	0.0	0.4	0.0	0.0	0.0
Western South America	0.2	0.3	0.1	0.1	0.1	0.3
Northern Europe and Mediterranean	8.7	5.4	12.3	12.3	16.1	6.7
Western Africa	4.7	2.2	8.9	7.1	9.1	3.3
Middle East	24.5	0.4	25.4	21.2	34.5	19.5
Far East	0.1	0.1	0.1	0.2	0.0	0.0
Lightered	14.2	51.8	18.6	20.7	6.1	34.9
Beaumont Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, *Waterborne Commerce of the U.S.*, 2002–2007.
The LRS was used to obtain the vessel DWT and associated characteristics.

Table 36 presents comparative trade route data for PADD III. Table 37 presents SNWW's trade route distribution. The SNWW data were compiled were from USACE NDC, and the PADD III data were compiled from the EIA data records.[29] The first part of the top shows PADD III imports. Comparison of PADD III data with SNWW indicates the SNWW receives a higher percentage of its crude oil imports from Mexico and a lower percentage from Venezuela than PADD III. Additionally, based on the combined total of Middle East and "lightered tonnage," the SNWW receives a much higher percentage of Middle Eastern crude than PADD III; however, SNWW's "lightered tonnage" also includes shuttle vessels associated with lightening of tankers from West Africa.

[29] USDOE, EIA, Imports by Country of Origin (includes vessel and pipeline movements).

Table 36
PADD III Percentage of Crude Petroleum Imports by Trade Route

Trade Route	2002	2003	2004	2005	2006	2007	2008
Canada	1.1	0.5	0.3	0.4	1.1	1.7	2.0
Mexico	27.0	26.8	26.2	26.0	27.4	24.6	22.1
Central and South America and Caribbean	1.8	1.6	1.2	1.3	1.2	0.8	0.5
Venezuela	20.4	19.5	20.1	18.3	17.3	17.6	16.4
Colombia	2.7	1.9	1.5	1.6	1.5	1.5	2.0
Brazil and Argentina	0.6	0.4	0.4	0.8	0.0	1.2	1.8
Western South America	0.1	0.5	1.2	1.4	1.1	0.8	0.9
Northern Europe and Mediterranean	8.4	8.8	7.4	9.7	10.0	9.4	8.0
Western Africa	7.9	10.3	13.5	14.6	16.6	18.1	18.2
Middle East	29.1	29.1	27.0	24.6	23.8	24.1	28.1
Other (not identified)	1.0	0.7	1.3	1.5	–	–	–
Lightered (not available)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PADD III Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: USDOE, compiled from the EIA website, 2009.

Table 37
SNWW Percentage of Crude Petroleum Imports by Trade Route, 2002–2007

Trade Route	2002	2003	2004	2005	2006	2007
Canada	3.6	1.3	0.0	0.3	0.5	0.7
Mexico	37.4	32.7	32.1	32.0	35.9	11.1
Central and South America and Caribbean	0.4	1.1	1.6	2.1	1.9	2.8
Venezuela	5.7	9.3	6.9	8.5	5.8	9.5
Colombia	3.2	2.9	2.4	2.1	1.3	1.4
Brazil and Argentina	0.4	0.0	0.3	0.0	0.0	0.0
Western South America	0.2	0.5	0.2	0.4	0.1	0.3
Northern Europe and Mediterranean	9.2	4.7	11.9	14.3	13.6	9.1
Western Africa	4.0	2.0	8.9	7.3	8.0	4.8
Middle East	22.7	0.3	25.1	26.7	29.8	20.1
Other (Far East)	0.1	0.1	0.1	0.1	0.2	0.0
Gulf of Mexico Lightering	13.0	45.0	10.6	6.2	2.9	40.0
Beaumont Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, *Waterborne Commerce of the U.S.*, 2002–2007.

Under the current and future without- and with-project conditions, the "mother vessels" offload partial cargoes to shuttle vessels and both vessels come into port. The lightened mother vessels were modeled in the ERDC ship simulation. These "lightened mother vessels" are the "design vessels." The analysis for the offshore transfer process was based exclusively on operating costs. The duration of the transfer, number of shuttle tankers, supply boats, and equipment was estimated in terms of a "range of time," and

the costs for vessels and equipment were determined. The shuttle vessel costs and additional pilot and tug charges were identified.

For a with-project condition that includes deepening, the mother vessels would discharge less cargo offshore. Based on the mother vessel discharging less cargo offshore, the with-project condition would affect the number and sizes of the shuttle vessels. For direct shipments, a with-project condition where the channel is deepened would allow for fewer vessel trips as the existing range of vessels would be able to carry more cargo. The specific differences in the without- and with-project conditions are outlined in the transportation cost analysis section (Section 6).

The trade route forecast for SNWW's crude petroleum imports was prepared based on analysis of U.S. import and world production forecasts and application of recent historical SNWW and U.S. Gulf Coast routings. The U.S. and Gulf Coast 2006 period base distribution and the EIA 2010–2030 trade route forecast are presented in Table 38. The EIA is forecasting significant decrease in imports from Mexico. The SNWW ports have historically received over 30 percent of its crude petroleum imports from Mexico; however, in 2007 imports from Mexico only represented 11 percent. The EIA forecasts indicate that the majority of U.S. crude oil imports will come from the Middle East, Europe, and Africa. The principal sources for Middle East and European shipments are included under the following origins: Persian Gulf, Russia,, Asia, Eurasia, and China.

Table 38
EIA Production Forecast Conventional Crude Production and
Sources of U.S. Crude Oil Imports and SNWW Application

	U.S. Imports by Trade Route (%)			
Trade Region	2006	2010	2019	2029
Mexico	5.1	3.3	2.9	2.9
South and Central America	8.5	8.5	9.1	0.106
Europe and West Africa	42.4	44.5	43.8	43.0
Middle East and Asia	44.0	43.7	44.1	43.6
Total	100.0	100	100	100

	PADD III Imports (%)			SNWW Imports (%)		
Trade Region	2006	2007	2008	2006	2007	2019/2029
Mexico	27.4	24.6	22.1	35.9	11.0	10.0
South and Central America	21.1	23.8	21.6	9.1	14.0	17.0
Europe and West Africa	27.7	27.5	28.2	30.3	41.3	37.7
Middle East and Asia	23.8	24.1	28.1	24.8	33.8	35.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Application of AEO2009 forecasts and EIA and USACE base data.

The trade route forecast presented in Table 38 was then applied to the crude petroleum tonnage projections. Mileages were weighted based on existing and anticipated percentage of tonnage by trade region. Trade regions were grouped based on general regions and similar vessel utilization patterns and port constraints.

3.6 PETROLEUM PRODUCT CARRIERS

Examination of the vessel characteristics and geographic routings associated with SNWW petroleum products suggests that some product carriers could be more fully loaded. Distribution of SNWW petroleum product imports and exports by vessel DWT class is displayed in Table 39. Analysis of product imports showed that from 32 to 54 percent of 1998–2007 imports and 5 to 27 percent of exports were transported in vessels of 60,000 DWT or more. In 2007, 42 percent of product imports and 14 percent of exports were transported in vessels of 60,000 DWT or more. As noted in Section 2.2, product import variability is also reflected in the distribution of the U.S. products types. This distribution is characterized by annual fluctuations prompted by conditions where outputs fall short or are preempted by other market drivers.

Table 39
SNWW Petroleum Product Import Tonnage by Vessel DWT

	SNWW Percentage of Imports by DWT Range					
DWT Range	1998	2001	2004	2005	2006	2007
<10,000	4.3	0.0	0.4	0.0	0.4	1.3
10,000 to 29,999	12.1	6.2	2.8	4.4	1.1	4.4
30,000 to 49,999	45.8	48.9	41.3	48.7	58.1	45.6
50,000 to 59,999	5.5	3.0	1.4	1.1	2.2	7.1
60,000 to 69,999	3.8	15.1	16.7	9.3	12.8	6.9
70,000 to 79,999	2.7	0.0	15.2	18.4	17.0	21.2
80,000 to 89,999	4.0	8.9	5.4	7.3	0.0	0.0
90,000 to 99,999	15.8	5.4	3.7	3.3	2.1	0.5
100,000 to 116,000	6.0	12.6	13.2	7.5	6.4	13.1
Total	100.0	100.0	100.0	100.0	100.0	100.0
	SNWW Percentage of Exports by DWT Range					
<10,000	2.9	2.5	3.0	1.0	1.4	1.7
10,000 to 29,999	14.3	11.9	9.5	15.5	7.2	8.6
30,000 to 49,999	67.3	57.0	69.0	72.9	77.6	61.2
50,000 to 59,999	7.2	1.4	10.0	4.2	8.7	14.5
60,000 to 69,999	4.1	12.1	4.4	1.7	2.7	5.5
70,000 to 79,999	1.9	11.4	4.0	4.7	0.6	8.5
80,000 to 89,999	2.2	0.0	0.0	0.0	1.7	0.0
90,000 to 99,999	0.1	1.2	0.0	0.0	0.0	0.0
100,000 to 116,000	0.0	2.4	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, *Waterborne Commerce of the U.S.*, 1998–2007.

The Fairplay/Lloyds Register of Ships (LRS) was used to obtain the vessel DWT and associated characteristics. Vessel DWT, design drafts over 40 feet, and parcel size were among the variables examined to help evaluate the potential transition to deeper vessel loads. Tables 40 and 41 present product imports and exports by major commodity type and shows the annual percent of each grouping transported in vessels of 60,000 DWT or more.

Examination of the data in tables 40 and 41 shows that there are large annual variances in the percentage of annual tonnage associated with the draft and parcel size. Based on this variance and planning guidance, depths at trading ports and comparable operations at similar ports were also evaluated. Discussions with local shippers also indicated that product carriers for some trade routes and customers would be loaded to depths over 40 feet if the channel was deepened. Examination of petroleum product import and exports transported through other U.S. Gulf Coast ports with channel depths over 40 feet showed that 34 percent of distillate imports were loaded to drafts of 42 feet or greater and 24 percent of petroleum coke exports were loaded to drafts of 42 feet or more. Many of these shipments were associated with ports in Russia, North Africa, Venezuela, and Brazil. Other routings include the Far East. The use of the Panama Canal for all of the Far East and over half of the South America destinations will limit the sizes of vessels used for that trade until the Panama Canal expansions are completed after 2014.

Table 42 shows the world petroleum product fleet data as compiled from the LRS. The table includes the percentage of vessels on order as of January 2009. Table 42 shows that 45 percent of the petroleum product tankers on order in 2009 have design drafts of 47 to 49 feet or more and 12 percent have design drafts of 50 feet or more.

Table 40
Imports and Exports Shipped in Vessels of 60,000 DWT or Larger
SNWW Petroleum Product Imports
1998–2007 (select years)

Major Commodity Group	Total Imports by Commodity Group (1,000s of short tons)						Percent of Imports Transported in Vessels ≥60,000 DWT					
	1998	2001	2004	2005	2006	2007	1998	2001	2004	2005	2006	2007
Gasoline	–	33	1,613	2,213	1,678	1,096	–	0	6	14	8	15
Distillate Fuel	102	572	728	1,286	1,267	1,872	40	75	73	7	78	67
Residual Fuel	57	25	810	804	351	355	100	100	59	94	74	16
Lube Oil and Greases	2,140	700	619	50	71	2	83	90	80	0	39	39
Naphtha and Solvents	808	1,138	1,977	595	368	719	21	5	81	49	16	16
Asphalt, Tar and Pitch	11	–	–	7	–	–	–	–	–	–	–	–
Petroleum Coke	250	266	255	365	84	276	10	–	21	48	–	10
Other	124	–	–	29	–	–	6	–	–	–	–	–
Total Imports	3,492	2,734	6,003	5,349	3,819	3,744	58	42	54	46	39	40

Source: USACE, *Waterborne Commerce of the U.S.*, 1998–2007.
The LRS was used to obtain the vessel DWT and associated characteristics.

Table 41
SNWW Petroleum Product Exports
1998–2007 (select years)

Major Commodity Group	Total Exports by Commodity Group (1,000s of short tons)						Percent of Exports Transported in Vessels ≥60,000 DWT					
	1998	2001	2004	2005	2006	2007	1998	2001	2004	2005	2006	2007
Gasoline	1,376	1,258	19,49	1,778	1,777	1,970	1	–	3	–	1	10
Distillate Fuel	602	179	449	371	371	345	42	–	–	11	9	58
Residual Fuel	206	12	0	51	68	–	12	–	–	–	50	–
Lube Oil and Greases	41	63	57	99	117	60	10	–	–	–	10	10
Naphtha and Solvents	0	146	8	58	94	22	4	–	–	–	4	–
Petroleum Coke	1,622	3,447	4,688	4,362	4,362	4,210	13	35	13	14	6	9
Other	463	17	0	104	33	–	–	–	–	–	–	–
Total Imports	4,328	5,122	7,151	6,823	6,822	6,607	8	23	9	9	5	15

Source: USACE, *Waterborne Commerce of the U.S.*, 1998–2007.
The LRS was used to obtain the vessel DWT and associated characteristics.

Table 42
World Petroleum Product Fleet

Design Draft (feet)	Median DWT	Percentage of Total DWT	
		Built 1985–2004	On Order as of January 2009
<36	13,000	13	4
36–38	38,500	14	2
39–40	46,000	23	13
41–42	47,000	26	12
43–44	68,000	5	12
45–46	85,000	7	0
47–49	99,900	9	45
50–51	110,000	2	12
	Total	100	100

Source: LRS, 2009.
* Excludes crude oil and chemical tankers.

While it is anticipated that annual variance will continue, the use of draft-constrained vessels for several markets served by the SNWW is also anticipated to continue and likely increase due to increases in maximum beam width and loaded draft for Panama Canal transits that will open trade opportunities to additional markets. SNWW petroleum coke exports are expected to remain steady due to the construction of an additional coker and increased refinement of high-sulfur crude oil. Table 43 displays the major destinations for U.S. petroleum coke exports. Of the destinations shown in Table 43, the U.S. Gulf Coast primarily serves the North and South American and European markets; however, expansion of the U.S. Gulf Coast share to include Pacific markets may increase after 2014 as a result of the Panama Canal expansion. While published forecasts of specific trade routes are not available, the SNWW presently serves markets that can accommodate more fully loaded product carriers, and it was assumed that some cargo movements would transition to more fully loaded vessels based on the economics of scale of loading to increased depths and availability of channel depths in excess of 40 feet at some trading ports. As shown in tables 40 and 41, relatively large carriers are used for high-volume commodities such as distillate and residual fuel imports and petroleum coke exports.

Table 43
U.S. Petroleum Coke Exports by Major Destination
(Percentage)

	Western Hemisphere			Europe and Mediterranean			Pacific			Major	All
Year	Canada	Mexico	Brazil	Italy	Netherlands	Spain	China	India	Japan	Importers	Other
2002	4.5	7.4	6.5	8.0	3.6	12.5	2.7	0.3	14.5	42.4	57.6
2003	6.1	9.4	7.2	10.2	3.0	10.8	5.0	0.8	11.9	46.8	53.2
2004	6.3	7.7	7.1	7.7	3.7	10.6	0.9	1.7	13.1	43.1	56.9
2005	6.9	8.9	8.9	7.5	4.0	8.9	1.7	2.0	13.5	45.2	54.8
2006	6.6	11.2	9.3	8.5	3.3	8.7	1.4	1.9	12.6	47.5	52.5
2007	6.3	12.8	11.2	7.7	1.9	11.2	1.6	3.0	11.7	51.1	48.9
2008	7.7	13.3	9.3	7.7	2.7	8.8	1.3	2.4	12.5	49.3	50.7

Source: USDOE, compiled from the EIA website, 2009.

For petroleum product imports and exports, a steady volume of domestic coastwise product tankers use Port Arthur and Beaumont. Domestic coastwise movements primarily consist of gasoline, distillate, and residual fuel shipments. These products are refined at the SNWW ports and then shipped to the U.S. East Coast, specifically eastern Florida. In 2006, coastwise shipments totaled 3.6 million short tons. Coastwise receipts were 978,000 short tons. Examination of vessel specifics showed that approximately 10 percent of outbound coastwise shipments were transported in draft-restricted tankers. These product carriers generally are between 60,000 and 70,000 DWT with design drafts in the 41- to 43-foot range. The vessels used are all U.S. flag vessels, Jones' Act vessels. The median age of the current fleet exceeds 10 years, with most vessels built in the 1980s. The combination of U.S. tanker availability, depths at trading ports, parcel size demand, the cost effectiveness of loading to greater drafts, and industry discussion suggest that the percentage of tonnage that would utilize channel depths over 40 feet would be closer to 10 percent in the short term increasing to 20 percent over the period of analysis

3.7 CHEMICAL PRODUCT CARRIERS

For the period 2002–2007, chemical imports and exports represented approximately 3 percent of both SNWW and U.S. total foreign tonnage. Evaluation of 1998–2007 chemical exports showed that the percentage of tonnage associated with design drafts between 40 and 44 feet ranged from zero to 14 percent, averaging 4 percent annually. An average of 16 percent of 1998–2006 export tonnage was transported in loaded drafts between 36 and 40 feet. In 2007, 18 percent of SNWW chemical products were transported in vessels with loaded drafts between 36 and 40 feet. Export tonnage represented 75 percent of SNWW 2002–2006 import-export total. Approximately two-thirds of 2002–2007 exports were shipped from Beaumont and the remainder from Port Arthur. Seventy-nine percent of 2002–2007 imports were shipped into Beaumont and the remainder to Port Arthur.

Review of the chemical carrier fleet showed the youngest fleet sector includes a large number of vessels between 30,000 and 49,999 DWT. This portion of the fleet represents over 50 percent of the total fleet. Tables 44 and 45 present data associated with the existing chemical fleet and with vessels on order. Table 44 shows the chemical fleet through 2004, and Table 45 provides comparison of the percentage of total deadweight tonnage for representative classes for 1985–2004 and 2009. Table 45 shows that 21.8 percent

of the chemical tankers on order in 2009 have design drafts of 43 feet or more, and 1.6 percent of chemical tankers on order have design drafts of 47 feet or more.

Consideration of "vessel-on-order" records, world port development trends, and the Panama Canal expansion represent indicators used for projecting future vessel use. Integral to estimating changes in vessel selections is the operational goal of minimizing vessel transportation cost. Minimization of transportation cost, given trade route constraints and commodity parcel needs, recognizably drives long-term vessel choices. Of the vessels on order, 1.6 percent of vessels have design drafts of 48 feet. Review of existing cargo loads suggests that the draft-constrained tonnage will likely consist of metallic salt exports, ammonia imports and acyclic hydrocarbon exports. Project benefits were calculated assuming that approximately 10 percent of future chemical imports and 15 percent of future chemical export tonnage would be transported in vessels with loaded drafts between 40 and 49 feet.

Table 44
World Chemical Product Fleet, Vessels Built between 1985 and 2004

	Total	% of	Median Vessel Characteristics				Year
DWT Range	DWT	DWT	DWT	LOA	Beam	Design Draft	Built
<10,000	2,793,389	9.9	5,780	338	54	21	1997
10,000 to 20,000	3,479,986	12.4	14,364	454	71	29	1999
20,000 to 30,000	1,593,037	5.7	25,415	557	84	34	1998
30,000 to 39,999	6,544,848	23.3	37,068	599	91	36	2001
40,000 to 49,999	11,246,740	4.0	45,632	599	106	40	2000
50,000 to 59,999	568,838	2.0	50,600	600	106	44	1987
60,000 to 69,999	129,976	0.5	64,988	750	106	43	2000
70,000 to 79,999	146,521	0.5	73,261	749	106	47	1996
80,000 to 102,000	1,620,338	5.8	83,987	750	106	53	1988
Total	28,123,673	100.0					

Source: LSR, 2006.

Table 45
Chemical Product Fleet

Design Draft (feet)	Median DWT	Percentage of Total DWT	
		Built 1985–2004	On Order as of Jan 2009
<36	13,000	36.1	34.1
36–38	38,500	23.6	18.6
39–40	46,000	24.2	17.7
41–42	47,000	6.6	6.2
43–44	50,000	3.5	21.8
45–46	85,000	0.9	–
47–49	95,000	5.1	1.6
50–51	n/a	–	–
	Total	100.0	100.0

Source: LRS, 2009.

3.8 GRAIN EXPORTS

Grain is exported from the Beaumont elevator located just below the Port of Beaumont main turning basin. Wheat presently composes 100 percent of Beaumont's grain exports for the most recent 5-year period and represented 5 percent of U.S. 2007 wheat exports. During earlier years, wheat represented 85 percent, sorghum 10 percent and corn 5 percent. Table 46 displays Beaumont's 2001–2007 grain export tonnage by grain type and loaded draft.

Table 46
Beaumont Bulk Grain Export
Distribution of Tonnage by Grain Type
and Loaded Vessel Draft

	2001	2002	2003	2004	2005	2006	2007
Bulk Grain Export Totals by Year (Short Tons)							
Total Exports	831,000	835,000	1,125,000	1,329,000	1,080,639	1,214,010	1,632,000
% by Grain Type							
Wheat	79.0	88.8	100.0	100.0	100.0	100.0	100.0
Corn	6.5	8.4	0.0	0.0	0.0	0.0	0.0
Sorghum	14.5	2.8	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
% by Loaded Draft (feet)							
≤35	56.8	65.8	65.3	67.8	62.8	35.5	50.8
36–37	6.7	5.5	11.6	9.0	15.2	25.7	18.5
38–40	36.5	28.7	23.1	23.2	22.0	38.8	30.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE, Waterborne Commerce Database, 2001–2007.

Thirty percent of 2002–2007 grain export tonnage was shipped in vessels with design drafts over 40 feet. The maximum DWT presently used for grain exports is in the 60,000 to 75,000 DWT range, with 68 percent of 2006 exports. These vessels have design drafts between 42 and 43 feet. The large increase in the concentration of larger vessels since 2006 was due to exports to Iraq. For 2003–2007, the destination for the larger vessels primarily consisted of Egypt, Jordan, and Lebanon. Until the early 1990s, grain carriers in excess of 100,000 DWT used the SNWW. These larger vessels were associated with Eastern Europe grain shipments. The deeper-loaded vessels are nearly all associated with wheat shipments. Review of grain exports for other U.S. Gulf Coast ports with channel depths of 45 feet showed that bulk carriers transporting wheat exports are loaded to 45 feet.[30] The specific type of bulk carriers used for grain is "load-on/load off" or "LoLo" vessels. LoLo vessels are also used for SNWW steel slab, limestone, and wood product tonnage. The median year of construction for the range of vessels transporting grain from Beaumont is 1985, which is older than the median of 1998 associated with the world fleet. Review of the distribution of vessels on order and the port depths at receiving ports indicates that some transition in the average DWT range from the existing 60,000 to 75,000 DWT into the 80,000 to 94,000 DWT range is reasonable to expect. Table 47 displays the existing fleet of LoLo vessels in the world fleet; the table also displays LoLo vessels on order.

[30] USACE, unpublished data.

Table 47
LoLo Bulk Dry Cargo Carriers (World Fleet)

	Vessels in Operation				
DWT Range	Total DWT	Percent DWT	Median DWT	Design Draft (feet)	Year Built
<25,000	5,825,500	3	20,035	30	1996
25,000 to 44,000	31,009,518	14	32,755	34	1994
45,000 to 64,000	33,235,975	15	49,061	39	2000
65,000 to 79,000	58,832,687	27	73,445	45	1998
80,000 to 94,000	3,716,652	2	88,405	43	2000
95,000 to 106,999	414,221	0	105,712	50	2001
107,000 to 169,999	38,252,170	18	151,257	57	1994
170,000 to 260,000	45,324,613	21	172,964	58	2000
Total	216,611,336	100			

	Vessels on Order			
DWT Range	Total DWT	Percent DWT	Median DWT	Design Draft (feet)
<25,000	775,191	1	18,500	28
25,000 to 44,000	4,430,571	8	34,525	34
45,000 to 64,000	11,825,398	21	54,500	41
65,000 to 79,000	9,044,747	16	75,750	46
80,000 to 94,000	9,382,833	17	82,788	47
95,000 to 106,999	815,150	1	100,000	44
170,000 to 199,999	18,990,990	34	177,015	59
Total	55,264,880	100		

Source: LRS, 2006.

3.9 STEEL SLAB AND IRON ORE CARRIERS

For the period, 2002–2006, an average of 2.5 percent of U.S. iron ore and steel slab imports were transported through the SNWW ports. For the period 2002–2007, imports ranged from a low of 240 thousand short tons in 2007 and a high of 1,136 thousand short tons in 2005. The 2002–2006 average annual import volume of 783 thousand short tons is over 100 percent higher than 1990–1993 average levels. The decline in 2007 appears to be reflective of the U.S. market. It is noted that imports were unusually high in 2006 partially due to increased demand and higher prices paid in the U.S. market in comparison to foreign markets.[31] As a result, U.S. inventories increased in 2006. In 2007, import orders were slowed by the excessive inventory and foreign demand. It was emphasized in the *U.S. and International Market Outlook for 2007* that the origin of U.S. steel imports is evolving. It is noted that the shift in the origin of U.S. steel imports applies not only to simpler items like bars and rods but also to more-sophisticated products like oil country goods, cold-rolled coils, and hot-dip galvanized coils. Thus, in oil country goods the leader in 2006 was China; in cold-rolled coils the leaders were Brazil and China; in hot-dip coils India and China. The price of steel scrap dropped in 2007. Long-term expectations are that the market will rebound. Table 48 displays the 2005–2007 countries of origin for SNWW iron and steel imports. India is the seventh largest producer of steel in the world and supplied 26 percent of SNWW steel slab imports in 2007. Steel products are shipped from the Indian port of Dhamra on the eastern coast where channel deepening commenced in 2007. Dhamra will be the deepest port of India with a draught of 18 meters, which can accommodate super cape-size vessels up to 180,000 DWT. The master plan provides for 13 berths, capable of handling more than 83 million tons per annum of dry bulk, liquid bulk, breakbulk, and containerized cargo. The project is expected to be completed by March 2010.[32]

Presently, the most common carriers used on the SNWW for the transport of steel slab and iron ore are LoLo bulkers in the 45,000 to 53,000 DWT range, with a maximum vessel size of 78,000 DWT. Review of the Lloyd's/Fairplay Vessel Register (2003) showed that 23 percent of bulk carriers constructed over the past decade are in the 66,000 to 78,000 DWT range. As noted, this is the same vessel type that is used for grain; however, the specific vessels are different with each cargo having dedicated carriers. Examination of the foreign ports of call for 1998–2001 SNWW tonnage showed that an average of 8 percent of tonnage was transported through world ports with channel depths of 44 to 47 feet. Examination of 2005–2007 routings shows a similar distribution of foreign ports as in 1998–2001. Vessel usage and general indicators, such as depths at trading ports and the design drafts for new vessel orders, suggests that, in the short-term, a minimum of 10 percent of present iron ore movements would utilize channel depths over 40 feet. Expansion of the Panama Canal is expected to increase the percentage to 50 percent by the year 2014. Project benefits were calculated assuming that 10 percent of 2015–2020 tonnage and 50 percent of 2020–2069 would be transported in vessels with loaded drafts between 40 and 49 feet.

[31] Phelps, David, President, American Institute for International Steel, U.S. and International Market Outlook for 2007 and Trade Policy Update, presentation at the 5th International Steel Market and Trade Conference 2007 in Guangzhou, China, March 2007.
[32] http://www.dhamraport.com/default.asp.

Table 48
Percentage of SNWW Iron and Steel Product Imports by Country of Origin

Country	2005	2006	2007
Argentina	0.2	–	–
Brazil	11.3	16.0	0.2
Colombia	0.0	0.0	–
Mexico	52.2	43.8	17.0
Venezuela	3.0	2.8	25.1
Denmark	–	–	1.0
Federal Republic Germany	–	–	3.2
Italy	0.1	–	–
Netherlands	0.3	–	1.0
Portugal	–	–	–
Poland	–	0.1	–
Russia	7.5	7.1	17.7
United Kingdom	0.4	0.0	1.0
China (Mainland)	1.9	3.7	1.8
Hong Kong	–	–	1.0
India	–	–	26.0
New Zealand	–	0.5	–
Thailand	–	–	5.0
Other (via crude oil tankers)	23.1	26.2	0.0
Total	100.0	100.0	100.0
Total Imports (short tons)	1,138,000	826,000	240,000

Source: USACE, *Waterborne Commerce of the U.S.*, 2005–2007, detailed files; LRS, 2006.

3.10 LIMESTONE AND ROCK CARRIERS

SNWW aggregate tonnage primarily consists of imports of limestone, rock, and other raw building materials. For the period 2005–2007, 3 percent of U.S. limestone and rock imports were transported through the SNWW ports. Table 49 displays SNWW aggregate tonnage. Presently, the most common carriers used on the SNWW are in the 46,000 to 77,000 DWT range. Table 50 displays the fleet used for SNWW 2002–2007 aggregate imports. Presently nearly all tonnage is transported in vessels with design drafts over 40 feet. Current vessel usage and general indicators, such as depths at trading ports and the design drafts for new vessel orders, suggests that some 50 percent of iron ore movements would utilize channel depths over 40 feet due to the expansion of the Panama Canal. The shipments of clay and refractory materials are associated with vessels with loaded drafts over 37 feet and design drafts over 40 feet.

Table 49
SNWW Building Material Imports and Exports (1,000s of short tons)

	Sand, Gravel, and Limestone Imports (Total Imports and Estimated Port Share)			Sulphur and Refractory Material Exports (Total Exports and Estimated Port Share)			Estimated % of Combined Tonnage Transported in Vessels with Design Drafts ≥40 feet		
Year	Total	Port Arthur	Beaumont	Total	Port Arthur	Beaumont	Sand and Gravel	Limestone	Sulphur and Refractory Materials
1999	617	90	10	0	0	0	100	0	0
2000	495	36	64	13	0	100	99	60	0
2001	635	18	82	40	0	100	99	37	0
2002	1,117	20	80	16	12	88	99	78	0
2003	658	40	60	46	2	100	99	57	0
2004	642	35	65	104	28	72	99	100	0
2005	815	36	64	91	12	88	100	100	21
2006	816	44	56	261	18	82	99	100	0
2007	829	41	59	463	12	88	99	99	11

Source: USACE, *Waterborne Commerce of the U.S.*, 1999–2007.

Table 50
SNWW Aggregate Tonnage Fleet, 2002–2007

Vessel DWT	Loaded Draft (feet)	Estimated % of 2002–2006 Imports	Vessel Characteristics			
			Length (feet)	Beam (feet)	Design Draft (feet)	Year Built
46,606	33	11	615	106	37	1995
62,594	40	4	747	106	44	1982
67,044	35–40	54	753	106	43	1984
77,499	40	26	804	106	46	1991
<40,000	n/a	5	n/a	n/a	n/a	n/a
	Total	100				

Source: USACE, *Waterborne Commerce of the U.S.*, 2002–2007, detailed files.

3.11 WOOD PRODUCT CARRIERS

For 1998–2006, approximately 1 percent of U.S. wood product tonnage was transported through the SNWW ports. Wood products also represent 1 percent of the SNWW 1998–2006 foreign total. The largest wood product carriers used on the SNWW are in the 50,000 to 60,000 DWT range. The design drafts of these ships are right at 40 feet; and it was found that wood chip carriers, like container vessels, characteristically reach capacity in terms of volume before they reach their design drafts. Review of 2002–2006 data showed that the load patterns were the same as for 1998–2001. The nature of wood chip cargo suggests it is unlikely that the current fleet could be loaded to depths greater than 40 feet and, therefore, deepening benefits were not calculated for wood products. Discussion with industry representatives confirmed this. Additionally, review of the LRS showed that the maximum design draft

for wood chip carriers built between 1995 and the present is 39.4 feet. Analysis of the parcel sizes and 1995 to present construction and ships on order suggests that wood products are unlikely to realize benefits from channel depths over 40 feet in the near future. Analysis of 2002–2007 wood product movements and consultation with industry representatives confirmed these initial findings.

3.12 LIQUEFIED NATURAL GAS (LNG) FLEET

Discussion with industry representatives and review of the vessels on order revealed that LNG vessels with design drafts of 40 feet or more are being constructed. The existing vessel sizes and underkeel clearance requirements suggest that channel depths of 43 to 44 feet would be necessary. Table 51 displays the world LNG fleet, including vessels on order.

Table 51
World Liquefied Natural Gas Fleet

Year Built	DWT Total	Percent of DWT	DWT	Length of Ship (feet)	Beam (feet)	Design Draft (feet)
Constructed Between 1980–2002 (Average Vessel Dimensions)						
1980–1990	1,742,877	25.6	69,715	910	142	38
1991–2002	5,064,932	74.4	67,532	889	144	37
Total	6,807,809	100.0				
Vessels Constructed After 2002 (Average Vessel Dimensions)						
Design Draft Range (feet)	Total DWT	Percent of DWT	DWT	Length of Ship (feet)	Beam (feet)	Design Draft (feet)
36.6 to 39.9	2,868,168	66.0	74,852	927	147	38
40.0 to 41.1	1,453,796	34.0	77,750	930	144	41
Total	4,321,964	100.0				
Vessels on Order 2007 (Average Vessel Dimensions)						
21 to 30	83,242	0.7	8,200	450	98	24
35 to 41	230,250	1.8	58,900	825	127	38
37 to 41	5,516,514	43.9	74,400	945	145	39
37 to 40	2,102,350	16.7	83,000	928	142	38
39 to 45	3,129,719	24.9	100,000	1,033	164	45
39 to 45	1,499,200	11.9	125,600	1,132	176	39
Total	12,561,275	100.0				

4.0 COMMODITY AND FLEET FORECASTS

Commodity and fleet forecasts were prepared for crude petroleum and petroleum and chemical products, grain, iron and steel products, limestone and building materials, and LNG. The remaining oceangoing commodity groups, which were found either not to be transported in draft-constrained vessels at the current time or were of limited volumes, were analyzed in the aggregate. Estimation of total traffic was needed for the widening analysis and also provided critical input for the shore erosion effects evaluation performed by ERDC.

National forecast data and general indicators were assessed in relationship to the study area's historical commodity-specific tonnage flows for the purpose of evaluating the relationship between historical U.S. tonnage volumes and study area tonnage. The vessel fleet forecasts incorporate recent historical practices, which reflect continued and increased utilization of draft-constrained vessels under the without- and with-project futures.

The outputs of the commodity and fleet projections were based on forecasts published by Global Insight, USDOE's EIA *Annual Energy Outlook* (AEO2008) and (AEO2009); Global Insight, *The U.S. Economy, The 30-Year Focus*, First Quarter 2008 and Second Quarter 2009; USDA *Agricultural Baseline Projection Tables, USDA Baseline Projections Report to 2018*, February 2008 and February 2009; and from indices developed from historical trend data. The EIA forecasts extend through 2030. The Global Insight forecasts extend through 2035. The USDA forecasts extend through 2018.

The commodity forecasts presented in this document were initially prepared in 2008. The effect of 2009 EIA, Global Insight, and USDA 2009 forecast releases were evaluated and some changes were made to the SNWW projections based on the 2009 forecast releases. The effects of recent forecasts not incorporated into the base analysis are addressed in the sensitivity analysis.

4.1 REVIEW OF PETROLEUM FORECASTS

Table 52 presents the current range of U.S. crude petroleum import forecasts outlined in the AEO2008, AEO2009 and AEO2010. The forecasts presented include the AEO 2008 (January 2008), AEO2009 (March 2009), AEO2010 (May 2010) Global Insight, and Purvin and Gertz's. The AEO2010 data was received late in the report preparation process; therefore, discussion of it is not included in the text. The AEO2009 forecast shows U.S. crude oil imports declining at an annual rate of approximately –2.0 percent between 2007 and 2030. The AEO2009 forecast reflects the effect of the American Recovery and Reinvestment Act of 2009 in February 2009 and shows U.S. demand for liquid fuels growing by only 1 million BPD between 2007 and 2030 and shows no growth in oil consumption over the forecast period. Oil use is curbed due to the combined effects of a rebounding oil price, more-stringent corporate average fuel economy standards, and requirements for the increased use of renewable fuels. A key difference between the AEO and Global Insight forecasts is that the relative percentage crude oil and petroleum imports reflects higher volumes of products than the Global Insight forecast. Comparison of the relative distributions of U.S. and SNWW imports between crude oil and refined products shows that SNWW's

distribution reflects a significantly higher relative percentage of crude oil than products. Table 53 displays distributions of SNWW and U.S. relative percentages of crude petroleum versus refined products. Comparison of the SNWW and U.S. distributions shows that SNWW receives a significantly higher share of crude petroleum than the Nation as a whole. As a major refinery center, the SNWW distribution shown in Table 53 is expected to continue without- and with-project future conditions.

Table 52
U.S. Crude Oil Imports Comparative Projections
(Millions of Barrels Per Day)

	AEO Reference			AEO 2010 Low Price	Purvin & Gertz			Global Insight		
Year	2008	2009	2010		2008	2009	2010	2008	2009	2010
2007	10.0	10.0	10.0	10.0	n/a	10.0	10.0	10.0	10.0	10.0
2015	10.2	8.1	8.9	10.1	n/a	n/a	11.8	12.0	11.1	9.7
2025	11.0	6.7	8.7	11.7	n/a	12.4	12.3	13.7	12.1	10.6
2030	11.9	7.0	8.7	12.7	n/a	12.7	n/a	14.5	12.5	11.7
2035	n/a	n/a	8.7	13.6	n/a	n/a	n/a	n/a	12.9	n/a

Source: USDOE, AEO2008, 2008, and 2010. Global Insight 2035 forecast value was obtained from non-published back-up data obtained from Global Insight.

Table 53
U.S. and SNWW Distribution of Crude Oil and Petroleum Imports
Relative Percentage of Crude Petroleum Imports Versus Refined Products

	U.S. Import Distribution		SNWW Import Distribution	
Year	Crude Oil	Petroleum Products	Crude Oil	Petroleum Products
1990	74	26	90	10
1995	82	18	95	5
2000	79	21	93	7
2001	79	21	93	7
2002	79	21	92	8
2003	79	21	92	8
2004	76	24	94	6
2005	74	26	94	6
2006	74	26	94	6
2007	75	25	94	6

Source: Global Insight and USACE, *Waterborne Commerce of the U.S.*, 1990–2007.

Another major difference between AEO and Global Insight is that the EIA reference forecast reflects higher domestic crude oil production throughout the projection period. Additionally, the EIA shows domestic production increasing rapidly instead of gradually. As noted on the EIA website, their forecast not only shows higher domestic production, it also shows rapid increase in domestic production.

In spite of differences in the relative distribution of crude oil versus products, analysis of the national and regional crude petroleum import volumes showed a high degree of correlation between study area and U.S. tonnage levels. The high correlation rates suggested that application of U.S. forecast trends to the study area is generally appropriate (Section 2); evaluations also showed that SNWW's overall rate of growth is higher than for the U.S. and Gulf Coast (see Table 8). Continuation of historical trends suggests that SNWW crude petroleum imports would grow at higher rates than the region (PADD III) and the Nation. Refineries in PADD III provide significant product supply to both the East Coast and Midwest. For example, about 60 percent of all gasoline produced in PADD III refineries is moved to other regions for consumption. In 2008, nearly half of the gasoline consumed in the East Coast region (PADD I)–about 1.6 million BPD–was supplied from PADD III. PADD III refineries supplied about 18 percent or approximately 0.5 million BPD of gasoline consumed in the Midwest (PADD II). PADD III also supplies a small amount of gasoline to the West Coast region (PADD V), mainly Arizona. Most of the gasoline volume moved from PADD III to those regions travels by pipeline (80 percent by pipeline into PADD I, 90 percent into PADD II, and virtually all into PADD V).

The historical trendline and anticipated 2012 completion of the 325,000 barrel per day crude petroleum refinery capacity in Port Arthur suggests that downward growth rate reflected in the AEO2009 forecast does not characterize SNWW's future. The Port Arthur and Beaumont terminals transport 400,000 BPD of waterborne crude oil via pipelines to inland refineries including refineries in Texas, Louisiana, Oklahoma, Ohio, Arkansas, and Kentucky.[33] The SNWW refineries supply 15 percent of the product on Colonial's system and 13 percent of the product on Explorer's system (see Figure 10). SNWW's capacity represents 6 percent of the U.S. total. Specific capacity is 572,000 BPD for Port Arthur and 577,000 BPD for Beaumont. SNWW capacity levels for 2009 are presently 12 percent higher than in 2004, and 31 percent higher than in 1994. The Motiva expansion of 600,000 BPD will result in a 52 percent increase in SNWW refinery capacity from the current volume of 1,149,000 BPD to 1,749,000 BPD. The Motiva expansion will make it the largest refinery in the U.S. and one of the largest in the world.

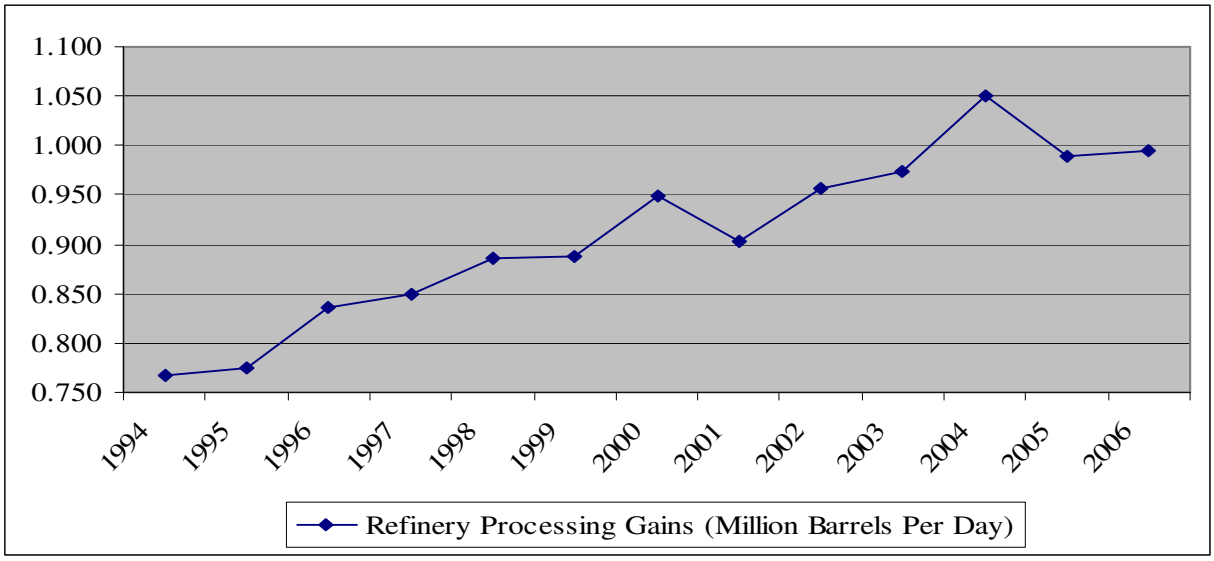
SNWW's crude oil imports were prepared using the Global Insight forecast shown in Table 52. The Global Insight's forecast reflects continuous increases in refinery processing gains through 2035. Refinery gains, which are measured by the differences in volumetric gains and are reflected by total outputs greater than input due to the processing of crude into products, were significant over the last 12 years (Figure 26). Review of the data presented on Figure 26 shows a maximum processing gain of 1.05 million BPD in 2004. Global Insight forecast of refinery gains exceed historical levels by approximately 5 percent in 2019 and 15 percent by 2030.

Other considerations in forecasting include the geographical source of imports or the use of oceangoing vessels versus pipeline, and, as noted, the share of conventional versus nonconventional liquids. Both the AEO and Global Insight project increases in nonconventional energy production and trade. SNWW

[33]Martin Associates. 2006. Economic Impacts of the Sabine-Neches Waterway and Economic Benefits of Maintenance Dredging of the Waterway. Martin Associates, Lancaster, Pennsylvania.

presently receives some conventional Canadian crude by vessel and through existing pipelines; however, annual volumes are low due to pipeline limitations and market logistics that favor other locations.

Figure 26
U.S. Refinery Processing Gains
1994–2006 Data



Source: Global Insight, 1994–2007.

Canadian crude oil has historically been consumed in five market areas that include Ontario, British Columbia, Washington State, U.S. Rocky Mountains, and U.S. Midwest.[34] The TransCanada Corporation is in the process obtaining permits for expansion to the Keystone Pipeline System. While the system that stretches from Alberta, Canada, to Cushing, Oklahoma, is completed, an additional extension from Cushing to the U.S. Gulf Coast is under evaluation. Financial commitments for the extensions to the Texas Gulf Coast are not expected before 2011.[35]

4.2 SNWW CRUDE PETROLEUM FORECAST APPLICATION

Identification of the specific range of import volumes was estimated by incorporating the forecast volumes into a regression equation using SNWW imports as a function of U.S. imports. Table 54 displays SNWW's regression equation application using the Global Insight forecast results shown in Table 52. The equation is based on 1990–2007 data. An R Square of 0.903 was produced from the equation. The t-value and F statistic for the equation are significant at statistical confidence levels exceeding 99.999 percent. The resulting application shown in Table 54 includes the application of one standard deviation from the mean. The mean values range from 86,639 thousand short tons in 2019 to 101,016 thousand short tons in 2035. The band associated with the standard deviation produces import estimates of plus and minus

[34] Canadian Association of Petroleum Producers, "Crude Oil Pipeline Forecast, Markets, and Pipeline Expansions, June 2007 Expansion Project Summary Report," February 2005, reference to the Muse, Stancil and Company Report.
[35] March 2008 RebObit News Article.

approximately 41 percent, which produces a 2035 minimum of 60,218 thousand and a maximum of 141,813 thousand sort tons, with 101,016 thousand representing the mean.

Table 54
1990–2007 Regression Equation Data for
SNWW Crude Oil Imports

Component	Description of Data and Outputs
Dependent Variable	SNWW Crude Imports (1990–2007)
Independent Variable	U.S. Crude Imports
Adjusted R Square	0.903
No. of Observations	17
Degrees of Freedom	1
F Statistic	150.02
Significance of F statistic and t values	0.9999

	Regression Equation Data		
	Base	Application of Standard Deviation	
	Output	Minus 1	Plus 1
Constant	–41677.6	–57644.2	–25711
Standard Error of Y Estimate	5456.66	5456.66	5456.66
X Coefficient: U. S. Crude Oil Imports	0.2009	0.1660	0.2360

		SNWW (1,000s of Short Tons) 2003–2007			
Historical	U.S.		Base	Application of Standard Deviation	
Year	Imports	Actual	Estimate	Minus 1	Plus 1
2003	528,703	70,158	70,158	30,128	99,045
2004	553,337	69,875	69,875	34,218	104,858
2005	553,923	59,691	59,691	34,315	104,996
2006	553,489	57,615	57,615	34,243	104,894
2007	547,958	56,088	58,110	33,324	103,588

		SNWW Regression Based Forecast a/		
Forecast	U.S.	Base	Application of Standard Deviation	
Year	Imports	Estimate	Minus 1	Plus 1
2015	614,522	81,835	44,375	119,295
2019	638,425	86,639	48,343	124,936
2030	689,959	96,997	56,899	137,096
2035	709,951	101,016	60,218	141,813

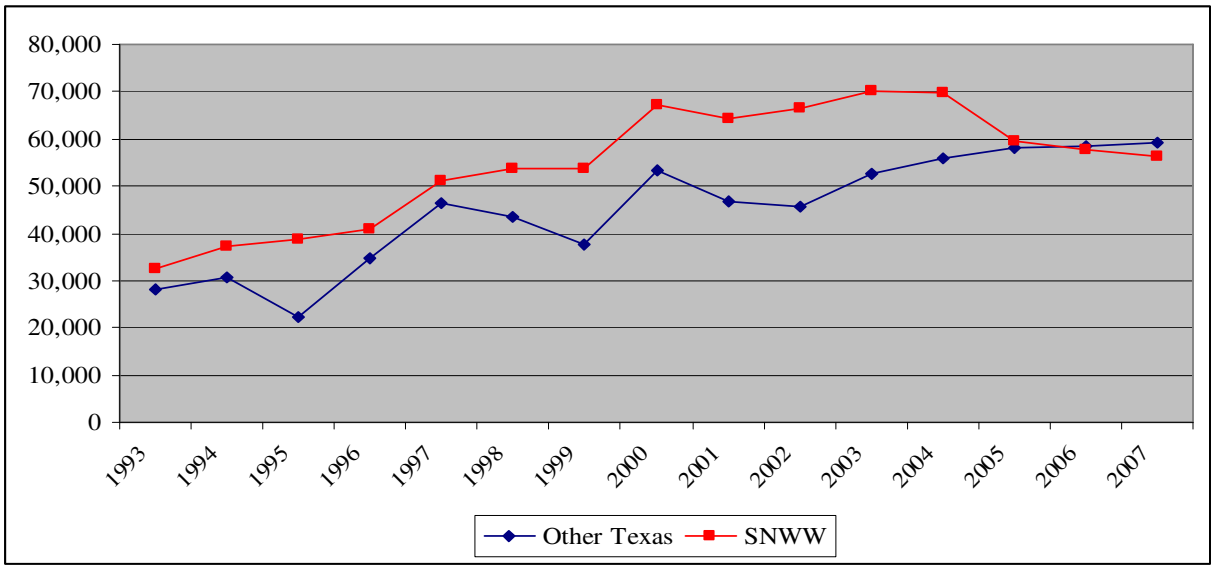
Source: USACE, *Waterborne Commerce of the U.S.* 2003–2007 and USDA, EIA, Presentation of Global Insight Forecast, USDOE/EIA-0383(2009), Table 20, Comparison of Liquids Projections.

a/ SNWW 2019 Imports = –41677.6 + (0.5456.66 * 638,425) with 638,425 short tons being U.S. imports in 2019.

The SNWW regression equation results presented in Table 54 reflect the inclusion of several variables that reduce future estimated volumes. One variable is the effect of Hurricane Rita. Declines in 2005–2007 imports are largely attributable to supply disruptions associated with Hurricane Rita, which devastated the SNWW region in September 2005. The hurricane surge resulting from Rita resulted in sand bars at the offshore Entrance Channel and silting of the Neches River Channel to Beaumont. Silting of the Neches River Channel severely limited transit of the upper reaches for several months and resulted in tonnage diversions to other ports due to loaded-draft limitations. The effect of shoals in the Entrance Channel and

silt deposits in the Neches River due to the hurricane surge had a particularly strong effect on crude petroleum traffic due to the use of large heavily loaded vessels. Comparison of SNWW crude petroleum tonnage with comparable ports is shown on Figure 27. The figure helps to illustrate the effect on short-term trends and resulting changes in the distribution of imports.

Figure 27
SNWW and Other Texas Ports
Crude Petroleum Imports (1,000s of short tons)



Source: USACE, *Waterborne Commerce of the U.S.*, 2005–2007, unpublished data.

Based on concerns from SNWW industry interests, the effect of excluding 2005–2007 data was examined. The results of excluding 2005–2007 produces a higher volume of long-term imports and reduces the standard error associated with the Y estimate (Table 55). The mean values range from 94,229 thousand short tons in 2019 to 110,765 thousand short tons in 2035. The band associated with the standard deviation produces import estimates of plus and minus approximately 21 percent.

Figure 28 displays the regression estimate associated with equations using SNWW imports as a function of U.S. imports. Figure 29 displays 1990–2004 actual imports and the statistical estimated, including the 95 percentile confidence interval. Excluding 2005–2007 from the regression based forecast helps to account for the short-term effects of Hurricane Rita; however, there are other variables that are likely to result in higher future import volumes than the 1990–2004 based regression equation would suggest. The key variable that cannot be measured accounted for in regression is refinery capacity expansions. Construction on the 325,000 BPD crude petroleum refinery capacity in Port Arthur is expected to be completed in the first quarter of 2012. This addition will result in a 28 percent increase in SNWW refinery capacity from the current volume of 1,149,000 BPD to 1,473,000 BPD.

Table 55
1990–2004 Regression Equation Data for
SNWW Crude Oil Imports

Component	Description of Data and Outputs
Dependent Variable	SNWW Crude Imports (1990–2004)
Independent Variable	U.S. Crude Imports
Adjusted R Square	0.9784
No. of Observations	15
Degrees of Freedom	1
F Statistic	633.52
Significance of F statistic and t values	0.9999

	Regression Equation Data		
	Base	Application of Standard Deviation	
	Output	Minus 1	Plus 1
Constant	–53,360.3	–62,129.2	–44,591.4
Standard Error of Y Estimate	2,691.57	2,691.57	2,691.57
X Coefficient: U. S. Crude Oil Imports	0.2312	0.2114	0.2510

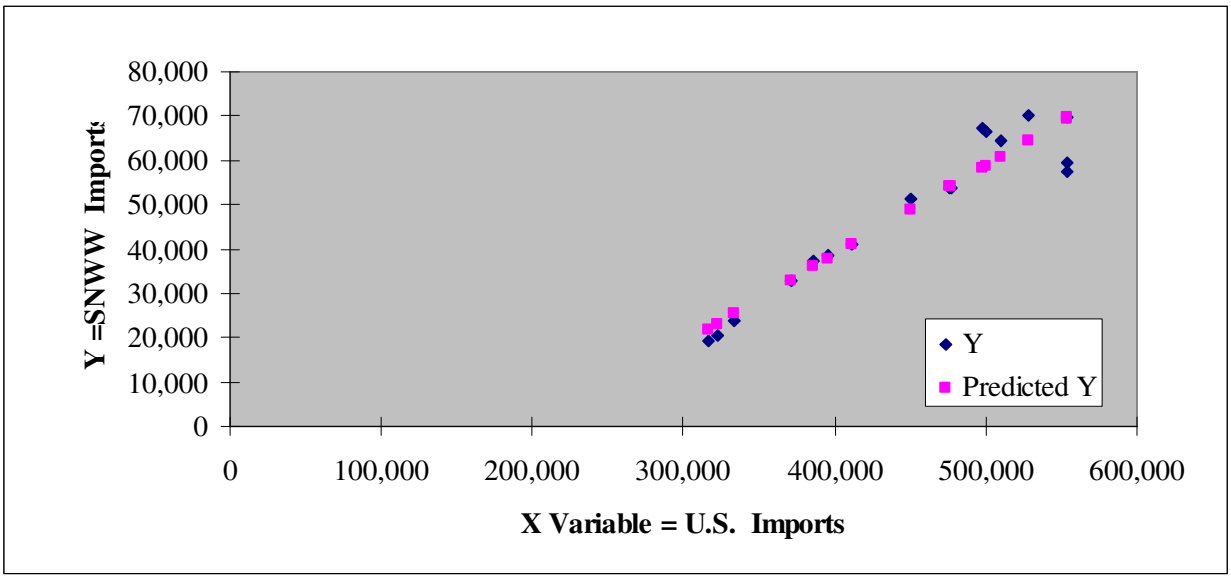
		SNWW (1,000s of Short Tons) 2003–2007			
Historical	U.S.		Base	Application of Standard Deviation	
Year	Imports	Actual	Estimate	Minus 1	Plus 1
2003	528,703	70,158	68,864	49,605	88,124
2004	553,337	69,875	74,559	54,811	94,307
2005	553,923	59,691	74,694	54,934	94,454
2006	553,489	57,616	74,594	54,843	94,346
2007	547,958	56,088	73,315	53,674	92,957

		SNWW Regression Based Forecast a/		
Forecast			Application of Standard Deviation	
Year	U.S. Imports	Base Estimate	Minus 1	Plus 1
2015	614,522	88,704	67,741	109,666
2019	638,425	94,229	72,793	115,666
2030	689,959	106,143	83,684	128,602
2035	709,951	110,765	87,909	133,621

Source: USACE, *Waterborne Commerce of the U.S.* 2003–2007 and USDOE, EIA, Presentation of Global Insight Forecast, USDOE/EIA-0383(2009), Table 20, Comparison of Liquids Projections.

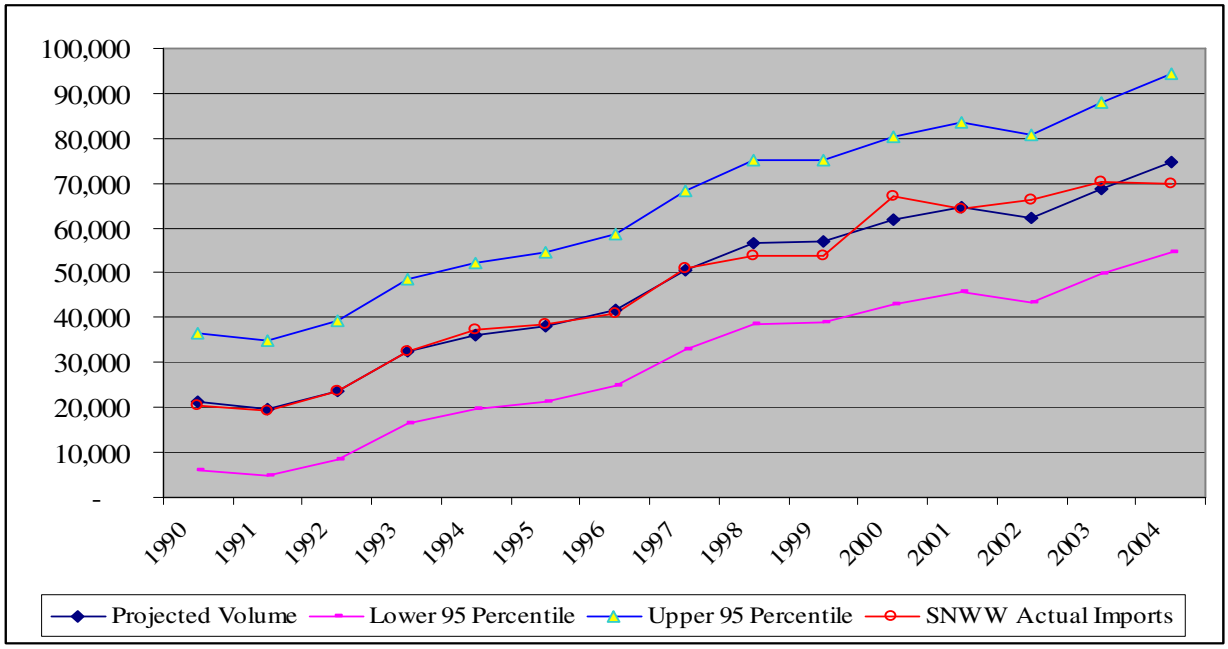
a/ SNWW 2019 Imports = –53360.3 + (0.2312 * 638,425) with 638,425 short tons being U.S. imports in 2019.

Figure 28
SNWW and U.S. Crude Petroleum Imports, 1990–2004
1,000s of Short Tons



Source: USACE, *Waterborne Commerce of the U.S.*, Part 2, 1990–2006 and EIA (2008).

Figure 29
SNWW Crude Petroleum Imports Projected and Actual Volumes (1,000s of Short Tons)



Other forecasting methods considered include trendline estimates. Table 56 presents the outputs of trendline estimates using 1980–2004 and 1990–2007 input data. As shown in Table 56, the mean values associated with the base are reasonable but the range of the 95 percentile confidence interval does not produce meaningful results.

Table 56
SNWW Trendline Equation Output
SNWW 1980–2007 and 1990–2007 Crude Oil Imports as a Function of Time

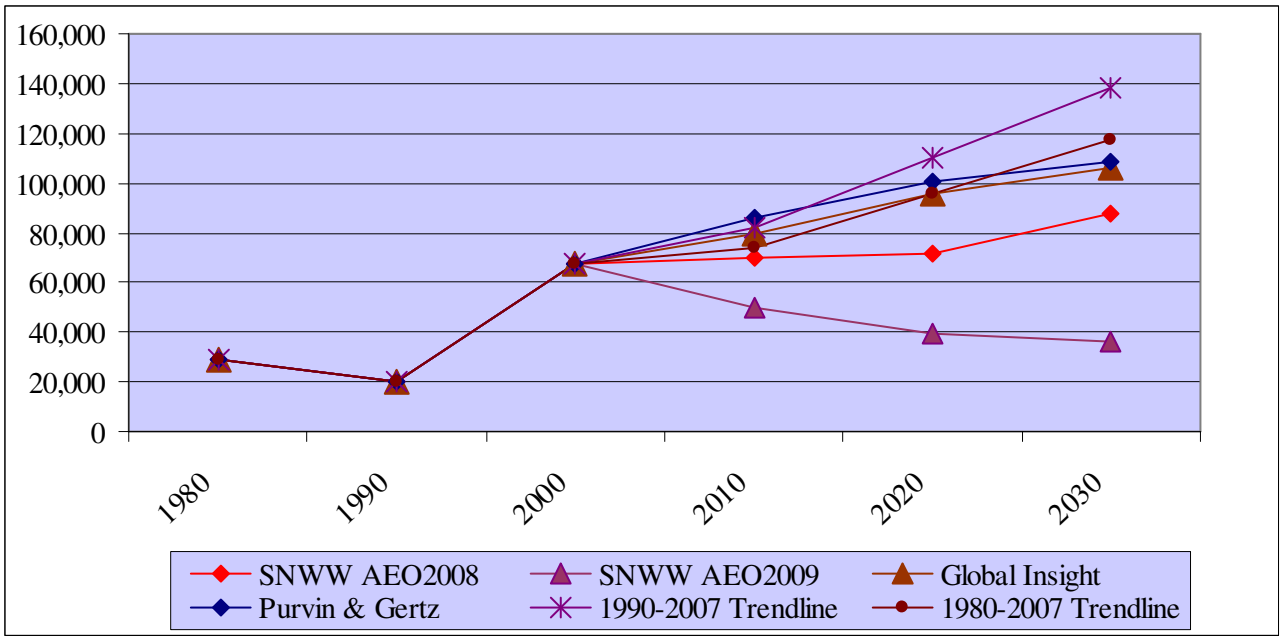
Base Period	1980–2007	1990–2007
Adjusted R Square	0.7903	0.7673
No. Observations	28	18
Constant	–4,253,310	–5,623,692
X Coefficient Value	2,153	2,839
F Statistic	102.81	57.061
t-value	–10.14	–7.484
Standard Error of Y	9,075.98	8,271.30
95 Percentile Confidence Level Associated with Constant and X Coefficient		
Lower 95% Constant	–5,123,406	–7,215,714
Lower 95% X Coefficient Value	1,717	2,041
Upper 95% Constant	–3,383,213	–4,031,670
Upper 95% X Coefficient Value	2,589	3,635

	1980–2007 Trendline SNWW Imports (1,000s of Short Ton)			1990–2007 Trendline SNWW Imports (1,000s of Short Ton)		
	Base	Standard Deviation Application		Base	Standard Deviation Application	
Year	Estimate	Minus 1	Plus 1	Estimate	Minus 1	Plus 1
2003	59,220	–1,685,113	1,803,553	61,931	–3,125,692	3,249,555
2004	61,373	–1,683,397	1,806,142	64,770	–3,123,650	3,253,190
2005	63,526	–1,681,680	1,808,732	67,609	–3,121,608	3,256,825
2006	65,679	–1,679,963	1,811,321	70,447	–3,119,566	3,260,461
2007	67,832	–1,678,247	1,813,911	73,286	–3,117,524	3,264,096
2015	85,056	–1,664,514	1,834,627	95,994	–3,101,189	3,293,177
2019	93,668	–1,657,648	1,844,985	107,348	–3,093,021	3,307,718
2030	117,352	–1,638,766	1,873,469	138,572	–3,070,560	3,347,704

Source: USACE, *Waterborne Commerce of the U.S.*, Part 2, 1980–2007.

Figure 30 displays comparison of the AEO2008, AEO2009, Global Insight, Purvin and Gertz, and 1980- and 1990–2007 trendline SNWW projection estimates. Comparison of the slopes associated with the SNWW's 1980–2000 base data illustrates higher historical rate of growth for most years. The presentation shows that application of the AEO2009 forecast produces declining imports for 2010–2030. The other forecasts presented on Figure 25 show a range of increasing import volumes. SNWW high growth between 1990 and 2004 strongly affects SNWW's future trendline. The Global Insight import estimates shown on Figure 30 correspond to the regression outputs shown in Table 55; these volumes were used for the base case. Sensitivity analyses were performed based on the AEO2009 forecast.

Figure 30
SNWW Crude Petroleum Import Forecast Comparisons



Source: USACE, *Waterborne Commerce of the U.S.*, Part 2, 1980–2006, Global Insight (2008), and EIA (2008).

Additional equations were calculated based on the inclusion of year in combination with the AEO2008, AEO2009, Global Insight, and Purvin and Gertz import forecasts. Those equations produced adjusted R squared values in the 85 to 90 percent range; however, they exhibited higher ranges of variances than the trendline output shown in Table 55. Other variables evaluated included world petroleum production. These variables performed poorly individually and in combination with U.S. imports and refinery capacity variables. It was concluded that U.S. crude oil imports by itself performed better statistically than any other single variable or combination of variables. Table 57 presents the SNWW crude petroleum import forecast.

Table 57
SNWW Crude Oil Imports, 2002/2004 to 2069
(1,000s of Short Tons)

Trade Route	2002–2004 Average	2019	2029	2039	2049	2059	2069
			Beaumont				
Canada	1,110	1,764	2,257	2,436	2,485	2,536	2,587
Mexico	15,034	8,057	8,961	9,514	9,708	9,905	10,105
Central and South America	7,556	12,963	14,416	15,307	15,619	15,937	16,258
Western South America	123	683	762	808	822	839	878
Europe and Africa	8,862	30,253	33,741	35,779	36,436	37,156	38,887
Middle East	25,782	28,305	31,569	33,476	34,090	34,764	36,383
Total	58,467	81,980	91,463	97,152	99,136	101,149	103,189
			Port Arthur				
Canada	2	136	158	168	172	175	179
Mexico	8,348	1,217	1,357	1,441	1,471	1,501	1,531
Central and South America	362	1,955	2,179	2,311	2,353	2,400	2,513
Western South America	95	103	115	122	125	127	130
Europe and Africa	474	4,565	5,091	5,407	5,518	5,630	5,743
Middle East	1,057	4,271	4,763	5,059	5,163	5,267	5,374
Total	10,338	12,248	13,663	14,509	14,800	15,100	15,469
			SNWW Total Crude Petroleum Imports				
Canada	1,112	1,838	2,086	2,377	2,623	2,728	179
Mexico	23,382	9,281	10,351	10,978	11,183	11,404	11,896
Central and South America	7,918	15,715	17,525	18,584	18,925	19,299	20,196
Western South America	218	785	874	928	947	966	986
Europe and Africa	9,336	34,818	38,832	41,187	41,954	42,786	44,630
Middle East	26,839	32,576	36,332	38,535	39,253	40,031	41,757
Total	68,587	94,229	105,126	111,661	113,937	116,248	118,659
Total Tonnage Used for the Benefit Calculations		89,052	99,282	105,139	106,899	108,967	116,347

4.3 PETROLEUM PRODUCT IMPORTS

Forecast of SNWW petroleum product imports and exports is based on analysis of regional data and national trends. Large increases for U.S. imports of gasoline and distillate occurred over the last 16 years, with the SNWW generally experiencing comparable or greater increases. For instance, SNWW 2004–2006 average distillate import volume of 1,668,000 short tons is 1800 higher than 1990–1992 levels. SNWW distillate imports presently make up 3.1 percent of the U.S. distillate import total. SNWW gasoline imports averaged 11,000 short tons for 1990–1992, with the 2004–2006 average increased to 1,696,000 short tons. Table 58 displays U.S. and SNWW 1994/1996 and 2004/2006 average import volumes by major commodity group. Inclusion of 2007 data reduces SNWW's most recent 3-year average to 4,202 thousand short tons from the 2004–2006 average of 5,057 thousand short tons shown in Table 58. In spite of downturns in 2007, SNWW experienced significant overall increases in gasoline and distillate imports (see Table 13). Inclusion of 2007 data reduces the 2004–2006 U.S. average by approximately 1 percent.

Table 58
U.S. and SNWW Petroleum Product Imports
1994/1996 and 2004/2006 Averages
1,000s of Short Tons

	U.S. Petroleum Product Imports			SNWW Petroleum Product Imports		
Product	1994–1996	2004–2006	Average Annual Growth (%)	1994–1996	2004–2006	Average Annual Growth (%)
Gasoline	15,459	59,343	14.4	72	1,696	37.2
Kerosene	4,120	1,657	–8.7	0	0	–
Naphtha	12,445	7,912	–4.4	203	581	11.1
Distillate Fuel Oil	14,188	53,408	14.2	127	1,668	29.4
Residual Fuel Oil	30,025	12,478	–8.4	70	628	24.5
Lube Oil	9,453	3,776	–8.8	764	247	–10.7
Petroleum Coke	1,935	5,127	10.2	179	235	2.8
LNG	4,212	19,125	16.3	126	3	–31.2
Other	–	–	–	4	0	–
Total	91,836	162,828	5.9	1,544	5,057	12.6

Source: USACE, *Waterborne Commerce of the U.S.*, Parts 2 and 5, 1990–2006.

While SNWW 2002–2007 product imports are at historical highs, overall U.S. product imports are projected to decline from 2010–2030. Table 59 shows comparison of the AEO2008 projections with Global Insight's forecast. The Global Insight forecast shows product imports increasing after 2030.

Table 59
Comparison of AEO2008 and Global Insight Forecasts
U.S. Net Petroleum Product Imports
(1,000s of Barrels Per Day)

Year	U.S. Net Petroleum Product Imports 2003–2007	
2003	2,599	
2004	3,137	
2005	3,588	
2006	3,589	
2007	3,422	
	U.S. Net Petroleum Product Imports 2010–2035	
	Global Insight	AEO2009
2010	2,682.1	3,106.2
2015	2,356.5	2,585.6
2019	2,114.4	2,367.5
2020	1,869.6	2,103.2
2025	2,201.2	1,946.9
2029	2,321.8	2,213.4
2030	2,321.8	2,213.4
2034	3,074.6	n/a
2035	3,300.0	n/a
Average Annual Growth Rates		
2003/2007 to 2030	–1.3%	–1.5%
2003/2007 to 2035	0.03%	n/a

Source: EIA/Annual Energy Outlook (AEO2009), March 2009 and Global Insight, October 2007.

4.4 FUEL OIL IMPORTS

Comparison of the national and regional fuel oil volumes shows some correlation between study area and U.S. product imports. While total product volumes are correlated with the U.S. levels, the specific correlations with SNWW's distillate and residual fuel oils are weaker. Regional growth for distillate and residual fuel is considerably higher than the U.S. rates. While the EIA notes in earlier publications that structural shifts occurred over the last few decades in the mix of products and that residual fuel oil imports are projected to decline and be replaced by unfinished gasoline and gasoline blending components, analyses conducted for the current SNWW waterway study show that PADD III residual fuel imports have continued to increase. Table 60 presents SNWW 1990–2006 residual and distillate fuel imports and the region's respective shares. Current indications suggest that PADD III and SNWW waterborne imports of distillate, which is a light product, will increase some in the future.

Table 60
Comparison of SNWW and Regional and National Totals
Petroleum Product Imports
(1,000s of short tons)

Year	SNWW Distillate Imports	U.S. Distillate Imports	SNWW Distillate % of U.S.	SNWW Residual Imports	U.S. Residual Imports	SNWW Residual % of U.S.
1990	74	13,644	0.5	1,035	41,502	2.5
1995	12	12,915	0.1	72	25,914	0.3
1998	102	23,291	0.4	57	35,327	0.2
1999	230	25,781	0.9	49	35,229	0.1
2000	1,047	21,111	5.0	319	40,361	0.8
2001	572	20,589	2.8	25	40,891	0.1
2002	566	19,936	2.8	541	35,411	1.5
2003	1,337	29,115	4.6	56	31,330	0.2
2004	2,008	53,876	3.7	728	13,955	5.2
2005	1,728	52,679	3.3	804	13,757	5.8
2006	1,268	53,670	2.4	351	9,723	3.6
2007	1,872	55,627	3.4	355	10,771	3.3

Source: USACE, *Waterborne Commerce of the U.S.*, Parts 2 and 5, 1990–2007.

Figure 31 shows total U.S. distillate imports for 1990–2007, and Figure 32 presents a comparison of U.S. waterborne distillate imports with SNWW volumes. Comparisons of U.S. and SNWW residual fuel oil imports are shown on figures 33 and 34. Figure 31 includes waterborne and land route imports. As noted, Table 60 is limited to waterborne movements, and does not include Canadian products transported by pipeline, rail, or truck.[36] Overall, analyses of the EIA databases showed that approximately 16 percent of 2004–2006 U.S. product imports are from Canada.

[36] Unless otherwise noted, tables and figures only include waterborne traffic.

Figure 31
U.S. Imports of Distillate Fuel
Waterborne and Land Routes, 1990–2007

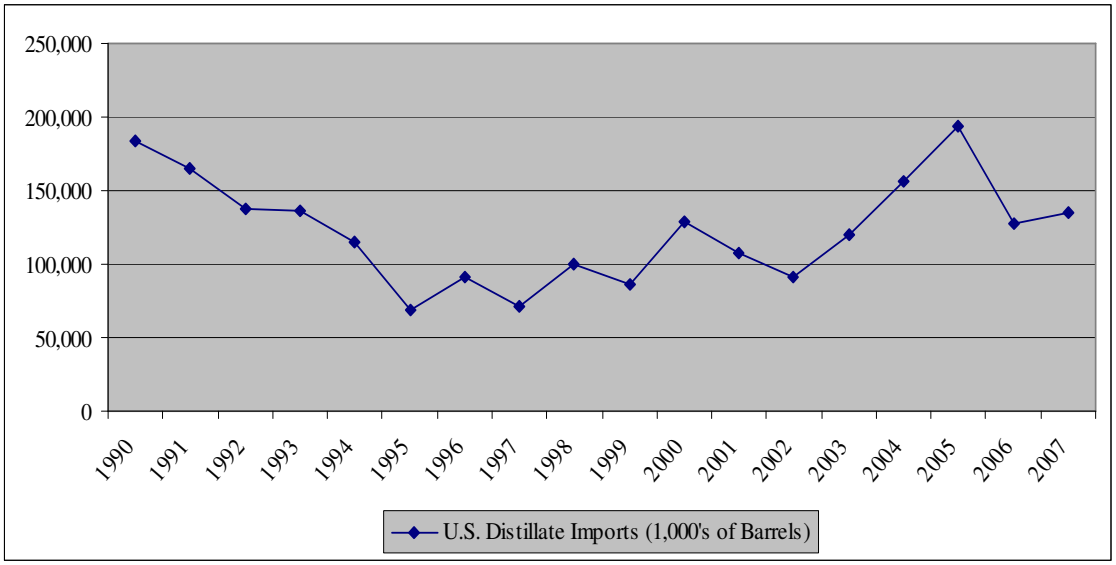


Figure 32
U.S. and SNWW Distillate Fuel Imports, 1990–2007 (Waterborne Routes Only)

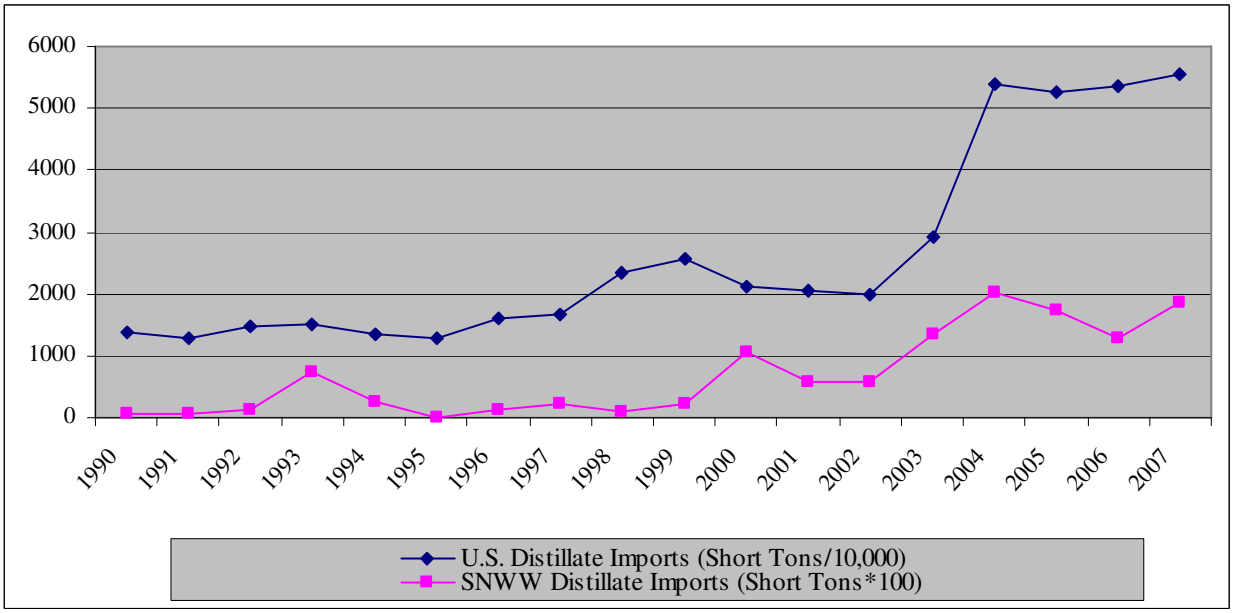


Figure 33
U.S. Imports of Residual Fuel,
Waterborne and Land Routes 1990–2007

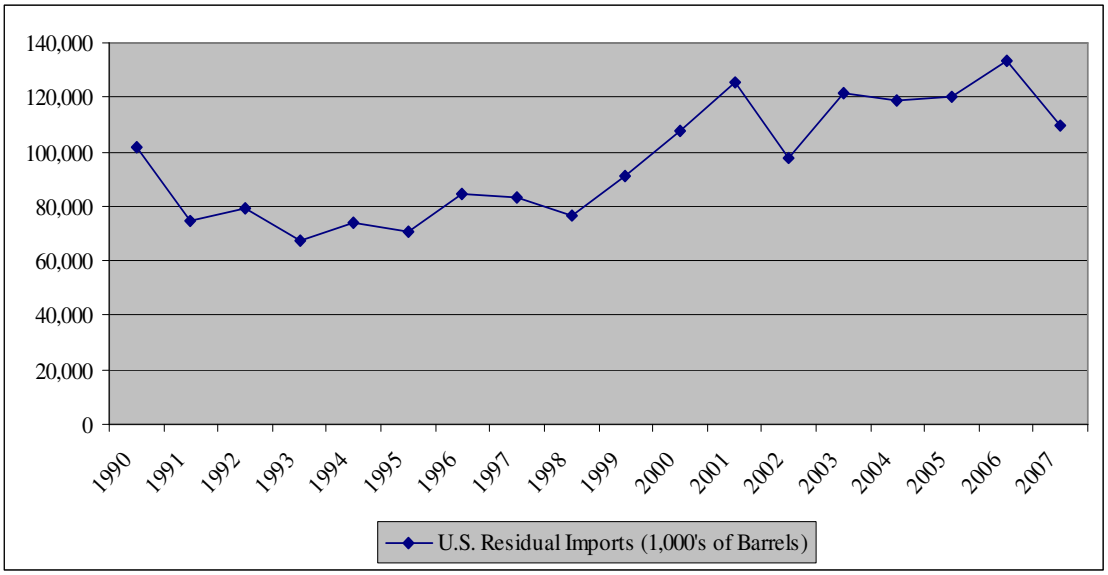
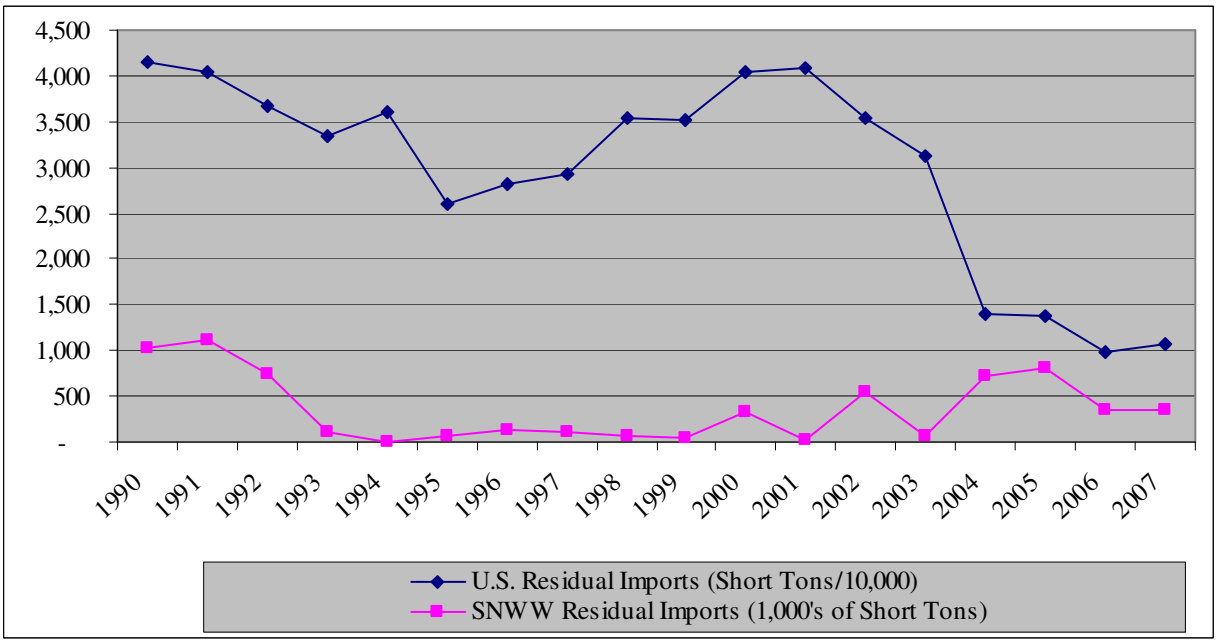


Figure 34
U.S. and SNWW Residual Fuel Imports 1990–2007 (Waterborne Routes Only)



The percentage of U.S. petroleum products imported from Canada increased by 74 percent from 1994/1996 to 2004/2006. The EIA shows Canadian production of conventional fuel declining relative to its oil sand production. Historically, imports of products from Canada to the SNWW ports are low due to the relatively longer distances compared to other markets in the Midwest and the East Coast. Expectations about expansion of Canadian crude and products to the Gulf Coast are uncertain, but recognizably could significantly affect SNWW's tonnage forecast. PADD III imports of Canadian petroleum products decreased by 8 percent over the same period.

The AEO2008 is forecasting that 2006–2030 imports of "blending components" decrease by –1.1 percent. Blending components include oxygenates, but consist mainly of products that could be classified as finished gasoline in other jurisdictions or products that require little additional blending to be classified as finished gasoline. For purposes of the waterborne commerce classification, blending components are classified as gasoline. Distillate is contained in the EIA classification of "unfinished oils." Unfinished or light oils are produced by partial refining of crude oil and include naphtha and lighter oils, kerosene and light gas oils, heavy gas oils, and residuum. Based on direct application of AEO and Global Insight anticipated trends, residual SNWW imports could decline; however, due to its use as an input in the refining process and for the production of specialized products, anticipated regional declines, if any, will be less than for the Nation. At the same time it is recognized that petroleum products contribute to a significantly smaller percentage of total petroleum imports (see Table 53) Comparison of 2002–2007 U.S. and PADD III residual fuel imports shown in Table 61 illustrates that while both U.S. and regional imports grew in 2007, regional growth was considerably higher. The presentation shows that PADD III residual fuel imports increased at significantly higher rates than the U.S. and East Coast rates. The East Coast is contained in PADD II and is presented here to illustrate its large market share and its weighted effect on national averages.

Light products and unfinished oils, including gasoline, naphtha, distillate, and, liquefied natural gas, are projected to increase at higher rates than heavy products. The EIA definition of unfinished oils includes light products. While imports of heavy products such as residual fuel oil are projected to decline and be replaced by unfinished gasoline and gasoline blending components, the market for residual may remain relatively high for SNWW and other Texas refinery centers that process heavy, or high-sulfur, crude petroleum. Texas Gulf Coast oil company transportation analysts verified that an increase in refined product imports would be necessary to meet processing needs and associated demand with growing imports for both light and heavy products. The Gulf Coast imports a significant amount of feedstock to support its role as the main U.S. refining and petrochemical center. The AEO forecast shows low growth for unfinished product imports, with an average annual growth rate of 0.1 percent from 2006 to 2030. Again, expectations are for slightly higher regional growth of unfinished products imports. An additional item worth noting is that the current U.S. volume of 0.69 million BPD represents an estimated 41 percent increase of the 2004 volume and, therefore, provides a significantly higher base level for the forecast application.

Table 61
U.S. Residual Fuel Imports, 2002–2007
1,000s of Barrels

Year	Total U.S. Imports of Residual Fuel Oil Imports	U.S. Imports of Residual Fuel Oil with Less than 0.31% Sulfur	U.S. Imports of Residual Fuel Oil with 0.31 to 1.00% Sulfur	U.S. Imports of Residual Fuel Oil with Greater than 1.00% Sulfur
2002	90,896	15,617	19,135	56,144
2003	119,496	18,174	36,429	64,893
2004	156,024	32,563	51,347	72,114
2005	193,294	33,824	63,872	95,598
2006	127,761	11,541	28,740	87,480
2007	135,545	16,700	32,642	86,203
AAG a/	8.3%	1.4%	11.3%	9.0%
PADD II (U.S. East Coast)				
2002	70,422	12,646	17,514	40,262
2003	95,382	14,658	30,682	50,042
2004	122,133	24,605	42,943	54,585
2005	147,101	28,365	48,879	69,857
2006	88,161	6,275	21,403	60,483
2007	77,974	11,986	14,645	51,343
AAG a/	2.1%	-1.1%	-3.5%	5.0%
PADD III Imports (U.S. Gulf Coast)				
2002	6,717	1,664	901	4,152
2003	9,673	1,775	3,702	4,196
2004	19,526	5,414	6,352	7,760
2005	28,489	2,870	12,627	12,992
2006	20,452	2,183	5,002	13,267
2007	42,486	4,227	15,038	23,221
AAG a/	44.6%	20.5%	75.6%	41.1%

Source: Compiled from the EIA web data. 2008.
a/ Average annual growth rate (AAG).

Comparison of 2002–2007 U.S. distillate imports with PADD volumes show that while both U.S. and regional imports grew in 2007, growth for the U.S. Gulf Coast, as represented by PADD III, was considerably higher. Again, the variance in regional growth rates can be seen based on the data presented in Table 62. The presentation shows that distillate imports for PADD III increased relative to U.S. and East Coast rates.

SNWW fuel oil import forecasts are based on the assumption that the region will maintain its recent historical share of the U.S. market with imports increasing. Forecasts were prepared for distillate, residual

and gasoline imports. As shown in Table 62, the U.S. 2002–2007 average annual growth rate of 2.4 percent compares to the PADD III recent historical rate of 71.6 percent.

Table 62
U.S. Distillate Fuel Imports, 2002–2007
1,000s of Barrels

Year	Total U.S. Imports Distillate Fuel Oil Imports	U.S. Imports of Distillate Fuel Oil with Less Than 500 ppm Sulfur a/	U.S. Imports of Distillate Fuel Oil with Greater Than 500 ppm Sulfur a/
2002	97,603	38,945	58,658
2003	121,672	49,400	72,272
2004	119,118	54,266	64,852
2005	120,009	56,793	63,216
2006	133,126	68,847	64,279
2007	109,875	67,313	42,562
AAG	2.4%	11.6%	-6.2%
PADD II (U.S. East Coast)			
2002	90,092	32,387	57,705
2003	112,903	42,115	70,788
2004	102,512	41,464	61,048
2005	106,151	45,981	60,759
2006	109,232	50,320	58,912
2007	84,539	47,933	35,606
AAG	–1.3%	8.2%	–9.2%
PADD III Imports (U.S. Gulf Coast)			
2002	594	490	104
2003	924	332	592
2004	4,043	2,045	1,998
2005	4,130	3,484	646
2006	6,672	4,549	2,023
2007	8,848	2,866	5,982
AAG	71.6%	42.4%	124.9%

Source: compiled from the EIA web data. 2008.
a/ Parts per million (ppm).

Table 63 displays SNWW distillate fuel oil import forecast. Comparison of SNWW 1994–1996 and 2004–2006 rates with those for the Nation showed that the region historically experienced higher growth rates than the Nation. A 1 percent growth rate was used for 2019–2069. While recognizably subject to uncertainty, the SNWW increases represent a new market, and short-term higher growth is anticipated. The effects of this uncertainty were evaluated in the sensitivity section of the Final Feasibility Report and are discussed in the risk section of this report. Figure 35 shows the SNWW forecast applications.

SNWW's low growth scenario assumes that regional distillate import growth will be comparable to the U.S. import rate. The scenario used for the benefit calculations was prepared using the expectation that the average annual growth rate for SNWW distillate imports would increase at approximately 1 percent annually through 2069. This forecast is included in the third column in Table 63.

Table 63
SNWW 2004/2006 to 2069 Distillate Fuel Oil Imports
(1,000s of Short Tons)

Year	Base Line Trendline	1% Growth Rate	Low Growth Sensitivity
2004–2006	1,668	1,668	1,668
2006	1,268	1,268	1,268
2007	1,872	1,872	1,872
2010	1,878	1,668	1,227
2015	2,486	1,753	1,235
2019	3,022	1,896	1,188
2020	3,095	1,918	1,178
2025	3,484	2,036	1,140
2029	3,831	2,136	1,254
2030	3,923	2,240	1,289
2039	4,973	2,524	1,289
2049	6,304	2,844	1,289
2059	6,963	3,204	1,289
2069	7,692	3,610	1,289
2004/2006–2019	4.3%	0.9%	–2.4%
2004/20006–2069	2.4%	1.2%	–0.4%

Figure 35
SNWW Distillate Imports 2000–2030
(1,000s of Short Tons)
Comparison of AEO2008 U.S. Forecast and SNWW Applications

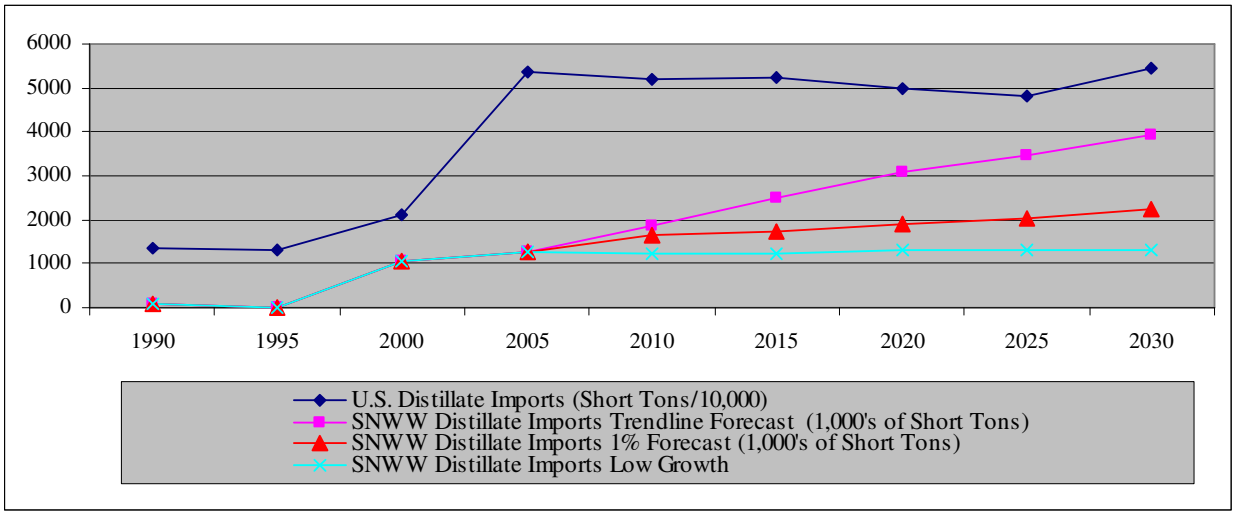


Table 64 displays SNWW residual fuel oil import forecast. Due to uncertainty associated with residual imports, SNWW residual fuel import forecasts were assumed to grow at 1 percent annually between 2004/06 and 2069. While specific residual fuel import forecasts are not published by the EIA or Global Insight, Global Insight publishes a residual and distillate demand forecast. The growth rates associated with Global Insight's demand forecasts were considered, along with SNWW distillate and residual import tonnage, in estimating future imports. Table 65 summarizes Global Insight's residual and distillate fuel demand forecasts.

Table 64
SNWW 2004/2006 to 2069 Residual Fuel Oil Import Forecast
(1,000s of Short Tons)

Year	Base Line	No Growth Sensitivity
2004–2006	628	628
2010	660	628
2015	693	628
2019	664	628
2020	672	628
2025	714	628
2029	750	628
2030	760	628
2038	838	628
2039	848	628
2049	958	628
2059	1,083	628
2069	1,223	628
2004/2006–2019	0.4%	0.0%
2004/2006–2069	1.0%	0.0%

Table 65
Global Insight U.S. Residual and Distillate Fuel Oil Import Demand Forecasts
(1,000s barrels per day)

	Residual Fuel Oil			Distillate Fuel Oil		
Year	Industrial	Commercial	Power Generation	Industrial	Commercial	Power Generation
2000	13.29	0.00	8.28	245.27	40.61	36.81
2004	21.93	0.39	32.75	224.62	20.77	1.9
2005	40.93	0.34	16.2	235.31	25.98	5.6
2006	39.91	0.33	2.81	237.54	24.71	3.91
2010	40.84	0.34	9.48	242.1	25.58	13.09
2015	41.44	0.34	8.82	247.41	25.37	12.19
2020	42.17	0.33	8.19	251.95	25.14	11.31
2025	42.36	0.33	8.03	253.1	25.14	11.09
2030	43.30	0.33	7.25	258.92	25.21	10.02
2004/2006 to 2030 Average Annual Growth Rates						
	0.9%	–0.3%	–3.4%	0.4%	0.2%	4.0%

Source: Global Insight, *The U.S. Economy, The 30-Year Focus*, First Quarter 2008.

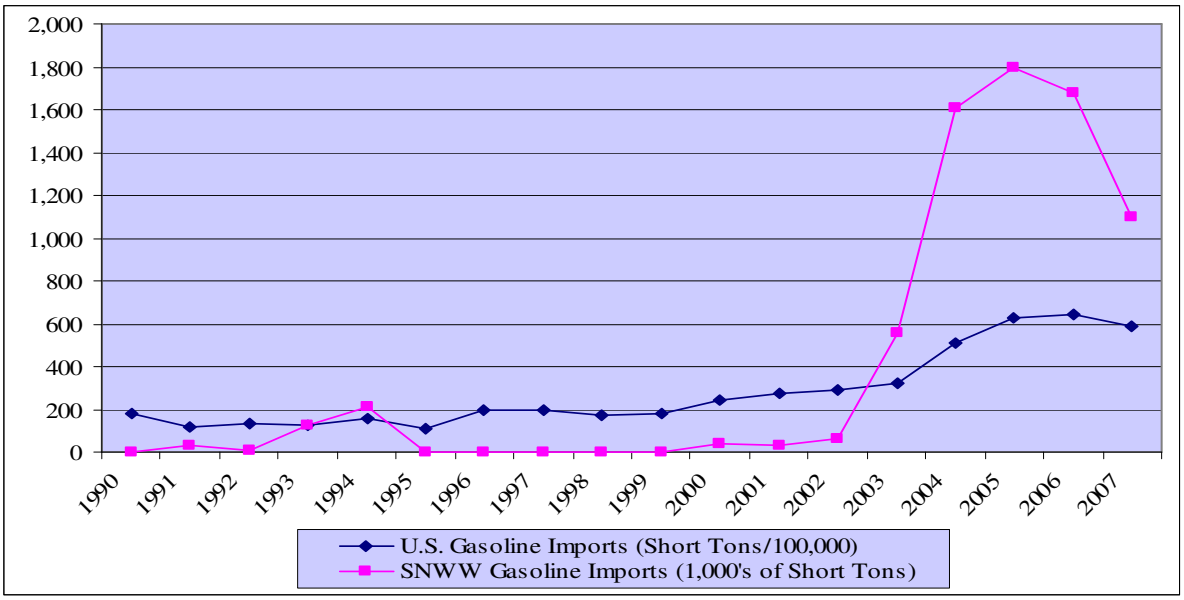
4.5 GASOLINE IMPORTS

SNWW gasoline imports increased significantly since the early 1990s, with current volumes exceeding 1.6 million short tons. SNWW gasoline imports presently compose approximately 3 percent of the U.S.

total waterborne gasoline imports. For the most recent 10-year period, approximately 90 percent of SNWW gasoline imports were shipped to Beaumont, with the remaining 10 percent to Port Arthur. Figure 36 presents a comparison of U.S. 2000–2006 gasoline imports with combined Beaumont and Port Arthur imports.

While U.S. gasoline imports have also increased dramatically, the EIA shows reductions in U.S. imports of gasoline blending components from 2006 to 2030. Increases in U.S. refinery capacity may be contributing to expected decline in the need for U.S. gasoline imports by allowing for increased domestic production. Over 98 percent of SNWW gasoline imports arrive by ship. In comparison, over 75 percent Midwest gasoline imports are transported by land from Canada. Canadian imports to the U.S. increased from 7 percent for 1994–1996 to 13 percent for 2004–2006.

Figure 36
U.S. and SNWW Waterborne Gasoline Imports and SNWW Gasoline Imports
(1,000s of Short Tons)



SNWW gasoline imports are expected to increase at slower rates than those recently experienced and, while future expectations are subject to a high level of uncertainty, regional imports forecasted to increase for the SNWW base scenario. The base scenario assumes that SNWW gasoline imports will grow at 1 percent annually from 2006 to 2069. Table 66 presents SNWW 2004–2069 gasoline import forecast. SNWW gasoline import forecast was assumed to grow at approximately 1 percent annually between 2004/06 and 2069. In its December 2007 report to Congress, the GAO[37] notes petroleum is a key impetus for growth in global trade in petroleum products and that there has been a structural surplus in production

[37] United States Government Accountability Office, Report to Congressional Requesters, GAO report number GAO-08-14 entitled 'Energy Markets: Increasing Globalization of Petroleum Products Markets, Tightening Refining Demand and Supply Balance, and Other Trends Have Implications for U.S. Energy Supply, Prices, and Price Volatility' released January 18, 2008. http://www.gao.gov/htext/d0814.html.

of gasoline and a deficit in production of diesel in Europe. They note that the surplus of gasoline is largely the result of a "systematic switch" in European countries toward automobiles with diesel-powered engines, which are more efficient than gasoline-powered engines. European regulators promoted diesel fuel use in Europe by taxing diesel at a lower rate, and European demand for diesel fuel-powered vehicles rose. The European refining and marketing sector responded to this change in demand by importing increasing amounts of diesel and exporting a growing surplus of gasoline to the U.S. A conclusion was that the effect of this structural imbalance within the European Union will continue for the foreseeable future, and perhaps widen, resulting in more exports of European gasoline and blending components to the U.S.

Table 66
SNWW Gasoline Import Forecast
(1,000s of short tons)

Year	Baseline	Sensitivity
2004	1,611	1,611
2005	1,800	1,800
2006	1,678	1,678
2007	1,096	1,096
2019	1,835	1,096
2029	2,027	1,096
2039	2,239	1,096
2049	2,474	1,096
2059	2,732	1,096
2069	3,018	1,096
2004/2006–2019	0.6%	0.0%
2004/2006–2069	0.9%	0.0%

4.6 PETROLEUM PRODUCT EXPORT FORECAST

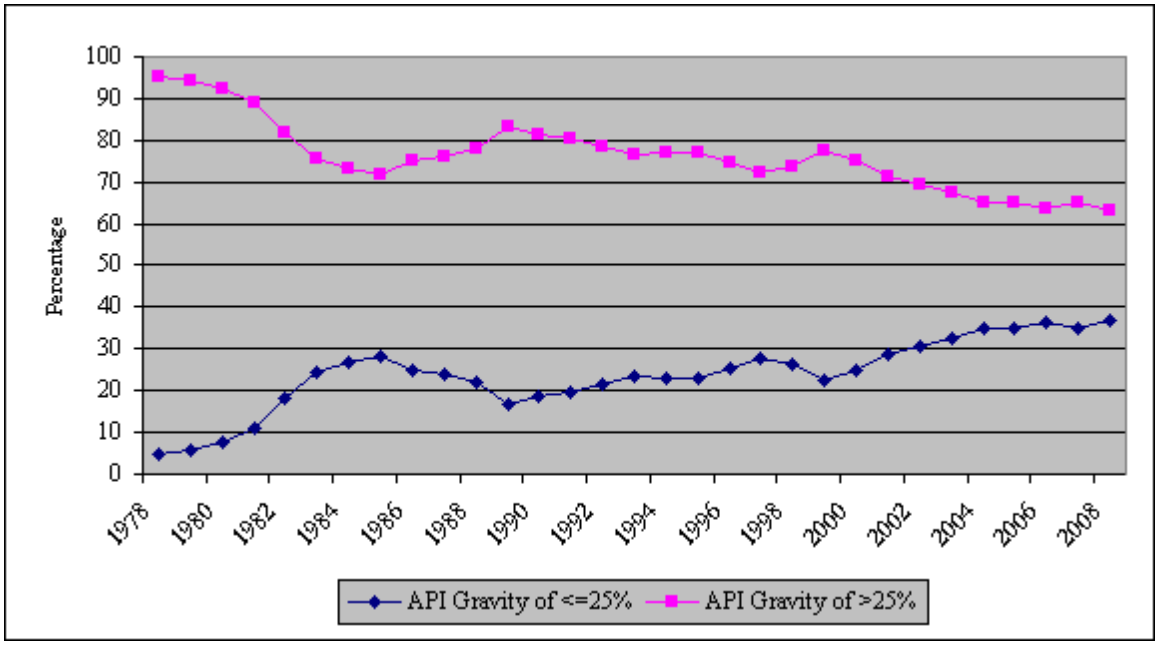
U.S. petroleum product exports primarily consist of petroleum coke (47 percent), distillate fuel (16 percent), gasoline (16 percent), and residual fuel oil (13 percent). SNWW exports primarily consist of petroleum coke (67 percent) and gasoline (25 percent). Analysis of SNWW's specific export groups, particularly petroleum coke and gasoline exports, show fair to good degrees of correlation between the study region and the U.S. For instance, the R square using 1990–2007 period data is 0.79 for petroleum coke and is 0.78 for gasoline.

4.7 PETROLEUM COKE EXPORTS

Published forecasts of U.S. coke exports are not available; however, indicators suggest an increased demand for coke. Ongoing construction of cokers in regions other than SNWW is indicative of increased demand. Increasing volumes of high-sulphur crude oil also suggest increasing volumes of residual coke.

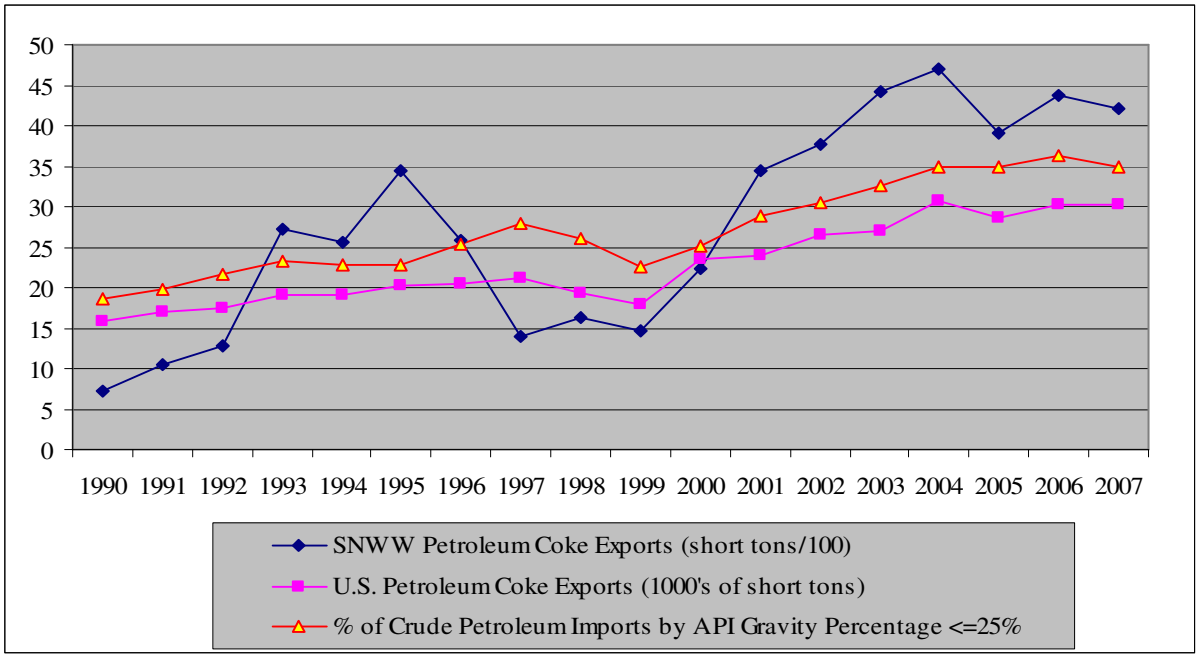
Figure 37 illustrates the change in API index of U.S. crude petroleum imports.[38] Subsequently, analysis of the relationship between U.S. and SNWW petroleum coke exports and API indices associated with heavy crude oil demonstrated that coke exports are well correlated increasing U.S. imports of high-sulfur crudes (Figure 38).

Figure 37
U.S. Crude Petroleum Imports by API Gravity Classification (%)



[38] The API (American Petroleum Institute) gravity measures the relative density of oils. It serves as a rough measure of the quality of crude oils. The higher the API gravity number, the higher the API gravity, the lighter the compound. Light crude oils generally exceed 38 degrees API.

Figure 38
SNWW and U.S. Petroleum Coke Exports and
% of U.S. Crude Petroleum Imports by API Gravity Classification (%)



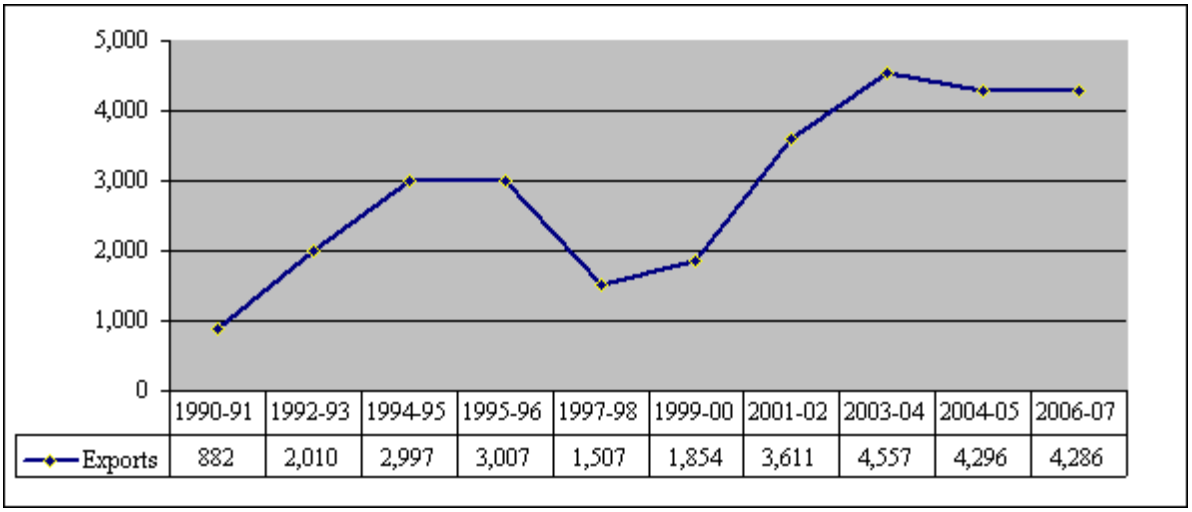
Analysis of the 1990–2007 relationship between U.S. petroleum coke exports and the percentage of crude petroleum imports with an API of 25 percent or less produced an adjusted R square of 0.94. The t value and F statistics associated with the equation is significant at the greater than 99.9 percent confidence levels. The relationship between SNWW petroleum coke exports and the API percentage produced an adjusted R square of 0.71, with a value of F statistic significant at the 99.99 confidence level.

Examination of 1990–2007 data showed that SNWW petroleum coke exports represents 14 percent of the U.S. waterborne exports, up from 4.6 percent in 1990. The U.S. is the world's largest supplier of petroleum coke. U.S. petroleum coke exports increased in 2008 by 3 percent over 2007 levels. The EIA shows refinery consumption and other domestic use of petroleum coke declining through 2030. At the same time, domestic production will increase based on the production of additional capacity and increased refinement of high-sulfur crude oil. Based on general indicators, including SNWW coker expansion, SNWW petroleum coke exports were assumed to follow SNWW and U.S. historical export trendlines. The refinement of high-sulfur crude oil, the processing of petroleum coke as a by-product, and the expansion of SNWW's coke-processing facilities supports this expectation. High-sulphur crudes are associated with both foreign imports of crude and Gulf of Mexico production.

Given the expectation of increased growth, a trendline using 1990–2005 SNWW exports as a function of time was used to represent the base forecast. Data for 2006–2007 were not originally available when the forecasts were prepared. Alternative forecasts using average annual growth rates were evaluated; however, the average annual growth exhibited variations. SNWW's 1990–1995 average annual growth rate is 36.5 percent, the 1995–2005 average annual growth rate is 1.3 percent, and the 2000–2005 average

annual rate is 11.8 percent. Growth rates based on 2-year point averages from 1990–2007 exports range from 3 and 10 percent. Figure 39 displays the 1990–2007 point averages.

Figure 39
SNWW Petroleum Coke Exports (1,000s of short tons)
1990–2007 Point Averages



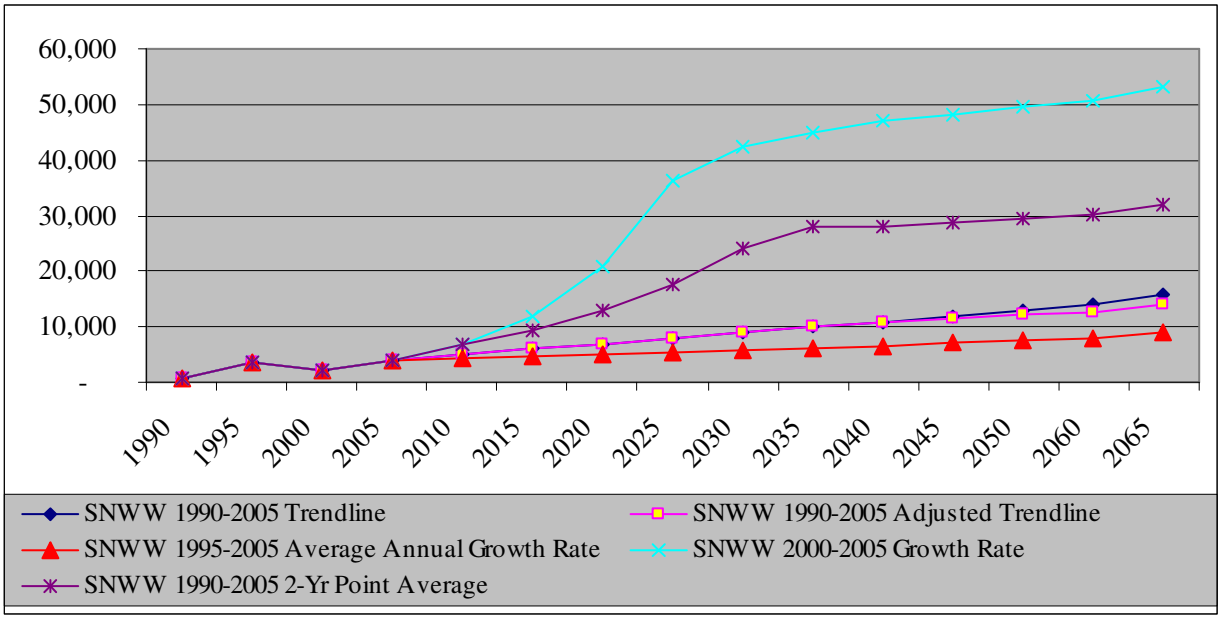
	1990-91	1992-93	1994-95	1995-96	1997-98	1999-00	2001-02	2003-04	2004-05	2006-07
Exports	882	2,010	2,997	3,007	1,507	1,854	3,611	4,557	4,296	4,286

Table 67 summarizes projections prepared using the 1990–2005 trendline, the 1995–2005 average annual growth rate of 1.3 percent, the 2000–2005 average annual growth rate of 11.8 percent, the 1990–2005 point averages of 3 and 10 percent, and the "no growth" forecast. SNWW transportations savings benefits were calculated using the forecast labeled "1990–2005 adjusted trendline." A 2039–2069 average annual growth rate of 1 percent was used for all of the forecasts except the "1990–2005 trendline" and the "no growth forecast." Figure 40 displays a comparison forecast trendlines shown in Table 66.

Table 67
SNWW Petroleum Coke Export Forecast Scenarios
(1,000s of Short Tons)

Year	1990–2005 Trendline	1990–2005 Adjusted Trendline	1995–2005 Growth Rate Application	2000–2005 Growth Rate Application	1990–2007 2–Year Point Average	No Growth After 2005–2007 Average
1990	724	724	724	724	724	724
1995	2,558	2,558	2,558	2,558	2,558	2,558
2000	3,435	3,435	3,435	3,435	3,435	3,435
2005	3,903	3,903	3,903	3,903	3,903	3,903
2006	4,362	4,362	4,362	4,362	4,362	4,362
2007	4,210	4,210	4,210	4,210	4,210	4,210
2019	6,802	6,802	5,044	18,603	12,016	4,158
2029	8,768	8,768	5,740	38,073	22,555	4,158
2039	10,735	10,735	6,531	46,562	28,070	4,158
2049	12,701	11,955	7,432	47,968	28,694	4,158
2059	14,667	13,206	8,457	50,435	30,170	4,158
2069	16,633	14,588	9,509	54,336	32,503	4,158
Average Annual Growth Rates						
2005–2019	4.0%	4.0%	1.8%	11.8%	8.4%	0.5%
2005–2069	2.3%	2.1%	1.4%	4.2%	3.4%	0.1%

Figure 40
SNWW Petroleum Coke Export Forecast Scenarios
(1,000s of Short Tons)



4.8 GASOLINE EXPORTS

SNWW gasoline exports steadily increased since the early 1990s. For the most recent 3-year period, exports averaged 1.8 million short tons. Figure 41 shows SNWW's 1990–2007 trendline of gasoline exports. SNWW gasoline exports compose approximately 18 percent of the U.S. total waterborne gasoline exports. As shown on Figure 41, regional gasoline exports growth is strong, with the regional growth continuing to increase through 2007 when U.S. and PADD III exports volumes dropped slightly. Figure 42 displays 1982–2007 U.S. and PADD III export volumes.

For the most recent 3-year period, approximately 75 percent of SNWW gasoline imports were shipped to Beaumont and the remaining 15 percent to Port Arthur. Port Arthur's share increased from zero in 1990 to 28 percent in 2006. Most of SNWW gasoline exports are shipped to Mexico. The study region's share is more constant than the U.S. share, which declined some over the most recent 10-year period. Over 2005–2007, nearly 75 percent of U.S. gasoline exports were also transported to Mexico. For 2002–2004, 83 percent of U.S. gasoline exports were transported to Mexico. Over 95 percent of SNWW gasoline exports for the most recent 5-year period were shipped to Mexico.

Figure 41
SNWW Gasoline Exports
1,000s of short tons

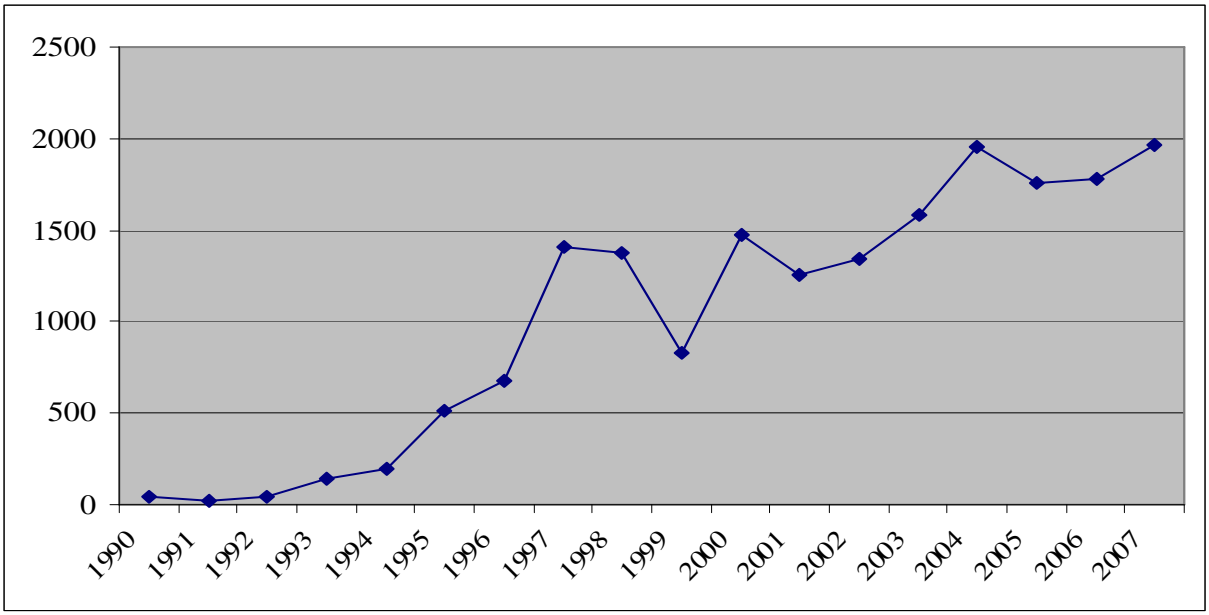
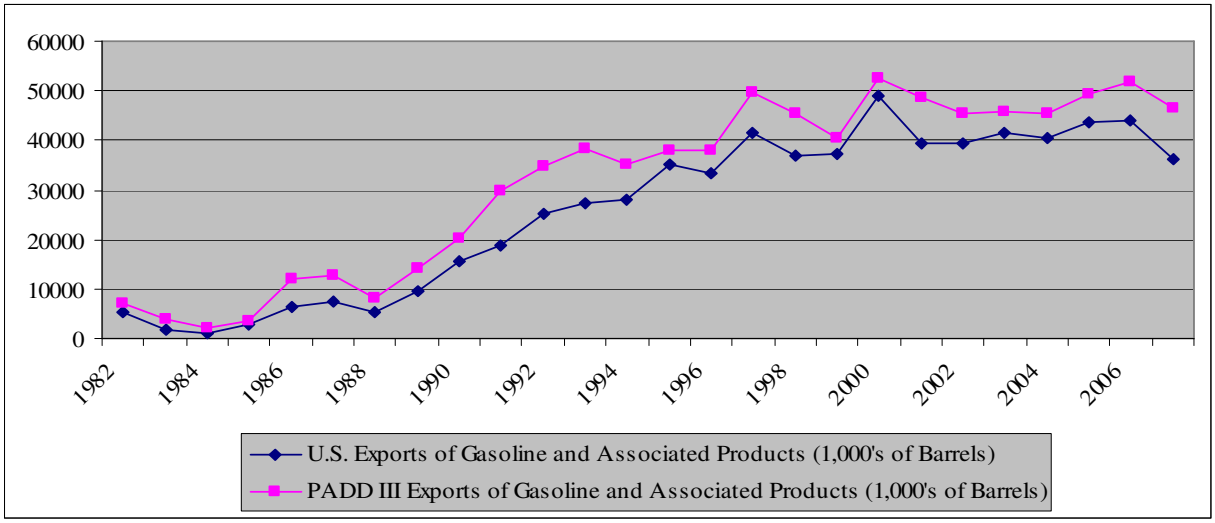


Figure 42
U.S. and PADD III Gasoline Exports, 1982–2007
1,000s of Barrels

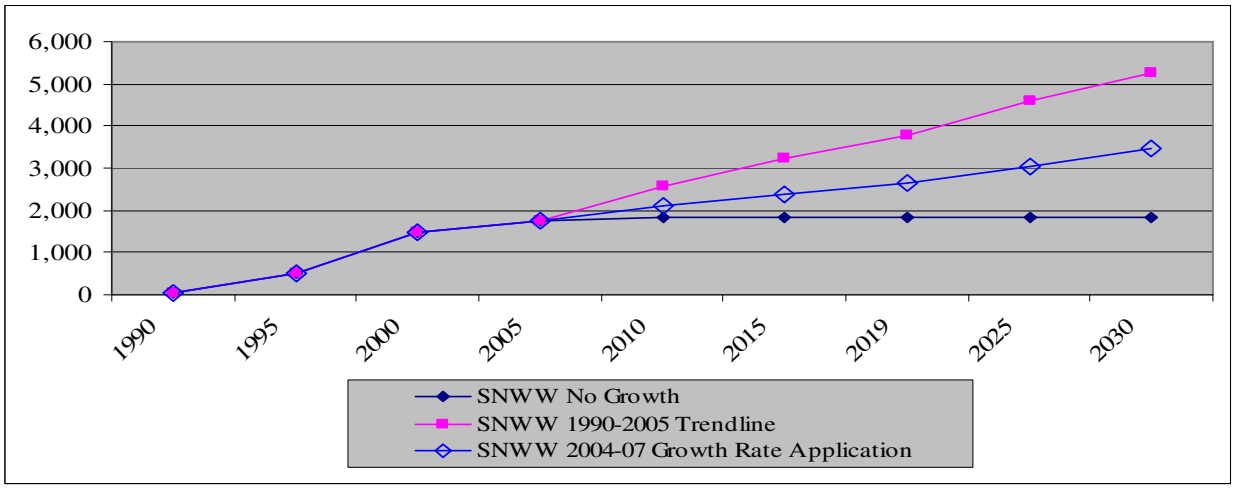


Comparison of U.S. and SNWW waterborne commerce records for gasoline exports showed a relatively strong level of correlation between the Nation and the region. The R square between 1990–2007 SNWW petroleum and U.S. gasoline exports is 0.71. PADD III gasoline exports produced an R square of 0.79. Published forecasts of gasoline exports are not available from the EIA or Global Insight. SNWW gasoline exports grew at an average annual rate of 27 percent from 1990 to 2007 and approximately 2.7 percent from 2004 to 2007. U.S. and PADD III 1990–2007 gasoline exports grew at an average annual rate of approximately 17 percent, with 2004–2007 U.S. and PADD III exports growing at rates comparable to the 1990–2007 rates. Trendline analysis of 1990–2007 SNWW gasoline exports as a function of time produced an adjusted R square of 0.92. Forecast of SNWW gasoline exports was evaluated based on comparison of the trendline and growth rate applications. Table 68 summarizes the gasoline export forecast applications evaluated for the SNWW study. SNWW's future gasoline exports were forecasted based on the 2004–2007 growth rate application (column 3, Table 68). Figure 43 displays a comparison of the forecasts evaluated.

Table 68
SNWW Gasoline Export Forecast Scenarios
(1,000s of Short Tons)

Year	1990–2005 Trendline	2004–2007 Growth Rate Application	No Growth After 2005–2007 Average
		39	39
1990	39	9	9
1995	518	518	518
2000	1,474	1,474	1,474
2005	1,755	1,755	1,755
2006	1,778	1,778	1,778
2007	1,970	1,970	1,970
2010	2,575	2,096	1,834
2015	3,247	2,394	1,834
2019	3,785	2,664	1,834
2025	4,592	3,043	1,834
2030	5,264	3,480	1,834
2039	6,473	4,431	1,834
2049	7,818	5,641	1,834
2059	9,162	7,183	1,834
2069	10,506	9,145	1,834
Average Annual Growth Rates			
2005–2019	5.6%	3.0%	0.4%
2005–2069	2.8%	2.6%	0.1%

Figure 43
U.S. and PADD III Gasoline Exports
1,000s of Short Tons 1990–2030



4.9 DISTILLATE EXPORTS

U.S. distillate exports increased at an annual rate of 14 percent between 1990 and 1994 and declined from 1994 through 2002 before increasing to 1991 levels. PADD III exports also followed a similar pattern. In 2006 and 2007, SNWW exports were comparable to 1990–1991 levels. Figure 44 shows U.S. and PADD III 1990–2007 distillate exports. Distillate fuel oil represents approximately 7 percent of SNWW's 2004–2006 product exports. Approximately 80 percent of SNWW's distillate exports were shipped from Port Arthur, with the remaining 20 percent shipped from Beaumont. Figure 45 shows comparison of U.S. and SNWW waterborne distillate exports

As shown on Figure 45, U.S. distillate exports increased dramatically between 2004 and 2006. SNWW distillate exports remained relatively flat from 1990 through 1995 before increasing to over 600,000 short tons in 1997 and 1998. Exports then dropped to near zero in 2000 before steadily increasing through 2005, with volumes down in 2006 and 2007, and 2007 exports totaling 345,000 short tons. While distillate is exported to countries all around the world, the largest share of SNWW distillate exports is shipped to Mexico. Review of 2004–2006 vessel records showed that the largest vessels are associated with shipments to Mexico. Review of International Energy Administration world trade data for 2006–2008 show an increase in U.S. trade with Mexico between 2006 and 2008. Comparison of the EIA's first quarter 2008 product exports show an 18 percent increase over first quarter 2007. In its AEO2009 (SR/OIA/2009-03), the EIA shows U.S. petroleum product exports increasing at an average annual growth rate of 1 percent from 2006 through 2030. For forecasting purposes, SNWW's 2004–2006 average tonnage was used a base for the forecast application. In its December 2007 report to Congress, the GAO noted that petroleum product trade will continue to grow as global trends move towards increasing demand of lower sulfur fuel.

Figure 44
U.S. and PADD III Distillate Fuel Exports
1990–2007 Waterborne and Land Routes

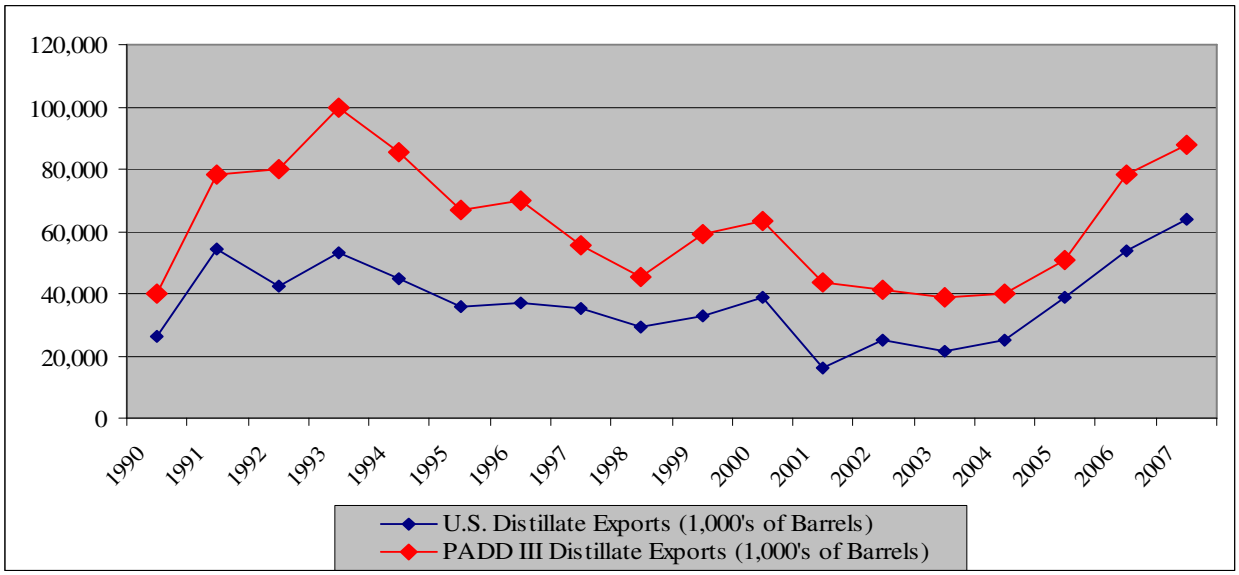
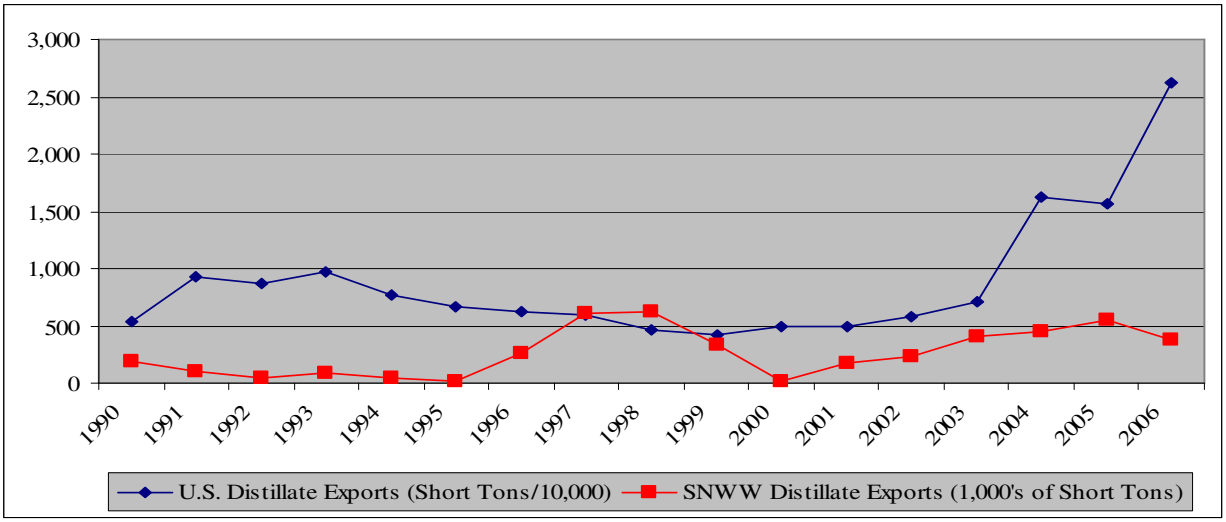


Figure 45
U.S. and SNWW Distillate Fuel Exports
1990–2006 Waterborne



The indication is that lower sulfur fuel will necessitate increased processing as it becomes increasingly scarce. The GAO noted that strong demand for certain petroleum products, particularly distillates, will increase competition for and facilitate global trade of petroleum products in particular distillates. Based on its position as a major refinery center, expectations are that SNWW product exports will increase at a greater rate than the Nation. All indications are that refining and export of petroleum products will increase. Based on these indicators, an average annual growth rate of 2.5 percent was used for SNWW 2006–2069 exports. Table 69 summarizes the gasoline export forecast applications evaluated for the SNWW study. The first column presents U.S. distillate exports and application of the AEO2009 (SR/OIA/2009-03) petroleum product export forecast. The next column summarizes application of the AEO growth rates to SNWW's 2004–2006 base. The AEO applications result in an average annual growth rate of 1 percent over 2004–2006 to 2029. The 2039–2069 volumes are based on continuation of a 1 percent growth rate. The third column summarizes application of a growth rate of 2.5 percent to the SNWW 2004–2006 base through 2039. The forecast in the last column is based on no growth beyond the 2004–2006 average. The forecast shown in column three was used for the benefit calculations. The 2039–2069 volumes for all growth forecasts are based on continuation of a 1 percent growth rate.

Table 69
SNWW Distillate Export Forecast Scenarios
(1,000s of Short Tons)

Year	U.S. Distillate Exports AEO2009 Application	SNWW Distillate Exports Using AEO2009	SNWW Distillate Exports Using a 2.5% Growth Rate	No Growth After 2004–2006 Average
1990	5,349	192	192	192
1995	6,625	8	8	8
2004	16,202	449	449	449
2005	15,642	546	546	546
2006	26,249	371	371	371
2007	27,068	345	345	345
2010	20,037	471	515	455
2015	20,635	485	582	455
2019	21,832	513	643	455
2029	24,598	578	823	455
2039	26,984	634	1,053	455
2049	29,807	700	1,349	455
2059	32,926	774	1,726	455
2069	36,371	855	2,210	455
Average Annual Growth Rates				
2004/2006–2019	0.9%	0.9%	1.2%	0.4%
2004/2006–2069	1.0%	1.0%	2.5%	0.1%

Source: USDOE, EIA, 2009 Annual Energy Outlook, SR/OIA/2009-03, March 2009.

4.10 COASTWISE PETROLEUM PRODUCTS

SNWW domestic coastwise movements primarily consist of gasoline. Examination of vessel characteristics and geographic routings suggested that 10 to 20 percent of outbound coastwise shipment tonnage would benefit from channel depths over 40 feet. The draft-restricted product carriers are generally between 60,000 and 70,000 DWT with design drafts in the 41- to 43-foot range. As shown on Figure 46, SNWW coastwise movements increased steadily since the mid-nineties. Movements prior to 1995 primarily consisted of crude petroleum. Current movements consist almost exclusively of gasoline shipments. The majority of shipments are to Florida and the U.S. Northeast. As with product exports, based on SNWW's position as a major refinery center, expectations are that coastwise shipments are expected to increase at an increasingly steady rate based on the region's position as a major refinery center. Table 70 summarizes the SNWW coastwise forecasts evaluated for the SNWW study.

Figure 46
SNWW Coastwise Shipments
1995–2007 Waterborne

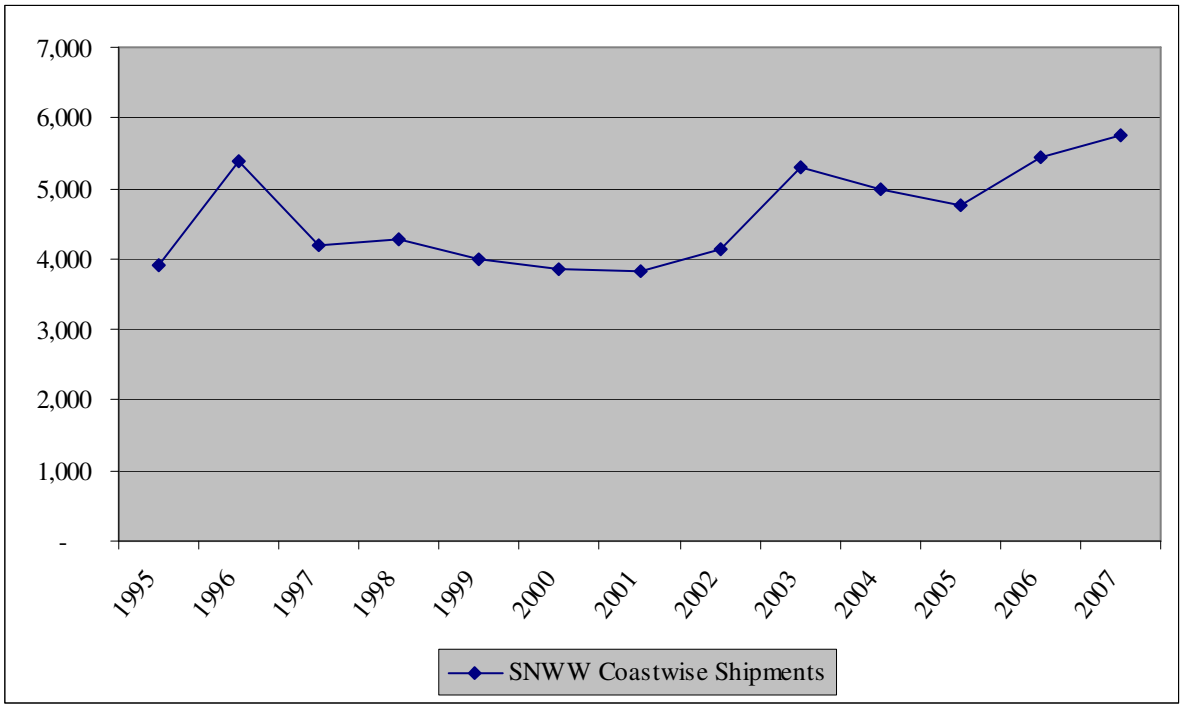


Table 70
SNWW Coastwise Movement Forecast Scenarios
(1,000s of Short Tons)

Year	SNWW Coastwise Movements 1998–2007 Trendline	SNWW Coastwise Movements 1% Growth	SNWW No Growth Beyond 2005–2007 Average
1990	8,906	8,906	8,906
1995	3,909	3,909	3,909
1996	5,386	5,386	5,386
1997	4,197	4,197	4,197
1998	4,284	4,284	4,284
1999	3,989	3,989	3,989
2000	3,863	3,863	3,863
2005	4,770	4,770	4,770
2006	5,438	5,438	5,438
2007	5,762	5,762	5,762
2010	6,121	5,595	5,323
2015	7,110	5,880	5,323
2019	7,901	6,119	5,323
2029	9,879	6,759	5,323
2039	11,857	7,466	5,323
2049	13,834	8,248	5,323
2059	15,812	9,110	5,323
2069	17,790	10,064	5,323
Average Annual Growth Rates			
2005–2019	2.9%	1.0%	0.0%
2005–2069	1.8%	1.0%	0.0%

While review of the historical vessel movements showed that nearly half of petroleum product shipments was shipped in vessels with design drafts over 40 feet, the combination of U.S. tanker availability, depths at trading ports, parcel size demand, and industry discussion suggests that the tonnage that would utilize channel depths over 40 feet would not exceed 10 percent. Channel deepening benefits were calculated based on 10 percent of 2019–2069 tonnage.

4.11 REMAINING PETROLEUM PRODUCT EXPORTS

SNWW's remaining product exports include lube oil and naphtha, with each representing approximately 1.5 percent of total petroleum product exports and totaling less than 100,000 short tons from 1995 through 2006. The 2004–2006 export volumes for lube oil and naphtha were assumed to grow at 1 percent annually in future years.

4.12 CHEMICAL IMPORTS

The largest volumes, and the highest growth rates, for SNWW imports are for alcohols and ammonia, with present imports of these inorganic chemicals up by over 4,000 percent from the previous 10-year period. In comparison, U.S. chemical imports are currently over 200 percent higher than in the early 1990s. Currently, U.S. alcohol imports are over 500 percent higher than in the early 1990s, and ammonia imports are up by over 200 percent. Figure 47 displays U.S. alcohol and ammonic imports for 1990–2007. For 2004–2007, Beaumont ammonia imports represented approximately 6 percent of the U.S. total, having increased from less than 5,000 short tons in the early 1990s to 460,000 short tons in 2006. The largest rates of growth for U.S. imports were for agricultural fertilizers. Fertilizers compose 33 percent of total chemical imports. While agricultural fertilizers are exported from SNWW, none are imported.

Figure 47
U.S. Alcohol and Ammonia Waterborne Imports 1990–2007
(1,000s of short tons)

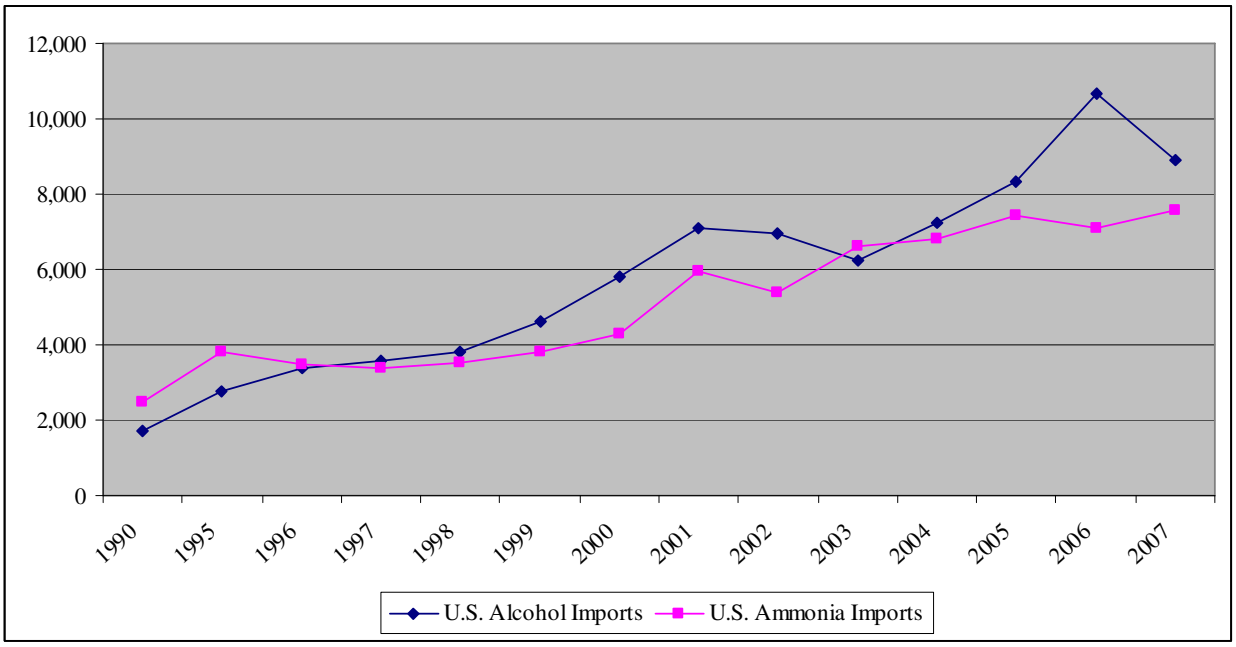


Figure 48 displays SNWW 1990–2007 alcohols and ammonia imports. Eighty-nine percent of SNWW methyl alcohol imports comes from Trinidad, 8 percent comes from Chile, and the remaining 3 percent from Venezuela. The Trinidad plant represents the world's largest methanol production plant and is capable of producing 5,000 tons per day. The plant located in Punta Arenas, Chile, plans to triple its methanol production capacity by the end of 2008. Additionally, the Economic Research Service of the USDA notes that new plants are planned in West Africa and the Middle East, with those locations presently serving markets other than the SNWW.

U.N. studies suggest that worldwide demand will grow at 5 percent but indicate that the higher growths are expected to be associated with emerging markets. Analysis of the SNWW and national total indicated a reasonable level of correlation between the study area and the Nation; however, SNWW tonnage was equally correlated with year. Analysis of the 1990–2007 relationship between U.S. and SNWW chemical imports showed strong statistical correlation, with a corresponding adjusted R square of 0.82. An adjusted R square of 0.78 was produced when "year" was used instead of "U.S. imports." The t value and F statistics associated with both of the equations are significant at the greater than 0.99 percent confidence levels. An average annual growth rate of 1 percent was used for SNWW 2006–2049 alcohol and ammonia imports. For forecasting purposes, SNWW's 2004–2006 average tonnage was used as a base for the forecast application. SNWW's alcohol and ammonia import forecast is displayed on Figure 49.

Figure 48
SNWW Alcohol and Ammonia Waterborne Imports 1990–2007
(1,000s of short tons)

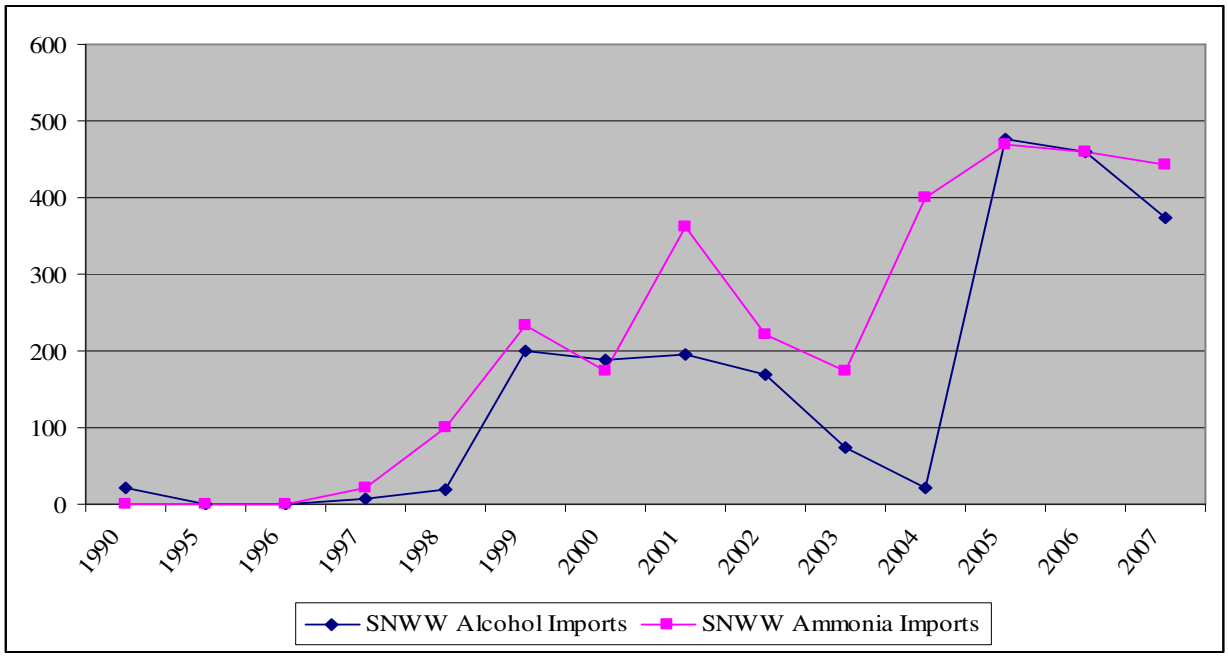
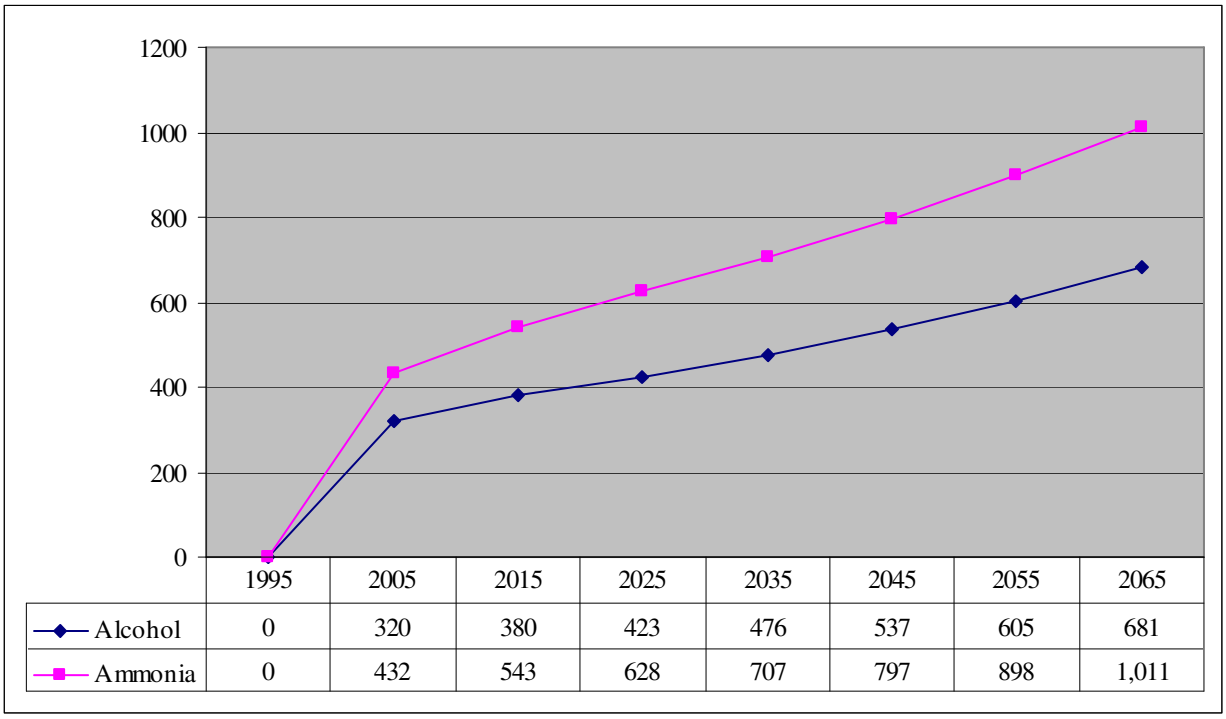


Figure 49
SNWW Alcohol and Ammonia Imports 1995–2065
Waterborne (1,000s of Short Tons)



	1995	2005	2015	2025	2035	2045	2055	2065
Alcohol	0	320	380	423	476	537	605	681
Ammonia	0	432	543	628	707	797	898	1,011

Future transition to larger and more fully loaded vessels for SNWW alcohol and ammonia imports was evaluated based on examination of vessel sizes and loaded drafts associated with other regional ports. These analyses showed that the loaded drafts associated with these commodities are generally less than 36 feet. The analyses also indicated that the use of vessel sizes constrained by the existing 40-foot channel depth is presently limited, with future transition being uncertain. While expectations concerning future chemical imports to SNWW are uncertain, larger and more deeply loaded carriers are presently being used.

4.13 CHEMICAL EXPORTS

Like imports, SNWW chemical exports grew at very fast rates. In 2006, SNWW exported 2.9 million short tons of chemicals, representing a record high. Review of 1990–2007 records show 1995–2007 exports had minimum exports of 724 thousand short tons in 1995. With few exceptions, SNWW exports steadily increased. In comparing SNWW's growth rates to U.S. rates, U.S. growth was slower but increased, with 2006 exports totaling 59 million short tons, up from 40 million in 1990.

SNWW's largest percentage increase was for fertilizer mixes, and the largest share of tonnage is associated with the organic compound and metallic salt commodity classifications (Table 17). U.S. exports of these commodities also increased. Figures 50 and 51 shows U.S. and SNWW metallic salts and organic compound exports for 1990–2006. For 2004–2006, SNWW exported 18 percent of the U.S. metallic salt waterborne total and 11 percent of the organic compound total. Based on these indicators, an

average annual growth rate of 2.5 percent was used for SNWW 2006–2039 metallic salts and organic compounds. A growth rate of 1 percent was used for 2039–2069. For forecasting purposes, SNWW's 2004–2006 average tonnage was used as a base for the forecast application. Ten percent of future tonnage was forecasted to use channel depths over 40 feet. The transition to larger and more fully loaded vessels for 10 percent of future tonnage was based on general indicators associated with chemical vessel fleet trends summarized in the fleet forecast section (see Table 44). SNWW's metallic salts and organic compound export forecast is displayed on Figure 52.

Figure 50
U.S. Metallic Salts and Organic Compound Exports
Waterborne (1,000s of Short Tons)

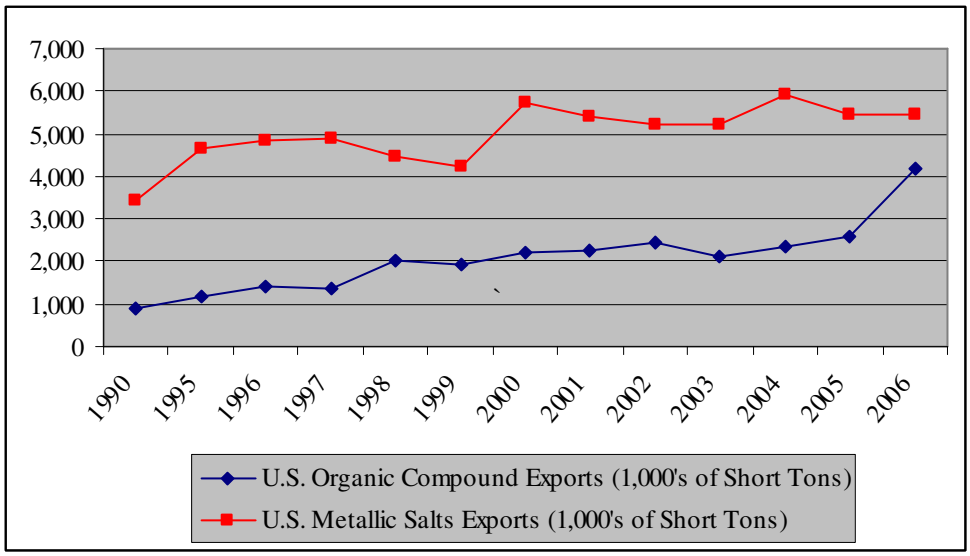


Figure 51
SNWW Metallic Salts and Organic Compound Exports

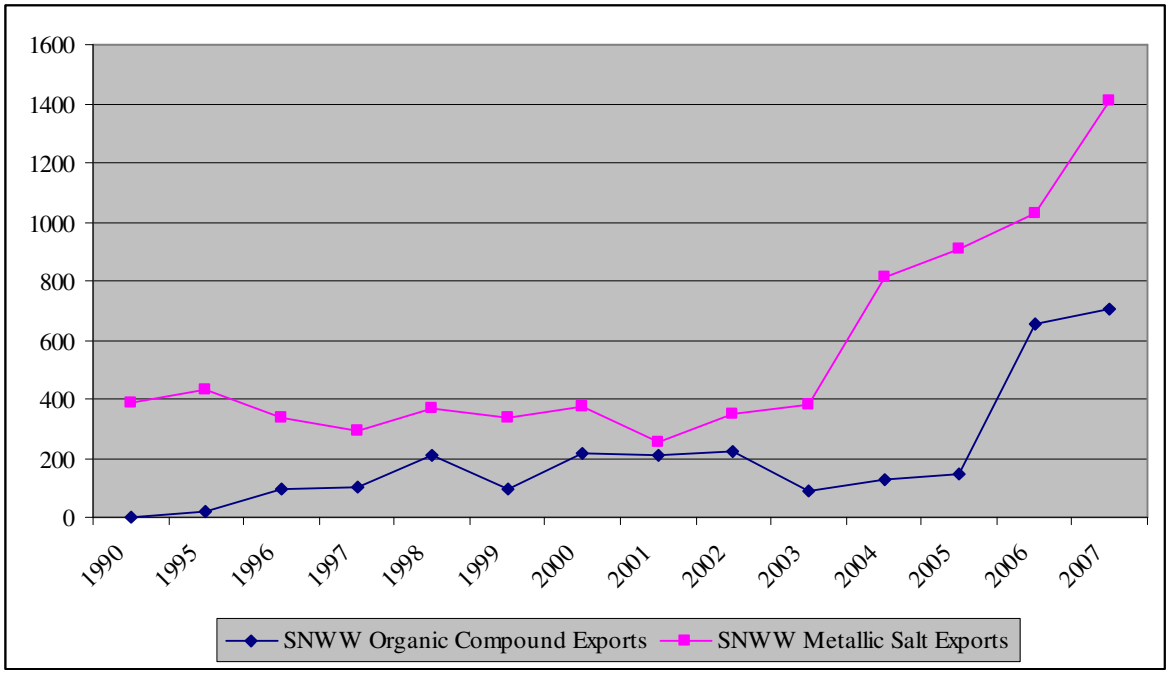
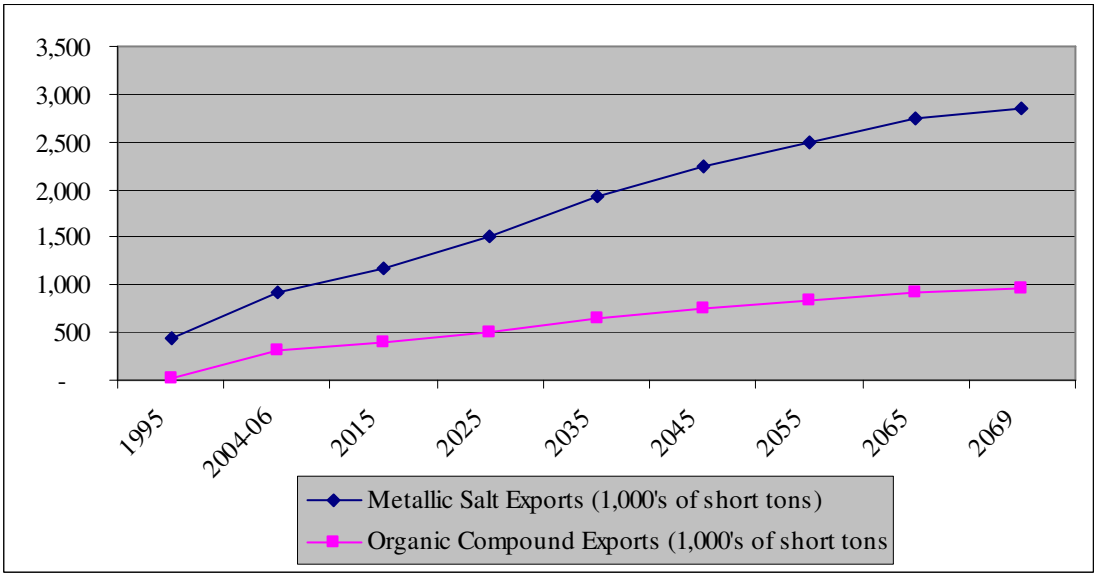


Figure 52
SNWW Metallic Salts and Organic Compound Exports 1995–2069
Waterborne



4.14 LIQUEFIED NATURAL GAS

LNG will play an increasingly important role in the natural gas industry and global energy markets in the next several years. Table 71 shows SNWW current and future capacity volumes for the SNWW facilities. Phase I of the Cheniere terminal is presently complete, and the first vessels arrived in April 2008. Phase 1 consists of 10.1 Bcf of LNG storage in three tanks, each with an LNG capacity of 160,000 cubic meters (m^3), and a maximum continuous regasification rate of 2.6 billion cubic feet per day (Bcf/d). Phase 2 will be built in stages. The first stage of Phase 2 will include the addition of fourth and fifth storage tanks, additional vaporizers that will bring the maximum continuous regasification rate up to 4.0 Bcf/d with a peak sendout capacity of 4.3 Bcf/d. In the future stages of Phase 2, a sixth storage tank may be added and related facilities will bring the total LNG storage volume to 20.2 Bcf.

Table 71
Distribution of Liquefied Natural Gas
Operational Capacity

Facility	Full Operational Output (Bcf/d)	Annual Output (Bcf)
Sabine Pass	3.360	1,226.40
Golden Pass	2.268	827.82
Port Arthur	2.520	919.80
Total SNWW	8.148	2,974.02

Construction of the Exxon Golden Pass LNG terminal is scheduled for completion by 2011. The Golden Pass facility, which is being constructed by ExxonMobil and Conoco Phillips, will consists of a dock and unloading facilities, 5 LNG storage tanks (≈17 Bcf), and vaporization capacity of 2.7 Bcf/d. The Port Arthur project consists of two ship berths, three to six storage tanks (160,000 m^3), and vaporization capacity of 1.5–3 Bcf/d. The LNG for the Golden Pass terminal is anticipated to be supplied primarily from the Ras Laffan 3 and the Qatargas 3 projects in Qatar, which will produce and process natural gas from Qatar's offshore North Field.

Construction of the Sempra terminal is anticipated after 2012. The Sempra LNG terminal will be capable of delivering between 1.5 and 3 Bcf per day of natural gas. The terminal will include two unloading docks for ships and three to six full containment storage tanks and associated equipment in order to transform the LNG back to its gaseous state. As noted, construction of this third facility is planned for after 2012. At full utilization, Sabine Pass and Golden Pass could handle 2.05 trillion cubic feet (Tcf) annually. The Sempra annual capacity increases regional capacity by 2.97 Tcf without pushing peak capacity.

There are about 40 LNG terminals that are either before the Federal Energy Regulatory Commission (FERC) or are being discussed by the LNG industry for North America. Six terminals are already operating on the East Coast, Puerto Rico, and Alaska. There are six onshore LNG terminals in the continental U.S., these are located in Everett, Massachusetts; Lake Charles, Louisiana; Elba Island, Georgia; Cove Point, Maryland; Cameron, Louisiana; Sabine, Texas; and Freeport, Texas. The Cameron,

Sabine, and Freeport terminals are new. In addition to these three terminals, the Northeast Gateway port offshore Massachusetts received its first supplies in 2008. With these four terminals now operational, U.S. capacity to receive LNG imports has increased from approximately 5.0 Bcf/d at the end of 2007 to about 9.1 Bcf/d as of the end of the year. The Sabine Pass facility adds 2.6 Bcf, or 29 percent to U.S. Bcf capacity.

In 2007, the U.S. imported an estimated 771 Bcf, or 21.2 million short tons, of LNG. Shipments to existing U.S. facilities in 2006–2008 came from Trinidad (64 percent), North Africa (22 percent), Western Africa (11 percent), Norway (2 percent), and the Middle East (1 percent). The EIA reported total LNG import shipments of 771 Bcf in 2007 to these terminals, with each importing similar volumes—each between 20 and 30 percent of the total. Imports in 2008 only reached 352 Bcf. Despite declines in 2008, the EIA expects U.S. LNG imports to increase to about 500 Bcf in 2009, up from 352 Bcf in 2008, and rise to about 740 Bcf in 2010. The 2008 fall in imported natural gas to the U.S. reflects the increased need for natural gas in other countries willing to compete for available global supplies. While U.S. imports increased in 2009 over 2008 levels, U.S. LNG import growth this year has been constrained because of increased LNG demand in Europe and delays and maintenance to new and existing LNG liquefaction capacity. With limited natural gas storage availability, recent data suggest that European inventory levels are now nearing capacity. The expectation is that LNG shipments may be redirected to U.S. ports in the coming months as prices in the European market become less attractive to LNG suppliers. A similar scenario may also occur in Canada, with natural gas pipeline imports increasing in the months ahead as Canadian storage facilities are topped off. The EIA notes that an increase in U.S. natural gas imports would likely be balanced by larger-than-expected declines in domestic natural gas production.

4.15 U.S. LNG IMPORT FORECAST

The EIA notes that annual U.S. LNG imports are projected to exceed 1 Tcf by 2015 but are expected to drop to 800 million cubic feet by 2030. Table 72 presents the LNG import forecasts outlined in the AEO2009. Short-term forecast revisions note that LNG imports are expected to increase to about 506 Bcf in 2009 from 352 Bcf in 2008, because of a combination of weak demand and growing supply in the global LNG market. Lower demand for LNG in Japan and South Korea has increased the amount of available LNG in the global market, leading to larger LNG purchases in China and Europe. However, with limited natural gas storage capacity in Asia and Europe, lower global demand is expected to increase available LNG cargoes for import by the United States.

The likelihood of a region's ability to capture a share of the LNG market is obviously subject to uncertainty; however, some sites, such as those on the SNWW, may have more-obvious advantages because of FERC approval, lack of public opposition, or locational advances (close access to international waters). The SNWW facilities have the advantage of FERC approval, relatively high levels of public and political support, and locational advances in terms of access to the U.S. Gulf. For the analysis, 20 percent of the U.S. waterborne LNG imports market was used for SNWW. Table 73 displays the expected distribution of imported by country of origin. The distribution was prepared based on industry input and

reflects a higher proportion of imports from Trinidad than the EIA forecast. The EIA is currently forecasting higher volumes from the Middle East than the distribution shown in Table 73.

Table 72
U.S. and SNWW Liquefied Natural Gas Imports, 2005–2030
Updated June 2009

	U.S. Total LNG Imports		SNWW
Year	Trillion Cubic Feet	Waterborne Short Tons	LNG Forecast Short Tons
2005	0.5661	16,566,000	-
2006	0.5840	18,617,000	-
2007	0.7708	21,238,000	-
2015	1.1460	31,575,957	3,157,596
2019	1.4101	38,852,755	5,827,913
2020	1.3808	38,045,447	9,511,362
2025	1.1269	31,049,691	7,008,843
2029	0.8964	24,698,681	6,174,670
2030	0.8097	22,309,819	6,174,670
2039	n/a	n/a	6,174,670
2049	n/a	n/a	6,174,670
2059	n/a	n/a	6,174,670
2069	n/a	n/a	6,174,670

Source for U.S. Imports: USDOE, 2009 Annual Energy Outlook, March 2009.

Table 73
SNWW Liquefied Natural Gas Trade Route Forecast, 2019–2069
Short Tons

Year	Middle East	Trinidad	Algeria	Total
2019	1,946,522	1,940,695	1,940,695	5,827,913
2029	2,062,339	2,056,165	2,056,165	6,174,669
2039	2,062,340	2,056,165	2,056,165	6,174,670
2049	2,062,340	2,056,165	2,056,165	6,174,670
2059	2,062,340	2,056,165	2,056,165	6,174,670
2069	2,062,340	2,056,165	2,056,165	6,174,670

Note: SNWW 2015–2030 volumes are based on application of the EIA 2010–30 growth rates.

4.16 GRAIN EXPORT FORECAST

Grain is exported from the Beaumont elevator located just below the Port of Beaumont main turning basin. While exports have exceeded 1 million short tons since 2003, recent volumes remain less than half the 1993 peak volume of 3.5 million. While relatively low in comparison to the Pacific Northwest and the Lower Mississippi, Beaumont has maintained a 1.4 to 1.7 percent share of the U.S. waterborne bulk grain export market. Table 74 displays Beaumont's 1990–2007 bulk grain exports by major product. Wheat

presently comprises 100 percent of Beaumont's grain exports for the most recent 4-year period. Beaumont's 2007 wheat exports represented 4.4 percent of the U.S. wheat export total.

Table 74
Beaumont Bulk Grain Exports and Percentage by Grain Type

	Wheat		Corn		Sorghum Grain		
Year	1,000s of Short Tons	%	1,000s of Short Tons	%	1,000s of Short Tons	%	Total Exports
1990	1,957	94	–	–	132	6	2,089
1991	1,863	96	–	–	73	4	1,936
1992	2,796	87	–	–	431	13	3,227
1993	3,038	88	–	–	433	12	3,471
1994	2,143	93	–	–	160	7	2,303
1995	1,486	87	–	–	227	13	1,713
1996	796	77	3	–	238	23	1,037
1997	999	73	51	4	320	23	1,370
1998	648	72	–	–	251	28	899
1999	629	67	–	–	308	33	937
2000	753	84	56	6	85	10	894
2001	679	82	55	7	97	12	831
2002	742	89	70	8	23	3	835
2003	1,125	100	–	–	–	–	1,125
2004	1,329	100	–	–	–	–	1,329
2005	1,081	100	–	–	–	–	1,081
2006	1,214	100	–	–	–	–	1,214
2007	1,632	100	–	–	–	–	1,632

Source: USACE, Waterborne Commerce Database, 1990–2007.

Figure 53 shows wheat exports by U.S. geographic region for 2002–2007. Figure 54 shows Beaumont's share of the Texas Gulf Coast wheat exports for 2002–2007. Comparison of Beaumont wheat export volumes with other major U.S. grain export locations showed that Beaumont has maintained a consistent market share since 1996. Figure 55 displays 1990–2006 U.S. total wheat exports, U.S. production, and Beaumont wheat exports. While corn exports have historically been low, sorghum grain constituted 14 percent of Beaumont's bulk grain exports prior to 2003.

Figure 53
U.S. Wheat Exports by Region
(1,000s of Short Tons)

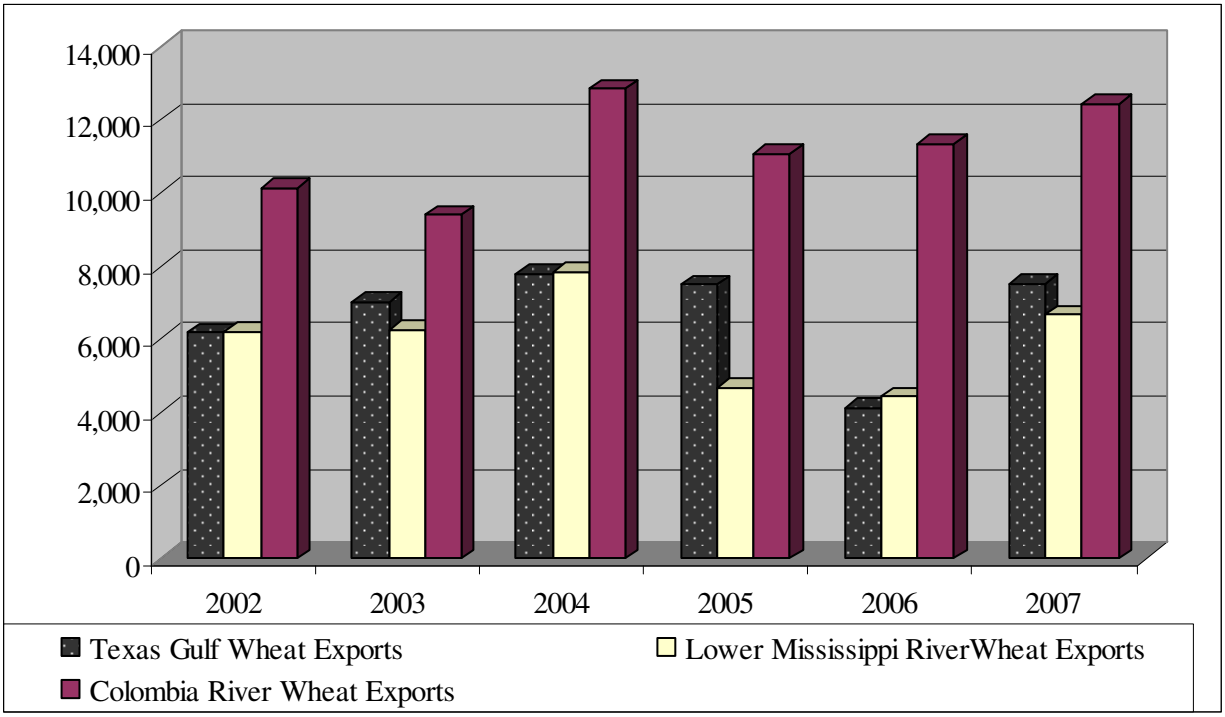


Figure 54
Beaumont Wheat Exports
(1,000s of Short Tons)

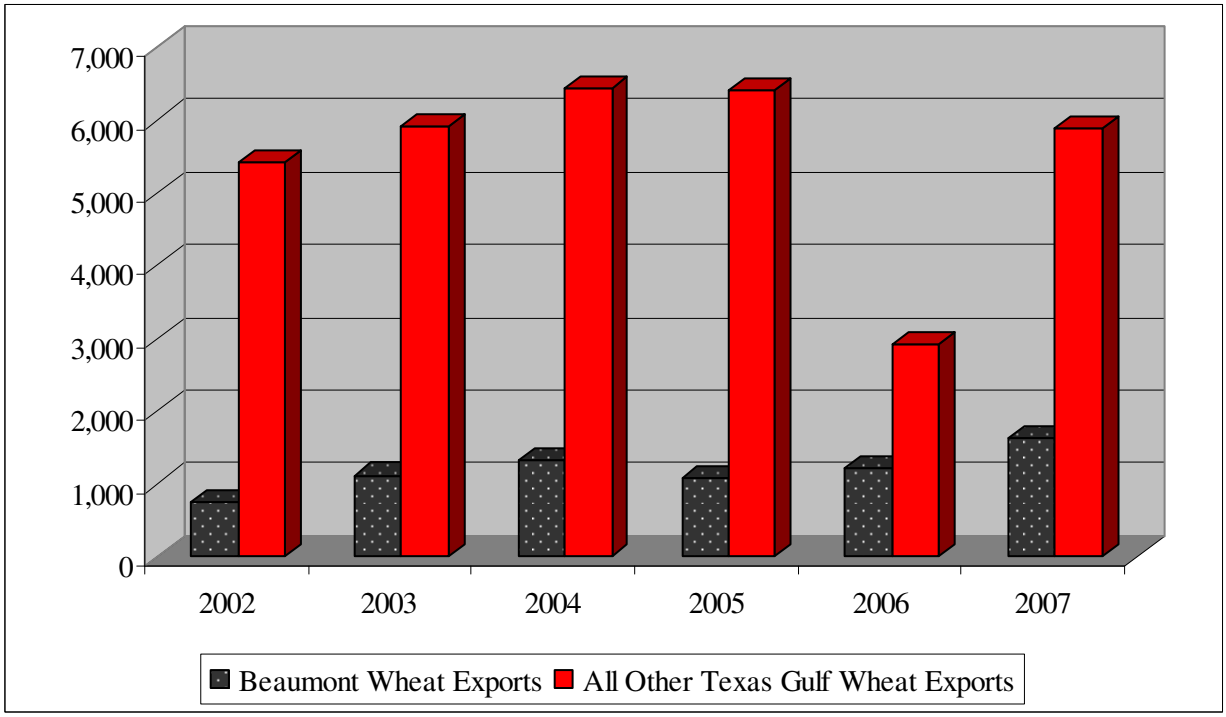
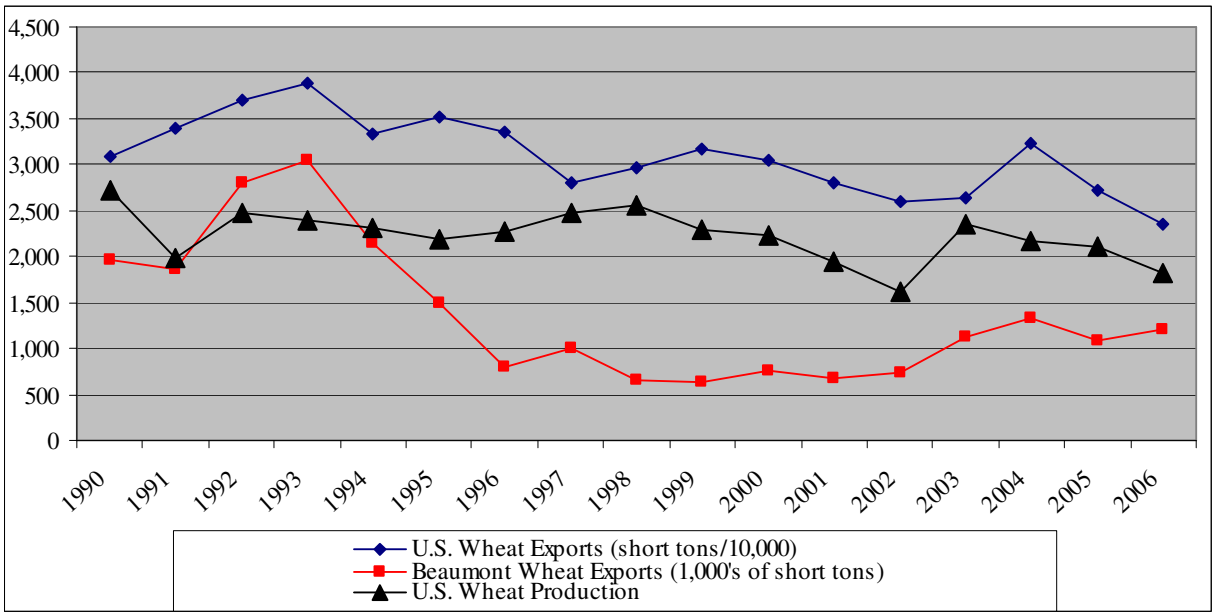


Figure 55
U.S. and Beaumont Wheat Exports and U.S. Wheat Production (short tons)



According to the U.S. Grains Council, the U.S. is currently positioned as the number two producer and number one exporter of sorghum on the world market. The U.S. share of the world sorghum trade has not dropped below 70 percent in more than a decade. World trade in sorghum is dominated by U.S. exports to Mexico. In the last 5 years, transportation of the commodities considered in this study (corn, sorghum, wheat, and soybeans) has shifted from maritime to overland.[39] Rail is the major overland transportation mode for all grains but sorghum. Sorghum is shipped by truck because of the proximity of the production areas in Texas's Rio Grande Valley to the border. Other importing countries and regions include Japan, Israel, South Africa, Spain, Morocco, and Eritrea.

Mexico is the world's third largest sorghum producer after Nigeria and the United States and the second largest world consumer after Nigeria. The United States is the only sorghum supplier to Mexico. Over the last 5 years, half of U.S. sorghum exports to Mexico were shipped by ocean through the U.S. Gulf, mostly from North Texas, South Texas, and the Mississippi River. The port of Veracruz is the major ocean point of entry. On average, trucks moved 30 percent and rail hauled 19 percent of sorghum shipped to Mexico. The top rail destinations for U.S. sorghum exports to Mexico in 2005 were Nuevo Leon, Veracruz, Estado de Mexico, Jalisco, and Guanajuato.[40] Texas (Laredo and El Paso) and Arizona (Santa Cruz) are the main rail entry points. The ports of Veracruz and Progreso are the major entry points by vessel. Half of the year's sorghum exports to Mexico occur between January and May, reaching a peak in April. The percentage of grain transported by oceangoing vessel declined from 60 percent in 2002 to 45 percent in 2006.

[39] USDA, U.S. Grain and Soybean Exports to Mexico – A Modal Share by Dalmy L. Salin, April 2008.

[40] Adcock, F. J, C. Parr Rosson III, and Alejandro Varela. 2007. Tracking U.S. Grain and Soybean Exports in Mexico. Center for North American Studies, Texas A&M University. http://cnas.tamu.edu/AMS%20Final%20Export%20Report.pdf

Analysis of Beaumont's grain exports does indicate reduction in shipments to Mexico and also shows that sorghum exports ceased after 2002. The specific reasons for Beaumont's drop in sorghum exports were not investigated; however, sorghum had composed a relative small share of Beaumont's grain. Analysis of Beaumont's 2004–2006 wheat exports by destination showed that the primary markets served are West Africa and the Middle East. Table 75 displays Beaumont's 1998–2006 wheat exports by destination.

Table 75
Beaumont Wheat Exports by Destination, 1998–2006
Short Tons

Destination	1998	2002	2004	2005	2006	%
Brazil	–	52,087	–	–	–	1
Caribbean	4,617	22,532	63,008	59,507	85,240	5
Colombia	17,218	170,807	58,426	65,438	43,799	7
East Africa	–	–	–	23,864	–	0
Mexico	25,266	71,888	84,881	–	–	4
Middle East	82,287	–	17,416	272,894	873,854	24
Mediterranean and North Africa	278,892	210,088	512,318	63,643	–	21
South Africa	17,505	94,114	–	26,467	–	3
W South America	67,461	89,375	89,739	–	–	5
West Africa	107,511	124,239	502,829	568,825	211,118	30
Far East	62,422	–	–	–	–	1
Total	663,179	835,130	1,328,617	1,080,639	1,214,010	100

Source: USACE, Navigation Data Center, detailed unpublished vessel records, 2004–2006.

Review of research conducted by Texas A&M University shows that the Gulf of Mexico ports are a major export outlet for U.S. wheat, in particular hard red winter wheat. Hard red winter wheat is railed from Kansas, Oklahoma, Texas, and Colorado for Texas export. Figure 56 displays the 1997–2006 relationship between wheat exports destination by state of origin and Beaumont's exports. The states of Kansas, Oklahoma, Texas, and Colorado originate virtually all of the 5 to 8 million tons of hard red winter wheat annually shipped to Texas Gulf ports. Transport of nearly all Texas Gulf grain exports is by unit train. The Burlington Northern Santa Fe, Missouri Pacific, Southern Pacific and Union Pacific railroads are used to transport wheat to export facilities in Brownsville, Corpus Christi, Galveston, and Houston.

The relative locations of the grain production areas to either rail lines or to the Mississippi River is the major determinant in the distribution of grain exports between the Texas Gulf Coast ports and the Lower Mississippi River.[41] The U.S. Grains Council notes that while infrequent corn will move from Nebraska and Iowa to Texas ports during periods of Mississippi River low flow or of excess demand, red winter wheat from Louisiana, Mississippi, Arkansas, Missouri, Illinois, Indiana and other states in the Illinois and Ohio River basins tends to move via barge and rail through the Mississippi River ports.[42] The Pacific Northwest is noted to have a freight advantage over the other U.S. Gulf for Asian destinations. The

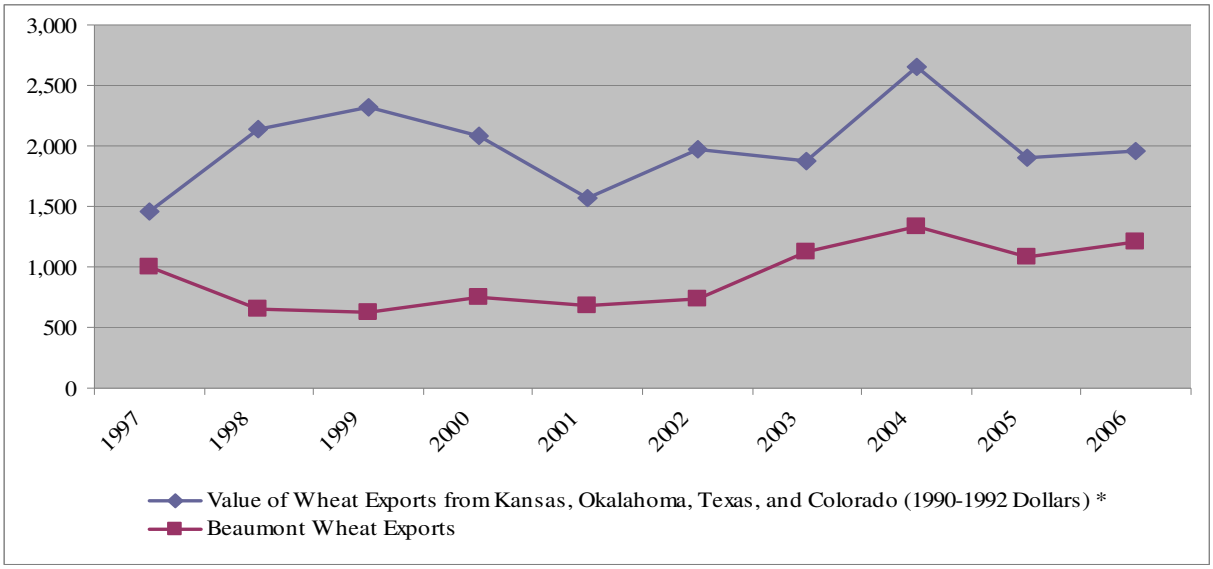
[41] Besslerand, David and Stephen W. Fuller, Transportation Research: Part E: Logistics and Transportation Review, Volume 36, Number 1: "Railroad Wheat Transportation Markets in the Central Plains: Modeling with Error Correction and Directed graphs", Department of Agricultural Economics, Texas A&M University.

[42] U.S. Grains Council – Importer Manual, August 2004, Chapter 5, p. 64.

shorter distance from the Pacific Northwest to Asian destinations is mentioned as contributing to the willingness to pay a substantially higher price for feed grains delivered from that coast. While having an ocean freight advantage, the Pacific Northwest is noted as being relatively far from feed grains production areas.

Figure 56

Wheat Exports by State and Beaumont Exports, 1997–2006



*Constant 1990–1992 dollars. ftp://ftp-fc.sc.egov.usda.gov/Economics/priceindexes/Data/PPPI_CPI_CCI.xls.

Beaumont's tonnage forecast is based on application of the USDA's Baseline Projections Report February 2009 forecast. The forecast shown in Table 76 is based on Beaumont capturing between 4.4 percent and 7.8 percent of U.S. wheat exports, with 7.8 percent representing the 1990–2006 maximum and 4.4 percent representing the 2004–2006 average. The baseline forecast used for the transportation cost calculations is based on Beaumont capturing a 6.6 percent share of the U.S. export market. The transportation savings benefits are based on 30 percent of tonnage would load to drafts over 40 feet.

Table 76
Beaumont Wheat Export Forecast (2004–2069)

	U.S. Wheat Exports		Beaumont Wheat Exports	
Year	Bushels	Short Tons	Total Exports	Volume Used for Benefit Calculations
2004	1,066,000	31,980,000	1,208,333	–
2005	1,002,000	30,060,000	1,081,000	–
2006	909,000	27,270,000	1,214,000	–
2007	1,264,000	34,400,000	1,632,000	–
2019	1,075,000	29,300,000	2,128,500	638,550
2029	–	–	2,351,188	705,356
2039	–	–	2,597,175	779,152
2049	–	–	2,868,896	860,669
2059	–	–	3,169,046	950,714
2069	–	–	3,500,599	1,050,180

The USDA is presently showing modest growth in wheat exports between 2006 and 2018/2019.[43] U.S. 2006–2018/2019 exports are forecasted to increase from approximately 990 million bushels in 2006 to 1,075 million bushels by 2014/2015 and remain constant at that level through the end of the forecast period in 2018/2019. Egypt maintains its position as the world's biggest importer of wheat, as imports climb slowly to nearly 9 million tons. Imports by developing countries in Sub-Saharan Africa, North Africa, and the Middle East rise to nearly 12 million tons and account for 45 percent of the total increase in world wheat trade. While the shares of the world wheat market held by Canada and the U.S. are noted to decline slightly and be offset by increases in the European Union, Ukraine, Russia, Australia, and Argentina, total U.S. wheat exports increase slightly. The USDA also notes that changing consumption patterns will boost wheat imports by some major importing countries. In Indonesia, strong economic growth and diversification of diets are projected to increase per capita wheat consumption. The USDA notes that for most developing countries there is little change in per capita wheat consumption but imports expand modestly because of population growth. Table 77 displays major destination ports for SNWW grain exports that can accommodate large bulk carriers.

An average of nearly 30 percent of Beaumont's 2000–2007 grain export tonnage was shipped in vessels with design drafts over 40 feet (Table 78). The maximum DWT presently used for grain exports is in the 60,000 to 70,000 DWT range. The vessels have design drafts between 42 and 43 feet. Until the early 1990s, grain carriers in excess of 100,000 DWT were used for the Texas bulk grain exports. The larger vessels were associated with the former Soviet Union and Northern Europe grain shipments. Currently, the maximum parcel sizes are in the 50,000 to 60,000 short tons range.

[43] USDA, Economic Research Service, USDA Wheat Baseline to 2018/2019, Wheat Trade Projections (Table 35), February 2009.

Table 77
Beaumont Bulk Grain Exports
to Ports with Channel Depths Over 40 Feet

	Trade Partners for Draft-Restricted Tonnage						
Destination	2000	2001	2002	2003	2004	2005	2006
Damietta, Egypt	65,571	66,612	184,374	57,417	64,403	63,643	53,998
Aqaba, Jordon	110,802	57,292	0	43,070	111,903	0	0
Durban, South Africa	0	55,186	0	0	0	0	0
Haifa, Israel	0	35,834	0	0	0	0	0
Constanta, Romania	0	0	0	59,061	59,341	0	0
Khor al Zubair, Iraq	0	0	0	0	0	104,905	724,461
Djibouti, Djibouti	0	0	0	0	0	191,853	43,276
Exports to Ports with Depths Over 40 feet	176,373	214,923	184,374	159,548	235,647	360,401	821,735
Total Bulk Grain Exports	894,000	858,000	835,000	1,125,000	1,329,000	1,082,000	1,214,000
% of Total Grain Exports	19.7	25.0	22.1	14.2	17.7	33.3	67.7

Source: Compiled from the USACE, NDC detailed records.

Table 78
Importers of Wheat (USDA Forecast), 2004/2005 to 2015/2016 a/

% Distribution	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2015/2016
Brazil	4.9	5.1	5.4	5.7	5.7	5.9	5.9	5.8
Europe and Mediterranean	32.0	32.5	32.4	32.7	32.8	32.9	32.8	44.2
Africa (non- Mediterranean)	11.2	11.5	11.3	11.1	11.1	11.0	11.0	0.0
Far East	29.2	26.5	26.1	25.8	26.0	26.0	26.0	26.0
Former Soviet Union	4.2	3.6	4.2	4.4	4.4	4.4	4.4	4.4
India/Bangladesh	3.1	2.4	2.4	2.4	2.4	2.4	2.3	2.4
Mexico, South and Central America	11.7	12.2	12.2	12.1	12.1	12.2	12.1	11.9
Mideast	2.9	3.7	3.8	3.6	3.5	3.4	3.4	3.5
Other	0.7	2.3	2.1	2.1	2.1	2.0	2.0	1.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: USDA, Economic Research Service, February 2006.

a/ February 2006, an updated trade route distribution was released but not presented (February 2009). Beaumont's wheat exports were assumed to continue Europe and the Mediterranean and expand to other markets as demand arises.

Note: Totals may not add due to rounding.

4.17 BREAKBULK IMPORT FORECAST

Analysis of the vessel fleets and utilization, and existing and future constraints associated with imports of aggregate products, such as iron ore, steel slab, limestone, and sand and gravel, and discussion with industry personnel suggested that 50 percent of limestone and sand and gravel, iron ore, and steel slab would be transported in vessels with loaded drafts over 40 feet (sections 3.9 and 3.10). Limestone and rock are classified as crude materials by WCSC. Iron ore and steel slab are classified as manufactured goods by WCSC. In addition to these classifications, crude materials are exported. SNWW's crude materials, primarily dry sulfur, clay, and refractory materials, are exported from SNWW. Table 79 displays SNWW's breakbulk tonnage forecast.

Table 79
SNWW Bulk Commodities Forecast, 2019–2069
2001–2007 Historical Data, Short Tons

	Crude Materials Imports Historical		Crude Materials Exports Historical		Manufactured Goods Imports Historical	
Year	Beaumont	Port Arthur	Beaumont	Port Arthur	Beaumont	Port Arthur
2001	622,000	131,000	165,000	0	103,000	665,000
2002	394,000	919,000	14,000	2,000	204,000	641,000
2003	583,000	481,000	73,000	20,000	115,000	557,000
2004	559,000	531,000	104,000	41,000	420,000	564,000
2005	624,000	558,000	106,000	14,000	471,000	710,000
2006	550,000	566,000	243,000	54,000	364,000	542,000
2007	617,000	513,000	421,000	64,000	173,000	122,000
	Crude Materials Import Forecast		Crude Materials Export Forecast		Manufactured Goods Import Forecast	
Year	Beaumont	Port Arthur	Beaumont	Port Arthur	Beaumont	Port Arthur
2019	760,862	712,739	344,873	38,319	428,221	523,626
2029	884,920	828,951	400,240	44,471	498,041	607,630
2039	1,029,206	964,110	465,498	51,722	579,247	705,110
2049	1,197,017	1,121,308	541,397	60,155	673,692	818,228
2059	1,392,189	1,304,136	629,672	69,964	783,537	949,493
2069	1,619,184	1,516,661	732,339	81,371	911,292	1,101,817

5.0 FORECAST OF TOTAL OCEANGOING TONNAGE

Tables 80 and 81 summarize the forecasts for the major commodity groups evaluated for channel deepening. The Port Arthur forecast is shown in Table 80 and Beaumont's forecast in Table 81. Discussions of each of the tonnage forecasts major groups are provided in the sections that follow.

Table 80
Port Arthur Tonnage Evaluated for Channel Deepening*
(1,000s of short tons)

		Petrochemicals					Breakbulk		Liquefied Natural Gas Imports
		Petroleum Products		Chemical Products					
Year	Crude Petroleum Imports	Imports	Exports	Imports	Exports	Coastwise a/ Products	Crude Materials	Primary Manuf. Goods	
2001	11,064	641	2,327	25	136	1,043	131	665	0
2002	9,013	997	3,143	89	176	1,422	921	641	0
2003	11,987	1,152	3,734	60	210	2,577	501	557	0
2004	10,015	2,150	4,255	225	889	1,804	572	564	0
2005	9,320	2,205	3,858	194	998	1,803	572	710	0
2006	10,627	1,144	4,391	111	1,330	2,323	620	542	0
2007	10,334	772	3,978	97	1,525	3,330	577	122	0
Port Arthur Tonnage Forecast*									
2019	12,248	1,811	6,879	223	1,462	3,002	751	524	5,828
2029	13,663	2,027	9,013	246	1,872	3,754	873	608	6,175
2039	14,509	2,312	10,255	272	2,396	4,506	1,016	705	6,175
2040	14,800	2,589	11,619	301	2,647	4,977	1,181	818	6,175
2059	15,100	2,901	13,124	332	2,924	5,498	1,374	949	6,175
2069	15,469	3,250	14,850	367	3,229	6,073	1,598	1,102	6,175

a/ Includes coastwise crude petroleum shipments and receipts.
*Deepening Benefits were calculated for a percentage of the tonnage presented in this table. Discussion of the commodity-specific percentages is contained in the previous and following sections.

Table 81
Beaumont Tonnage for Major Commodity Groups *
1,000s of short tons

		Petrochemicals						Breakbulk	
	Crude Petroleum	Petroleum Products		Chemical Products		Coastwise a/	Grain	Crude	Primary Manuf.
Year	Imports	Imports	Exports	Imports	Exports	Products	Exports	Materials	Goods
2001	53,162	2,093	2,793	729	1,160	2,793	858	787	103
2002	57,370	4,031	2,492	594	1,411	2,712	835	408	204
2003	58,171	4,035	2,839	374	1,345	2,732	1,125	656	115
2004	59,860	3,852	2,897	431	1,215	3,191	1,329	663	420
2005	50,371	3,144	2,496	890	893	2,967	1,082	703	471
2006	46.988	2,676	2,432	1,133	1,574	3,115	1,214	793	364
2007	47,776	2,948	2,713	858	1,644	3,261	1,632	1,632	173
Beaumont Tonnage Forecast *									
2019	81,980	3,362	4,586	967	1,787	4,899	2,129	1,106	428
2029	91,463	3,765	6,008	1,068	2,288	6,125	2,351	1,285	498
2039	97,152	4,293	7,458	1,180	2,928	7,351	2,597	1,495	579
2049	99,136	4,809	8,450	1,303	3,235	8,120	2,869	1,738	674
2059	101,149	5,387	10,738	1,439	3,573	8,970	3,169	2,022	784
2069	103,189	6,036	12,150	1,590	3,947	9,908	3,501	2,352	911

a/ Includes coastwise crude petroleum shipments and receipts.

* Deepening Benefits were calculated for a percentage of the tonnage presented in this table.

Discussion of the commodity-specific percentages is contained in the previous and following sections.

6.0 TRANSPORTATION SAVINGS BENEFITS

This section presents the transportation savings benefits. Transportation savings benefits were calculated for channel widening and deepening.

6.1 VESSEL OPERATING COSTS

The vessel operating costs are shown in tables 82 to 84. Table 82 displays the hourly operating costs for tankers. The hourly operating costs include fuel, labor, and maintenance. The costs used were obtained from deep-draft vessel operating cost EGM December 2008 update. The tanker costs were used for the crude petroleum, petroleum product, and chemical product transportation cost calculations. The maximum-sized vessels using the channel to Beaumont on a regular basis are in the 150,000 DWT class. The maximum size using the Taylor Bayou Port Arthur facilities are in the 110,000 to 116,000 DWT range. As previously noted, the Port Arthur fleet is smaller, in terms of DWT, because the existing width at the mouth of Taylor Bayou limits the allowable vessel size. The U.S. flag tanker costs contained in Table 82 were used for calculating the transportation costs for U.S. coastwise product movements. Table 83 displays the foreign flag bulk carrier operating costs which were used for the grain exports and imports of iron ore, metal products, limestone and rock. Table 84 displays the LNG vessel operating costs. The LNG costs were estimated in consultation with the Institute of Water Resources (IWR).

Table 82
Tanker Characteristics and Hourly Operating Cost
Double-Hull Tankers, December 2008 IWR Release

Vessel DWT	Design Draft (feet)	Immersion Factor	Hourly Cost ($)			
			Foreign-Flag		U.S. Flag	
			At Sea	In Port	At Sea	In Port
20,000	32.3	78.7	659	403	1,470	1,214
25,000	33.4	90.8	696	430	1,565	1,300
35,000	35.6	112.6	766	481	1,747	1,463
50,000	38.7	141.4	865	554	2,005	1,693
60,000	40.7	158.9	952	622	2,239	1,909
70,000	42.6	175.4	1,001	653	2,354	2,007
80,000	44.6	191.0	1,058	692	2,496	2,130
90,000	46.4	205.9	1,107	724	2,610	2,226
110,000	50.0	234.1	1,192	772	2,793	2,374
150,000	56.4	285.4	1,369	878	3,190	2,700
165,000	58.6	303.4	1,439	922	3,350	2,833
175,000	70.3	410.7	1,485	951	4,400	3,707
265,000	73.2	444.5	1,900	1,207	4,764	4,010
320,000	74.5	463.3	2,061	1,306	4,971	4,182

Source: Application of USACE, December 2008 Foreign Flag Tanker Costs presented in Economic Guidance Memorandum #08-04, Deep-Draft Vessel Operating Cost FY 2008, December 2007.

Table 83
Dry Bulk Carrier Characteristics and Hourly Operating Cost
Foreign Flag Dry Bulk Carriers, December 2008 IWR Release

Vessel DWT	Design Draft (feet)	Immersion Factor	Hourly Cost ($)	
			At Sea	In Port
60,000	41.6	153.5	807	552
70,000	43.6	168.6	847	578
80,000	45.6	183.7	886	603
90,000	47.5	197.4	940	643
100,000	49.4	211.1	994	683
120,000	52.0	236.5	1,092	754
135,000	55.9	271.8	1,236	857
150,000	55.9	271.8	1,236	857
175,000	58.7	299.2	1,355	942

Source: USACE, December 2008 unpublished update of Economic Guidance Memorandum #08-04, Deep-Draft Vessel Operating Cost FY 2008, December 2008.

Table 84
Liquefied Natural Gas Carriers
Characteristics and Hourly Operating Cost (December 2008 Vessel Costs)

Vessel DWT	Design Draft (feet)	Cubic Meters Capacity	Immersion Factor	Hourly Cost ($)	
				At Sea	At Sea
76,500	37	145,000	248.7	1,773	1,506
100,000	39	210,000	315.2	2,073	1,753
125,000	40	250,000	358.1	2,302	1,937
125,000	40	265,000	372.4	2,423	2,039

Source: Application of USACE, December 2008 Foreign Flag Tanker Costs presented in Economic Guidance Memorandum #08-04, Deep-Draft Vessel Operating Cost FY 2008, December 2008.

The LNG design vessel used by ERDC for the ship simulations consisted of a 140,000-m^3 spherical-tank-type vessel 920 feet long, 142 feet wide, and 37.4 feet in draft, and a proposed 250,000-m^3 membrane-type tanker 1,126 feet long, 177 feet wide, and 39.4 feet in draft. The LNG facilities are in the Sabine Pass Channel and Port Arthur reaches. The project design vessel for crude petroleum tankers using the entrance channel and going to Beaumont is 899 feet long and 164 feet wide. These dimensions correspond to a 158,000 DWT crude petroleum tanker.

6.2 UNDERKEEL CLEARANCE

Underkeel clearance is defined as the minimum clearance available between the deepest point on the vessel and the channel bottom, in still water. The SNWW project depth allows vessels to transit with a maximum draft of 40 foot fresh water subject to the most recent USACE's hydrographic report, prevailing weather, and tidal conditions.[44] Galveston District's dredging practice also provides 2 feet of

[44] http://www.sabinepilots.com/index.html.

advance maintenance and 2 feet of overdepth to the existing project depth of 40 feet mean low tide. The availability of advance maintenance and overdepth can provide an extra 4 feet of underkeel clearance. As the dredging cycle transpires, the stated project depth of 40 feet mean low tide and the range of underkeel clearance available on a period basis obviously varies and generally diminishes. Given these circumstances, it is also recognized that the dredging cycle is established with the goal of maintaining a minimum available project depth of 40 feet mean low tide. As indicated, the subsequent effect of the dredging cycle interval may result in a greater concentration of vessels loaded to 39 to 40 feet for the period closer to the completion of maintenance dredging. While the current analysis contained in this portion of the report does not include an investigation of the dredging history in relationship to vessel trips by loaded draft, the annual distributions of trips by draft from the pilots and USACE NDC were evaluated. Specifically, the pilots' policy was evaluated in relationship to the USACE and the pilot records of trips by loaded draft as a means of understanding existing underkeel clearance practices.

Data associated with the number of vessel trips by loaded draft was presented in Table 23 as part of the vessel utilization presentation (Section 3.3). Interpretation of the pilots' policy suggests that loaded drafts in excess of 40 feet should be rare, Table 23 shows this to be true, with few loaded drafts over 40 feet. Based on analysis of the Corps data and the pilots' records, vessels are loaded to a maximum draft of 40 feet.

While the pilots emphasize 3 feet of underkeel clearance, review of the waterborne commerce data shows some sailing drafts exceed 40 feet. The pilot emphasis of 3 feet of underkeel for liquid cargoes and review of the WCSC-WCUS data, which show a high number of vessels with loaded drafts over 37 feet, revealed discrepancies that showed uncertainty. Based on these findings, the transportation cost calculations were made based on 1 foot of underkeel clearance used for all vessels except LNG. Based on industry input a 4- to 6-foot underkeel clearance was used for LNG vessels. The indication from pilot discussion was that an absolute minimum of 4 feet underkeel clearance would be required and the preference was for 6 feet. The effects of varying underkeel clearance are addressed in detail in the Sensitivity section of this appendix (Section 8).

6.3 CHANNEL WIDENING BENEFITS

Reduction in delay benefits were calculated for channel widening and for holding area alternatives. The benefit estimates are based on comparison of transit times between project alternatives. Transportation costs for existing conditions, the without-project condition, and the project alternatives were calculated using 2004 SNWW traffic base. Pilot records for 2001 and 2004–2005 were obtained from the SPA. Vessel characteristics and related details were obtained from the USACE NDC detailed records.

In terms of channel width, there are three main traffic rules presently affecting vessel traffic. The traffic rules, which affect movements in the 400- and 500-foot project reaches, are instituted by the SPA for the purpose of helping to ensure safe navigation (Section 1, Table 3). The results of these rules provide for a safe channel and a relatively low accident rate; however, the rules affect a significant portion of traffic in the form of vessel delays. The traffic first rule is that vessels with combined beam widths equaling or

exceeding 50 percent of the channel width cannot meet each other. The second main rule is that vessels of 85,000 DWT or more will not meet vessels of 30,000 or more or with loaded drafts of 30 feet or more above buoys 29 and 30. The third rule is that vessels of 48,000 DWT or more with a loaded draft of 30 feet or more will not meet above buoys 29 and 30. Vessels going to existing port facilities in Port Arthur, Beaumont, and terminals in between are all affected by these traffic rules. The effect of the pilot rules in the existing 400- and 500-foot reaches is that inbound crude petroleum tankers that characteristically are in the 90,000 to 150,000 DWT range with beam widths between 135 and 145 feet and inbound loaded over drafts of 35 feet cannot meet an outbound tanker of a comparable size at a lesser or a blast draft nor can it meet a 106-foot-beam outbound chemical or product tanker.

The HarborSym model was used in evaluation of the Entrance Channel widening and the Neches River turning basin and anchorage features. The outputs from HarborSym were aggregated into Excel spreadsheets and are summarized in this section of the report. HarborSym is a planning-level model developed by the IWR to assist in economic analyses of channel widening improvements. HarborSym is an event-driven simulation model and includes data from user-specified transit rules that the model processes with each vessel call in order to calculate delays within the system. While not yet certified, the model is scheduled for review under the USACE certification system. The model is presently in the model certification process. The model is presently being used by several USACE district offices for channel-widening studies, and these outputs have undergone Agency Technical Review and USACE headquarters review.

As noted, channel widening was considered for the channel reaches from the Sabine Pass Channel inland through the Neches River Channel during the initial screening. The channel-widening alternatives evaluated include widening of the existing 500-foot Sabine Pass Channel and Port Arthur Canal and the 400-foot Sabine-Neches Canal and Neches River Channel. Table 85 presents the mileage from the offshore Entrance Channel to the jetty where the Sabine Pass Channel starts. The pilots board at either the Sabine Bar (SB) Buoy or the Sea Buoy. As shown from the mileage points in Table 85, the SB Buoy is farther seaward than buoys 29 and 30. Under present conditions, the pilots steer vessels from the SB Buoy or from buoys 29 and 30. Under present conditions, vessels with loaded drafts of 28 feet or more are piloted to and from SB Buoy, and vessels with lighter drafts are piloted from buoys 29 and 30. The effect of widening the Sabine Pass Channel to 500 feet will provide a continuous series of reaches for the inbound and outbound convoys to meet.

Table 85
SNWW Mileage Points

Location	Approximate Mileage Point
Sabine Bar (SB) Buoy	0.0
Sea Buoy (Markers #29 and 30)	14.0
East Jetty Light	16.3
LNG Facilities Sabine Pass	21.6
LNG Facility Port Arthur Canal	24.5
Texas Island (Junction to Taylor Bayou)	30.2
Taylor Bayou Crude Oil and Product Facilities	31.5
Martin Luther King Bridge	32.2
Port of Port Arthur Bulk Materials	32.6
Mouth of Neches River Channel to Beaumont	40.0
Rainbow Bridge	41.5
Crude Petroleum and Product Facilities, Lower Neches	41.7
Port Neches Crude Petroleum and Product Facilities	44.8
Crude Petroleum Terminal	46.1
Crude Petroleum Terminal	47.6
Crude Petroleum Terminal	50.9
Petroleum Coke Terminal	54.8
Crude Petroleum Terminal	55.2
Municipal Docks Bulk Materials	56.1
Trinity Industries	57.2

In addition to channel widening, the proposed Neches River turning basin anchorages were identified based on user input as a less costly alternative to channel widening. These proposed features would be used to facilitate vessel passing. The turning basin and anchorages would all be located above mile 40 shown in Table 86. Current and future use of the existing turning basins and new holding and turning sites is outlined in Table 86. The table shows the cross-section stations and approximate mile, from the Sabine Bank to the turning basin anchorages.

Under existing and without-project future conditions, there are four federally maintained turning basins on the Neches River. These are TBA 1, TBA 4, TB 6, and the Beaumont Maneuvering Area. TBA 1, TBA 4, and TB 6 are used to turn Suezmax vessels. The maximum-sized vessels using the Beaumont Maneuvering Area are light Aframax vessels. The Beaumont Maneuvering Area is not currently designed for Suezmax vessels nor will it be under the with-project future. Under existing conditions, Suezmax vessels partially use the maneuvering area but also rely on the open channel in order to turn. This condition will continue under the with-project condition. In addition to the four federally maintained turning basins, light Aframax vessels presently use TBA 2, a privately maintained basin, for turning and anchorage.

Table 86
Neches River Turning Basin and Anchorage Features

					CURRENT USE Maximum Vessel Size and Federal Authority (Y/N)				PROPOSED USE Maximum Vessel Size and Federal Authority (Y/N)			
					TURNING Maximum Vessel Size		ANCHORAGE Maximum Vessel Size		TURNING Maximum Vessel Size		ANCHORAGE Maximum Vessel Size	
Title	Location	Description	Station Number	Estimated Miles from Sea Buoy	FEDERAL (Y/N)				FEDERAL (Y/N)			
TBA 1	Lower Fina	Turning Basin Anchorage 1	210+00	43.4	Suezmax	Y	None a/	N	Suezmax	Y	Suezmax	Y
TBA 2	Upper Fina	Turning Basin Anchorage 2	275+00	44.6	Suezmax a/	N	None a/	N	Suezmax	Y	Suezmax	Y
TB 3	Port Neches	Turning Basin 3	370+00	46.4	None	N	None	N	Suezmax	Y	None	N
TBA 4	Lower Sun	Turning Basin Anchorage 4	510+00	49.1	Suezmax	Y	None a/	N	Suezmax	Y	Suezmax	Y
TB 5	Upper Sun	Turning Basin 5	570+00	50.2	Shallow-Draft Barges b/	N	Shallow-Draft Barges b/	N	Suezmax	Y	None	N
TB 6	Oil Tanking	Turning Basin 6	700+00	52.7	Suezmax	Y	None	N	Suezmax	Y	None	N
AB 7	PA 25	Anchorage Basin 7	750+00	53.6	None	N	None	N	None	N	Suezmax c/	Y
AB 8	Below Exxon	Anchorage Basin 8	850+00	56.5	None	N	None	N	None	N	Suezmax c/	Y
None	Beaumont	Beaumont Maneuvering Area	975+00	58.8	Suezmax	Y	None	N	Suezmax	Y	None	N

a/ Light vessels under emergency conditions.

b/ Under existing conditions, TB 5 is private and used by shallow-draft barges. A new turning basin is proposed immediately north of existing TB 5. This basin would be designed for loaded Suezmax tankers.

c/ For the "with-project future," anchorage basins 7 and 8 are designed for anchorage; however, the pilots intend to use anchorage basins 7 and 8 for both the anchorage and turning of Suezmax vessels.

While official publications note that there are no Federal anchorage areas on the Neches River Channel and that only emergency anchorage is permitted[45], analysis of the pilots' records showed that several sites are routinely used for temporary anchorage of light vessels. Table 87 displays the 2005 distribution of inbound vessels by docks and anchorage basins and suggests that the anchorages are used on more than emergency basis by light vessels. The pilots verified that the anchorages are used by light vessels (TBA 1, TBA 2, and TBA 4). The data shown in Table 87 indicate that 11 percent of vessels presently use unofficial anchorages. Of the total of 1,404 shown in Table 87, 161 vessels used the unofficial anchorages under existing conditions.

Seven federally maintained turning basins, including the Beaumont Maneuvering Area, and five anchorages are proposed under the with-project condition. TB 2, TB 3, and TB 5 would become Federal turning basins under the with-project condition. TB 1, TB 4, TB 6, and the Beaumont Maneuvering Area are existing Federal features, and they would be enlarged under the with-project condition. All of the anchorage basin components represent new Federal features (TBA 1, TBA 2, TBA 4, AB 7, and AB 8). Three of the basins (TBA 1, TBA 2, and TBA 4) are used for anchorage under existing conditions to a limited extent, but the limited anchorage component is not presently part of the Federal project. The pilots noted that under present conditions, the vessels are wedged in at those locations. Depth availability is limited to light-loaded or ballasted vessels. Additionally, while TBA 1, TBA 2, and TBA 4 currently provide anchorage function; they cannot serve as turning basins while vessels are anchored in them. The with-project condition would provide for concurrent use of TBA 1, TBA 2, and TBA 4 for both turning and anchorage of individual vessels.

As the titles indicate, some of the individual features will include a turning basin and an anchorage (TBAs 1, 2, and 4), and some just a turning basin (TB 3, TB 5, and TB 6) or an anchorage (AB 7 and AB 8). The SPA noted that the turning basin and anchorages, such as TBA 1, TBA 2, TBA 4, TBA 7, and AB 8 will be designed to enable a 48-foot loaded Suezmax tanker to use the inner portion of the feature as an anchorage and also allow a 48-foot loaded Suezmax tanker to turn in the turning basin section. While some of the features listed in Table 87 would be developed from existing basins (TBA 1, TBA 4, and TB 6) or are new basins (TBA 2, TB 3, TB 5, AB 7, and AB 8); the anchorage components of the features are essentially new and the proposed dimensions represent new dredging.

[45] NDC, Ports of Port Arthur, Beaumont, and Orange, Texas, NDC-01-P-5, Port Series, No. 22, Revised 2001.

Table 87
Neches River Inbound Vessels by Destination
Existing Base

Destination	Annual CY 2005 Inbound Vessels a/	Maximum Vessel Beam (feet) in CY2005 a/	Channel Depth (feet) b/	Maximum Vessel Length (feet) b/	Closest Existing or Future Anchorage Basin
Fina Anchorage (Lower)	112	158	-	-	TBA 1-2
Fina Anchorage (Upper)	49	144	-	-	TBA 1-2
Sun Anchorage Lower	20	158	-	-	TBA 4
Suezmax and Aframax Size Docks					
Total Petrochemicals #2	130	158	40	900	TBA 1
Motiva, Port Neches #1	127	139	40	950	TBA 2
Unocal #5	64	138	40	1,170	TBA 4
Unocal #2	100	151	40	1,020	TBA 4
Sun Terminal #1	48	138	38	875	TBA 4
Sun Terminal #2	67	164	40	1,000	TBA 4
Sun Terminal #3	86	164	40	1,000	TBA 4
Sun Terminal #4	99	158	40	1,000	TBA 4
Sun Terminal #5	63	146	40	1,000	TBA 4
Oil tanking (North)	141	158	40	900	TBA 4
Exxon Mobil #5	212	139	40	850	AB 7–8
Subtotal	1,137				
% of Total	81				
Panamax Size Docks					
Total Petrochemicals #1	1	106	≤40	≤800	TBA 1
Huntsman East	13	106	≤40	≤800	TBA 2
Huntsman West	1	68	≤40	≤800	TBA 2
Transit Mix	4	106	≤40	≤800	TBA 2
Unocal #1 Main Dock	28	106	≤40	≤800	TBA 4
Martin Gas/Sulphur Basin	11	106	≤40	≤800	TBA 4
Oil tanking (South)	40	106	≤40	≤800	TBA 4
Exxon Mobil #2	25	106	≤40	≤800	AB 7–8
Exxon Mobil #4	42	106	≤40	≤800	AB 7–8
Neches River Terminal	15	106	≤40	≤800	AB 8
Port of Beaumont	26	106	≤40	≤800	AB 8
Grain Elevator	24	106	≤40	≤800	AB 8
Carrol St., Beaumont Bulk	36	106	≤40	≤800	AB 8
Bean's West Fleet	1	60	≤40	≤800	AB 8
Subtotal	267				
% of Total	19				
Total Number of Inbound Vessels	1,404				

a/ Sabine Pilots Association, 2007.
b/ USACE, NDC, Ports of Port Arthur, Beaumont, and Orange, Texas, NDC-01-P-5, Port Series, No. 22, Revised 2001.

The HarborSym model was used to evaluate widening of the Sabine Pass Channel and Port Arthur Canal and the turning basin and anchorage features. The HarborSym model results are for the baseline benefit calculations. Sensitivity analysis of the turning basin and anchorages was made using pilot interview data. Pilot interview data, including vessel log information and estimate of transit times, were crucial parts of building the SNWW HarborSym application. Model calibration is additionally crucial, and concerns about the ability of HarborSym to capture and model the pilots' anticipated behavior as it relates to the Neches River turning basin anchorage features were not resolved. There is a greater level of uncertainty associated with the Neches River anchorages than with the widening of the Sabine Pass Channel and Port Arthur Canal reaches. In reviewing the model outputs with the pilots, they found that the effects on transit times and vessel throughput associated with Sabine Pass Channel and Port Arthur Canal outputs were within their expectations. The time savings associated with the HarborSym Neches River turning basin and anchorage features runs are much lower than anticipated.

6.3.1 HarborSym Model

The HarborSym model is designed to create an event-driven simulation based on data stored in a database, instead of customization within a simulation environment. Included in these data are the user-specified transit rules that the model processes with each vessel call in order to calculate delays within the system. Users can define alternative sets of channel dimensions or rules reflecting harbor improvements to determine potential transportation cost savings resulting from reduced delays.

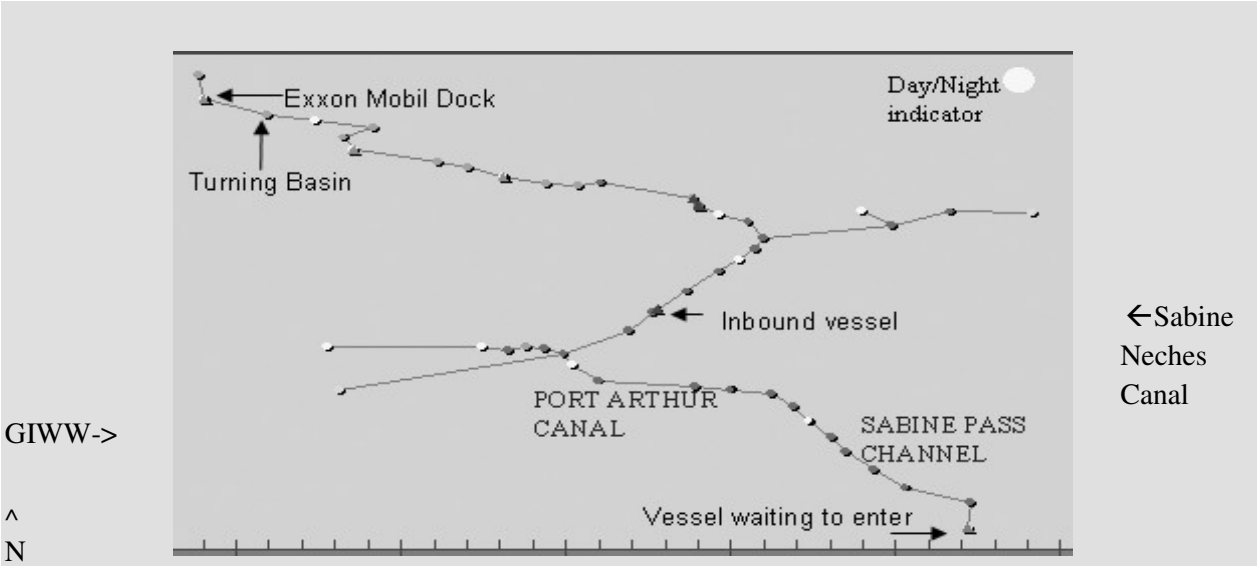
HarborSym outputs were crucial for aggregation and understanding of base condition delays. Pilot interviews were used to identify a wide range of information, including delay times. Vessel-class-specific delay times were obtained from the model output, with these inputs having been defined using pilot logs and extensive pilot interviews. A basic schematic of the SNWW from within the jetty starting at the Sabine Pass Channel is displayed on Figure 57. The key element in modeling the harbor system was replicating transit rules as listed in Table 3 of Section 1.

Inland waterway barge traffic was not included in HarborSym. Barge traffic moves through the Sabine-Neches Canal section of the SNWW. The Sabine-Neches Canal reach presently has a deep-draft project width of 400 feet, and deep-draft vessels do not meet other deep-draft vessels or tows in that reach. The project reach proposed for widening is the Sabine Pass Channel and the Port Arthur Canal, which is approximately 15 miles long and south of the Sabine-Neches Canal. Vessel-to-barge communication and the recently active VTM will help ensure that tow-barge and vessel transits do not overlap. Presently, every effort is made to avoid overlap of tow-barge and vessel transits.

Vessel-to-tow communication has greatly improved since the beginning of the study process. Additionally, the VTM is operational and very effective in planning vessel transits. Discussions with the tow industry, the VTM, and the deep-draft vessel pilots indicated that the relative impacts to tow-barge traffic are anticipated to be similar between the without- and with-project future due to vessel management. The with-project condition of channel deepening will provide the advantage of fewer oceangoing vessel trips for a given volume of traffic and, therefore, result in a net reduction in overall

congestion between the without- and with-project future conditions. The decision to forgo the barge shelf was made by the tow industry due to reconsideration of how vessels and barges would interact. The concern that was raised, but not physically modeled, was that the tow-barges could get pulled under or out into the channel as it either meets a deep-draft vessel or "held-up or idled" in the barge shelf. The tow operators originally thought that they wanted the shelf in case radio and/or other communication failed and a tow-barge could not clear the channel as a deep-draft vessel began its transit through the reach. An additional variable in deciding against the barge shelf was the activation of the VTM.

Figure 57
SNWW HarborSym Network



6.3.1.1 Model Input Overview

HarborSym requires inputs associated with vessel traffic, channel dimensions, docks, reach length, entrance and exits, and topographic nodes. The point of entrance is the Gulf of Mexico. From the "entrance point," the channel moves inward through a series of topographic nodes along the Sabine Pass Jetty Channel to the Sabine Pass Channel and then to the Port Arthur Canal and onward. Most topographic nodes are situated at the end of one channel reach and the start of another, such as the nodes on either end of the Sabine Pass Channel and the Port Arthur Canal. Some are at the junction of the Sabine-Neches Canal at the Neches River Channel and the junction of the Port Arthur Canal and Taylor Bayou. The Port Arthur Canal and Taylor Bayou junction is just north of the Port Arthur Canal junction with the GIWW. The topographic nodes generally reflect traffic rule changes.

For modeling purposes, docks are generally aggregated as a group. Moving in from the offshore entrance channel, the first dock destination on the Sabine Pass Channel is for Cheniere LNG and Offshore Marine. Moving into the next reach, the Golden Pass LNG, which is presently under construction, and the proposed Sempra terminal are contained in the next dock cluster located on the Port Arthur Canal. Within Taylor Bayou there are two major dock points with other docks within Taylor Bayou being grouped under

one of the two majors. At the lower end of the Neches River, several petroleum terminals are tied to a central dock destination. The Neches River Channel includes six center dock destinations.

Ten vessel types were defined and two or more classes per vessel type were defined. The vessel types are general cargo/RoRo, oil tanker, chemical tanker, LPG tanker, LNG tanker, bulk carrier, oceangoing tank/barge, tugboat, miscellaneous/other, and tug/barge. The vessel classes are based on vessel dimensions. Table 88 lists most of the major vessel classes and their associated DWT, beam width, and vessel operating costs. Additional variables, such as vessel length and load draft, were necessary inputs but are not shown in the table. Vessel loaded draft was tied to the "vessel call list," which is another major level. The model structure contained several first level components and vessel characteristics and associated operating costs are included under the "vessel type heading." Port traffic is a level one heading and it includes the vessel call list. Table 89 displays the general framework used for SNWW and shows most of the major line items. For nearly all of the items listed, additional levels of definitions and details are inputted. For example, under the reach heading, 48 reaches are defined. The general framework shown in Table 90 would be similar for other port studies.

6.3.1.2 Vessel Traffic Input

Vessel trip estimates were prepared for the 2000–2004-period base and for 2030–2040 average trips. The vessel classes were established based on the HarborSym vessel structure. The coding sheet corresponding to the vessel classes is presented in Table 14. The 2000–2004 period tonnage and the 2000–2004 fleet are presented in tables 91 and 92.

Table 88
SNWW HarborSym Model Vessel Classes

Vessel	DWT Range		Beam Range (feet)		Hourly Operating Cost ($)		Port Shifting
Type a/	Min	Max	Min	Max	at Sea	In Port	Cost ($)
OIL5	133,000	170,000	142	160	1,585	953	737
OIL1	8,000	56,000	60	104	825	475	358
OIL2	45,000	73,000	104	107	1,011	607	385
OIL3	67,000	97,000	115	127	1,174	712	449
OIL4	80,000	113,000	127	150	1,399	846	509
TNKB1	–	25,000	0	76	654	530	358
TNKB2	25,000	50,000	0	76	654	530	358
TUG1	–	25,000	0	76	463	350	358
TUG2	25,000	50,000	76	100	976	719	358
MISC1	–	50,000	0	76	463	350	358
MISC2	50,000	70,000	106	131	976	719	379
BLKC1	–	25,000	0	76	634	311	358
BLKC2	25,000	53,000	76	106	799	424	358
BLKC3	34,000	78,000	105	107	957	523	396
CHEM1	–	25,000	0	76	759	420	358
CHEM2	25,001	44,000	76	104.9	887	522	358
CHEM3	33,000	49,000	105	107	1,015	610	358
CHEM4	85,000	105,000	130	138	1,337	810	503
LPG1	–	25,000	0	76	654	520	358
LPG2	25,000	56,000	76	107	729	574	358
LPG3	60,000	70,000	115	120	857	669	379
LPG4	157,000	167,000	140	150	995	774	780
GCRR1	–	25,000	0	76	657	352	358
GCRR2	25,000	50,000	76	104	1,081	632	358
GCRR3	42,000	69,000	104	107	1,469	930	377
GCRR4	75,000	95,000	120	160	2,337	1,661	462

a/ This column contains the abbreviations for each of vessel classes. The abbreviations are shown for presentation purposes of how the inputs were defined.

Table 89
SNWW HarborSym Model Framework

Description of Inputs	Model Layer
Existing Condition	Level 1
Vessel Info	Level 2
Vessel Types	Level 3
General Cargo/RoRo	Level 4
Oil Tanker	Level 4
Chemical Tanker	Level 4
Bulk Carrier	Level 4
LNG Tanker	Level 4
Commodity Info	Level 2
Crude	Level 3
Petroleum Products	Level 3
Grain	Level 3
Chemicals	Level 3
Wood	Level 3
Stone	Level 3
etc.	Level 3
Port Structures	Level 2
Reaches	Level 3
Anchorage	Level 3
Entry/Exit	Level 2
Turning Basins	Level 2
Anchorage	Level 2
Docks	Level 2
Reaches	Level 2
Outer Bar	Level 3
Jetty Channel	Level 3
etc.	Level 3
Port Traffic	Level 3
New Project Alternative	Level 1
Vessel Info	Level 2
Commodity Info	Level 2
Port Structures	Level 2
Entry/Exit	Level 2
Turning Basins	Level 2
Anchorage	Level 2
Docks	Level 2
Reaches	Level 2
Port Traffic	Level 2
Run Model	

Table 90
HarborSym Vessel Classes

		Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Total Calls
Bulk	Min Beam	0	76.1	105				
	Max Beam	76	104.9	107				
	# calls	46	143	59				248
	Min Capacity	0	25,001	34,000				
	Max Capacity	25000	53000	78,000				
Chemical Tanker	Min Beam	0	76.1	105	130			
	Max Beam	76	104.9	107	138			
	# calls	102	76	131	1			310
	Min Capacity	0	25001	33000	85,000			
	Max Capacity	25000	44000	49000	105,000			
General Cargo	Min Beam	0	76.1	104	120			
	Max Beam	76	103.9	107	142			
	# calls	125	58	16	3			202
	Min Capacity	0	25,001	42,000	75,000			
	Max Capacity	25,000	50,000	69,000	95,000			
LPG	Min Beam	0	76.1	115	140			
	Max Beam	76	107	120	150			
	# calls	15	16	1	1			33
	Min Capacity	0	25,001	60,000	157,000			
	Max Capacity	25,000	56,000	70,000	167,000			
MISC	Min Beam	0	106					
	Max Beam	76	131					
	# calls	3	2					5
	Min Capacity	0	50,000					
	Max Capacity	25,000	70,000					
Oil Tanker	Min Beam	60	104.1	115	127.1	142		
	Max Beam	104	107	127	150	160		
	# calls	49	96	153	657	15		970
	Min Capacity	8,000	45,000	67,000	80,000	133,000		
	Max Capacity	56,000	73,000	97,000	113000	170,000		
Tank Barge	Min Beam	0	76.1					
	Max Beam	76	107					
	# calls	92	11					103
	Min Capacity	0	25,001					
	Max Capacity	25,000	50,000					
Tug	Min Beam	0	76.1					
	Max Beam	76	100					
	# calls	55	12					67
	Min Capacity	0	25,001					
	Max Capacity	25,000	50,000					
Total Calls	# calls	487	414	360	662	15		1,938
		25.1%	21.4%	18.6%	34.2%	0.8%		100.0%

Table 91
SNWW 2000/2004 Tonnage (1,000s of Short Tons) a/

Type/Class Code	1,000s Tonnage by Vessel Class, 2000/2004 Base					Total
	1	2	3	4	5	
Bulk	544.6	3,964.1	2,596.2	0.0	0.0	7,105.0
Chem	733.9	1,583.9	2,950.9	96.7		5,365.5
GenCargo	705.3	418.6	190.6	24.1		1,338.7
LPG	147.3	235.0	1.7	2.9		386.9
Misc	0.0	0.3				0.4
Oil Tanker	2,915.0	4,344.8	9,595.6	52,542.6	1,170.0	70,568.1
Tank Barge	1,306.3	138.6				1,444.9
Tug	17.6	153.1				170.7
LNG					5,777.0	5,770.0
Total	6,370.0	10,838.6	15,335.4	52,666.3	6,947.0	95,150.1

a/ LNG tonnage and vessels were included in the 2000/2004 HarborSym traffic analysis.

Table 92
Sabine-Neches Waterway 2000/2004 Trips a/

Type /Class Code	Estimated Number of Vessel Calls by Vessel Class at Existing Depth					Total
	1	2	3	4	5	
Bulk	46	143	59	0	0	248
Chem	102	76	131	1	0	310
GenCargo	125	58	16	3	0	202
LPG	15	16	1	1	0	33
Misc	3	2	0	0	0	5
Oil Tanker	49	96	153	657	15	970
Tank Barge	92	11	0	0	0	103
Tug	55	12	0	0	0	67
LNG	0	0	0	0	119	119
Total	487	414	360	662	134	2,057

a/ LNG tonnage and vessels were included in the 2000/2004 HarborSym traffic analysis.

Tables 93 through 95 present the 2030–2040 period tonnage and trip data. A "widening and deepening alternative" would generate greater savings than widening. In regard to the pilot rules (see Table 3), rule 1 would change if the channel was widened and deepened. Rule 1 says that vessels with combined beam widths that equal or exceed one-half of the channel width are not permitted to meet day or night. If the channel was just widened, rules 3 and 4 would be relaxed as well. The effect of deepening and widening will likely be to result in vessels with loaded drafts of less than 40 feet being able to meet; however, vessels with loaded drafts over 40 feet would be much more restricted. While the vessel pilots indicated that the effect of deepening would mean a loss of some of the gains in terms of relaxing rules 3 and 4, a widening-only alternative would produce a lower number of vessels and could result in higher savings. The effects of deepening and widening on total transportation costs are discussed in the sensitivity section (Section 8).

Table 93
SNWW 2030/2040 Tonnage (1,000s of Short Tons)

	1000s Tonnage by Vessel Class						
Type /Class Code	1	2	3	4	5	6	Total
Bulk	835	6,079	3,982	–	–	–	10,896
Chem	1,231	2,656	4,949	162	–	–	8,998
GenCargo	1,155	685	312	40	–	–	2,191
LPG	235	376	3	5	–	–	618
Misc	–	–	–	–	–	–	–
Oil Tanker	4,497	6,703	14,804	81,064	1,805	–	108,875
Tank Barge	2,284	270	–	–	–	–	2,553
Tug	0	0	–	–	–	–	1
LNG	–	–	–	–	5,777	–	5,777
Total	10,237	16,770	24,049	81,271	7,582	–	139,909

Table 94
SNWW 2030/2040 Vessel Trips Without Deepening

	Estimated Number of Vessel Trips by Vessel Class						
Type/Class	1	2	3	4	5	6	Total
Bulk	71	219	90	0	0	0	380
Chem	171	127	220	2	0	0	520
GenCargo	205	95	26	5	0	0	331
LPG	24	26	2	2	0	0	53
Misc	1	1	0	0	0	0	2
Oil Tanker	76	148	236	1,014	23	0	1,497
Tank Barge	145	17	0	0	0	0	163
Tug	87	19	0	0	0	0	105
LNG	0	0	0	0	119	0	119
Total	780	652	574	1,023	142	0	3,170

Table 95
SNWW 2030/2040 Vessel Trips With Deepening

Type/Class	Vessel Trips by Vessel Class 1	2	3	4	5	6	Total
Bulk	71	138	112	–	–	–	321
Chem	171	80	210	6	–	–	467
GenCargo	205	60	41	7	–	–	312
LPG	24	14	7	3	–	–	48
Misc	1	1	–	–	–	–	2
Oil Tanker	236	86	61	579	315	–	1,277
Tank Barge	145	17	–	–	–	–	162
Tug	87	19	–	–	–	–	105
LNG	–	–	–	–	119	–	119
Total	940	415	431	595	434	0	2,815

6.3.1.3 Evaluation of Project Alternatives

The HarborSym model was run for existing conditions and each of the project alternatives. The widening alternatives included widening of the Sabine Pass Channel and Port Arthur Canal channel from 500 to 700 feet. Evaluation of widths less than 700 feet was also conducted. Widening of the Sabine Pass Channel and Port Arthur Canal reaches were evaluated with and without the Neches River turning basin and anchorage alternatives, and the turning basin anchorage features were evaluated on an incremental basis. The transportation cost savings associated with widening of the Sabine Pass Channel and Port Arthur Canal reaches and Neches River turning basin and anchorage features were evaluated based on a 40-foot channel depth.

An anticipated effect of widening the Sabine Pass Channel and Port Arthur Canal to 700 feet would be to allow a higher percentage of vessels in the proposed 700-foot reach. The effect of widening on rule 1 would be that a larger number of vessels with wider beam would be able to meet. Rule 2 would not change with widening as it applies to the Sabine-Neches Canal, which is shared by GIWW barge traffic. Widening of the Sabine-Neches Canal reach was evaluated during the early formulation stages; however, cargo docks are located on the west side of canal in the lower end of the reach, and the Port Arthur Hurricane Protection Levee, also on the west side, is located in the following section of this reach.

Anticipated costs associated with channel widening due to the Hurricane Protection Levee in the Sabine-Neches Canal and docks along the Sabine-Neches Canal and Neches River Channel reaches limited the extent of structural alternatives that were carried into detailed analysis. As part of plan formulation, the Neches River anchorage basins were introduced as a less costly alternative to widening of the Neches River Channel to Beaumont. The anchorages would be used to facilitate vessel passing. During the initial screening, extensive but intermittent widening was evaluated for the channel reaches from Sabine Pass Channel, inland through the Neches River Channel. This and the other alternatives were screened based on comparison of anticipated reductions in vessel delay costs and initial project construction cost estimates and the outputs of the ERDC ship simulation modeling. Widening of the Neches River reach

was found not be a cost effective alternative due to costly dock relocations and extensive dredging. Additionally, intermittent widening of the Neches River Channel did not perform well during ERDC ship simulation modeling. In comparison, the Neches River anchorages and Sabine Pass Channel and Port Arthur Canal widening features performed favorably. The results of the ERDC modeling showed that a minimum width of 700 feet through the Sabine Pass Channel and Port Arthur Canal would be necessary for the Suezmax and Aframax vessels to meet smaller vessels in the Sabine Pass Channel and Port Arthur Canal. The project design vessel is 899 feet long and 164 feet wide. These dimensions correspond to a 158,000 DWT Suezmax crude petroleum tanker. A loaded and a ballast design vessel could not successfully meet in the ERDC test of the 600-foot channel nor could the design vessel and a smaller 110,000 DWT Aframax tanker meet. Aframax tankers characteristically range from 90,000 to 120,000 DWT, and the Suezmax tankers characteristically range from 120,000 to 175,000 DWT.

6.3.1.4 Entrance Channel Widening Benefits

Evaluation of widening of the entrance channel to 700 feet through the Sabine Pass Channel and Port Arthur Canal showed that, using 2000–2004 traffic levels, vessels would save an average of 1.5 hours per round trip voyage, with an annual savings of $3,487,322. Summary output from the HarborSym model associated with widening the Sabine Pass Channel and Port Arthur Canal to 700 feet is displayed in Table 96. The benefits of widening only through the Sabine Pass Channel totaled approximately $2,269,264. Evaluation of Port Arthur by itself resulted in annual savings of approximately $2,579,760. The widening benefits shown in Table 96 are for the existing 40-foot channel depth and 2000–2004 period traffic. The effect of reductions in total vessel movements resulting from channel deepening is evaluated in the sensitivity section of this appendix.

Examination of the output data shows that for the without-project condition, which reflects the inclusion of LNG carriers, vessels are in the system for 78.2 hours. The output also shows that expansion of the Entrance Channel will reduce the time in system to 76.7 hours. In reviewing the changes in delay times, it was found that there are large variances in throughput times. The minimum time for the without-project condition was on average 11.9 hours, and the minimum time for the with-project condition also averaged 11.9 hours. The larger crude oil tankers showed throughput savings for the with-project condition. For instance, Suezmax vessels took an average of 86.7 hours under the without-project condition and an average of 83.1 hours with the widened entrance channel. The addition of the LNG vessels will result in longer waiting times for several vessel classes. Without the LNG vessels, the average number of hours in the system was 66.4. The effect of introducing the LNG vessels increases total delay times but reduces average times because the LNG vessels represent a large increase in vessels that travel shorter distances than the existing tanker fleet going to the Neches River and, therefore, will not be subject to delays.

Table 96
SNWW HarborSym Output Annual Savings by Vessel Class (2004-Period Traffic), Widening Only

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
OIL5	System	45.971	44.472	1.499				
133,000 to	Waiting	11.835	10.332	1.503				
170,000 DWT	Reaches	12.531	12.527	0.004	1,585	6	54	342
	Loading	19.194	19.2	–0.006	953	–6	54	–309
	TB	0.311	0.311	0	1,585	0	54	0
	Docking	1.5	1.5	0	1,585	0	54	0
	Undocking	0.6	0.601	–0.001	1,585	–2	54	–86
	Wait Entry	7.53	5.026	2.504	1,585	3,969	54	214,317
	Wait Dock	4.305	5.306	–1.001	953	–954	54	–51,513
	Waiting TB	0	0	0	953	0	54	0
	Waiting FN	0	0	0	953	0	54	0
						Subtotal		162,752
Oceangoing	System	61.703	61.67	0.033				
Tank Barge	Waiting	1.424	1.391	0.033				
Up to 25,000	Reaches	8.078	8.078	0	654	0	76	0
DWT	Loading	49.518	49.518	0	520	0	76	0
	TB	0.306	0.306	0	654	0	76	0
	Docking	1.699	1.698	0.001	654	1	76	50
	Undocking	0.679	0.679	0	654	0	76	0
	Wait Entry	0.423	0.331	0.092	654	60	76	4,573
	Wait Dock	0.95	1.025	–0.075	520	–39	76	–2,964
	Waiting TB	0	0	0	520	0	76	0
	Waiting FN	0.051	0.034	0.017	520	9	76	672
						Subtotal		2,330

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
Oceangoing	System	49.192	48.8	0.392				
Tank Barge	Waiting	1.824	1.43	0.394				
25,000 to 50,000	Reaches	9.2	9.2	0	995	0	11	0
DWT	Loading	35.344	35.344	0	774	0	11	0
	TB	0.338	0.338	0	995	0	11	0
	Docking	1.779	1.78	–0.001	995	–1	11	–11
	Undocking	0.707	0.708	–0.001	995	–1	11	–11
	Wait Entry	0.918	0.375	0.543	995	540	11	5,943
	Wait Dock	0.838	1.026	–0.188	774	–146	11	–1,601
	Waiting TB	0	0	0	774	0	11	0
	Waiting FN	0.068	0.029	0.039	774	30	11	332
						Subtotal		4,653
MISC1	System	10.448	9.759	0.689				
<50,000 DWT	Waiting	1.563	0.874	0.689				
	Reaches	6.395	6.395	0	463	0	1	0
	Loading	0.062	0.062	0	350	0	1	0
	TB	0.316	0.316	0	463	0	1	0
	Docking	1.508	1.508	0	463	0	1	0
	Undocking	0.604	0.604	0	463	0	1	0
	Wait Entry	0.333	0.181	0.152	463	70	1	70
	Wait Dock	1.23	0.693	0.537	350	188	1	188
	Waiting TB	0	0	0	350	0	1	0
	Waiting FN	0	0	0	350	0	1	0
						Subtotal		258

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
MISC2	System	12.132	10.405	1.727				
>50,000 DWT	Waiting	2.859	1.139	1.72				
	Reaches	6.648	6.648	0	976	0	2	0
	Loading	0.216	0.216	0	719	0	2	0
	TB	0.306	0.306	0	976	0	2	0
	Docking	1.499	1.497	0.002	976	2	2	4
	Undocking	0.605	0.6	0.005	976	5	2	10
	Wait Entry	1.465	0.276	1.189	976	1,160	2	2,321
	Wait Dock	1.394	0.863	0.531	719	382	2	764
	Waiting TB	0	0	0	719	0	2	0
	Waiting FN	0	0	0	719	0	2	0
						Subtotal		3,098
Oceangoing	System	17.61	17.395	0.215				
Tug Type1	Waiting	0.222	0.007	0.215				
	Reaches	4.517	4.517	0	463	0	1	0
	Loading	10.452	10.452	0	350	0	1	0
	TB	0.309	0.309	0	463	0	1	0
	Docking	1.494	1.494	0	463	0	1	0
	Undocking	0.616	0.616	0	463	0	1	0
	Wait Entry	0.215	0	0.215	463	100	1	100
	Wait Dock	0	0	0	350	0	1	0
	Waiting TB	0	0	0	350	0	1	0
	Waiting FN	0.007	0.007	0	350	0	1	0
	System	17.61	17.395	0.215		Subtotal		100

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
Oceangoing Tug Type2	System	27.813	27.568	0.245				
	Waiting	0.765	0.518	0.247				
	Reaches	5.119	5.119	0	976	0	6	0
	Loading	19.51	19.51	0	719	0	6	0
	TB	0.314	0.314	0	976	0	6	0
	Docking	1.501	1.503	–0.002	976	–2	6	–12
	Undocking	0.602	0.603	–0.001	976	–1	6	–6
	Wait Entry	0.361	0.255	0.106	976	103	6	621
	Wait Dock	0.304	0.238	0.066	719	47	6	285
	Waiting TB	0	0	0	719	0	6	0
	Waiting FN	0.101	0.025	0.076	719	55	6	328
						Subtotal		1,216
LNG Small	System	100.565	100.565	0				
	Waiting	0.041	0.041	0				
	Reaches	1.832	1.832	0	1,773	0	107	0
	Loading	96.606	96.606	0	1,506	0	107	0
	TB	0	0	0	1,773	0	107	0
	Docking	1.501	1.501	0	1,773	0	107	0
	Undocking	0.601	0.601	0	1,773	0	107	0
	Wait Entry	0.026	0.026	0	1,773	0	107	0
	Wait Dock	0.015	0.015	0	1,506	0	107	0
	Waiting TB	0	0	0	1,506	0	107	0
	Waiting FN	0	0	0	1,506	0	107	0
						Subtotal		0

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
LNG	System	118.402	118.402	0				
Large	Waiting	0.028	0.028	0				
	Reaches	4.421	4.421	0	2,423	0	200	0
	Loading	111.715	111.715	0	2,039	0	200	0
	TB	0.152	0.152	0	2,423	0	200	0
	Docking	1.5	1.5	0	2,423	0	200	0
	Undocking	0.601	0.601	0	2,423	0	200	0
	Wait Entry	0.013	0.013	0	2,423	0	200	0
	Wait Dock	0.015	0.015	0	2,039	0	200	0
	Waiting TB	0	0	0	2,039	0	200	0
	Waiting FN	0	0	0	2,039	0	200	0
						Subtotal		0
Bulk Carrier1	System	38.117	37.972	0.145				
	Waiting	1.204	1.061	0.143				
	Reaches	6.754	6.754	0	634	0	53	0
	Loading	27.749	27.749	0	311	0	53	0
	TB	0.31	0.31	0	634	0	53	0
	Docking	1.5	1.499	0.001	634	1	53	34
	Undocking	0.6	0.599	0.001	634	1	53	34
	Wait Entry	0.392	0.325	0.067	634	42	53	2,251
	Wait Dock	0.711	0.692	0.019	311	6	53	313
	Waiting TB	0	0	0	311	0	53	0
	Waiting FN	0.101	0.044	0.057	311	18	53	940
						Subtotal		3,571

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
Bulk Carrier2	System	55.117	54.713	0.404				
	Waiting	1.259	0.856	0.403				
	Reaches	6.11	6.11	0	799	0	134	0
	Loading	45.337	45.337	0	424	0	134	0
	TB	0.31	0.31	0	799	0	134	0
	Docking	1.501	1.5	0.001	799	1	134	107
	Undocking	0.6	0.6	0	799	0	134	0
	Wait Entry	0.544	0.264	0.28	799	224	134	29,978
	Wait Dock	0.623	0.559	0.064	424	27	134	3,636
	Waiting TB	0	0	0	424	0	134	0
	Waiting FN	0.093	0.033	0.06	424	25	134	3,409
						Subtotal		37,131
Bulk Carrier3	System	76.241	75.503	0.738				
	Waiting	1.851	1.113	0.738				
	Reaches	7.559	7.559	0	957	0	61	0
	Loading	64.42	64.42	0	523	0	61	0
	TB	0.311	0.311	0	957	0	61	0
	Docking	1.501	1.501	0	957	0	61	0
	Undocking	0.599	0.6	–0.001	957	–1	61	–58
	Wait Entry	0.898	0.238	0.66	957	632	61	38,529
	Wait Dock	0.808	0.836	–0.028	523	–15	61	–893
	Waiting TB	0	0	0	523	0	61	0
	Waiting FN	0.146	0.039	0.107	523	56	61	3,414
						Subtotal		40,991

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
Chem1	System	36.364	36.088	0.276				
	Waiting	1.329	1.05	0.279				
	Reaches	6.491	6.491	0	759	0	120	0
	Loading	26.099	26.099	0	420	0	120	0
	TB	0.311	0.311	0	759	0	120	0
	Docking	1.525	1.526	–0.001	759	–1	120	–91
	Undocking	0.609	0.61	–0.001	759	–1	120	–91
	Wait Entry	0.526	0.301	0.225	759	171	120	20,493
	Wait Dock	0.724	0.724	0	420	0	120	0
	Waiting TB	0	0	0	420	0	120	0
	Waiting FN	0.079	0.025	0.054	420	23	120	2,722
						Subtotal		23,032
Chem2	System	52.078	51.696	0.382				
	Waiting	1.58	1.196	0.384				
	Reaches	7.109	7.109	0	887	0	75	0
	Loading	40.388	40.388	0	522	0	75	0
	TB	0.369	0.369	0	887	0	75	0
	Docking	1.881	1.88	0.001	887	1	75	67
	Undocking	0.752	0.754	–0.002	887	–2	75	–133
	Wait Entry	0.745	0.372	0.373	887	331	75	24,814
	Wait Dock	0.696	0.739	–0.043	522	–22	75	–1,683
	Waiting TB	0	0	0	522	0	75	0
	Waiting FN	0.139	0.085	0.054	522	28	75	2,114
						Subtotal		25,178

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
Chem3	System	54.421	53.758	0.663				
	Waiting	2.12	1.457	0.663				
	Reaches	8.132	8.132	0	1,015	0	104	0
	Loading	41.672	41.672	0	610	0	104	0
	TB	0.314	0.314	0	1,015	0	104	0
	Docking	1.558	1.559	–0.001	1,015	–1	104	–106
	Undocking	0.624	0.624	0	1,015	0	104	0
	Wait Entry	1	0.37	0.63	1,015	639	104	66,503
	Wait Dock	1.1	1.082	0.018	610	11	104	1,142
	Waiting TB	0	0	0	610	0	104	0
	Waiting FN	0.02	0.005	0.015	610	9	104	952
						Subtotal		68,491
Chem4	System	152.792	150.139	2.653				
	Waiting	19.552	16.904	2.648				
	Reaches	7.865	7.865	0	1,337	0	1	0
	Loading	120.861	120.861	0	810	0	1	0
	TB	0.309	0.309	0	1,337	0	1	0
	Docking	3.003	2.991	0.012	1,337	16	1	16
	Undocking	1.202	1.209	–0.007	1,337	–9	1	–9
	Wait Entry	4.789	2.919	1.87	1,337	2,500	1	2,500
	Wait Dock	14.763	13.985	0.778	810	630	1	630
	Waiting TB	0	0	0	810	0	1	0
	Waiting FN	0	0	0	810	0	1	0
						Subtotal		3,137

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
LPGT1	System	31.893	31.816	0.077				
	Waiting	1.172	1.095	0.077				
	Reaches	7.02	7.02	0	654	0	13	0
	Loading	21.294	21.294	0	520	0	13	0
	TB	0.309	0.309	0	654	0	13	0
	Docking	1.5	1.501	–0.001	654	–1	13	–9
	Undocking	0.599	0.597	0.002	654	1	13	17
	Wait Entry	0.41	0.336	0.074	654	48	13	629
	Wait Dock	0.762	0.759	0.003	520	2	13	20
	Waiting TB	0	0	0	520	0	13	0
	Waiting FN	0	0	0	520	0	13	0
						Subtotal		658
LPGT2	System	65.482	65.154	0.328				
	Waiting	1.49	1.163	0.327				
	Reaches	7.055	7.055	0	729	0	18	0
	Loading	54.523	54.523	0	574	0	18	0
	TB	0.312	0.312	0	729	0	18	0
	Docking	1.502	1.502	0	729	0	18	0
	Undocking	0.6	0.599	0.001	729	1	18	13
	Wait Entry	0.608	0.351	0.257	729	187	18	3,372
	Wait Dock	0.882	0.812	0.07	574	40	18	723
	Waiting TB	0	0	0	574	0	18	0
	Waiting FN	0	0	0	574	0	18	0
						Subtotal		4,109

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
LPGT3	System	15.49	14.966	0.524				
	Waiting	1.315	0.811	0.504				
	Reaches	5.878	5.878	0	857	0	1	0
	Loading	5.886	5.886	0	669	0	1	0
	TB	0.313	0.313	0	857	0	1	0
	Docking	1.502	1.489	0.013	857	11	1	11
	Undocking	0.595	0.588	0.007	857	6	1	6
	Wait Entry	0.526	0.104	0.422	857	362	1	362
	Wait Dock	0.789	0.707	0.082	669	55	1	55
	Waiting TB	0	0	0	669	0	1	0
	Waiting FN	0	0	0	669	0	1	0
						Subtotal		434
LPGT4	System	40.871	36.812	4.059				
	Waiting	22.644	18.585	4.059				
	Reaches	6.873	6.873	0	995	0	1	0
	Loading	8.927	8.927	0	774	0	1	0
	TB	0.319	0.319	0	995	0	1	0
	Docking	1.516	1.516	0	995	0	1	0
	Undocking	0.593	0.593	0	995	0	1	0
	Wait Entry	9.485	7.019	2.466	995	2,454	1	2,454
	Wait Dock	13.159	11.567	1.592	774	1,232	1	1,232
	Waiting TB	0	0	0	774	0	1	0
	Waiting FN	0	0	0	774	0	1	0
						Subtotal		3,686

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Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
GCRR1	System	29.632	29.489	0.143				
	Waiting	0.879	0.736	0.143				
	Reaches	5.556	5.556	0	657	0	133	0
	Loading	20.771	20.771	0	352	0	133	0
	TB	0.311	0.311	0	657	0	133	0
	Docking	1.512	1.511	0.001	657	1	133	87
	Undocking	0.605	0.605	0	657	0	133	0
	Wait Entry	0.263	0.191	0.072	657	47	133	6,291
	Wait Dock	0.572	0.524	0.048	352	17	133	2,247
	Waiting TB	0	0	0	352	0	133	0
	Waiting FN	0.044	0.021	0.023	352	8	133	1,077
						Subtotal		9,703
GCRR2	System	47.611	47.221	0.39				
	Waiting	1.422	1.032	0.39				
	Reaches	7.085	7.085	0	1,081	0	57	0
	Loading	36.693	36.693	0	632	0	57	0
	TB	0.311	0.311	0	1,081	0	57	0
	Docking	1.499	1.499	0	1,081	0	57	0
	Undocking	0.601	0.6	0.001	1,081	1	57	62
	Wait Entry	0.625	0.303	0.322	1,081	348	57	19,841
	Wait Dock	0.786	0.722	0.064	632	40	57	2,306
	Waiting TB	0	0	0	632	0	57	0
	Waiting FN	0.011	0.007	0.004	632	3	57	144
						Subtotal		22,352

Continued next page

Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
GCRR3	System	124.117	123.908	0.209				
	Waiting	0.977	0.769	0.208				
	Reaches	5.581	5.581	0	1,469	0	10	0
	Loading	115.176	115.176	0	930	0	10	0
	TB	0.281	0.281	0	1,469	0	10	0
	Docking	1.503	1.502	0.001	1,469	1	10	15
	Undocking	0.599	0.6	–0.001	1,469	–1	10	–15
	Wait Entry	0.401	0.19	0.211	1,469	310	10	3,100
	Wait Dock	0.557	0.571	–0.014	930	–13	10	–130
	Waiting TB	0	0	0	930	0	10	0
	Waiting FN	0.019	0.007	0.012	930	11	10	112
						Subtotal		3,081
OIL1	System	43.474	42.898	0.576				
	Waiting	1.453	0.878	0.575				
	Reaches	8.037	8.037	0	825	0	33	0
	Loading	31.512	31.512	0	475	0	33	0
	TB	0.31	0.31	0	825	0	33	0
	Docking	1.543	1.544	–0.001	825	–1	33	–27
	Undocking	0.618	0.617	0.001	825	1	33	27
	Wait Entry	0.733	0.259	0.474	825	391	33	12,905
	Wait Dock	0.581	0.569	0.012	475	6	33	188
	Waiting TB	0	0	0	475	0	33	0
	Waiting FN	0.139	0.051	0.088	475	42	33	1,379
						Subtotal		14,472

Continued next page

Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
OIL2	System	47.631	46.767	0.864				
	Waiting	1.592	0.729	0.863				
	Reaches	5.664	5.664	0	1,011	0	85	0
	Loading	37.974	37.974	0	607	0	85	0
	TB	0.3	0.3	0	1,011	0	85	0
	Docking	1.5	1.499	0.001	1,011	1	85	86
	Undocking	0.601	0.601	0	1,011	0	85	0
	Wait Entry	0.918	0.189	0.729	1,011	737	85	62,647
	Wait Dock	0.459	0.454	0.005	607	3	85	258
	Waiting TB	0	0	0	607	0	85	0
	Waiting FN	0.215	0.086	0.129	607	78	85	6,656
						Subtotal		69,646
OIL3	System	42.648	40.676	1.972				
	Waiting	6.343	4.364	1.979				
	Reaches	6.939	6.936	0.003	1,174	4	100	352
	Loading	26.962	26.97	–0.008	712	–6	100	–570
	TB	0.305	0.305	0	1,174	0	100	0
	Docking	1.499	1.5	–0.001	1,174	–1	100	–117
	Undocking	0.6	0.6	0	1,174	0	100	0
	Wait Entry	4.034	2.088	1.946	1,174	2,285	100	228,460
	Wait Dock	2.145	2.23	–0.085	712	–61	100	–6,052
	Waiting TB	0	0	0	712	0	100	0
	Waiting FN	0.164	0.047	0.117	712	83	100	8,330
						Subtotal		230,404

Continued next page

Table 96 (Cont'd)

Vessel Type	Average Time	Existing Condition (hrs)	SPC/PAC Widening (hrs)	Difference	Hourly Operating Cost ($)	Change Cost/Vessel ($)	# of vessels	Savings ($)
OIL4	System	47.201	44.533	2.668				
	Waiting	13.789	11.118	2.671				
	Reaches	10.653	10.649	0.004	1,399	6	695	$3,889
	Loading	20.377	20.385	–0.008	846	–7	695	–$4,704
	TB	0.278	0.278	0	1,399	0	695	$0
	Docking	1.502	1.502	0	1,399	0	695	$0
	Undocking	0.601	0.601	0	1,399	0	695	$0
	Wait Entry	8.514	5.437	3.077	1,399	4,305	695	$2,991,782
	Wait Dock	5.254	5.675	–0.421	846	–356	695	–$247,535
	Waiting TB	0	0	0	846	0	695	$0
	Waiting FN	0.022	0.006	0.016	846	14	695	$9,408
						Subtotal		$2,752,840
					Total Savings (all vessels)			3,487,322

The benefits shown in Table 96 are based on widening only and are based on 2004-period traffic levels. Table 97 summarizes the average annual benefits for 2019–2069 for widening of the Sabine Pass Channel and the Port Arthur Canal. Table 98 displays the incremental economic summary data associated with the widening of the Sabine Pass Channel and the Port Arthur Canal. The results of the benefit-cost analysis indicated that widening was not an incremental justified feature.

Table 97
Sabine Pass Channel and Port Arthur Canal Widening Only
Average Annual Benefits (2008 Dollars at 4.375%)

Year	Sabine Pass Channel	Port Arthur Canal	Sabine Pass Channel and Port Arthur Canal
2004	2,269,264	2,579,760	3,487,322
2019	2,922,548	3,431,103	4,335,553
2029	3,738,979	4,431,691	5,486,406
2039	4,691,482	5,599,044	6,829,067
2049	5,262,983	6,299,456	7,634,664
2059	6,215,486	7,466,809	8,977,326
2069	7,548,990	9,101,103	10,857,052
		Average Annual Benefits (4.375%)	6,379,579

Table 98
Sabine Pass Channel and Port Arthur Canal Widening Only
Economic Summary Data (2008 Dollars at 4.375%)

Item	Sabine Pass Channel and Port Arthur Canal
First Cost	78,448,000
Mitigation Cost	48,484,500
Interest During Construction	36,282,311
Total First Cost	163,214,811
Average Annual Construction Cost	8,091,727
Incremental Average Annual Operations and Maintenance (O&M) Cost	9,587,005
Total Average Annual Cost	17,678,733
Average Annual Benefits	6,338,991
Benefit to Cost Ratio	0.4

The benefit calculations are based on 2004-period historical and 2030-2040 projected traffic. The future traffic levels do not account for channel deepening. The effect on the reduction in total vessel movements resulting from channel deepening is evaluated in the sensitivity section of this appendix. For the sensitivity, HarborSym widening model was run based on the reduction in vessel trips as a result of channel deepening The purpose of the sensitivity was to determine changes in the annual delays in relationship to widening and deepening of the Sabine Pass Channel and Port Arthur Canal. The change in vessel trips due to channel deepening was estimated based on the decrease in the number of trips

necessary to transport future tonnage. The model results show that the reduction in the number of vessel trips resulting from channel deepening has a significant effect on the net difference in the duration of vessel delays between the without- and with-project conditions. Further analyses based on various ranges of fleet forecasts indicate that the increase in benefits from scenarios that included either "deepening and widening" or "deepening and the turning basins" were primarily attributable to the reduction in trips due to channel deepening. These savings result from the reduction in trips based on vessels carrying additional cargo or the redistribution of vessel sizes based on the availability of a deeper channel and do vary significantly from the "widening only" benefits shown in Table 98. The effect of adding these savings to the project benefits is outlined in the sensitivity section (Section 8).

6.3.1.5 Neches River Holding Areas

Determination of the number of turning basins, turning basin anchorage combinations, and anchorages was initially made based on pilot interviews. The turning basins and turning basin anchorage combinations are used for both turning and for vessels to wait while others pass. The TBAs allow loaded vessels to await berths at the dock and will save the time that they originally would have spent "inbounding" when the berth became clear. With the TBAs, instead vessels only have to shift from one of these sites to a dock rather than awaiting an outbound ship to sail and to start in accordance with the traffic rules. The pilots said that they would trade vessels out between the Neches River "holding areas" and "docks," thus violating established rules. According to ER 1105-2-100 and the Policy Digest, features such as turning basins can be in the Federal interest if they facilitate safe and efficient vessel navigation; this is clearly the case for the Neches River turning basins. In regards to incremental justification review concerns, there was considerably reluctance to allow anything less than the six turning basins; however, the pilots indicated that if priorities had to be placed on TBA construction, the priorities would be 1, 4, and 7. Next noted grouping was 1, 4, 5, and 7. It was emphasized that the priority was for all turning basin improvements. Current and without-project future use of the existing turning basins and new holding and turning sites is summarized in Table 99.

The pilots noted that the number of hours saved depends on the dock facility and that the benefits will be primarily for the crude oil tankers and some product carriers; however, all traffic would realize some savings. Pilot expectation is that the crude oil carriers would save about 7 hours. It also noted that the Panamax-size product carriers that load at ExxonMobil will save about 7 hours. The pilots noted that they did not expect a difference between the Aframax and Suezmax savings. The number of hours saved for vessels in the lower end of the Neches River Channel would be less.

Table 99
Neches River Proposed Turning Basin Anchorages

	Description	Approximate Miles from Sabine Bank		Current Use
		Station	SB Buoy	
TBA 1	Turning Basin Anchorage 1	210+00	43.4	Limited with no anchorage
TBA 2	Turning Basin Anchorage 2	275+00	44.6	None
TB 3	Turning Basin 3	370+00	46.4	None
TBA 4	Turning Basin Anchorage 4	510+00	49.1	Limited with no anchorage
TB 5	Turning Basin 5	570+00	50.2	None
TB 6	Turning Basin 6	700+00	52.7	Turning Basin
TBA 7	Anchorage Basin 7	750+00	53.6	None
TBA 8	Anchorage Basin 8	850+00	56.5	None
	Beaumont Maneuvering Area	975+00	58.8	Maneuvering Area

Pilot meetings conducted during the initial screening and during the HarborSym model building continued to show that the model was accurately calibrating existing conditions for the Entrance Channel reaches. In addition, the transit times were accurate for vessel throughput times. Discussion with the pilots after the runs were completed and review of the transit costs helped reconfirm that the model outputs for the Entrance Channel behavior were reasonably accurate for existing conditions as were expectations for the with-project condition; however, it was found that the model did not validate current or future use of the Neches River turning basins. The model results indicated a transfer in vessel delays from the present offshore location to the proposed siding locations. Detailed discussions with the vessel pilots initially revealed that the model was not set-up to account for pilots anticipated behavior of switching vessels between docks and holding areas. For this reason, HarborSym was not initially used for the Neches River turning basin analysis. In 2007–2008, modifications were made to the model in order to better capture the pilots anticipated behavior. The results of these modifications resulted in an increase in savings; however, the increase in savings is still significantly less than the pilots anticipated.

The model input is based on the assumption that the major difference in the Neches River without- and with-project conditions would be that, “as holding areas,” the “with project condition” would enable two vessels to be stored in TBA 1, TBA 2, TB 5, TBA 7, and TBA 8, instead of one small vessel in each. An additional item revealed at the meetings was that the maximum vessel size using the turning basins was the same for the without- and with-project conditions. Additionally, the model assumptions were based on “no change in Neches River transit rules” for the with-project condition. At the meeting, the pilots said that they would, in fact, trade vessels out between the Neches River “holding areas” and “docks” despite night rules and beam and depth restrictions. The indication was that “trading places” would be orchestrated to minimize the dangerous effects of violating established rules.

As an example of how the turning basins would be used, an inbound convoy would arrive on the Neches River Channel with the vessels going to docks on the upper end of the Neches leading the convoy. Each vessel would proceed to their respective dock and head into the berth (for the SNWW vessels turn after finishing at the dock). It takes about 1.5 hours to tie up at the docks, and loading or unloading takes about 18 hours, depending largely on cargo load. While the goal is for the vessel to get in and away from the dock within 24 hours, it is difficult to meet that goal, and vessel dock time frequently exceeds 30 hours. The goal of working to minimize unloading time or synchronizing it based on the other vessels in the convoy is an important consideration as the goal of completing dock time can be particularly crucial if another offshore convoy is set-up to come in. Under present conditions, the dockside convoy will leave its respective docks and head down the Neches River Channel. A vessel normally takes 2 hours to get from Exxon near the Beaumont Turning Basin at Neches River Station 990 to the lower end of the Neches River Channel (Station 240+00), a distance of about 14 miles. It was noted that outbound convoys often include one to two additional vessels. Under present condition, the vessels move down the Neches River Channel out to Buoy 29 and 30 in the Entrance Channel and into the 800-foot channel reach before they can meet single vessels with comparable dimensions or likewise an inbound convoy. Vessel meetings between inbound vessels and the outbound convoy are very restricted due to the combined beam and loaded-draft restrictions.

The pilots emphasized that the seven holding area improvements would allow loaded vessels to await berths and would save time that they originally would have spent in an inbound transit mode while the berth became clear. With the holding areas, vessels would only have to shift from the anchorage instead of awaiting the ship to sail and to start in accordance with the traffic rules. The pilots noted that the number of hours saved depends on the dock facility and that the benefits will be primarily for the crude oil tankers and some product carriers; however, all traffic would realize some savings. Pilot expectation is that the crude oil carriers would save about 7 hours. It also noted that the Panamax-sized product carriers that load at ExxonMobil will save about 7 hours. The pilots noted that they did not expect a difference between the Aframax and Suezmax savings. The number of hours saved for vessels in the lower end of the Neches River Channel would be lower.

The pilots noted that with the anchorages, future inbound convoys will include additional ships to await berths. Under present conditions, the size of an inbound convoy is limited due to berth space. When the berths are available, the vessels will switch from the holding area to a berth. They noted that it is quicker to put a vessel in an anchorage (approximately 20 minutes) than to dock (approximately 1 hour). Similarly, it is quicker to depart from anchorage than to undock and turn. The net result is that the convoys will move faster and include additional vessels.

The benefits of the turning basin features were evaluated based on pilot input and examination of the HarborSym output data associated with waiting times and other related variables. The initial focus of the discussions with the pilots was to understand present use of the turning basins and obtain clarification on the DWT, loaded drafts, beam, length, and number of vessels associated with each of the turning basins. Presently, the turning basins are used for vessel turning and holding of light vessels (i.e., loaded drafts less than 29 feet). Some turning basins are also used for holding light Aframax tankers, again with drafts

loaded to less than 29 feet. It was noted that Aframax tankers can be pushed into a turning basin; however, lack of maintenance dredging makes this practice less frequent and more difficult, but it will occur if a vessel, communication, or other breakdown situation requires.

The vessel arrivals and departures from the Neches River Channel are planned and/or orchestrated rather than random. Under present conditions, a new Neches River inbound fleet cannot come in until the outbound Neches River fleet has traveled down the Neches and has cleared the Jetty Channel and is in the Outer Bar Channel. Under the without-project condition, the vessels wait offshore. Under the with-project condition, they will also wait offshore; however, the sidings will allow a vessel to move to the dock and start unloading when, under the without-project condition, it would be waiting for an outbound convoy to clear the jetty channel. By widening the Entrance Channel through the Sabine Pass Channel, the inbound and outbound convoys have a longer reach in which to meet. By building the Neches River sidings, an inbound convoy can save a significant portion of the inbound transit time by being in the sidings and ready to move to the docks as the outbound convoy leaves. The convoy behavior will not change between the without- and with-project conditions. Table 100 presents the HarborSym output associated with the Neches River anchorages. Discussion with the pilots indicated uncertainty concerning shifting charges; therefore, the effect of their inclusion was evaluated. The benefits were calculation based on shifting costs being levied 50 percent of the time. Tables 101 and 102 summarize the average annual savings in comparison to the average construction cost. Table 101 is similar to Table 102 and presents the same combinations but differs in that the annual benefits reflect inclusion of “pilot shifting costs” for 100 percent of the time. The annual benefits presented in tables 101 and 102 do not reflect future growth and are based on 2004-period traffic levels. Analysis of the data presented in tables 101 and 102 shows that the combination of basins that include alternatives 1, 4, and 8 produce the highest net excess benefits among the alternatives evaluated.

Table 100
Neches River Anchorage Basins (2004-Period Savings)

Feature	No Shifting Cost ($)	With Shifting Cost ($)	Shifting Cost 50% of the Time ($)
Alt 1	1,011,421	212,798	612,110
Alt 2	1,085,993	287,370	686,682
Alt 3	5,045	1,335	3,190
Alt 4	711,087	0	355,544
Alt 5	3,304	0	1,652
Alt 7	367,215	0	183,608
Alt 8	278,304	0	139,152
Alt 1, 2	1,590,026	791,403	1,190,715
Alt 1, 3	1,012,551	213,928	613,240
Alt 1, 4	1,598,751	800,128	1,199,440
Alt 1, 5	1,012,551	213,928	613,240
Alt 1, 7	1,328,837	530,215	929,526
Alt 1, 8	1,263,380	464,758	864,069
Alt 2, 4	1,598,187	799,565	1,198,876
Alt 2, 7	1,413,856	615,233	1,014,545
Alt 2, 8	1,344,211	0	672,106
Alt 4, 7	1,178,793	380,170	779,482
Alt 4, 8	1,103,461	304,838	704,150
Alt 1, 2, 3	1,592,519	793,896	1,193,208
Alt 1, 2, 4	1,897,906	1,099,283	1,498,595
Alt 1, 2, 5	1,208,613	297,153	752,883
Alt 1, 2, 7	1,824,395	1,025,773	1,425,084
Alt 1, 2, 8	1,750,352	951,730	1,351,041
Alt 1, 3, 4	1,601,048	802,425	1,201,737
Alt 1, 3, 5	1,012,551	213,928	613,240
Alt 1, 3, 7	1,334,789	536,166	935,478
Alt 1, 3, 8	1,334,789	536,166	935,478
Alt 1, 4, 5	1,601,048	802,425	1,201,737
Alt 1, 4, 7	1,697,713	898,950	1,298,332
Alt 1, 4, 8	1,761,501	962,878	1,362,190
Alt 2, 4, 7	1,796,902	0	898,451
Alt 2, 4, 8	1,750,548	0	875,274
Alt 2, 7, 8	1,370,980	998,280	1,184,630
Alt 4, 7, 8	1,259,138	460,516	859,827
Alt 1, 2, 3, 4	1,902,467	1,103,845	1,503,156
Alt 1, 2, 4, 7	2,100,114	1,301,491	1,700,803
Alt 1, 2, 4, 8	2,062,240	1,263,618	1,662,929
Alt 1, 2, 7, 8	1,879,960	1,081,337	1,480,649
Alt 1, 4, 7, 8	1,850,392	1,051,629	1,451,011
Alt 2, 3, 4, 5	1,797,233	998,610	1,397,922
Alt 2, 4, 7, 8	1,707,628	909,005	1,308,317
Alt 1, 2, 4, 7, 8	1,982,703	1,184,081	1,583,392
Alt 2, 3, 4, 5, 7	1,797,233	998,610	1,397,922
Alt 2, 4, 5, 7, 8	1,838,302	1,039,679	1,438,991
Alt 3, 4, 5, 7, 8	1,261,556	462,934	862,245

Table 101
Average Annual Cost, Transportation Savings Benefits, Net Excess Benefits (4.375%), and Benefit to Cost Ratios (No Shifting Charges)

Feature	Average Annual Cost ($)	Benefits Based on 2004-Period Traffic ($)	Net Excess Benefits ($)	Benefit to Cost Ratio
Alt 1	317,880	1,011,421	693,541	3.2
Alt 2	393,568	1,085,993	692,424	2.8
Alt 3	120,157	5,045	–115,112	0.0
Alt 4	192,390	711,087	518,697	3.7
Alt 5	351,101	3,304	–347,797	0.0
Alt 7	144,821	367,215	222,393	2.5
Alt 8	132,768	278,304	145,536	2.1
Alt 1, 2	711,448	1,590,026	878,578	2.2
Alt 1, 3	438,037	1,012,551	574,514	2.3
Alt 1, 4	510,270	1,598,751	1,088,481	3.1
Alt 1, 5	462,701	1,012,551	549,849	2.2
Alt 1, 7	450,648	1,328,837	878,189	2.9
Alt 1, 8	317,880	1,263,380	945,501	4.0
Alt 2, 4	585,958	1,598,187	1,012,229	2.7
Alt 2, 7	538,390	1,413,856	875,466	2.6
Alt 2, 8	526,337	1,344,211	817,874	2.6
Alt 4, 7	337,211	1,178,793	841,582	3.5
Alt 4, 8	325,158	1,103,461	778,303	3.4
Alt 1, 2, 3	831,605	1,592,519	760,914	1.9
Alt 1, 2, 4	903,838	1,897,906	994,068	2.1
Alt 1, 2, 5	1,062,549	1,208,613	146,064	1.1
Alt 1, 2, 7	856,269	1,824,395	968,126	2.1
Alt 1, 2, 8	844,216	1,750,352	906,136	2.1
Alt 1, 3, 4	630,427	1,601,048	970,621	2.5
Alt 1, 3, 5	789,138	1,012,551	223,413	1.3
Alt 1, 3, 7	582,858	1,334,789	751,930	2.3
Alt 1, 3, 8	570,805	1,334,789	763,983	2.3
Alt 1, 4, 5	861,371	1,601,048	739,677	1.9
Alt 1, 4, 7	655,091	1,697,713	1,042,622	2.6
Alt 1, 4, 8	643,038	1,761,501	1,118,463	2.7

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Table 101 (Cont'd)

Feature	Average Annual Cost ($)	Benefits Based on 2004-Period Traffic ($)	Net Excess Benefits ($)	Benefit to Cost Ratio
Alt 2, 4, 7	730,780	1,796,902	1,066,123	2.5
Alt 2, 4, 8	889,491	1,750,548	861,057	2.0
Alt 2, 7, 8	683,211	1,370,980	687,769	2.0
Alt 4, 7, 8	469,980	1,259,138	789,159	2.7
Alt 1, 2, 3, 4	1,023,995	1,902,467	878,472	1.9
Alt 1, 2, 4, 7	1,048,659	2,100,114	1,051,455	2.0
Alt 1, 2, 4, 8	1,036,606	2,062,240	1,025,634	2.0
Alt 1, 2, 7, 8	989,038	1,879,960	890,922	1.9
Alt 1, 4, 7, 8	787,859	1,850,392	1,062,533	2.3
Alt 2, 3, 4, 5	1,057,216	1,797,233	740,017	1.7
Alt 2, 4, 7, 8	863,548	1,707,628	844,080	2.0
Alt 1, 2, 4, 7, 8	1,181,428	1,982,703	801,276	1.7
Alt 2, 3, 4, 5, 7	1,202,038	1,797,233	595,195	1.5
Alt 2, 4, 5, 7, 8	1,189,985	1,838,302	648,317	1.5
Alt 3, 4, 5, 7, 8	941,238	1,261,556	320,318	1.3

Table 102
Average Annual Cost, Transportation Savings Benefits, Net Excess Benefits (4.375%), and Benefit to Cost Ratios (Shifting Charges 100% of the Time)

Feature	Average Annual Cost ($)	Benefits Based on 2004-Period Traffic ($)	Net Excess Benefits ($)	Benefit to Cost Ratio
Alt 1	317,880	212,798	–105,082	0.7
Alt 2	393,568	287,370	–106,198	0.7
Alt 4	192,390	0	–192,390	0.0
Alt 7	144,821	0	–144,821	0.0
Alt 8	132,768	0	–132,768	0.0
Alt 1, 2	711,448	791,403	79,955	1.1
Alt 1, 3	438,037	213,928	–224,109	0.5
Alt 1, 4	510,270	800,128	289,859	1.6
Alt 1, 5	462,701	213,928	–248,773	0.5
Alt 1, 7	450,648	530,215	79,567	1.2
Alt 1, 8	317,880	464,758	146,878	1.5
Alt 2, 4	585,958	799,565	213,607	1.4
Alt 2, 7	538,390	615,233	76,843	1.1

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Table 102 (Cont'd)

Feature	Average Annual Cost ($)	Benefits Based on 2004-Period Traffic ($)	Net Excess Benefits ($)	Benefit to Cost Ratio
Alt 2, 8	526,337	0	–526,337	0.0
Alt 4, 7	337,211	380,170	42,959	1.1
Alt 4, 8	325,158	304,838	–20,320	0.9
Alt 1, 2, 3	831,605	793,896	–37,709	1.0
Alt 1, 2, 4	903,838	1,099,283	195,446	1.2
Alt 1, 2, 5	1,062,549	297,153	–765,396	0.3
Alt 1, 2, 7	856,269	1,025,773	169,503	1.2
Alt 1, 2, 8	844,216	951,730	107,513	1.1
Alt 1, 3, 4	630,427	802,425	171,998	1.3
Alt 1, 3, 5	789,138	213,928	–575,210	0.3
Alt 1, 3, 7	582,858	536,166	–46,692	0.9
Alt 1, 3, 8	570,805	536,166	–34,639	0.9
Alt 1, 4, 5	861,371	802,425	–58,946	0.9
Alt 1, 4, 7	655,091	898,950	243,859	1.4
Alt 1, 4, 8	643,038	962,878	319,840	1.5
Alt 2, 4, 7	730,780	0	–730,780	0.0
Alt 2, 4, 8	889,491	0	–889,491	0.0
Alt 2, 7, 8	683,211	998,280	315,068	1.5
Alt 4, 7, 8	469,980	460,516	–9,464	1.0
Alt 1, 2, 3, 4	1,023,995	1,103,845	79,850	1.1
Alt 1, 2, 4, 7	1,048,659	1,301,491	252,832	1.2
Alt 1, 2, 4, 8	1,036,606	1,263,618	227,012	1.2
Alt 1, 2, 7, 8	989,038	1,081,337	92,299	1.1
Alt 1, 4, 7, 8	787,859	1,051,629	263,770	1.3
Alt 2, 3, 4, 5	1,057,216	998,610	–58,606	0.9
Alt 2, 4, 7, 8	863,548	909,005	45,457	1.1
Alt 1, 2, 4, 7, 8	1,181,428	1,184,081	2,653	1.0
Alt 2, 3, 4, 5, 7	1,202,038	998,610	–203,427	0.8
Alt 2, 4, 5, 7, 8	1,189,985	1,039,679	–150,306	0.9
Alt 3, 4, 5, 7, 8	941,238	462,934	–478,304	0.5

Table 103 summarizes the project cost and benefits associated with the combination of 1, 4, and 8. The annual benefits presented in Table 104 are average annual numbers and reflect future growth based on 2019–2069 traffic levels. The benefit calculations are based on a project condition without deepening. The project construction cost is based on a project depth of 48 feet.

Table 103
SNWW Neches River Anchorage Analysis
Basins 1, 4, and 8
Economic Summary Data
October 2008 Dollars

First Cost of Construction	9,452,214
Interest During Construction	190,786
Total Investment	9,643,000
Average Annual Construction Cost	478,073
Average Annual O&M	190,106
Total Annual Cost	668,179

Average Annual Benefits at 4.375%
Incorporates Traffic Growth (2019–2069)
Based on Pilot Shifting Cost Scenarios

Benefit Component	Based on No Pilot Shifting Cost	Based on Pilot Shifting Cost 100% of the Time	Based on Pilot Shifting Cost 50% of the Time
Average Annual Benefits	2,784,668	1,522,166	2,153,417
Net Excess Benefits	2,116,489	853,987	1,485,238
Benefit to Cost Ratios	4.2	2.3	3.2

6.4 CHANNEL DEEPENING BENEFITS

The transportation costs and the savings associated with the proposed project depth increase were calculated using commodity-specific vessel class and trade route distributions. Transportation costs were calculated based on the channel depth alternatives and variables associated with vessel design drafts, maximum feet of light-loading, underkeel clearance, mileage traveled, and the number of hours to load and unload. Maximum vessel cargo capacities for crude oil and petroleum products were estimated based on review of the range of load factors obtained based on review from IWR Report 91-R-13, *National Economic Development Procedures Manual Deep Draft Navigation* (1991) and consultation with SNWW industry and the SPA. The IWR (1991) cargo capacity factors published in the deep-draft manual for dry bulk carriers and tankers are shown in Table 104. Consultation with industry and the pilots revealed that these estimates are reasonable. Table 105 presents representative round-trip mileage for the trade routes or junction points used for the transportation savings computations.

Table 104
Adjustments for Estimating Actual Vessel Capacity

Vessel DWT	Dry Bulk	Tanker
<20,000	0.90	0.90
20,000–70,000	0.92	0.92
70,000–120,000	0.95	0.95
>120,000	0.97	0.97

Table 105
Representative Round-Trip Mileage to SNWW

Location	Total Miles
Coatzacoalcos, Mexico	1,376
U.S. Gulf Coast Lightering/Lightening Zone	160
Venezuela	3,612
Panama Canal	3,120
Brazil (Maceio/Sao Paulo weighted average)	9,422
Rotterdam, Netherlands	10,040
Sture, Norway	10,528
North Africa, Algiers	10,294
West Africa (Nigeria and Angola)	12,500
Persian Gulf and Indian Subcontinent via Suez Canal	19,704
Persian Gulf and Indian Subcontinent via Cape of Good Hope	25,112
Singapore via Panama Canal	24,248
Singapore via Cape of Good Hope	26,304

6.4.1 Transportation Savings Benefits for Channel Deepening

Transportation savings benefits from reductions in the vessel operating costs were calculated based on the relative difference in transportation costs between the without-project and with-project conditions. Transportation costs and savings were calculated for vessels that minimize transportation costs given trade route constraints. As previously noted, long-term fleet selection will continue to reflect goals of minimizing vessel operating costs. The basic procedure used to calculate transportation costs using 110,000 and 150,000 DWT foreign flag tankers as an example is illustrated in Table 106. Similar computations were made for appropriate distances and vessel sizes for each of the channel depth alternatives. The resulting costs-per-ton computations were calculated over the relevant range of vessels projected for each channel depth improvement, and the associated savings per ton were measured using the net differences in costs between the existing 40-foot channel and the depth alternative. Unless otherwise noted, the 2019–2069 tonnage forecasts used for the benefit calculations are shown in tables 81 and 82 summarizing the transportation savings benefits. Table 107 lists the terminal locations by channel and mileage point for the commodities included in the deepening analysis.

Table 106
Transportation Cost Calculation (South America to SNWW)

Channel Depth	40 feet	45 feet	50 feet	40 feet	45 feet	50 feet
Vessel Deadweight Tons	110,000	110,000	110,000	150,000	150,000	150,000
Design Draft (feet)	50.0	50.0	50.0	56.4	56.4	56.4
Cargo Capacity (%) a/	95	95	95	97	97	97
Cargo Capacity (short tons) a/	104,500	104,500	104,500	145,500	145,500	145,500
Immersion Factor (tons per inch)	234.1	234.1	234.1	285.4	285.4	285.4
Hourly Cost at Sea (from EGM)	1,192	1,192	1,192	1,369	1,369	1,369
Underkeel Clearance (feet) b/	1	1	1	1	1	1
Hourly Cost in Port (from EGM)	$772	$772	$772	$878	$878	$878
Round Trip Mileage from South America b/	5,627	5,627	5,627	5,627	5,627	5,627
Speed (Knots)	15	15	15	15	15	15
Total Voyage Cost	447,127	447,127	447,127	513,521	513,521	513,521
Other Components (Loading and Unloading and Port Time)						
Maximum Load at Channel Dept	73,599	87,645	101,691	85,908	103,032	120,156
Cost per Ton for Sea Voyage	6.08	5.10	4.40	5.98	4.98	4.27
Loading/Unloading Rate (short tons/hour)	5,250	5,250	5,250	5,250	5,250	5,250
Hours in Port	24	24	24	24	24	24
Total Loading Cost at Foreign Port	18,528	18,528	18,528	21,072	21,072	21,072
Total Unloading Cost SNWW	18,528	18,528	18,528	21,072	21,072	21,072
Pilot and Tug Costs	45,501	48,624	51,031	56,923	60,331	62,908
Total Loading, Unloading, and Port Costs	82,557	85,680	88,087	99,067	102,475	105,052
Total Cost Sum	529,684	532,808	535,214	612,588	615,996	618,573
Total Cost Per Ton	7.20	6.08	5.26	7.13	5.98	5.15

a/ Estimated short tons =~ ((DWT * Maximum % Load) - (Immersion Factor * 12 inches per ton * number of feet light-loaded).

b/ Weighted mileage based on distance from Venezuela and Brazil. The weight factor of 0.7 was used for Venezuela, and a factor of 0.3 was used for Brazil. The weights were determined based on the expected percentage of tonnage by origin.

Table 107
SNWW Facilities Associated with Draft-Constrained Vessels by Channel Reach, Mileage Point, Facility Name, Major Commodity, and Cross Section Reference

Channel Reach	Estimated Miles from Sea Buoy	Existing Facility (Company Name)	Major Commodity	USACE Cross Section Reference Estimate
Sabine Bank Channel	0	n/a	n/a	n/a
Sabine Pass Outer Bar Channel	14	n/a	n/a	n/a
Sabine Pass Jetty Channel	16	n/a	n/a	n/a
Sabine Pass Channel	22	Cheniere; Golden Pass	LNG	SPC090+00
Port Arthur Canal	25	Sempra a/	LNG	PAC170+00
Taylor Bayou	32	Motiva; Premcor	Crude Oil, Petroleum and Chemicals	PAC310+00
Sabine-Neches Canal	33	Port of Port Arthur	Bulk Materials	SNC300+00
Neches River Channel	40	n/a		
	42	Fina	Crude Oil, Petroleum and Chemicals	NRC020+00
	45	Motiva; Huntsman	Crude Oil, Petroleum and Chemicals	NRC300+00
	46	Transit Mix	Bulk Materials	NRC340+00
	48	Sun Oil; Union Oil	Crude Oil, Petroleum and Chemicals	NRC520+00
	51	Oil Tanking	Crude Oil and Petroleum Products	NRC700+00
	55	ExxonMobil	Crude Oil, Petroleum and Chemicals	NRC950+00
	56	Port of Beaumont	Grain; Bulk Materials	NRC975+00

a/ Anticipated to be constructed in 2012.

6.4.1.1 Crude Petroleum Imports

The costs per ton computations were calculated over the relevant range of vessels projected for each channel depth improvement. The associated savings per ton were measured using the net differences in costs between the existing 40-foot channel and the depth alternative. The transportation costs were calculated using foreign flag tankers (see Table 82). The distribution of tonnage between the ports of Beaumont and Port Arthur was assumed to reflect the relative historical tonnage shares. The sensitivity section of this appendix addresses the effects of Port Arthur's future share increasing relative to Beaumont's present share. Table 108 presents Port Arthur and Beaumont crude oil import forecasts.

Table 108
SNWW Crude Petroleum Imports by Port and Trade Route, 2019–2069
1,000s of Short Tons

Beaumont	2019	2029	2039	2049	2059	2069
Canada	–	–	–	–	–	–
Mexico	7,817	8,716	9,234	9,392	9,575	10,277
Central/South America	12,576	14,023	14,857	15,111	15,405	16,534
Western South America	–	–	–	–	–	–
Europe and Africa	29,327	32,701	34,644	35,237	35,922	38,556
Middle East	27,439	30,596	32,414	32,968	33,610	36,074
Beaumont Total	77,159	86,037	91,150	92,708	94,512	101,441

Port Arthur	2019	2029	2039	2049	2059	2069
Canada	–	–	–	–	–	–
Mexico	1,193	1,329	1,412	1,440	1,469	1,505
Central/South America	1,915	2,133	2,262	2,304	2,350	2,470
Western South America	–	–	–	–	–	–
Europe and Africa	4,475	4,987	5,296	5,403	5,512	5,647
Middle East	4,187	4,666	4,955	5,055	5,157	5,283
Port Arthur Total	11,769	13,116	13,925	14,202	14,488	14,906
SNWW Used for the Benefits Calculations	88,928	99,153	105,075	106,909	109,000	116,347
SNWW Total	94,229	105,129	111,669	113,950	116,263	118,608
% Used for Benefits	95	95	95	95	95	95

An increase in the channel depth to Port Arthur from 40 to 45 feet would allow the existing range of 90,000 to 120,000 DWT vessels to carry approximately 20 percent more cargo. A depth increase from 40 to 50 feet or more would allow the same range of vessels to carry 35 percent more cargo. Table 109 displays the maximum cargo tons by vessel size and channel depth alternatives for representative vessels used in the analysis. Table 110 shows the number of shuttle vessels by channel depth alternatives necessary to offload a VLCC. The maximum loads shown in Table 109 and the number of shuttles shown in Table 110 are based on application of 1 foot of underkeel clearance. The effects of greater underkeel clearance are evaluated in the sensitivity analysis (Section 8). Shuttle vessels between 70,000 and 165,000 DWT were used for Beaumont's lightering cost calculations. Shuttle vessels between 70,000 and 120,000 DWT were used for Port Arthur's lightering cost calculations.

Table 111 summarizes the transportation cost by trade route used for the with- and without-project future condition calculations. The transportation costs for existing conditions and the without-project future are defined by the same range of vessel sizes. The existing range of vessels is concentrated between 75,000 and 120,000 DWT. The maximum vessel sizes presently used are in the 150,000 to 175,000 DWT range. Current distribution of crude oil imports by vessel size can be found in Section 3 (see tables 29, 31, and 32). There is a gap in the world tanker fleet between 175,000 and 250,000 DWT. The reason for the gap is that it is not cost effective to use tankers significantly larger than 175,000 DWT for channel depths of less than 55 feet (Section 3.5.1). An increase in channel depth of the SNWW would provide opportunity for the current range of vessels used for direct shipment and as shuttle vessels associated with offshore lightering to be more fully loaded.

The per ton transportation costs correspond to the least-cost method of shipment associated with the particular trade route. Review of the depths at trading ports and significant savings per ton indicate that a large share of crude petroleum tonnage from Mexico, Venezuela, and Trinidad would be loaded to vessel drafts over 40 feet.

Expectations concerning the percentage of Middle East and Africa movements are subject to greater uncertainty. Nearly all Middle East tonnage is lightered, and nearly all West Africa crude is lightened. The logistics associated with these offshore transfers introduces higher degrees of uncertainty than with direct shipment and, therefore, generates large cost variances.

Additionally, and as Table 111 illustrates, the cost savings for offshore transfer are lower than with direct shipment; however, distinct cost savings are apparent. The savings for lightering results from increases in shuttle loads due to greater channel depth in SNWW. For lightering, the effect of increasing channel depths at SNWW allows for the reduction in the number of shuttles necessary to totally lighter VLCCs. The savings for lightened movements results from decreases in offshore unloading time from the mother vessel to shuttles. For lightening, the mother vessel is substituting offshore unloading time for dock-side unloading time. Additionally, the shuttle vessel reduces its overall loading and unloading time.

Table 109
SNWW Foreign Flag Tanker Vessel Application
Maximum Cargo by Vessel Size and Channel Depth (feet)

			Channel Depth (feet) =		40	43	44	45	46	47	48	50
	Ratio of		Maximum Loaded Draft =		39	42	43	44	45	46	47	49
DWT	Cargo to DWT (%)	Immersion Factor	Design Draft	Full Load	Cargo Capacity by Channel Depth Alternative							
9,000	90	-	-	8,100	8,100	8,100	8,100	8,100	8,100	8,100	8,100	8,100
12,000	90	-	-	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
14,000	90	-	-	12,600	12,600	12,600	12,600	12,600	12,600	12,600	12,600	12,600
18,000	90	-	-	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200	16,200
20,000	92	79	32	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400
25,000	92	91	33	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000
35,000	92	113	36	32,200	32,200	32,200	32,200	32,200	32,200	32,200	32,200	32,200
50,000	92	141	39	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000
60,000	92	159	41	55,200	51,958	55,200	55,200	55,200	55,200	55,200	55,200	55,200
70,000	95	160	46	66,500	53,060	58,820	60,740	62,660	64,580	66,500	66,500	66,500
75,000	95	180	47	71,250	53,970	60,450	62,610	64,770	66,930	69,090	71,250	71,250
80,000	95	191	45	76,000	62,248	69,124	71,416	73,708	76,000	76,000	76,000	76,000
85,000	95	198	46	80,750	64,795	71,939	74,320	76,702	79,083	80,750	80,750	80,750
90,000	95	206	46	85,500	67,216	74,628	77,099	79,570	82,041	84,512	85,500	85,500
105,000	95	227	49	99,750	72,232	80,405	83,130	85,855	88,579	91,304	94,028	96,753
125,000	96	253	52	119,875	78,951	88,071	91,111	94,151	97,191	100,231	103,271	106,311
130,000	96	260	53	125,000	80,539	89,890	93,007	96,124	99,241	102,358	105,475	108,592
135,000	96	266	54	130,125	82,028	91,610	94,804	97,998	101,192	104,386	107,580	110,774
150,000	97	285	56	145,500	85,908	96,183	99,608	103,032	106,457	109,882	113,307	116,732
165,000	97	303	59	160,050	88,690	99,613	103,254	106,894	110,535	114,176	117,817	121,458
175,000	97	314	60	169,750	91,456	102,765	106,534	110,304	114,074	117,843	121,613	125,382
190,000	97	330	62	184,300	95,040	106,928	110,891	114,854	118,816	122,779	126,742	130,704

Table 110
Number of Shuttle Vessels Needed by Channel Depth Alternative

Channel Depth (feet) Alternative	Shuttle Vessel Trips by Channel Depth Alternative and Vessel DWT													
	42,500	50,000	70,000	80,000	85,000	90,000	110,000	115,000	120,000	125,000	130,000	135,000	150,000	165,000
40	9.0	7.0	6.0	6.0	5.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0
43	9.0	7.0	6.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
44	9.0	7.0	6.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
45	9.0	7.0	6.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0
46	9.0	7.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0
47	9.0	7.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0
48	9.0	7.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0
49	9.0	7.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0
50	9.0	7.0	5.0	5.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0
52	9.0	7.0	5.0	5.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Table 111
SNWW Crude Petroleum Imports Transportation Cost and Savings
Most Likely Transportation Mode Trade Route and Channel Depth (December 2008 Vessel Costs)

Trade Route/Depth (feet) And Method of Shipment	40	45	46	47	48	49	50
Mexico	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Cost/ton Beaumont	2.76	2.34	2.28	2.21	2.15	2.11	2.07
Cost/ton Port Arthur	2.77	2.37	2.30	2.23	2.18	2.14	2.11
Savings/ton Beaumont		0.41	0.48	0.55	0.60	0.65	0.69
Savings/ton Port Arthur		0.41	0.47	0.54	0.59	0.63	0.67
Venezuela	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Cost/ton Beaumont	7.22	6.09	5.91	5.73	5.58	5.45	5.34
Cost/ton Port Arthur	7.28	6.17	5.98	5.81	5.67	5.55	5.47
Savings/ton Beaumont		1.13	1.31	1.49	1.64	1.77	1.88
Savings/ton Port Arthur		1.11	1.30	1.47	1.62	1.73	1.81
Africa/North Sea	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered
Cost/ton Beaumont	8.41	8.18	8.13	8.12	8.05	8.01	8.01
Cost/ton Port Arthur	8.46	8.19	8.13	8.12	8.12	8.11	8.08
Savings/ton Beaumont		0.23	0.28	0.30	0.36	0.40	0.40
Cost/ton Port Arthur		0.27	0.33	0.34	0.35	0.35	0.39
Middle East	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered
Cost/ton Beaumont	14.43	14.20	14.15	14.13	14.06	14.03	14.03
Cost/ton Port Arthur	14.48	14.19	14.13	14.11	14.11	14.10	14.06
Savings/ton Beaumont		0.23	0.28	0.30	0.36	0.40	0.40
Savings/ton Port Arthur		0.29	0.35	0.36	0.37	0.38	0.42

Lightening generates comparatively lower savings than lightering because the latter produces the possibility of reducing the number of shuttles needed. Examination of the cost data also revealed that as channel depth increases, the resulting savings may introduce incentive to switch from lightening to direct shipment for movements from Africa and the North Sea. Table 112 presents the lightening and Table 113 presents the lightering costs. Historically, lightening was the most common choice for Africa and the North Sea movements; however, lightering has become more common for this route in recent years due to structural changes in oil production off the coast of West Africa. Lightering has always been the method of choice for Middle East movements. The small percentage of North Sea using SNWW tends to be lightered, and an increasing portion of West Africa crude is lightered. Lightering was assumed to represent the without- and with-project future choice for West Africa crude due to its relative low cost and increasing popularity. Comparison of the cost data in tables 112, 113, and 114 for the Africa and North Sea route demonstrates why lightening will continue for this route; however, method of shipment choices for West African crude will remain subject to a higher level of uncertainty than for other routes. The relative closeness in costs between the shipping methods, and the uncertainty associated "turnaround times" for completing offshore transfers means that direct shipment and lightening will continue as viable

options. At the same time, the effect of an SNWW deeper channel depth will reduce the cost differential and make direct shipment more cost competitive for Africa and North Sea routings and, therefore, may result in a greater frequency of direct shipment, with the uncertainty associated with offshore transfers being a key variable affecting shippers' decision.

Table 112
SNWW Crude Petroleum Imports
Lightened Cost Per Ton by Channel Depth and Trade Route (December 2008 Vessel Costs)

Depth	40 feet	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
Mother Vessels (DWT)							
Minimum	150,000	150,000	162,500	162,500	162,500	162,500	162,500
Maximum	175,000	175,000	175,000	175,000	175,000	175,000	175,000
Shuttle Vessels (DWT)							
Minimum	72,000	57,000	57,000	57,000	57,000	57,000	57,000
Maximum	85,000	68,000	65,000	65,000	65,000	65,000	65,000
Africa and North Sea			Per Ton Transportation Cost to SNWW ($)				
Minimum	10.10	10.08	10.08	10.08	10.08	10.08	10.08
Mean	10.56	10.49	10.49	10.49	10.49	10.49	10.49
Maximum	11.02	10.90	10.90	10.90	10.90	10.90	10.90
Middle East			Per Ton Transportation Cost to SNWW ($)				
Minimum	14.70	14.68	14.68	14.68	14.68	14.68	14.68
Mean	15.17	15.10	15.10	15.10	15.10	15.10	15.10
Maximum	15.63	15.51	15.51	15.51	15.51	15.51	15.51

Table 113
SNWW Crude Petroleum Imports
Lightered Cost Per Ton by Channel Depth and Trade Route (December 2008 Vessel Costs)

Depth	40 feet	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
Africa and North Sea Per Ton Transportation Cost ($)							
Minimum	8.31	8.16	8.04	8.02	8.00	7.90	7.89
Mean	8.41	8.18	8.13	8.12	8.05	8.01	8.01
Maximum	8.66	8.53	8.51	8.28	8.26	8.26	8.26
Middle East Per Ton Transportation Cost ($)							
Minimum	14.33	14.17	14.06	14.04	14.02	13.92	13.91
Mean	14.43	14.20	14.15	14.13	14.06	14.03	14.03
Maximum	14.68	14.55	14.52	14.30	14.27	14.27	14.27

Tables 114 and 115 display Beaumont and Port Arthur's transportation cost savings based on the least-cost shipping methods displayed in Table 111. For Port Arthur, the maximum vessel DWT used for the benefit calculations is less than 121,000 DWT. As previously noted, deepening of the channel leading to the Taylor Bayou terminal will enable the existing fleet to be more fully loaded, but it will not result in transition to larger vessels. The transportation costs shown in Table 111 and the savings shown in Table 115 reflect continuation of this limitation.

Table 114
Beaumont Crude Petroleum Imports
Annual Transportation Savings ($1,000s) by Trade Route and Decade (December 2008 Vessel Costs)
2019–2069

Channel Depth Alternative/ Trade Route	2002/2004	2019	2029	2039	2049	2059	2069
45-foot Channel							
Mexico	6,065	3,227	3,597	3,808	3,870	3,945	4,235
Central/South America	8,348	14,216	15,850	16,779	17,052	17,380	18,660
Europe and Africa	2,021	6,842	7,629	8,076	8,207	8,365	8,981
Middle East	5,879	6,402	7,138	7,556	7,679	7,827	8,403
Total Savings	22,313	30,686	34,214	36,219	36,808	37,516	40,280
46-foot Channel							
Mexico	7,089	3,771	4,205	4,451	4,524	4,611	4,950
Central/South America	9,724	16,558	18,461	19,543	19,861	20,243	21,735
Europe and Africa	2,431	8,230	9,176	9,714	9,872	10,062	10,803
Middle East	7,071	7,700	8,585	9,088	9,236	9,414	10,107
Total Savings	26,315	36,259	40,427	42,796	43,493	44,329	47,595
47-foot Channel							
Mexico	8,051	4,283	4,775	5,055	5,137	5,236	5,622
Central/South America	11,016	18,758	20,914	22,140	22,500	22,933	24,623
Europe and Africa	2,566	8,687	9,685	10,253	10,420	10,620	11,403
Middle East	7,464	8,128	9,062	9,593	9,749	9,937	10,669
Total Savings	29,097	39,856	44,437	47,041	47,807	48,726	52,316
48-foot Channel							
Mexico	8,867	4,717	5,259	5,567	5,658	5,767	6,192
Central/South America	12,147	20,684	23,062	24,413	24,810	25,288	27,151
Europe and Africa	3,162	10,705	11,935	12,635	12,840	13,087	14,052
Middle East	9,198	10,016	11,167	11,821	12,014	12,245	13,147
Total Savings	33,373	46,121	51,423	54,437	55,323	56,387	60,541
49-foot Channel							
Mexico	9,549	5,080	5,664	5,996	6,093	6,210	6,668
Central/South America	13,093	22,295	24,858	26,315	26,743	27,258	29,266
Europe and Africa	3,490	11,816	13,175	13,947	14,174	14,447	15,511
Middle East	10,153	11,056	12,327	13,049	13,261	13,516	14,512
Total Savings	36,285	50,247	56,023	59,307	60,272	61,431	65,957
50-foot Channel							
Mexico	10,171	5,411	6,033	6,386	6,490	6,615	7,102
Central/South America	13,900	23,669	26,390	27,937	28,391	28,937	31,069
Europe and Africa	3,490	11,816	13,175	13,947	14,174	14,447	15,511
Middle East	10,153	11,056	12,327	13,049	13,261	13,516	14,512
Total Savings	37,714	51,952	57,924	61,319	62,317	63,515	68,195

Table 115
Port Arthur Crude Petroleum Imports
Annual Transportation Savings ($1,000s) by Trade Route and Decade (December 2008 Vessel Costs)
2019–2069

Channel Depth Alternative/ Trade Route	2002/2004	2019	2029	2039	2049	2059	2069
45-foot Channel							
Mexico	3,355	484	539	573	584	596	611
Central/South America	399	2,128	2,370	2,514	2,560	2,611	2,745
Europe and Africa	128	1,214	1,353	1,437	1,466	1,496	1,532
Middle East	299	1,194	1,331	1,414	1,442	1,471	1,507
Total Savings	4,180	5,020	5,594	5,937	6,053	6,174	6,395
46-foot Channel							
Mexico	3,928	567	631	670	684	698	715
Central/South America	465	2,481	2,764	2,931	2,985	3,044	3,201
Europe and Africa	154	1,467	1,635	1,736	1,771	1,807	1,851
Middle East	365	1,461	1,628	1,729	1,764	1,800	1,844
Total Savings	4,913	5,976	6,659	7,067	7,205	7,349	7,611
47-foot Channel							
Mexico	4,468	644	718	763	778	794	813
Central/South America	527	2,813	3,134	3,324	3,385	3,452	3,629
Europe and Africa	160	1,527	1,702	1,807	1,843	1,881	1,927
Middle East	382	1,528	1,703	1,808	1,845	1,882	1,928
Total Savings	5,537	6,512	7,256	7,701	7,851	8,008	8,297
48-foot Channel							
Mexico	4,908	708	789	838	855	872	893
Central/South America	580	3,094	3,446	3,655	3,722	3,796	3,991
Europe and Africa	163	1,550	1,728	1,835	1,872	1,910	1,957
Middle East	389	1,554	1,732	1,840	1,877	1,915	1,962
Total Savings	6,039	6,906	7,695	8,167	8,325	8,492	8,802
49-foot Channel							
Mexico	5,242	756	843	895	913	931	954
Central/South America	620	3,306	3,683	3,906	3,978	4,057	4,265
Europe and Africa	165	1,567	1,746	1,854	1,891	1,930	1,977
Middle East	393	1,573	1,753	1,861	1,899	1,937	1,985
Total Savings	6,420	7,201	8,024	8,516	8,681	8,855	9,181
50-foot Channel							
Mexico	5,501	793	884	939	958	977	1,001
Central/South America	649	3,461	3,856	4,089	4,165	4,247	4,465
Europe and Africa	182	1,730	1,928	2,048	2,089	2,131	2,184
Middle East	439	1,756	1,958	2,079	2,121	2,164	2,217
Total Savings	6,771	7,741	8,626	9,155	9,332	9,519	9,866

6.4.1.2 Petroleum and Chemical Product Transportation Savings Benefits

Reductions in the vessel operating costs for SNWW foreign petroleum product imports and exports and coastwise shipments were calculated based on the relative difference in transportation costs between the without-project and with-project conditions. For foreign imports and exports, transportation savings were calculated for petroleum product imports and exports and for chemical exports. Chemical imports were not found to be draft limited. As with crude petroleum, transportation costs and savings were calculated for vessels that minimize transportation costs given trade route constraints. Table 116 displays SNWW's petroleum product import forecast and the tonnage used for the benefit calculations. Table 117 displays the petroleum export forecast.

Table 116
SNWW Petroleum Product Imports (short tons), 2019–2069

Commodity	2004–2006 Representative Tonnage	2019	2029	2039	2049	2059	2069
	Total Petroleum Product Imports (Major Groups)						
Gasoline	1,546,750	1,835,204	2,027,207	2,239,298	2,473,578	2,732,369	3,018,235
Distillate	1,719,000	1,895,684	2,135,852	2,524,052	2,843,829	3,204,118	3,610,054
Residual	559,500	663,941	750,277	847,840	958,090	1,082,677	1,223,464
Naphtha	470,250	558,031	630,595	712,595	805,258	909,971	1,028,300
Lube Oil	185,500	220,127	248,751	281,098	317,651	358,957	405,635
Total Petroleum Product Imports	4,481,000	5,172,987	5,792,682	6,604,883	7,398,406	8,288,092	9,285,688
	Petroleum Product Imports Used for Benefit Calculations						
Gasoline	494,960	587,265	1,013,603	1,119,649	1,236,789	1,366,184	1,509,117
Distillate	536,328	591,453	1,067,926	1,262,026	1,421,914	1,602,059	1,805,027
Residual	279,750	331,970	375,139	423,920	479,045	541,338	611,732
Naphtha	81,353	96,539	315,297	356,298	402,629	454,986	514,150
Lube Oil	92,750	110,063	124,376	140,549	158,826	179,479	202,817
Total Used for Benefit Calculations	1,485,141	1,717,292	2,896,341	3,302,442	3,699,203	4,144,046	4,642,844
% of Total	33	33	50	50	50	50	50

Table 117
SNWW Petroleum Product Exports (short tons)
2019–2069

Commodity	2004–2006	2019	2029	2039	2049	2059	2069
	Total Petroleum Product Exports (Major Groups)						
Gasoline	1,834,000	3,785,043	5,129,249	6,473,454	7,329,704	8,299,210	9,396,953
Distillate Fuel	420,667	642,903	822,970	1,053,472	1,348,533	1,726,236	2,209,728
Residual Fuel Oil	22,667	26,898	34,431	44,075	56,420	72,222	92,451
Naphtha	63,667	89,959	115,156	147,409	188,696	241,547	309,200
Lube Oil	83,300	117,701	150,667	192,866	246,885	316,034	404,550
Petroleum Coke	4,318,000	6,802,246	8,768,425	10,734,605	11,955,318	13,206,108	14,587,759
Total Petroleum Product Exports	6,742,300	11,464,749	15,020,898	18,645,881	21,125,555	23,861,357	27,000,641
	Petroleum Product Exports Used for Benefit Calculations						
Gasoline	550,200	1,135,513	2,564,624	3,236,727	3,664,852	4,149,605	4,698,476
Distillate Fuel	126,200	192,871	411,485	526,736	674,266	863,118	1,104,864
Residual Fuel	11,333	13,449	17,216	22,038	28,210	36,111	46,225
Naphtha	12,733	17,992	57,578	73,704	94,348	120,773	154,600
Lube Oil	41,650	58,850	75,333	96,433	123,443	158,017	202,275
Petroleum Coke	2,159,000	3,401,123	4,384,213	5,367,303	5,977,659	6,603,054	7,293,880
Total Used for Benefit Calculations	2,901,117	4,819,798	7,510,449	9,322,941	10,562,777	11,930,678	13,500,321
% of Total Tonnage	43	42	50	50	50	50	50

Tables 118 and 119 displays the chemical product import and export forecasts. The presentations show total imports and exports, the commodity groups evaluated for deepening benefits, and the volumes and percentage of total tonnage used for the transportation cost calculations.

Table 118
SNWW Chemical Product Imports (short tons)
2019–2069

	2004–2006	2019	2029	2039	2049	2059	2069
Total Chemical Product Imports	957,000	1,135,641	1,279,518	1,441,622	1,624,264	1,830,045	2,061,897
Chemical Product Imports Evaluated for Benefit Calculations							
Alcohol Imports	333,250	395,457	445,558	502,007	565,607	637,265	718,001
Ammonia Imports	494,750	587,104	661,485	745,290	839,712	946,097	1,065,960
Chemical Product Import Tonnage Used for Benefit Calculations							
Draft Restricted Tonnage	82,800	98,256	110,704	124,730	140,532	158,336	178,396
% of Total Imports	9	9	9	9	9	9	9

Table 119
SNWW Chemical Product Exports (short tons)
2019–2069

	2004–2006	2019	2029	2039	2049	2059	2069
Total Chemical Product Exports	2,299,667	3,249,369	4,159,467	5,324,469	5,881,526	6,496,864	7,176,580
Chemical Product Exports Groups Evaluated for Benefit Calculations							
Organic Compounds	501,333	708,371	906,775	1,160,748	1,320,786	1,502,889	1,710,099
Metallic Salts	1,116,000	1,576,879	2,018,538	2,583,900	2,940,154	3,345,527	3,806,791
Chemical Product Export Tonnage Used for Benefit Calculations							
Draft Restricted Tonnage	339,640	479,902	614,316	786,376	894,797	1,018,167	1,158,547
% of Total Exports	15	15	15	15	15	16	16

Table 120 summarizes the annual transportation cost for Beaumont's petroleum product imports and exports. Table 121 summarizes the annual transportation cost for Port Arthur's petroleum product imports and exports. Table 122 presents the annual savings for Beaumont's and Port Arthur's petroleum product imports and exports.

Table 120
Beaumont Petroleum and Chemical Product Imports and Exports
Annual Transportation Cost ($1,000) by Trade Route and Decade (December 2008 Vessel Costs)
2019–2069

	2004/2006	2019	2029	2039	2049	2059	2069
40-foot Channel							
Imports	12,810	14,840	24,440	27,850	31,205	34,967	39,187
Exports	17,347	28,367	43,489	54,111	61,328	69,310	78,463
Total Cost	30,157	43,207	67,928	81,962	92,533	104,278	117,650
45-foot Channel							
Imports	10,795	12,506	20,595	23,469	26,296	29,467	33,023
Exports	14,618	23,905	36,648	45,599	51,681	58,408	66,121
Total Cost	25,413	36,411	57,243	69,069	77,977	87,874	99,143
46-foot Channel							
Imports	10,465	12,123	19,965	22,752	25,492	28,565	32,013
Exports	14,171	23,174	35,527	44,205	50,100	56,621	64,098
Total Cost	24,636	35,297	55,492	66,956	75,592	85,186	96,111
47-foot Channel							
Imports	10,155	11,764	19,374	22,077	24,737	27,719	31,064
Exports	13,751	22,487	34,474	42,895	48,615	54,943	62,199
Total Cost	23,906	34,251	53,848	64,972	73,352	82,662	93,263
48-foot Channel							
Imports	9,885	11,451	18,859	21,491	24,080	26,983	30,239
Exports	13,386	21,890	33,558	41,755	47,324	53,484	60,547
Total Cost	23,271	33,341	52,418	63,246	71,404	80,467	90,786
49-foot Channel							
Imports	9,646	11,174	18,403	20,971	23,497	26,330	29,507
Exports	13,062	21,360	32,746	40,745	46,179	52,189	59,081
Total Cost	22,708	32,534	51,149	61,716	69,676	78,519	88,588
50-foot Channel							
Imports	9,438	10,933	18,005	20,518	22,989	25,761	28,869
Exports	12,779	20,899	32,039	39,864	45,181	51,062	57,805
Total Cost	22,217	31,831	50,044	60,382	68,170	76,822	86,674

Table 121
Port Arthur Petroleum and Chemical Product Imports and Exports
Annual Transportation Cost ($1,000) by Trade Route and Decade (December 2008 Vessel Costs)
2019–2069

	2004/2006	2019	2029	2039	2049	2059	2069
40-foot Channel							
Imports	5,956	6,887	11,616	13,244	14,835	16,619	18,620
Exports	17,563	28,722	44,032	54,788	62,094	70,176	79,444
Total Cost	23,519	35,609	55,648	68,032	76,930	86,796	98,064
45-foot Channel							
Imports	5,039	5,826	9,826	11,204	12,550	14,059	15,751
Exports	14,858	24,297	37,249	46,347	52,529	59,366	67,205
Total Cost	19,896	30,123	47,075	57,551	65,079	73,425	82,957
46-foot Channel							
Imports	4,887	5,651	9,531	10,867	12,173	13,637	15,278
Exports	14,411	23,567	36,130	44,955	50,950	57,582	65,186
Total Cost	19,298	29,218	45,661	55,822	63,123	71,219	80,464
47-foot Channel							
Imports	4,745	5,486	9,253	10,551	11,818	13,240	14,833
Exports	13,991	22,881	35,077	43,645	49,466	55,905	63,287
Total Cost	18,736	28,367	44,331	54,196	61,285	69,144	78,121
48-foot Channel							
Imports	4,627	5,351	9,025	10,290	11,526	12,912	14,466
Exports	13,646	22,315	34,210	42,567	48,244	54,523	61,723
Total Cost	18,273	27,666	43,235	52,856	59,770	67,435	76,189
49-foot Channel							
Imports	4,529	5,237	8,832	10,071	11,281	12,637	14,158
Exports	13,355	21,840	33,481	41,659	47,215	53,361	60,408
Total Cost	17,884	27,076	42,314	51,730	58,496	65,998	74,566
50-foot Channel							
Imports	4,453	5,149	8,684	9,901	11,091	12,425	13,920
Exports	13,130	21,472	32,918	40,959	46,422	52,464	59,392
Total Cost	17,583	26,621	41,602	50,861	57,513	64,888	73,312

Table 122
SNWW Petroleum and Chemical Products Annual Savings by Channel Depth Alternative, 2019–2069
$1,000

	2004/2006	2019	2030	2040	2050	2060	2069
SNWW Total Petroleum Product Imports							
45-foot	2,932.7	3,395.3	5,633.8	6,421.2	7,194.1	8,060.7	9,032.6
46-foot	3,414.3	3,952.9	6,559.0	7,475.7	8,375.5	9,384.5	10,516.0
47-foot	3,866.7	4,476.8	7,428.3	8,466.5	9,485.5	10,628.2	11,909.7
48-foot	4,253.7	4,924.8	8,171.6	9,313.7	10,434.6	11,691.6	13,101.4
49-foot	4,591.6	5,316.0	8,820.4	10,053.1	11,263.1	12,619.9	14,141.5
50-foot	4,876.2	5,645.5	9,366.5	10,675.5	11,960.4	13,401.2	15,017.1
SNWW Total Petroleum Product Exports							
45-foot	5,434.3	8,886.9	13,624.2	16,952.0	19,212.9	21,713.5	24,581.0
46-foot	6,327.9	10,348.1	15,864.3	19,739.3	22,371.9	25,283.7	28,622.7
47-foot	7,167.6	11,721.3	17,969.5	22,358.7	25,340.7	28,638.9	32,421.0
48-foot	7,878.6	12,884.2	19,752.2	24,576.9	27,854.6	31,480.1	35,637.3
49-foot	8,493.4	13,889.5	21,293.5	26,494.6	30,028.1	33,936.5	38,418.1
50-foot	9,000.1	14,718.2	22,563.8	28,075.3	31,819.6	35,961.1	40,710.2

Table 123 summarizes the benefit calculations for coastwise product shipments and receipts. As noted, deepening of the channel leading to the Taylor Bayou terminal will enable the existing fleet to be more fully loaded but it will not result in transition to larger vessels. The transportation savings shown in Table 123 reflect continuation of this limitation. The maximum-sized coastwise vessels do not exceed Taylor Bayou's limitation. Transportation costs were estimated for 1-foot channel depth increments; however, the table presentations only include 40-, 45-, 47-, 48-, and 50-foot costs.

Table 123
SNWW Petroleum Product Coastwise Shipments and Receipts
Vessel Data, Base Tonnage, and Transportation Savings Benefit Summary (December 2008 Vessel Costs)

Origin-Destination Data: U.S. East Coast to/from SNWW

Initial % of total outbound shipments:	10
Round-trip mileage	3,000
Hourly Cost at Sea:	2,425
Hourly Cost in Port:	2,007
Vessel Speed (Knots)	14

Vessel Input Data and Transportation Cost

Channel Depth (feet)	Design Draft (feet)	Vessel DWT	No. of feet Light-Loaded	Cargo by Channel Depth	Round Trip Voyage Cost ($)	Loading, Unloading and Port Cost ($)	Total Cost ($)	Cost Per Ton ($)
40	45	75,000	6	58,571	519,643	124,110	643,753	10,99
45 to 50	45	75,000	1	69,173	519,643	124,110	641,908	9.64
							Savings/ton	1.36

SNWW Domestic Coastwise Petroleum Product Tonnage

Year	Total Short Tons	Short Tons Used For Benefits
2004–2006 Average	5,068,000	506,800

SNWW Domestic Coastwise Petroleum Product Annual Transportation Benefits

Year	Total Tonnage	Used for Benefits	Percentage Used for Benefits	Annual Savings ($)
2002–2004	5,067,667	506,767	10	687,121
2019	7,901,200	790,120	10	1,071,317
2029	9,878,897	987,890	10	1,339,472
2039	11,856,594	1,185,659	10	1,607,626
2049	13,834,291	1,383,429	10	1,875,781
2059	15,811,988	1,581,199	10	2,143,935
2069	17,789,685	1,778,968	10	2,412,089

6.4.1.3 Grain Exports Transportation Savings Benefits

Beaumont wheat exports compose 5 percent of the current U.S. total. Forecasts of future exports were estimated based on analysis conducted by the USDA. Beaumont's recent grain exports consist almost exclusively of wheat. Twenty-five percent of 2002–2006 grain export tonnage was shipped in vessels with design drafts over 40 feet. The maximum DWT presently used for grain exports is in the 60,000 to 70,000 DWT range. These vessels have design drafts between 42 and 43 feet. As previously noted, the median year of construction for the range of vessels presently used is 1985. Bulk carrier construction trends (see Table 47) suggest transition in the average DWT range up to the 80,000 to 94,000 DWT range. In the 1980s, grain vessels in the 135,000 to 150,000 DWT range were used for grain exports from

Beaumont and other Texas ports. These larger carriers transported grain to the former Soviet Union and to Northern Europe. Demand for large parcels and channel depth availability at the destination port could result in a return to 135,000 to 150,000 DWT vessels. Currently, the largest parcels from Texas ports are in the range of 40,000 to 60,000 short tons, and parcels of 10,000 to 20,000 short tons are typical. For grain shipped from the Canadian West Coast, it was noted that 40,000 DWT vessels are used for 10,000 parcels even though it is not cost effective. Reasons for small parcels could relate to specific demands not to commingle; however, that was not noted. Containerships are the most common vessel type used for Australian grain exported to Asian countries. Table 124 summarizes the per ton transportation cost associated with the range of bulk carriers expected to use the channel. Table 125 summarizes the grain exports for 2004–2007 and the annual transportation cost. Table 126 displays the annual tonnage forecast and the transportation savings. The transportation costs are based on the cost per ton (Table 124) multiplied by the annual tonnage (Table 125). The transportation savings benefits are based on 30 percent of tonnage would load to drafts over 40 feet (see Table 77). Port depth, trade route, historical vessel utilization data, and completion of the Panama Canal expansion were considerations used to identify the percentage of grain exports tonnage anticipated to benefit from the proposed SNWW depth increases.

Table 124
Beaumont Wheat Exports, Shipments to Europe, Mediterranean, and Far East
Total Cost Per Ton by Channel Depth (December 2008 Vessel Costs, in dollars) a/

	Channel Depth (feet)						
DWT	40	45	46	47	48	49	50
70,000	20.07	16.83	16.83	15.80	15.80	15.80	15.80
80,000	19.58	16.39	16.39	15.38	14.92	14.49	14.49
90,000	17.97	15.24	14.78	14.35	13.94	13.56	13.20
100,000	18.01	15.25	14.79	14.36	13.95	13.56	13.20
120,000	17.32	14.73	14.31	13.92	13.49	13.13	12.78

a/ Calculated based on a round-trip mileage of 18,000 and the foreign flag bulk carrier operating costs shown in Table 83.

The possibility of using containerships for grain transport is only being considered at a corporate level; however, the traditional use of bulk carriers provides a less expensive mode. Containerships for wheat and bulk grain transport have the noted advantage of increased versatility in the range of cargoes. The potential effect of using containerships through Beaumont or the transfer of bulk grain to another location is an uncertainty associated with grain export tonnage. The effect of this sensitivity is addressed in the sensitivity section (Section 8).

Table 125
Beaumont Wheat Exports and Annual Transportation Cost
(December 2008 Vessel Costs)

Year	Total Exports	Used for Benefit Calculations
2005	1,082.0	324.6
2006	1,214.0	364.2
2007	1,632.0	489.6
2005/2007	1,309.3	392.8

DWT	% by Vessel DWT	Transportation Cost ($1,000s) by Channel Depth (feet)						
		40	45	46	47	48	49	50
70,000	2.0	7,883	6,610	6,610	6,208	6,208	6,208	$6,208
80,000	15.0	7,691	6,437	6,437	6,040	5,860	5,690	$5,690
90,000	55.0	7,059	5,984	5,805	5,636	5,477	5,327	$5,184
100,000	20.0	7,074	5,991	5,811	5,642	5,479	5,327	$5,184
120,000	8.0	6,802	5,786	5,621	5,466	5,298	5,156	$5,019
Weighted Cost		7,153	6,050	5,902	5,696	5,535	5,385	5,267
2005/2007 Savings			1,103	1,251	1,457	1,618	1,768	1,886

Table 126
Beaumont Wheat Annual Transportation Savings, 2019–2069
(December 2008 Vessel Costs)

Year	Total Exports	Used for Benefit Calculations
2005/2007	1,309.3	392.8
2019	2,128.5	638.6
2029	2,351.2	705.4
2039	2,597.2	779.2
2049	2,868.9	860.7
2059	3,169.0	950.7
2069	3,500.6	1,050.2

Year	Annual Transportation Savings ($1,000) by Channel Depth (feet)					
	45	46	47	48	49	50
2005/2007	1,103	1,251	1,457	1,618	1,768	1,886
2019	1,793	2,033	2,369	2,630	2,874	3,065
2029	1,980	2,246	2,617	2,905	3,174	3,386
2039	2,187	2,480	2,890	3,209	3,506	3,740
2049	2,416	2,740	3,193	3,545	3,873	4,132
2059	2,669	3,027	3,527	3,916	4,278	4,564
2069	2,948	3,343	3,896	4,325	4,726	5,041

6.4.1.4 Crude Materials Transportation Savings

SNWW primary manufactured goods consist nearly exclusively of primary iron and steel products. Reductions in the vessel operating costs for SNWW steel slab and iron ore imports were calculated based on the relative difference in transportation costs between the without- and with-project conditions. As with the previous presentations, transportation costs and savings were calculated for vessels that minimize transportation costs given trade route constraints. Again, long-term fleet selection will continue to reflect goals of minimizing vessel operating costs. Port Arthur's breakbulk terminal is located outside the Taylor Bayou reach, and the bulk carriers are not subject to the beam and length limitations. However, the maximum beam width for the bulk carrier fleet is 106 feet. The design drafts for these vessels are generally less than 45 feet. The DWT range of bulk carriers used for the benefit calculations is 60,000 to 90,000. Larger vessels could be used but are not anticipated over the next 20 years. The maximum size presently being used is 78,000 DWT. The transportation savings calculations were based on average costs for the anticipated 60,000 to 90,000 DWT range.

Table 127 present the cost per ton transportation cost for the representative bulk carriers used to transport steel slab and iron ore. The costs shown are for Port Arthur and Beaumont. Based on existing port depths and vessel utilization, an estimated 10 percent of tonnage was projected to use channel depths over 40 feet for the years prior to 2014. By 2014, the expansion of the Panama Canal is expected to result in the existing base tonnage from the deepwater port of Lazaro Cardenas on the West Coast of Mexico to load to vessel drafts over 40 feet. At that time, an estimated 50 percent of tonnage is anticipated to be loaded to vessel drafts over 40 feet.

Table 127
SNWW Steel Slab and Iron Ore from South America and Far East and the Mediterranean Cost Per Ton by Channel Depth (December 2008 Vessel Costs)

	Channel Depth (feet)						
DWT	40	45	46	47	48	49	50
	Transportation Cost/Ton to Port Arthur						
60,000	17.63	14.60	14.13	13.66	13.66	13.66	13.66
70,000	15.60	13.08	12.68	12.29	12.29	12.29	12.29
80,000	15.22	12.74	12.35	11.96	11.60	11.26	11.26
90,000	14.12	11.95	11.60	11.25	10.94	10.63	10.35
	Transportation Cost/Ton to Beaumont						
60,000	18.35	15.22	14.73	14.23	14.23	14.23	14.23
70,000	16.23	13.63	13.22	12.80	12.80	12.80	12.80
80,000	15.84	13.29	12.89	12.49	12.12	11.77	11.77
90,000	14.70	12.47	12.12	11.77	11.44	11.14	10.84

A representative weighted mileage for the applicable South America, Mediterranean, and Far East routes was used. The weighted mileage is approximately 14,000 miles round-trip. The mileage estimated was based on 2005–2007 routings (see Table 48). As previously noted, the tonnage forecast and average annual growth rate for 2002–2004 to 2069 tonnage was displayed in tables 80 and 81. Tables 128 and 129 summarize historical tonnage base and the annual transportation savings benefits for Port Arthur's steel slab and iron ore import tonnage.

Table 128
Port Arthur Steel Slab and Iron Ore from South America, Mediterranean, and the Far East Historical Tonnage and Annual Transportation Cost by Ton
($1,000) (December 2008 Vessel Costs)

Year	Total Exports	Used for Benefit Calculations
2001	665,000	66,500
2002	641,000	64,100
2003	557,000	55,700
2004	564,000	56,400
2005	710,000	71,000
2006	542,000	54,200
2007	122,000	12,200
2005–2007 Average	458,000	45,800

	Transportation Cost by Vessel Size and Channel Depth Using 2005–2007 Average Tonnage a/						
DWT	40 feet	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
60,000	807	669	647	625	625	625	625
70,000	714	599	581	563	563	563	563
80,000	697	584	566	548	531	516	516
90,000	647	547	531	515	501	487	474
Average Cost	716	600	581	563	555	548	544
Average Savings		117	135	154	161	169	172

a/ The costs are based on the historical tonnage volume of 45.8 thousand short tons multiplied by the cost per ton shown in Table 124 for Beaumont. The transportation cost of $716,000 is the product of 45.8 thousand short tons times the transportation cost per ton at 40 feet (Table 127).

Note: Application of data as presented may produce some differences due to rounding.

Table 129
Port Arthur Steel Slab and Iron Ore from South America, Mediterranean, and Far East Tonnage Forecast and Transportation Savings
($1,000) (December 2008 Vessel Costs)

Year	Total Exports	Tonnage Used for Benefit Calculations
2003/2005	458,000	45,800
2019	523,626	262,651
2029	607,630	304,787
2039	705,110	353,683
2049	818,228	410,423
2059	949,493	476,266
2069	1,101,817	552,671

	Transportation Savings by Year a/					
Year	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
2005/2007	117	135	154	161	169	172
2019	669	775	881	925	967	986
2029	777	899	1,022	1,073	1,122	1,144
2039	901	1,044	1,186	1,246	1,302	1,328
2049	1,046	1,211	1,376	1,446	1,511	1,541
2059	1,214	1,405	1,597	1,677	1,754	1,788
2069	1,408	1,631	1,853	1,947	2,035	2,075

Tables 130 and 131 summarize historical tonnage base and the annual transportation savings benefits for Port Arthur's steel slab and iron ore import tonnage.

Table 130
Beaumont Steel Slab and Iron Ore from South America Mediterranean, and Far East Tonnage Historical Tonnage and Transportation Cost by Ton
($1,000) (December 2008 Vessel Costs)

Year	Total Exports	Used for Benefit Calculations
2001	103,000	15,450
2002	204,000	30,600
2003	115,000	17,250
2004	420,000	63,000
2005	471,000	70,650
2006	364,000	54,600
2007	173,000	25,950
2005–2007 Average	336,000	50,400

	Transportation Cost by Vessel Size and Channel Depth Using 2002/2004 Average Tonnage a/						
DWT	40 feet	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
60,000	616	511	495	478	478	478	478
70,000	545	458	444	430	430	430	430
80,000	532	446	433	420	407	395	395
90,000	494	419	407	395	385	374	364
Average Cost	547	459	445	431	425	419	417
Average Savings		88	102	116	122	128	130

a/ The costs are based on the historical tonnage volume of 50.4 thousand short tons multiplied by the cost per ton shown in Table 127. The transportation cost of $547,000 is the product of 50.4 thousand short tons times the difference in transportation costs for the channel depth alternatives.

Note: Application of data as presented may produce some differences due to rounding.

Table 131
Beaumont Steel Slab and Iron Ore from South America and Far East
and the Mediterranean Tonnage Forecast and Annual Transportation Savings
($1,000) (December 2008 Vessel Costs)

Year	Tonnage Used for Benefit Calculations
2002/2004	33,600
2019	213,254
2029	248,025
2039	288,465
2049	335,499
2059	390,201
2069	453,823

	Annual Transportation Savings by Year a/					
Year	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
2002/2004	88	102	116	122	128	130
2019	560	649	737	774	809	825
2029	652	755	857	900	941	960
2039	869	1,006	1,143	1,200	1,254	1,279
2049	1,175	1,360	1,546	1,623	1,697	1,730
2059	1,589	1,840	2,091	2,196	2,295	2,341
2069	2,150	2,489	2,828	2,970	3,105	3,166

a/ The savings for 2005/2007 are based on the difference in transportation costs from the previous table multiplied by the 2005/2007 tonnage. The savings for 2019–2069 are based on application of the tonnage growth to the 2005/2007 historical base.
Note: Application of data as presented may produce some differences due to rounding.

6.4.1.5 Crude Materials Transportation Savings Benefits

As with steel slab and iron ore, the DWT range of bulk carriers used for the aggregate rock and other crude materials benefit calculations are in the 60,000 to 90,000 DWT range. Larger vessels could be used but are not anticipated over the next 20 years. The maximum size presently being used is 78,000 DWT. The transportation savings calculations were based on average costs for the anticipated 60,000 to 90,000 DWT range. As with the previous presentations, transportation costs and savings were calculated for vessels that minimize transportation costs given trade route constraints. The DWT range of bulk carriers used for the benefit calculations are in the 60,000 to 90,000 DWT range.

The applicable tonnage forecast and average annual growth rate for 2002–2004 to 2069 was displayed in tables 80 and 81. The forecast includes imports and exports. Table 132 displays Port Arthur and Beaumont crude material imports and exports. Imports consist nearly exclusively of limestone, rock, and other building materials. Exports consist primarily of dry sulphur, clay, and refractory materials.

Table 132
Port Arthur and Beaumont Crude Materials Imports and Exports
Summary of Recent Historical and Tonnage Forecast (1,000s of short tons)

	Port Arthur			Beaumont		
Year	Imports	Exports	Total	Imports	Exports	Total
2001	131	–	131	622	165	787
2002	919	2	921	394	14	408
2003	481	20	501	583	73	656
2004	531	41	572	559	104	663
2005	558	14	572	624	106	730
2006	566	54	620	550	243	793
2007	513	64	577	617	421	1,038
Year	Port Arthur Crude Materials Import and Export Forecast			Beaumont Crude Materials Import and Export Forecast		
2019	713	38	751	761	345	1,106
2029	829	44	873	885	400	1,285
2039	964	52	1,016	1,029	465	1,495
2049	1,121	60	1,181	1,197	541	1,738
2059	1,304	70	1,374	1,392	630	2,022
2069	1,517	81	1,598	1,619	732	2,352
Year	Tonnage Used for Benefit Calculations					
2019	353	0	353	358	57	415
2029	410	0	410	416	66	482
2039	477	0	477	484	77	561
2049	555	0	555	563	90	653
2059	645	0	645	654	105	759
2069	751	0	751	761	122	883

Source: USACE, *Waterborne Commerce of the U.S.*, Parts, 2001–2007.

Based on existing port depths and vessel utilization, an estimated 50 percent of crude material imports and 10 percent of crude material exports was projected to use channel depths over 40 feet. A representative weighted mileage for the applicable South America and Far East was used. The weighted mileage is approximately 14,000 miles round trip. Table 133 present the cost per ton transportation cost for representative bulk carriers used to transport crude materials based on the trade routes shown.

Table 133
SNWW Crude Material Imports and Exports Via South America and Far East and the Mediterranean Cost Per Ton (December 2008 Vessel Costs)

	Channel Depth (feet)						
DWT	40	45	46	47	48	49	50
	Transportation Cost/Ton to Port Arthur						
60,000	17.85	14.78	14.31	13.83	13.83	13.83	13.83
70,000	15.79	13.25	12.84	12.44	12.44	12.44	12.44
80,000	15.41	12.90	12.51	12.11	11.75	11.41	11.41
90,000	14.30	12.09	11.75	11.40	11.08	10.77	10.48
	Transportation Cost/Ton to Beaumont						
60,000	17.93	14.85	14.37	13.89	13.89	13.89	13.89
70,000	15.86	13.30	12.90	12.49	12.49	12.49	12.49
80,000	15.48	12.96	12.56	12.16	11.80	11.46	11.46
90,000	14.36	12.14	11.80	11.45	11.12	10.82	10.52

Table 134 summarizes the annual transportation savings benefits for Port Arthur's import tonnage. Table 135 summarizes the annual transportation savings benefits for Beaumont's import tonnage. Table 136 summarizes the annual transportation savings benefits for SNWW's exports of crude materials. Transportation savings were calculated for 15 percent of future exports.

Table 134
Port Arthur Limestone and Rock Imports from South America, Mediterranean, and Far East ($1,000) (December 2008 Vessel Costs)

	Transportation Cost by Vessel Size and Channel Depth (feet)						
DWT	40	45	46	47	48	49	50
60,000	1,062	879	851	822	822	822	822
70,000	939	788	764	740	740	740	740
80,000	917	767	744	720	699	678	678
90,000	851	719	698	678	659	640	623
Average Cost	942	788	764	740	730	720	716
Average		154	178	202	212	222	226

Transportation Savings	45	46	47	48	49	50
2005/207	154	178	202	212	222	226
2019	1,042	1,205	1,368	1,452	1,531	1,579
2029	1,042	1,205	1,368	1,452	1,531	1,579
2039	1,211	1,402	1,592	1,689	1,781	1,837
2049	1,409	1,630	1,851	1,964	2,071	2,136
2059	1,639	1,896	2,153	2,284	2,409	2,484
2069	1,906	2,205	2,504	2,656	2,801	2,889

Table 135
Beaumont Limestone and Rock Imports from South America, Mediterranean, and Far East ($1,000) (December 2008 Vessel Costs)

	Transportation Cost by Vessel Size and Channel Depth (feet)						
DWT	40	45	46	47	48	49	50
60,000	1,070	886	858	829	829	829	829
70,000	947	794	770	746	746	746	746
80,000	924	774	750	726	704	684	684
90,000	858	725	704	683	664	646	628
Average Cost	950	795	770	746	736	726	722
Average Savings		155	179	204	214	224	228

Transportation Savings	45	46	47	48	49	50
2005/2007	155	180	204	214	224	228
2019	946	1,094	1,243	1,306	1,365	1,391
2029	1,279	1,480	1,682	1,766	1,846	1,882
2039	1,488	1,722	1,956	2,054	2,147	2,189
2049	1,730	2,002	2,275	2,389	2,497	2,546
2059	2,012	2,329	2,645	2,778	2,904	2,961
2069	2,340	2,709	3,077	3,231	3,378	3,444

Table 136
SNWW Sulphur and Refractory Material Exports to South America, Mediterranean, and Far East ($1,000) (December 2008 Vessel Costs)

	Transportation Cost by Vessel Size and Channel Depth (feet)						
DWT	40	45	46	47	48	49	50
60,000	535	443	429	415	415	415	415
70,000	473	397	385	373	373	373	373
80,000	462	387	375	363	352	342	342
90,000	429	362	352	342	332	323	314
Average Cost	475	397	385	373	368	363	361
Average		78	90	102	107	112	114

Transportation Savings	45	46	47	48	49	50
2005/2007	78	90	102	107	112	114
2019	148	171	194	204	213	217
2029	199	230	262	275	287	293
2039	232	268	304	320	334	341
2049	269	312	354	372	389	396
2059	313	363	412	433	452	461
2069	364	422	479	503	526	536

6.4.1.6 Liquefied Natural Gas Transportation Savings

Table 137 presents the trade route forecast used for the benefit calculations, Table 138 presents the per ton transportation cost. The bottom half of Table 138 presents the annual savings. The maximum loaded draft for LNG vessels is anticipated to be 40 to 42 feet. The majority of vessels will be loaded to 39 feet. The vessels will need from 3 to 6 feet underkeel clearance. The deepening benefits were therefore, believed to stop at a channel depth of approximately 43 feet. The benefits were calculated using 4 feet of underkeel clearance. Recalculation of the benefit estimates using 3 feet would reduce the average annual benefits by approximately 39 percent. Recalculation using 6 feet would increase the average annual savings by approximately 64 percent. Use of less than 4 feet of underkeel clearance is not expected for LNG vessels.

Table 137
SNWW Liquefied Natural Gas Trade Route Forecast, Short Tons

Year	Middle East	Trinidad	Algeria	Total
2015	1,946,522	1,940,695	1,940,695	5,827,913
2020	2,062,339	2,056,165	2,056,165	6,174,670
2030	2,062,340	2,056,165	2,056,165	6,174,671
2049	2,062,340	2,056,165	2,056,165	6,174,671
2059	2,062,340	2,056,165	2,056,165	6,174,671
2069	2,062,340	2,056,165	2,056,165	6,174,671

Table 138
Liquefied Natural Gas Transportation Cost per Ton by Channel Depth,
Vessel Dead Weight Tons, and Shipment Origin (December 2008 Vessel Costs)

Vessel DWT	Middle East		Trinidad		Algeria	
	40	43	40	43	40	43
76,500	26.70	25.65	5.83	5.62	14.12	13.58
100,000	24.14	20.78	5.28	4.61	12.77	11.03
125,000	22.11	19.22	4.82	4.25	11.69	10.20

	Savings/Ton for 43 Feet For SNWW Fleet		
DWT	Qatar	Trinidad	Algeria
100,000	0.00	0.00	0.00
125,000	3.36	0.67	1.74
Average	2.89	0.58	1.49

SNWW Liquefied Natural Gas Annual Transportation Savings by Trade Route
(December 2008 Vessel Costs)

Year	Qatar	Trinidad	Algeria	Total
2019	6,080,341	1,209,365	3,137,311	10,427,016
2029	6,442,118	1,281,321	3,323,978	11,047,417
2039	6,442,121	1,281,321	3,323,978	11,047,420
2049	6,442,121	1,281,321	3,323,978	11,047,420
2059	6,442,121	1,281,321	3,323,978	11,047,420
2069	6,442,121	1,281,321	3,323,978	11,047,420

7.0 NED BENEFIT SUMMARY

Table 139 summarizes the transportation cost savings by major group. The majority of benefits are associated with imports of crude petroleum, LNG, and petroleum product and exports of petroleum products. Crude petroleum and petroleum products represent 84 percent of the benefits at the 45-foot depth and 89 percent at the 50-foot depth. LNG comprises 7 percent of benefits at the 45-foot depth and 4 percent at 50 feet. The LNG benefits are for facilities in the Sabine Pass Channel and Port Arthur Canal reaches. Distributions of the Taylor Bayou, Port Arthur, and Neches River deepening benefits are presented in Table 140.

Table 139
Total Average Annual Deepening Benefits ($1,000s)
(50-Year Period of Analysis at 4.375%)
by Project Depth Alternative
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
Crude Petroleum Imports	41,130	48,650	53,411	61,081	66,173	68,759
Petroleum Products Imports	5,923	6,896	7,810	8,591	9,273	9,848
Petroleum Products Exports	15,309	17,826	20,191	22,194	23,926	25,354
Coastwise	1,481	1,481	1,481	1,481	1,481	1,481
Grain Exports	2,172	2,463	2,870	3,187	3,482	3,714
Breakbulk	4,536	5,247	5,247	5,247	5,247	5,247
LNG	11,140	11,140	11,140	11,140	11,140	11,140
Deepening Benefits	81,691	93,703	102,150	112,921	120,722	125,543
Neches River Anchorages	2,153	2,153	2,153	2,153	2,153	2,153
Total Annual Benefits	83,844	95,856	104,303	115,074	122,875	127,696

Table 141 summarizes the benefit cost analysis, including the first cost of construction, net excess benefits, and the benefit to cost ratio (BCR) for the project alternatives. The results of the analysis indicate that the 49-foot channel depth represents the plan that most reasonably maximizes net excess benefits.

Table 140
Total Average Annual Benefits ($1,000s)
by Channel Reach and Alternative
(50-Year Period of Analysis at 4.375%) (December 2008 Vessel Costs)

Reach and Commodity	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
Sabine Pass LNG	3,676	3,676	3,676	3,676	3,676	3,676
Port Arthur LNG	7,464	7,464	7,464	7,464	7,464	7,464
Taylor Bayou						
Crude Petroleum Imports	5,790	6,892	7,510	7,964	8,305	8,928
Petro Product Imports	2,369	2,758	3,124	3,436	3,709	3,939
Petro-Chem Product Exports	7,348	8,556	9,692	10,653	11,485	12,170
Coastwise Petro Products	563	563	563	563	563	563
Taylor Bayou Total	16,070	18,769	20,889	22,616	24,062	25,600
Sabine-Neches Canal						
Breakbulk and Aggregate	2,366	2,735	2,735	2,735	2,735	2,735
Neches River Channel to Beaumont						
Crude Petroleum Imports	35,340	41,759	45,901	53,117	57,868	59,832
Petro Product Imports	3,554	4,138	4,686	5,155	5,564	5,909
Petro-Chem Product Exports	7,961	9,269	10,499	11,541	12,442	13,184
Coastwise Petro Products	918	918	918	918	918	918
Grain Exports	2,172	2,463	2,870	3,187	3,482	3,714
Breakbulk and Aggregate	2,471	2,860	2,860	2,860	2,860	2,860
Neches River Turning Basins	2,153	2,153	2,153	2,153	2,153	2,153
Neches River Total	54,569	63,560	69,887	78,931	85,287	88,570
Total Annual Benefits a/	83,844	95,856	104,303	115,074	122,875	127,696

a/ Some totals may not add due to rounding.

Table 141
SNWW Economic Summary Data
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	798,920	889,906	980,891	1,071,877	1,152,079	1,232,280
Interest During Construction	88,981	99,115	109,248	119,382	128,315	137,247
Total Investment	887,901	989,021	1,090,139	1,191,259	1,280,394	1,369,527
Average Annual Cost	44,020	49,033	54,046	59,059	63,478	67,897
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	70,217	77,258	84,299	91,341	96,626	101,911
Average Annual Benefits	83,844	95,856	104,303	115,074	122,875	127,696
Net Excess Benefits	13,627	18,598	20,004	23,733	26,249	25,785
Benefit to Cost Ratios	1.2	1.2	1.2	1.3	1.3	1.3

7.1 INCREMENTAL ANALYSIS

The project benefits start in the Sabine Pass Channel reach where the Cheniere LNG terminal is located.[46]. The Port Arthur Canal reach follows the Sabine Pass Channel reach. The Golden Pass LNG terminal which is nearing completion, is located in the Sabine Pass Channel reach. An additional LNG terminal, Sempra, is permitted for construction in the Port Arthur Canal reach; however, due to uncertainty, the LNG transportation savings benefits (see Table 139) do not include Sempra. The Port Arthur Canal reach also provides access to the Taylor Bayou side channel and basin. The Port of Port Arthur facilities are located along the main portion of the Sabine-Neches Canal. The incremental analyses for channel improvements through Port Arthur excluding the Taylor Bayou side channel are shown in Table 142.

Table 142
Sabine Pass Channel, Port Arthur Canal, and Sabine-Neches Canal Incremental Analysis
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	510,640	564,696	618,751	672,807	725,314	777,822
Interest During Construction	48,541	54,539	60,538	66,536	71,713	76,889
Total Investment	559,181	619,235	679,289	739,343	797,027	854,711
Average Annual Cost	27,723	30,700	33,677	36,655	39,514	42,374
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	21,870	23,477	25,089	26,705	27,332	27,965
Total Annual Cost	49,767	54,365	58,967	63,575	67,067	70,566
Average Annual Benefits	13,205	13,527	13,527	13,527	13,527	13,527
Net Excess Benefits	–36,562	–40,838	–45,440	–50,048	–53,540	–57,039
Benefit to Cost Ratios	0.3	0.2	0.2	0.2	0.2	0.2

Separable analysis of Taylor Bayou is shown in Table 143. The analysis presented in Table 143 shows that the BCRs for the Taylor Bayou increment are well above unity. Table 144 presents the Sabine-Neches and Taylor Bayou increments as a separable unit. Table 144 indicates that the BCRs for the segment through the Sabine-Neches Canal and including Taylor Bayou are below unity due to the inclusion of the Entrance Channel costs and exclusion of the Neches River benefits. Incremental analysis of the Neches River reach is shown in Table 145, and the BCRs are well above unity. Table 146 displays Neches River analysis excluding Taylor Bayou. Table 147 reflects exclusion of benefits from Taylor Bayou, LNG, and breakbulk. Table 148 presents calculation of the benefits and costs without inclusion of LNG.

[46] Reference to the facility locations can be found on Figure 1.

The results of the analysis presented in tables 142 through 148 show that the downstream benefits are not needed to justify the upstream costs. The analysis shows that each of the major reaches provides significant incremental benefits.

Table 143
Taylor Bayou Incremental Analysis
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	43,755	51,811	59,865	67,919	76,527	85,136
Interest During Construction	2,106	2,494	2,882	3,270	3,683	4,099
Total Investment	45,861	54,305	62,747	71,189	80,210	89,235
Average Annual Cost	2,274	2,692	3,111	3,529	3,977	4,424
Average Annual O&M	1,267	1,451	1,631	1,807	1,945	2,075
Total Annual Cost	3,541	4,143	4,742	5,336	5,922	6,499
Average Annual Benefits	16,070	18,769	20,889	22,617	24,062	25,599
Net Excess Benefits	12,529	14,626	16,147	17,281	18,140	19,100
Benefit to Cost Ratios	4.5	4.5	4.4	4.2	4.1	3.9

Table 144
Project Improvements Through Port Arthur (including Taylor Bayou)
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	554,395	616,507	678,616	740,725	801,842	862,958
Interest During Construction	50,647	57,033	63,420	69,806	75,396	80,988
Total Investment	605,042	673,540	742,036	810,531	877,238	943,946
Average Annual Cost	30,171	33,580	36,989	40,399	43,712	47,025
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	23,137	24,929	26,720	28,512	29,276	30,041
Total Annual Cost	53,482	58,697	63,910	69,126	73,209	77,293
Average Annual Benefits	29,275	32,296	34,416	36,144	37,589	39,126
Net Excess Benefits	–24,207	–26,401	–29,494	–32,982	–35,620	–38,167
Benefit to Cost Ratios	0.5	0.6	0.5	0.5	0.5	0.5

Table 145
Neches River Incremental Economic Analysis
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	244,525	273,399	302,275	331,152	350,237	369,322
Interest During Construction	38,334	42,081	45,829	49,576	52,918	56,259
Total Investment	282,859	315,480	348,104	380,728	403,156	425,581
Average Annual Cost	14,023	15,641	17,258	18,875	19,987	21,099
Average Annual O&M	2,885	3,109	3,332	3,555	3,651	3,746
Total Annual Cost	16,908	18,750	20,590	22,430	23,638	24,845
Average Annual Benefits	54,570	63,560	69,888	78,931	85,287	88,570
Net Excess Benefits	37,661	44,811	49,298	56,500	61,649	63,725
Benefit to Cost Ratios	3.2	3.4	3.4	3.5	3.6	3.6

Table 146
SNWW Improvements (Excludes Taylor Bayou)
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	755,165	838,095	921,027	1,003,958	1,075,551	1,147,144
Interest During Construction	86,875	96,621	106,366	116,112	124,631	133,148
Total Investment	842,040	934,716	1,027,392	1,120,070	1,200,183	1,280,292
Average Annual Cost	41,746	46,341	50,935	55,530	59,502	63,473
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	24,755	26,586	28,422	30,260	30,982	31,712
Total Annual Cost	66,676	73,115	79,558	86,005	90,705	95,411
Average Annual Benefits	54,540	63,418	69,746	78,789	85,145	88,428
Net Excess Benefits	–12,135	–9,696	–9,812	–7,217	–5,559	–6,983
Benefit to Cost Ratios	0.8	0.9	0.9	0.9	0.9	0.9

Table 147
Neches River Project Improvements (Excludes Transportation Benefits for
All Other Reaches Except the Neches River)
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	755,165	838,095	921,027	1,003,958	1,075,551	1,147,144
Interest During Construction	86,875	96,621	106,366	116,112	124,631	133,148
Total Investment	842,040	934,716	1,027,392	1,120,070	1,200,183	1,280,292
Average Annual Cost	41,746	46,341	50,935	55,530	59,502	63,473
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	24,755	26,586	28,422	30,260	30,982	31,712
Total Annual Cost	66,676	73,115	79,558	86,005	90,705	95,411
Average Annual Benefits	38,470	44,649	48,857	56,172	61,084	62,829
Net Excess Benefits	–28,206	–28,465	–30,701	–29,834	–29,621	–32,582
Benefit to Cost Ratios	0.6	0.6	0.6	0.7	0.7	0.7

Table 148
SNWW Improvements (Excludes LNG)
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	755,165	838,095	921,027	1,003,958	1,075,551	1,147,144
Interest During Construction	86,875	96,621	106,366	116,112	124,631	133,148
Total Investment	842,040	934,716	1,027,392	1,120,070	1,200,183	1,280,292
Average Annual Cost	41,746	46,341	50,935	55,530	59,502	63,473
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	24,755	26,586	28,422	30,260	30,982	31,712
Total Annual Cost	66,676	73,115	79,558	86,005	90,705	95,411
Average Annual Benefits	72,702	84,716	93,164	103,935	111,736	116,556
Net Excess Benefits	6,026	11,601	13,606	17,930	21,031	21,144
Benefit to Cost Ratios	1.1	1.2	1.2	1.2	1.2	1.2

7.2 BENEFIT-COST RATIO AT 7 PERCENT

Calculation of benefits and costs at 7 percent interest is required by EC 11-2-194, commonly referred to as the budget Engineering Circular (paragraph 11). The 7 percent calculations are used for budget ranking purposes. Table 149 outlines the economic calculations at 7 percent.

Table 149
SNWW Economic Summary Data at 7 Percent
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	798,920	889,906	980,891	1,071,877	1,152,079	1,232,280
Interest During Construction	150,031	167,118	184,204	201,291	216,352	231,413
Total Investment	948,951	1,057,024	1,165,095	1,273,168	1,368,431	1,463,693
Average Annual Cost	68,761	76,592	84,423	92,254	99,156	106,059
Deferred Construction (F&W)	178	192	206	220	226	232
Average Annual O&M	25,942	27,971	29,999	32,027	32,885	33,742
Total Annual Cost	94,881	104,755	114,628	124,501	132,267	140,033
Average Annual Benefits	81,644	93,305	101,498	112,028	119,631	124,300
Net Excess Benefits	–13,237	–11,450	–13,130	–12,473	–12,636	–15,733
Benefit to Cost Ratios	0.9	0.9	0.9	0.9	0.9	0.9

8.0 SENSITIVITY ANALYSIS

Sensitivities were evaluated based on trade route variations, vessel underkeel clearance variance, the use of offshore or other pipeline alternatives, and the effect on vessel delays from reductions in vessel trips as a result of channel deepening. The effects of the sensitivities were evaluated in relationship to the BCRs, net excess benefits, and NED plan presented in Table 141. The effects of the combined sensitivities are also discussed.

8.1 UNDERKEEL CLEARANCE SENSITIVITY

Table 150 presents the results of a scenario using 3 feet of underkeel clearance instead of 1 foot for crude petroleum and petrochemical products. Table 151 presents the results of a scenario using 1 foot of underkeel clearance for vessels less than 100,000 DWT and 3 feet of underkeel clearance for vessels over 100,000 DWT. The underkeel clearance assumptions remain the same for the without- and with-project conditions. The basis for the second scenario is that as channel depth increases, vessel operators are likely to be more adverse to the risk associated with 1-foot underkeel clearance when operating larger vessels. Table 152 presents the results of using 1 foot of underkeel clearance for the without-project condition and 3 feet for the with-project condition.

Table 150
SNWW Economic Summary Data 3-foot Underkeel Clearance
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	798,920	889,906	980,891	1,071,877	1,152,079	1,232,280
Interest During Construction	88,981	99,115	109,248	119,382	128,315	137,247
Total Investment	887,901	989,021	1,090,139	1,191,259	1,280,394	1,369,527
Average Annual Cost	44,020	49,033	54,046	59,059	63,478	67,897
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	70,217	77,258	84,299	91,341	96,626	101,911
Average Annual Benefits	96,703	107,753	121,476	132,476	140,562	146,961
Net Excess Benefits	26,486	30,495	37,177	41,135	43,936	45,050
Benefit to Cost Ratios	1.4	1.4	1.4	1.5	1.5	1.4

Table 151
SNWW Economic Summary Data 1-Foot Underkeel Clearance for Vessels of Less Than 100,000 DWT
(Without- and With-Project Future)
3 Feet of Underkeel Clearance for Vessels Greater than 100,000 DWT (Without- and With-Project Future)
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	798,920	889,906	980,891	1,071,877	1,152,079	1,232,280
Interest During Construction	88,981	99,115	109,248	119,382	128,315	137,247
Total Investment	887,901	989,021	1,090,139	1,191,259	1,280,394	1,369,527
Average Annual Cost	44,020	49,033	54,046	59,059	63,478	67,897
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	70,217	77,258	84,299	91,341	96,626	101,911
Average Annual Benefits	94,548	105,743	117,164	126,893	133,533	140,071
Net Excess Benefits	24,331	28,485	32,865	35,552	36,907	38,160
Benefit to Cost Ratios	1.3	1.4	1.4	1.4	1.4	1.4

Table 152
SNWW Economic Summary Data 1-Foot Underkeel Clearance for the Without-Project Condition
3 Feet of Underkeel Clearance for the With-Project Future
Cost and Benefits ($1,000s)
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	798,920	889,906	980,891	1,071,877	1,152,079	1,232,280
Interest During Construction	88,981	99,115	109,248	119,382	128,315	137,247
Total Investment	887,901	989,021	1,090,139	1,191,259	1,280,394	1,369,527
Average Annual Cost	44,020	49,033	54,046	59,059	63,478	67,897
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	70,217	77,258	84,299	91,341	96,626	101,911
Average Annual Benefits	65,368	76,564	87,985	97,713	104,355	110,892
Net Excess Benefits	–4,849	–694	3,686	6,372	7,729	8,981
Benefit to Cost Ratios	0.9	1.0	1.0	1.1	1.1	1.1

The sensitivity presented in Table 152 is based on the assumption that vessel operators use the availability of a deeper channel depth to reduce the risk of operating with minimum underkeel clearance by insisting on greater underkeel clearance at vessels over 100,000 DWT under the with-project alternative. The transportation costs and savings for the scenario were run with the assumption that all crude and product carriers use 1 foot of underkeel clearance under the without-project condition and all carriers use 3 feet under the with-project scenarios. Table 139 presents the result on plan optimization.

8.2 OFFSHORE TERMINAL

This scenario evaluates a with- and without-project future represented by increased use of an offshore alternative or other pipeline alternative such as receipt of large volumes of Canadian crude by landside pipeline. These alternatives were evaluated as sensitivities, as plans for these projects are uncertain. Some industry representatives noted that for security reasons, access to more than one alternative is preferable. The logistics, including the use of other waterways and pipelines, necessary to receive feedstock during emergency situations is a part of emergency planning; however, the delivery costs associated with such alternatives exceed the costs associated with those of existing practices. The results of a scenario where 50 percent of future crude petroleum imports from West Africa and the Middle East use an offshore alternative are presented in Table 153. The results of the sensitivity indicate that the 48- and 49-foot deepening alternative project remain justified; however, the benefits are greatly reduced.

Table 153
SNWW Economic Summary Data Offshore Alternative
With 50% of West Africa and Middle East Using Offshore Alternative
Cost and Benefits ($1,000s) by Channel Depth Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	800,356	890,863	981,370	1,071,877	1,151,657	1,231,437
Interest During Construction	138,691	132,255	125,818	119,382	127,239	135,095
Total Investment	939,047	1,023,118	1,107,188	1,191,259	1,278,896	1,366,532
Average Annual Cost	46,555	50,723	54,891	59,059	63,404	67,749
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	72,752	78,948	85,144	91,341	96,552	101,763
Average Annual Benefits	74,829	84,994	92,858	101,352	107,894	112,515
Net Excess Benefits	4,612	7,736	8,559	10,011	11,268	10,604
Benefit to Cost Ratios	1.1	1.1	1.1	1.1	1.1	1.1

8.3 OFFSHORE TRANSFER TIME SENSITIVITY

This section evaluates the effects of using both increasingly optimal and less than optimal turnaround times for offshore lightering and lightening. Identification of the number of days used for the SNWW analysis was based on inputs from industry including data outlined in the Skaugen PetroTrans publication "Introduction to Lightering."[47] Detailed discussion of the variables associated with crude petroleum methods of shipment was presented in Section 3.5.1. As noted in that section, SNWW crude petroleum transportation costs were calculated based on the mother vessel being offshore for 24 hours for each shuttle vessel used. The 24-hour period includes offloading from the mother vessel and associated logistics, including routine delays. Table 154 includes the minimum and maximum hours per shuttle evaluated for the sensitivity.

Table 154
Mother Vessel Offshore Hours Per Shuttle (Hrs)

	Hours
Minimum	18
Most Likely	24
Maximum	36

The most likely times are based on the assumption of optimal turnaround times with the arrival of the shuttle vessels being coordinated to avoid any delays. The minimum times are based on increasingly optimal turnaround time. Table 155 presents the results of the minimum offshore hours. The maximum times are based on quotes obtained from the lightering companies and industry. Table 156 presents the results of the less than optimal offshore hours.

Table 155
SNWW Economic Summary Data Based on Minimal Mother Vessel Offshore Time
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	798,920	889,906	980,891	1,071,877	1,152,079	1,232,280
Interest During Construction	88,981	99,115	109,248	119,382	128,315	137,247
Total Investment	887,901	989,021	1,090,139	1,191,259	1,280,394	1,369,527
Average Annual Cost	44,020	49,033	54,046	59,059	63,478	67,897
Differed Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	70,217	77,258	84,299	91,341	96,626	101,911
Average Annual Benefits	76,428	87,466	95,413	105,653	113,451	118,245
Net Excess Benefits	6,211	10,208	11,114	14,312	16,825	16,334
B/C Ratios	1.1	1.1	1.1	1.2	1.2	1.2

[47] Skaugen Petro Trans Inc., Introduction to Lightering, October 25, 2006. http://www.teekay.com/PDFs/Lightering101.pdf.

Table 156
SNWW Economic Summary Data Based on Less Than
Optimal Mother Vessel Offshore Time
Cost and Benefits ($1,000s) by Channel Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	798,920	889,906	980,891	1,071,877	1,152,079	1,232,280
Interest During Construction	88,981	99,115	109,248	119,382	128,315	137,247
Total Investment	887,901	989,021	1,090,139	1,191,259	1,280,394	1,369,527
Average Annual Cost	44,020	49,033	54,046	59,059	63,478	67,897
Differed Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	70,217	77,258	84,299	91,341	96,626	101,911
Average Annual Benefits	90,732	103,802	115,167	124,827	135,600	143,581
Net Excess Benefits	20,515	26,544	30,868	33,486	38,974	41,670
B/C Ratios	1.3	1.3	1.4	1.4	1.4	1.4

8.4 VESSEL TRIP REDUCTION DUE TO CHANNEL DEEPENING

For this sensitivity, the HarborSym widening model was run based on the reduction in vessel trips as a result of channel deepening The purpose of the sensitivity was to determine changes in the annual delays in relationship to widening of the Sabine Pass Channel and Port Arthur Canal. The change in vessel trips due to channel deepening was estimated based on the decrease in the number of trips necessary to transport future tonnage. These vessel trip calculations were used in the ERDC shoreline effect study. Vessel trip estimates were prepared using 2000–2004 trips and for 2030–2040 average trips (see tables 94 and 95). The results of the HarborSym model show that the reduction in the number of vessel trips resulting from channel deepening will have a significant effect on the net difference in the duration of vessel delays between the without- and with-project conditions. The transportation costs and savings associated with the sensitivity are outlined in Table 157.

Table 158 presents a comparison of the economic summary data for “widening with deepening” and widening as a separate feature. The economic summary data for widening as a separate feature was previously presented in Table 98. Additional analyses based on a range of fleet forecasts indicate that the increase in benefits from scenarios that included either “deepening and widening” or “deepening and the turning basins” were primarily attributable to the reduction in trips due to channel deepening. These savings result from the reduction in trips based on vessels carrying additional cargo or the redistribution of vessel sizes based on the availability of a deeper channel.

Table 157
Comparison of Annual Savings ($1,000s)
Due to Vessel Trip Reductions, 2030
Without- and With-Project Future

Component	Without-Project Future	Widening No Deepening		Widening and Deepening
# in Call List a/	3,448	3,448		2,815
Number of Vessels Exiting	3,439	3,439		2,794
Average Vessel Time in System (hours)	58.6	57.7		59.2
Total Cost ($1,000s)	258,469.3	255,821.3		236,000.0
Total Cost SD ($1,000s)	934.0	885.3		607.8
Total Cost Max ($1,000s)	260,294.9	254,640.1		238,200.7
Total Cost Min ($1,000s)	256,367.1	251,205.5		235,265.8
Average Cost ($1,000s)	74.73	74.22		76.87
Average Time in Reaches (hours)	8.32	8.30		8.02
Average Time Waiting at Entry (hours)	4.01	2.56		2.24
Average Time Waiting (hours)	8.83	7.85		6.39
Savings in Total Cost ($1,000s)		3,487.3	b/	29,591.3

a/ The table reflects 297 LNG vessels. The effect of the lower LNG forecast was not prepared for this sensitivity.
b/ The savings of $3,487.3 thousands is shown on the last page of Table 96.

Table 158
Sabine Pass Channel and Port Arthur Canal
Economic Summary Data (2008 Thousands of Dollars at 4.375%)

Item	Sabine Pass Channel and Port Arthur Canal Widening to 700 feet		
First Cost		78,448.0	
Mitigation Cost		48,484.5	
Interest During Construction		36,282.3	
Total First Cost		163,214.8	
Average Annual Construction Cost		8,091.7	
Incremental Average Annual O&M Cost		9,587.1	
Total Average Annual Cost		17,678.7	
	Widening No Deepening (Table 97)	Deepening and Widening	Residual Benefits at 48 Feet
Average Annual Benefits	6,379.6	29,951.3	23,571.7
Net Excess Benefits	–11,299.1	12,272.6	5,893.0
Benefit to Cost Ratio	0.4	1.7	1.3

8.5 GRAIN EXPORT SENSITIVITY

The potential effect of using containerships through Beaumont or the transfer of bulk grain to another location is an uncertainty associated with grain export tonnage. For purposes of analysis, the effect of excluding transportation savings for grain exports was evaluated. The result of this sensitivity is summarized in Table 159.

Table 159
SNWW Economic Summary Data Offshore Alternative
Excluding Grain Exports
Cost and Benefits ($1,000s) by Channel Depth Alternative
(50-Year Period of Analysis at 4.375%)
(December 2008 Vessel Costs)

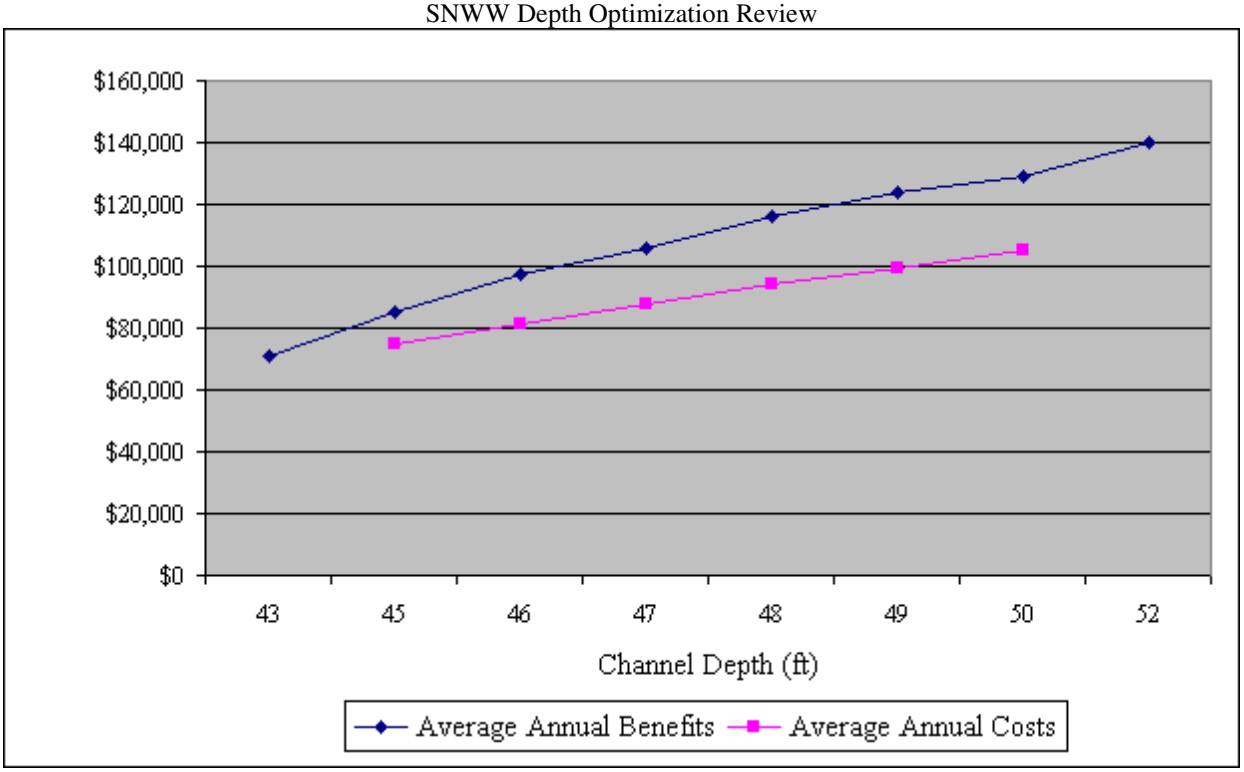
	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
First Cost of Construction	800,356	890,863	981,370	1,071,877	1,151,657	1,231,437
Interest During Construction	138,691	132,255	125,818	119,382	127,239	135,095
Total Investment	939,047	1,023,118	1,107,188	1,191,259	1,278,896	1,366,532
Average Annual Cost	46,555	50,723	54,891	59,059	63,404	67,749
Deferred Construction (F&W)	174	188	201	215	221	227
Average Annual O&M	26,023	28,037	30,052	32,067	32,927	33,787
Total Annual Cost	72,752	78,948	85,144	91,341	96,552	101,763
Average Annual Benefits	81,973	93,741	101,781	112,235	119,741	124,330
Net Excess Benefits	11,756	16,483	17,482	20,894	23,115	22,419
Benefit to Cost Ratios	1.2	1.2	1.2	1.2	1.2	1.2

8.6 DEPTH OPTIMIZATION SENSITIVITY REVIEW

This section provides a review of depth optimization. Current benefits calculations were reviewed in relationship to project construction costs. Benefit calculations for the range of channel depths between 43 and 50 feet continued to be maintained during the study process. While, detailed costs were not made for every channel depth increment after the initial optimization of benefits and costs were prepared, costs calculations for the 45-foot alternative were maintained as they were needed for cost allocation purposes. Comparison of recent project construction costs for the 45- and 50-foot channel depth increments and cost data for earlier study phases were used to estimate the project construction cost for 46, 47, and 49 feet. Detailed calculations were made for 45, 48, and 50 feet.

Comparison of the detailed cost values for 45, 48, and 50 feet with the inclusion of the interpolated values for 46, 47, and 49 feet with calculated transportation cost savings for 43, 45, 46, 47, 48, 49, 50, and 52 feet is displayed on Figure 58. The presentation shows that the average annual benefits by channel depth increase at a greater rate than costs. The results of this comparison suggest that channel depth alternatives less than 45 feet would not produce higher net excess benefits than the proposed 48-foot channel depth.

Figure 58
SNWW Depth Optimization Review



8.7 SUMMARY OF MAJOR SENSITIVITY EFFECTS

This sensitivity presents the results of using 1foot of underkeel clearance for the without-project condition and 3 feet for the with-project condition and including the incidental benefits from reductions in vessel trips. Table 160 displays the project benefits for this scenario. The total benefits include the channel deepening and anchorage basin benefits outlined in Table 141 and the incidental reduction in delay benefits shown in Table 157. The annual savings for the without-project future without deepening is $6,339,400. The annual savings for the without-project future that includes deepening to 48 feet is $29,591,300. The results of the analysis indicate that the residual savings from the combined effect of widening and deepening is represented by the net difference of $23,571,700. The savings for the 45-, 46-, and 47-foot depths was interpolated given a savings of zero at 40 feet and $23,571,700 at 48 feet. The savings at 49 and 50 feet were assumed to be the same as at 48 feet.

Table 160
Total Average Annual Deepening and Reduction in Delay Benefits ($1,000s)
(50-Year Period of Analysis at 4.375 percent)
by Project Depth Alternative
(December 2008 Vessel Costs)

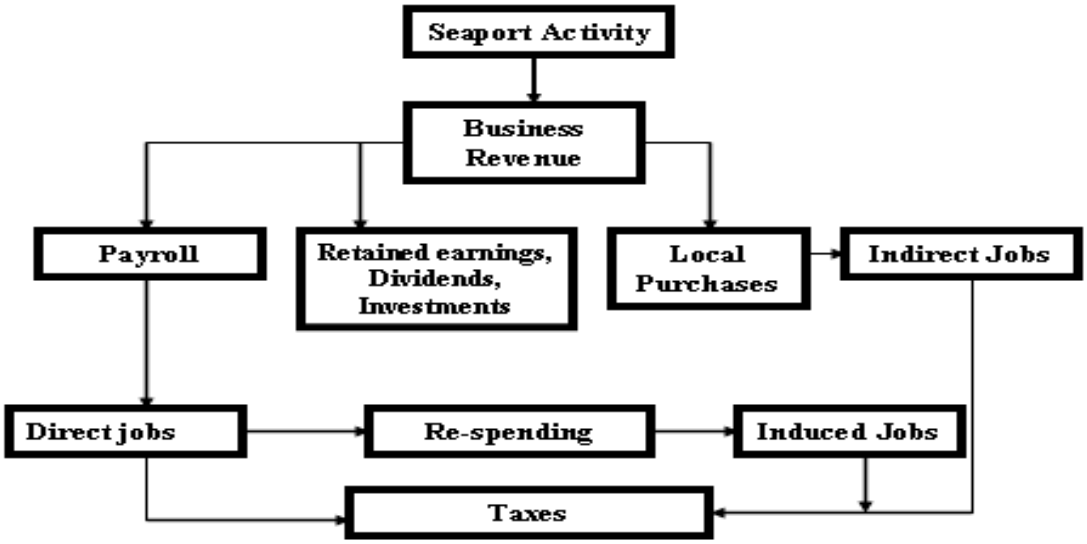
Item	45 feet	46 feet	47 feet	48 feet	49 feet	50 feet
Crude Petroleum Imports	49,003	55,296	62,659	68,948	72,572	75,760
Petroleum Products Imports	6,728	7,817	8,836	9,714	10,483	11,352
Petroleum Products Exports	17,335	20,146	22,778	25,023	26,975	29,224
Coastwise	1,481	1,481	1,481	1,481	1,481	1,481
Grain Exports	2,172	2,463	2,870	3,187	3,482	3,714
Breakbulk	4,837	5,595	5,595	5,595	5,595	5,595
LNG	11,140	11,140	11,140	11,140	11,140	11,140
Deep-Draft Benefits	81,992	94,051	102,498	113,269	121,070	125,891
Neches River Anchorages	2,153	2,153	2,153	2,153	2,153	2,153
Sabine Pass and Port Arthur Canal Widening	1,595	3,190	4,785	6,380	6,380	6,380
Reduction in Vessel Trips and Delays Due to Channel Deepening	5,893	11,786	17,679	23,572	23,572	23,572
Anchorage Basins and Widening Benefits	9,641	17,129	24,617	32,105	32,105	32,105
Total Benefits	91,633	111,180	127,115	145,374	153,175	157,996
Total Average Annual Construction Cost a/						
Deepening and Anchorage Basins	70,217	77,258	84,299	91,341	96,626	101,911
Widening of Sabine Pass Channel and Port Arthur Canal	17,679	17,679	17,679	17,679	17,679	17,679
Total Average Annual Construction Cost	91,633	111,180	127,115	145,374	153,175	157,996
Net Excess Benefits	3,737	16,243	25,137	36,354	38,870	38,406
Benefit to Cost Ratios	1.0	1.2	1.2	1.3	1.3	1.3

a/ The construction costs shown include the average annual construction costs presented in tables 141 and 155.

9.0 REGIONAL ECONOMICS

This section provides a summary of regional benefits of port-related activity. Martin Associates' "Jefferson County Waterway and Navigation District – Study for Economic Impact Maintenance Dredging and Economic Impact of Deepening and Widening of the Sabine-Neches Waterway"[48] is the principal source used in preparation of this section. The Martin report includes evaluation of the economic impacts generated by marine activity in 2004. Economic impacts were estimated in terms of jobs, personal earnings, business revenue, and state, local, and federal taxes. Figure 59 outlines how the waterway activity impacts the local, regional, and Federal economies.

Figure 59
Flows of Economic Impacts through the Economy



Source: Martin Associates, "Jefferson County Waterway and Navigation District - Study for Economic Impact Maintenance Dredging and Economic Impact of Deepening and Widening of the Sabine-Neches Waterway" July 2006, Exhibit E-2, page 3.

As the figure indicates, the marine cargo and vessel activity generates revenue to firms providing marine services. This revenue results in a series of impacts including payroll, retained earnings, stockholder earnings, dividends and reinvestment, purchase of goods and services from local firms, as well as national and international firms (creating indirect jobs with these firms). Businesses also pay taxes from the business revenue.

Descriptions of the general job effects associated with port activity are defined as follows:

[48] Martin Associates, "Jefferson County Waterway and Navigation District - Study For Economic Impact Maintenance Dredging and Economic Impact of Deepening and Widening of the Sabine-Neches Waterway," August 2006.

> Direct jobs are described as jobs with local firms providing support services to the waterway. These jobs are dependent upon this activity and would suffer immediate dislocation if the waterway activity were to cease. Direct jobs include employment with railroads and trucking companies, steamship agents, ship chandlers, warehouse operators, shipyards, and marine construction firms.
>
> Induced jobs are described as jobs created locally and throughout the regional economy due to purchases of goods and services by those directly employed. These jobs are with grocery stores, the local construction industry, retail stores, health care providers, local transportation services, etc., and would also be discontinued if waterway activity were to cease.
>
> Indirect jobs are described as jobs generated in the local economy as the result of local purchases by the firms directly dependent upon waterway activity. These jobs include jobs in local office supply firms, equipment and parts suppliers, maintenance and repair services, insurance brokers, business service contractors, and local utilities.

Cargo moving through marine terminals within the Jefferson County Waterway and Navigation District are noted to generate 83,692 jobs in Texas and Louisiana (Table 161). Of these, 14,987 are direct jobs generated by marine cargo and vessel activity. Wages and salaries associated with direct jobs were estimated to be $877.7 million annually. Local and regional purchases made by the 14,987 direct job holders were estimated to result in an additional 13,628 induced jobs. An additional 55,077 indirect jobs are noted to be supported by $3.7 billion in local purchases by businesses supplying services to marine terminals and marine-related businesses located along the SNWW. As the result of respending this income, an additional $1.5 billion of income and consumption expenditures were created. The 55,077 indirect job holders in Texas and Louisiana received $2.4 billion of indirect wages and salaries. In total, $4.7 billion of direct, induced, and indirect personal wages and salaries and consumption expenditures were generated by maritime activity at marine terminals located within the Jefferson County Waterway and Navigation District.

The report also includes an assessment of the job impacts on a “per 1,000 ton basis,” which is noted to provide a tool for port planners to use in evaluating the relative importance of different commodities as economic generators. Table 162 presents the job impacts per 1,000 tons for each commodity moving through the public and private marine terminals. Tables 161 and 162 and Figure 59 are all displayed as presented in the Martin Associates report with minor formatting changes.

Table 161
Summary of the Local and Regional Economic Impacts Generated by
Jefferson County Waterway and Navigation District

Regional and Local Jobs	
Direct	14,987
Induced	13,628
Indirect	55,077
Total	83,692
Regional and Local Personal Income and Expenditures ($ millions)	
Direct	877.7
Respending/Consumption	1,510.1
Indirect	2,351.3
Total Income	4,739.1
Revenue and Taxes	
Business Revenue	2,242.2
State/Local Taxes	426.5
Federal Income Taxes	853.0

Source: Martin Associates, "Jefferson County Waterway and Navigation District - Study for Economic Impact Maintenance Dredging and Economic Impact of Deepening and Widening of the Sabine-Neches Waterway" July 2006, Exhibit E-2, page 3.

Table 162
Direct Jobs Per 1,000 Tons of Cargo

Commodity	Number of Direct Jobs	Jobs/1,000s of Tons
Containers	46	1.24
Steel	383	0.50
General Cargo	408	1.12
Forest Products	207	0.33
Grain	231	0.17
Other Dry Bulk	437	0.48
Crude Petroleum	4,376	0.06
Petroleum Products	1,855	0.06
Chemical Products	6,097	0.49
Not Allocated	946	n/a
Total	14,987	n/a

Source: Martin Associates, "Jefferson County Waterway and Navigation District - Study for Economic Impact Maintenance Dredging and Economic Impact of Deepening and Widening of the Sabine-Neches Waterway" July 2006, Exhibit II-2, page 18.

Examination of the data presented in Table 162 shows that containers and general cargo create the largest number of direct jobs per 1,000 tons, followed by steel, chemical products, and other dry bulk. The presentation also shows that the relatively large impact per 1,000 tons for containers and general cargo corresponds to a relatively small tonnage handled. In comparison, the number of jobs per 1,000 tons for crude petroleum and petroleum products is small despite the fact that crude petroleum generated the second largest direct job impact. The number of jobs and the jobs per 1,000s of tons for chemical products both rate relatively high. On a per 1,000 ton basis, chemical products generates nearly 0.5 jobs per 1,000 tons. In comparison, crude petroleum and petroleum products results in 0.06 jobs per 1,000 tons. Dry bulk and chemicals represent approximately 10 percent of total tonnage. The remaining 90 percent of tonnage consists of petroleum. The finding that some cargoes generate relatively small direct jobs per 1,000 tons of throughput reflects the fact that the handling of these cargoes is much less labor intensive than handling other commodities. For instance, the supporting infrastructure of agents, freight forwarders and customs house brokers, and warehousing and terminal operators is greater for some cargo.

9.1 OTHER INDICATORS

In addition to the Martin Associates report, Beaumont-Port Arthur Metropolitan Statistical Area (MSA) employment data was reviewed in order to assess the distribution of employment and short-term trends. Table 163 displays 2001–2007 MSA employment statistics. Manufacturing, retail trade, and construction are the largest private industry employers. Waterway-related employment is largely associated with private companies, and likely includes, in order of magnitude, transportation and warehousing, manufacturing, and wholesale trade. Additionally, mining employment, particularly offshore-related exploration, results in direct, indirect, and induced employment and income impacts. Analysis of the data presented in Table 163 shows positive job growth in all sectors directly related to waterway activity. The most notable growth rates are for mining (11 percent), wholesale trade (3.4 percent), and transportation and warehousing (3.3 percent). It is recognized that not all jobs associated with these sectors are directly related to the waterway.

9.2 SUMMARY AND CONCLUSIONS

While the incremental effects of the Federal action on employment and regional income are not addressed in the Martin Associates report, it is expected that construction of the Federal project will facilitate regional growth. The greatest effect on employment and income are expected to continue to be concentrated among dry bulk and chemical cargoes. Significant growth occurred over the last 10–15 years in these labor-intensive commodity groups. Additionally, overall total tonnage growth will allow for continued increases in regional employment and income.

Table 163
Total Full-Time and Part-Time Employment by NAICS Industry a/

Employment by Place of Work	2001	2002	2003	2004	2005	2006	2007	Avg. Annual Growth (%)
Total employment	193,540	193,465	195,025	193,571	197,097	205,065	211,062	1.5
Wage and salary employment	164,515	162,340	162,137	160,073	161,132	167,076	170,725	0.6
Proprietors employment	29,025	31,125	32,888	33,498	35,965	37,989	40,337	5.6
Farm proprietors employment	1,501	1,528	1,493	1,486	1,510	1,505	1,494	–0.1
Nonfarm proprietors employment	27,524	29,597	31,395	32,012	34,455	36,484	38,843	5.9
Farm employment	1,823	1,800	1,751	1,718	1,761	1,716	1,729	–0.9
Nonfarm employment	191,717	191,665	193,274	191,853	195,336	203,349	209,333	1.5
Private employment	164,115	164,089	165,699	164,553	168,247	176,562	182,983	1.8
Forestry, fishing, and related activities	1,464	1,531	1,269	1,178	1,154	1,084	1,038	–5.6
Mining	1,046	1,024	1,128	1,122	1,611	1,887	1,979	11.2
Utilities	962	1,003	1,047	1,033	1,033	1,013	1,014	0.9
Construction	20,129	18,609	18,965	17,013	18,052	19,889	21,214	0.9
Manufacturing	22,361	20,963	19,971	19,598	19,818	21,770	23,599	0.9
Wholesale trade	4,787	4,701	4,866	4,851	5,045	5,308	5,867	3.4
Retail trade	24,791	25,136	25,230	25,276	25,138	26,045	25,952	0.8
Transportation and warehousing	5,906	5,892	6,681	7,084	7,282	7,236	7,166	3.3
Information	3,122	3,024	3,051	3,036	3,110	2,938	2,601	–3.0
Finance and insurance	6,405	6,394	6,412	5,998	6,339	6,435	6,695	0.7
Real estate and rental and leasing	4,185	4,449	4,742	4,907	5,385	5,885	6,685	8.1
Other b/	68,957	71,363	72,337	73,457	74,280	77,072	79,173	2.3
Government	27,602	27,576	27,575	27,300	27,089	26,787	26,350	–0.8

a/ NAICS (North American Industry Classification System).
b/ Primarily consists of health care and social services; hotel and food services; and other nonclassified.
Source: Bureau of Economic Analysis, Regional Economic Information System, Table CA25N, April 2009.

ECONOMIC APPENDIX ADDENDUM
SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
SOUTHEAST TEXAS AND SOUTHWEST LOUISIANA

PREPARED BY:

U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
SOUTHWESTERN DIVISION

10 June 2010

APPENDIX 2
ECONOMIC ADDENDUM

1.0 GENERAL

This addendum presents analysis of issues raised during the Independent External Peer Review (IEPR) (Battelle, 2010).

2.0 ANALYSIS OF LOOP AS A NON-STRUCTURAL ALTERNATIVE (IEPR COMMENT 1)

An offshore terminal has the potential of capturing 100 percent of all crude oil imports shipped from the routings represented by Middle East, Africa, North Sea, Mediterranean, and Brazil. Table 2A presents the tonnage that could potentially utilize an offshore terminal.

TABLE 2A
SNWW Offshore Terminal Tonnage and Transportation Cost Savings

Representative Trade Route	1,000's of Short Tons by Trade Routing					
	2019	2029	2039	2049	2059	2069
Brazil	4,347	4,847	5,136	5,224	5,326	5,701
Europe & Africa	33,801	37,688	39,940	40,639	41,434	44,203
Middle East	31,625	35,262	37,369	38,023	38,767	41,357
Total Tonnage	38,149	42,535	45,076	45,864	46,761	49,904
	Transportation Cost and Savings Per Ton					
		To the				
	40-ft	Offshore	Savings/			
Representative Route	SNWW	Terminal	Ton			
Brazil	$6.73	$6.28	$0.45			
Europe/Africa	$8.41	$7.84	$0.57			
Middle East	$14.43	$12.66	$1.77			
	Annual Transportation Savings					
Representative Route	2019	2029	2039	2049	2059	2069
Brazil	$2,466	$2,750	$2,913	$2,964	$3,022	$3,234
Europe & Africa	$19,175	$21,380	$22,658	$23,054	$23,505	$25,076
Middle East	$55,894	$62,321	$66,045	$67,201	$68,515	$73,093
Total	$75,069	$83,701	$88,703	$90,255	$92,021	$98,169

Table 2B provides a comparison of the transportation savings benefits between the channel deepening alternatives and an offshore oil terminal alternative. The cost for the offshore oil terminal and pipeline structure is estimated to be a first cost of $1.8 billion based on the 2001 BOOTs construction cost estimate published by its sponsor and potential partners. The total annual cost estimates for the offshore alternatives are conservatively low. They do not include escalation of the original 2001 BOOTS estimate to 2010 costs, and they do not include estimated costs for operation and

maintenance (O&M), as we have no means of determining O&M costs for an offshore terminal. The table presents three offshore terminal funding scenarios. The first is based on SNWW users funding 100 percent of the terminal construction; the other scenarios are based on 50 and 25 percent funding. The project benefits are based exclusively on crude petroleum imports.

TABLE 2B
SNWW Channel Deepening and Offshore Terminal Economic Summary Data

	SNWW Channel Deepening Alternatives (As Shown in Table 141, Economic Appendix)						Offshore Terminal		
	45	46	47	48	49	50	Funding 100% by SNWW	Funding 50% by SNWW	Funding 25% by SNWW
First Cost of Construction	$798.9	$889.9	$980.9	$1,071.9	$1,152.1	$1,232.3	$1,800.0	$900.0	$450.0
Interest During Construction	$89.0	$99.1	$109.2	$119.4	$128.3	$137.2	$0.0	$0.0	$0.0
Total Investment	$887.9	$989.0	$1,090.1	$1,191.3	$1,280.4	$1,369.5	$2,000.5	$1,000.2	$500.1
Average Annual Cost	$44.0	$49.0	$54.0	$59.1	$63.5	$67.9	$99.2	$49.6	$24.8
F&W Mitigation Differed Const.	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.0	$0.0	$0.0
Average Annual O&M	$26.0	$28.0	$30.1	$32.1	$32.9	$33.8	$0.0	$0.0	$0.0
Total Annual Cost	$70.2	$77.3	$84.3	$91.3	$96.6	$101.9	$99.2	$49.6	$24.8
Average Annual Benefits	$83.8	$95.9	$104.3	$115.1	$122.9	$127.7	$86.6	$86.6	$86.6
Net Excess Benefits	$13.6	$18.6	$20.0	$23.7	$26.2	$25.8	-$12.6	$37.0	$61.8
BCR	1.2	1.2	1.2	1.3	1.3	1.3	0.9	1.7	3.5

3. ANALYSIS OF CRUDE PETROLEUM IMPORTS BY VESSEL DRAFT (IEPR COMMENT 3)

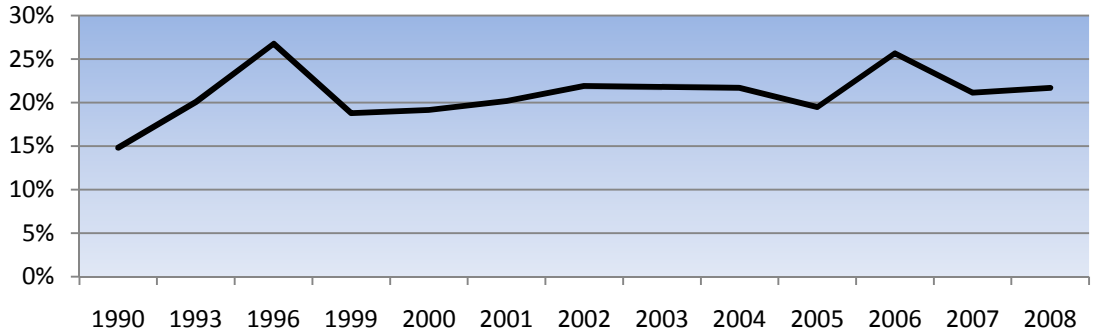
The top section of Table 3A shows the relationship between crude oil design and loaded drafts. The second and third sections of Table 3A show the relative volume and percentage of tonnage transported in vessels with loaded drafts over 37 feet. Figure 3A illustrates the percentage increase in tonnage experienced on the SNWW between 1990 and 2008. While not exhibiting dramatic increases, the table and figure clearly shows a high concentration of loaded drafts over 37 feet for all years, with the percentage of tonnage loaded to drafts over 37 feet increasing from 60 percent in 1999 to 71 percent in 2008. Table 3B includes additional distribution summary data. Trends are more apparent from the second table which shows an average of 7 percent of 2006-2008 tonnage associated with design drafts under 40 feet, compared to an average of 15 percent for 1999-2001. For the 1999-2008 period, the use of vessels with design drafts less or equal to 40 feet ranged from 27 percent in 1990 to 2 percent in 2008, with a mean of 12 percent and median of less than 10 percent. The data show more efficient utilization patterns within the constraints of the existing channel depth, given uncertainties associated with spot market sales, variability in refinery input needs, congestion, and dock and pilot availability.

TABLE 3A
SNWW Total Crude Oil Imports (1,000's of Short Tons) 1990-2008*
and Imports Transported at Loaded Drafts Over 37 feet (Short Tons and Percentage Distribution)

Design Draft (ft)	1999	2000	2001	2002	2003	2004	2006	2007	2008
	Total Crude Oil Imports by Vessel Design Draft and Year								
<=40 ft	14,597	6,329	5,334	9,415	2,727	14,414	4,763	6,256	770
41-44	18,863	15,422	25,821	13,019	17,673	5,816	9,497	13,171	13,858
45-49	18,889	43,994	31,450	39,073	43,263	43,934	39,445	34,200	32,554
>50	1,485	1,442	1,621	4,876	6,495	5,711	3,910	2,452	2,690
Total	53,834	67,187	64,226	66,383	70,158	69,875	57,615	56,078	49,872
Design Draft (ft)	Total Tonnage for Loaded Drafts Over 37 feet by Design Draft Class and Year								
<=40 ft	9,744	2,473	2,294	7,814	1,176	12,684	3,334	5,277	364
41-44	10,460	7,706	14,976	7,291	8,499	3,955	5,318	11,502	11,276
45-49	11,832	26,378	20,757	24,225	22,958	27,678	24,062	23,418	22,487
>50	793	432	859	3,364	3,446	3,598	1,369	1,192	1,049
Total	33,170	36,622	38,536	42,485	36,067	47,515	33,993	41,181	35,176
Design Draft (ft)	Total Tonnage for Loaded Drafts Over 37 feet by Design Draft Class and Year								
<=40 ft	65%	43%	43%	83%	52%	88%	70%	85%	47%
41-44	54%	55%	58%	56%	58%	68%	56%	88%	81%
45-49	61%	66%	66%	62%	64%	63%	61%	69%	69%
>50	52%	33%	53%	69%	64%	63%	35%	49%	39%
Total	60%	60%	60%	64%	62%	68%	59%	74%	71%

Source: USACE, Navigation Data Center Detailed Files (unpublished)
*CY2005 data is not presented due to reporting problems with the loaded draft field

FIGURE 3A
Percentage of Tonnage Shipped In Vessels with Loaded Drafts Over 37 ft



Source: USACE, Waterborne Commerce of the U.S., Part 2, IWR-WCSC-1990-2008-2

TABLE 3B SNWW Total Crude Oil Imports 1990-2008* Percentage of Imports by Vessel Design Draft									
Design Draft (ft)	1999	2000	2001	2002	2003	2004	2006	2007	2008
	% of Total Crude Oil Imports by Vessel Design Draft and Year								
<=40 ft	27%	9%	8%	14%	4%	21%	8%	11%	2%
41-44	35%	23%	40%	20%	25%	8%	17%	24%	28%
45-49	35%	66%	49%	59%	62%	63%	68%	61%	65%
>50	3%	2%	3%	7%	9%	8%	7%	4%	5%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
Design Draft (ft)	Loaded Drafts Over 37 ft (Percentage of Imports by Vessel Design Draft) by Year								
<=40 ft	29%	7%	6%	18%	3%	27%	10%	13%	1%
41-44	32%	21%	39%	17%	24%	8%	16%	28%	32%
45-49	36%	72%	54%	57%	64%	58%	71%	57%	64%
>50	2%	1%	2%	8%	10%	8%	4%	3%	3%

Source: USACE, Navigation Data Center Detailed Files (unpublished).

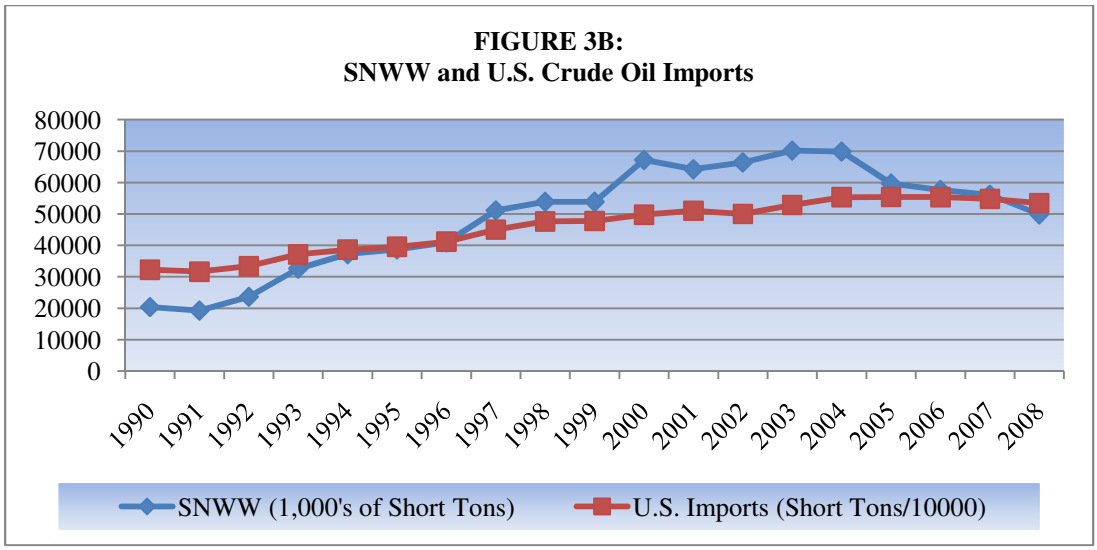
*CY2005 data is not presented due to reporting problems with the loaded draft field

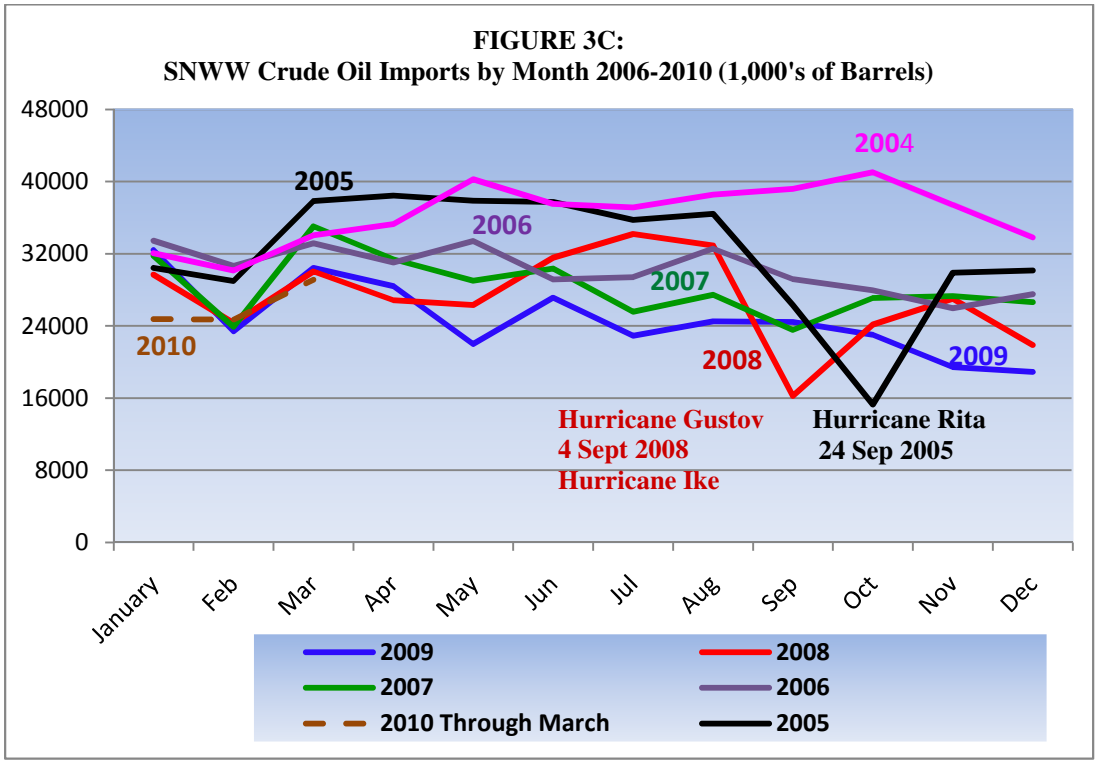
Estimation of how the Table 3A and 3B distributions might change given an increase in channel depth is difficult to discern based on the eight years of data; therefore, comparison to 1970-72 data was made in order to provide overall perspective. While the earlier data is unfortunately more general it provides a useful basis for evaluating overall changes (Table 3C). The change from 1970/72 to 2006/08 is dramatic and emphasizes how tanker load patterns evolved within a period of 35 years with no change in channel depth. As discussed in the Economic Appendix vessel trips have increased at a lower rate than tonnage because more cargo is transported per vessel, through a greater concentration of larger vessels. As outlined in the Appendix, expectations are that the number of vessels will increase as SNWW's cargo base diversifies due to LNG and increases in manufactured goods and dry bulk.

TABLE 3C SNWW Inbound Tanker Trips 1970/1972 and 2006/2008 (includes All Crude Petroleum and Petroleum and Chemical Products)						
Loaded Draft (ft)	1970	1971	1972	2006	2007	2008
<=24	1,015	973	991	185	168	184
25-29	144	113	199	187	151	184
30-37	228	238	198	481	363	337
38-40	1	2	14	492	588	558
Total	1,389	1,325	1,402	1,345	1,270	1,263
Loaded Draft (ft)	Distribution by Loaded Draft					
<=24	73%	73%	71%	14%	13%	15%
25-29	10%	8%	14%	14%	12%	15%
30-37	16%	18%	14%	36%	29%	27%
38-40	0%	0%	1%	37%	46%	44%
Total	100%	100%	100%	100%	100%	100%
Source: USACE, Waterborne Commerce of the U.S., Part 2, IWR-WCSC-1970-2008-2						

Table 3D provides a separate breakout of crude oil tanker trips included in Table 3C. SNWW 2006-2008 tonnage is down due to the effects of hurricanes and planned outages for refinery expansion; however, regional imports increased at significantly higher rates than the nation until 2004 (Figure 3B). The effect of the major hurricanes is illustrated in Figure 3C.

TABLE 3D SNWW Inbound Crude Oil Tanker Trip Data (Trips and Tonnage)										
Loaded Draft (ft)	1990	1993	1999	2001	2002	2003	2004	2006	2007	2008
	SNWW Inbound Crude Oil Tanker Trips									
<=24	4%	3%	0%	0%	1%	0%	0%	0%	0%	1%
25-29	5%	4%	1%	1%	1%	0%	1%	2%	1%	3%
30-37	32%	58%	38%	38%	34%	38%	33%	42%	26%	29%
38-40	59%	36%	60%	60%	64%	61%	66%	55%	72%	66%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Crude Oil Imports (Millions of Short Tons)									
	20.3	32.6	53.8	64.2	66.4	70.2	69.9	69.7	57.6	49.9
Source: USACE, Waterborne Commerce of the U.S., Part 2, IWR-WCSC-1990-2008-2 and Navigation Data Center Detailed Files (unpublished). CY2005 data is not presented due to reporting problems with the loaded draft field										





Source: Aggregated from U.S. Department of Energy Monthly Import Statistics, 2004-2010

As noted on page 99 of the Appendix, Hurricane Rita's surge resulted in sand bars at the offshore entrance channel and silting of the Neches River Channel to Beaumont, which severely limited transit of the upper reaches for several months and tonnage diversions to other ports well into 2006. The effect of shoals in the entrance channel and silt deposits on the Neches River had a particularly strong effect on crude petroleum traffic due to the use of large heavily loaded vessels.

Specific estimation of future expectations concerning the relationship between loaded and design drafts and future utilization were made based on strong long-term historical utilization of the existing channel, industry interest in channel deepening, the lack of constraints at the points of origin, increasing concentration of larger vessels (Table 3E), and reductions in transportation costs (Table 3F). These trends are indicative that load patterns will continue to become more efficient. A major advantage of the 45- to 50-foot channel depth alternatives is that they reduce the number of shuttles needed to lighter a VLCC (Economic Appendix, Table 110) by allowing the increasingly large concentration of 90,000 to 119,999 DWT vessels to be loaded more fully. Vessels in this group have design drafts between 45 and 49 feet (Economic Appendix, Table 33). Table 3F illustrates the large concentration of 90,000 to 119,999 DWT vessels and the dramatic increase in their use since 1980. As shown in the Appendix, the design drafts for all vessels groups except those less than 50,000 DWT exceed 40 feet. Examination of the 2008 SNWW 50,000 to 74,500 DWT group showed a design draft range of 39 to 48 feet, with a median of 45 feet. For the <50,000 DWT range, the maximum design draft was 43 feet and the median 37 feet.

TABLE 3F
SNWW Crude Petroleum Imports by Vessel Size
Percentage of Imports by Vessel DWT

Vessel DWT (1000)	Median Design Draft	1980	1990	1993	1998	1999	2002	2003	2004	2006	2007	2008
<50	37	*	1%	0%	0%	0%	0%	1%	2%	1%	1%	2%
50–74.5	45	*	4%	1%	9%	9%	3%	2%	2%	3%	4%	4%
75–84.9	43	*	18%	8%	24%	9%	18%	20%	18%	25%	23%	18%
85–89.9	42	*	**17%**	**11%**	10%	10%	5%	1%	0%	0%	0%	0%
90–119.9	48	<1%	56%	72%	54%	66%	66%	68%	72%	64%	66%	70%
120–149.9	54	0%	2%	3%	1%	3%	3%	3%	3%	2%	2%	2%
150–175	53	0%	2%	5%	1%	5%	5%	6%	4%	5%	5%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: USACE, Navigation Data Center Detailed Files (unpublished), 1990-2008. CY2005 data is not presented due to reporting problems with the loaded draft field.
*Data from SNWW 1981-period report shows that the largest vessel size in 1980 was 99,600. Indications are that the most common were 60,000 to 78,000 DWT.

Table 3G displays the project average annual cost and benefits based on various assumptions associated with the percentage of crude petroleum imports that will be loaded to vessel drafts over 40 feet. The first column shows the benefits presented in Economic Appendix. The calculations in the remaining columns are based on alternative percentages. The results of this analysis, based on study region vessel utilization trends data from 1970-2008, industry expectations, and transportation cost savings indicate that it is reasonable to expect that a significant portion of future crude oil imports will be loaded to drafts over 40 feet given an increase in channel depth for the 50-year planning period starting in CY2019.

TABLE 3G SNWW Project Average Annual Costs and Benefits Sensitivity Scenarios for the Percentage of Crude Oil Loaded to Drafts Over 40 ft						
Channel Depth (ft)	Average Annual Cost ($1,000) at 4.375%					
45	$70,217					
46	$77,258					
47	$84,299					
48	$91,341					
49	$96,626					
50	$101,911					
Average Annual Benefits Calculations ($1,000's) at 4.375% Based on Variation in the Percentage of Future Tonnage Using Channel Depth Increase 2019-2069						
Depth (ft)	94%	50%	60%	70%	80%	100%
45	$83,841	$65,538	$69,651	$73,764	$77,877	$86,103
46	$95,856	$74,207	$79,072	$83,937	$88,802	$98,532
47	$104,303	$80,535	$85,876	$91,217	$96,558	$107,240
48	$115,074	$87,893	$94,001	$100,109	$106,217	$118,434
49	$122,875	$93,428	$100,045	$106,663	$113,280	$126,515
50	$127,696	$97,099	$103,974	$110,850	$117,726	$131,478
	Net Excess Benefits ($1,000) Based on Utilization Scenarios					
45	$13,624	-$4,679	-$566	$3,547	$7,660	$15,886
46	$18,598	-$3,051	$1,814	$6,679	$11,544	$21,274
47	$20,004	-$3,764	$1,577	$6,918	$12,259	$22,941
48	$23,733	-$3,448	$2,660	$8,768	$14,876	$27,093
49	$26,249	-$3,198	$3,419	$10,037	$16,654	$29,889
50	$25,785	-$4,812	$2,063	$8,939	$15,815	$29,567
	BCRs Based on Utilization Scenarios					
45	1.2	.0.9	.0.9	1.1	1.1	1.2
46	1.2	.0.9	1.0	1.1	1.1	1.3
47	1.2	.0.9	1.0	1.1	1.1	1.3
48	1.3	.0.9	1.0	1.1	1.2	1.3
49	1.3	.0.9	1.0	1.1	1.2	1.3
50	1.3	.0.9	1.0	1.1	1.2	1.3

4.0 LNG MARKET SHARE (IEPR COMMENT 3)

The first part of this section addresses the basis for the market share. Table 4A displays the EIA U.S. LNG import forecast and the SNWW LNG forecasts that appear in the in the Economic Appendix (Table 72). As noted in the Appendix LNG permits were approved for the Cheniere Sabine Pass, Exxon-Mobil Golden Pass, and the Sempra Port Arthur Terminals. Cheniere opened in 2008 and Golden Pass is scheduled to open by 2011. Construction of the Sempra Terminal is planned after 2012.

TABLE 4A U.S. and SNWW LNG Waterborne LNG Forecast Short Tons		
Year	U.S. Waterborne LNG Imports	SNWW Waterborne LNG Imports
2005	16,565,000	
2006	18,617,000	
2007	21,238,000	4,000
2008	12,072,000	39,000
2009	15,514,400	not available
2019	38,852,755	5,827,913
2020	38,045,447	9,511,362
2025	31,049,691	7,762,423
2029	24,698,681	6,174,670
2030	22,309,819	6,174,670
2069	22,309,819	6,174,670
Source: USACE, Waterborne Commerce of the U.S., Part 2, IWR-WCSC-2005-08, Parts 2 and 5 Navigation Data Center and the U.S. Department of Energy, 2009 Annual Energy Outlook, March 2009.		

As noted in the Appendix, the SNWW LNG forecast is based on a market share of 20 percent. Determination of the expected SNWW market forecast was based on evaluation of industry input, and a report prepared by Michael Gorecki of Alexander Aaron, Inc. in May 2007 for the Galveston District. The Alexander Aaron, Inc. report predicted that the distribution amongst the facilities would range from 28.6 to 41.5 percent. These percentages were based on SNWW LNG plant capacities in relationship to the U.S. total. The 28.6 percent share was based on SNWW having two LNG terminals and the 41.5 percent was based on SNWW having three LNG terminals. Table 4B displays the anticipated U.S. market share presented in the Alexander Aaron, Inc. report. These market shares were expected to be reasonable given construction progress and industry investments. As noted, construction is complete for the Cheniere Terminal and nearly complete for Golden Pass. The market analysis indicated that given two SNWW terminals, the region was likely to capture 28.6 percent of the U.S. LNG import market. The Galveston District used a lower percentage in order to account for uncertainty. The percentage used in the Appendix is 15 percent in 2019 and 25 percent for 2029-2069, with import tonnage remaining constant after 2030.

The remainder of this section addresses the effects of varying the market share used in the report. Table 4C displays the EIA U.S. LNG import forecast and a range of SNWW LNG forecasts.

TABLE 4B Anticipated U.S. LNG Market Share						
Name	Operational Bcf/d	Operational Rate	Annual Import Bcf	Operational Bcf/d	Operational Rate	Annual Import Bcf
Everett, MA	0.869	0.627	199.0	0.869	0.719	228.3
Cove Point, MD	1.512	0.627	346.2	1.512	0.719	397.1
Elba Island, GA	1.777	0.627	406.7	1.777	0.719	466.5
Lake Charles, LA	1.764	0.627	403.8	1.764	0.719	463.2
Sempra Hackberry, LA *	2.226	0.627	509.6	2.226	0.719	584.6
Freeport, TX *	3.360	0.627	769.2	3.360	0.719	882.4
SNWW LNG Terminals						
Cheniere *	3.360	0.627	769.2	3.360	0.719	882.4
Golden Pass *	2.268	0.627	519.2	2.268	0.719	595.6
Sempra	2.520	0.627	576.9			
Total	19.656		4500.0			

Special Report prepared for the Galveston District by Michael Gorecki of Alexander Aaron, Inc., Sabine-Neches Waterway Project Liquefied Natural Gas Market Share, May 2007

*New or under construction in 2010.

Bcf/d: Billion cubic feet per day

TABLE 4C SNWW Market Share Sensitivity Analysis				
	SNWW LNG Forecast Range			
Year	Economic Appendix	Half of the Economic Appendix Volume	28.6% of the U.S. Market	41.5% of the U.S. Market
2019	5,827,913	2,913,957	6,993,496	9,713,189
2030	6,174,670	3,087,335	7,582,495	13,164,397
2069	6,174,670	3,087,335	7,582,495	13,164,397
	Average Annual Benefits Calculations ($1,000's) at 4.375% Based on Range of SNWW LNG Market Shares, 2019-2069			
45	$83,841	$78,271	$86,312	$92,753
46	$95,856	$90,286	$98,327	$104,768
47	$104,303	$98,733	$106,774	$113,215
48	$115,074	$109,504	$117,545	$123,986
49	$122,875	$117,305	$125,346	$131,787
50	$127,696	$122,126	$130,167	$136,608
BCRs Based Range of SNWW LNG. Market Shares (The Average Annual Costs Used for the BCR Calculations are Shown at the top of Table 3G)				
45	1.2	1.1	1.2	1.3
46	1.2	1.2	1.3	1.4
47	1.2	1.2	1.3	1.3
48	1.3	1.2	1.3	1.4
49	1.3	1.2	1.3	1.4
50	1.3	1.2	1.3	1.3

The following tables summarize evaluation of the crude petroleum vessel utilization and LNG market share presented in Tables 4A and 4C.

In conclusion, the sensitivities presented in Tables 4A-4D indicate that project justification is much more sensitive to crude oil tanker vessel utilization than to LNG market share. The results of the analyses presented in Table 4D shows that if less than 60 percent of 2019-2069 crude oil imports are regularly loaded to drafts less than 40 feet, the BCR will fall below unity. While not shown in the table, the BCR remains at unity given a reduction in the LNG market share to one-half of the percentages of 15 percent in 2019 and 25 percent for 2029-2069 in combination with 65 percent of 2019-2069 crude oil imports being loaded to drafts over 40 feet. In conclusion, the tanker utilization data presented in Table 3A (1990-2008) and Table 3C (1970/72 and 2006/08) provide sufficient justification to reasonably conclude that the crude oil tanker fleet will continue to realize increased efficiencies under both the without and with project future.

In terms of the SNWW tonnage forecast and the use of the AEO forecasts, the EIA notes that the reasons for variations between the AEO and other forecasters are due to differences among the assumptions that underlie the different projections. For example, the AEO 2010 reference case generally assumes that current laws and regulations will continue through the projection period as enacted, whereas some of the other projections assume the enactment of new public policy over the next 25 years. For the SNWW analysis, the AEO forecast was utilized. The sensitivities analysis addresses the effects of lower forecasts which could occur for a variety of reasons, some of which may include policy changes not explicitly discussed in the Appendix.

5.0 CRUDE PETROLEUM TRADE ROUTE AND LIGHTERING ANALYSIS (IEPR COMMENT 4)

This response provides data and discussion concerning lightering volumes and trade route choices. These calculations were based on the assumption that 100 percent of crude oil imports from Middle East and Africa would be lightered. The transportation cost calculations were made on a cost-per-ton basis using the available specific vessel volumes lightered and given knowledge of the range of vessel sizes used. The specific distribution of shuttle vessels used for lightering and lightening is not known because the Corps' National Data Center data records do not provide that level of detail. However, the Economic Guidance Memorandum (EGM) deep-draft vessel operating costs were used to calculate and verify the most efficient range of vessels. Shuttle vessels used for lightering are 80,000 to 120,000 DWT vessels. The number of shuttle trips necessary to offload a 325,000 DWT class VLCC is shown in Table 110 of the Appendix. The volume unloaded at the lightering zone is constrained by channel depth and refinery input needs. Vessel size data were obtained from the detailed waterborne commerce statistics. The vessel sizes used for existing condition lightering are identified in the Appendix (Table 111). The vessel sizes

TABLE 4D SNWW Combined Analysis of LNG Market Sensitivity and Crude Oil Vessel Utilization Share						
	Scenario Description					
	Economic Appendix	Half of the LNG Market And 50% of Crude Petroleum Loaded to Drafts Over 40 ft	Half of the LNG Market And 70% of Crude Petroleum Loaded to Drafts Over 40 ft	28.6% the LNG Market And 80% of Crude Petroleum Loaded to Drafts Over 40 ft	41.5% the LNG Market And 80% of Crude Petroleum Loaded to Drafts Over 40 ft	41.5% the LNG Market And 100% of Crude Petroleum Loaded to Drafts Over 40 ft
Channel Depth (ft)	Average Annual Benefits Calculations ($1,000's) at 4.375% Based on Range of SNWW LNG Market Shares, 2019-2069					
45	$83,841	$59,968	$68,194	$80,348	$86,789	$95,015
46	$95,856	$68,637	$78,367	$91,273	$97,714	$107,444
47	$104,303	$74,965	$85,647	$99,029	$105,470	$116,152
48	$115,074	$82,323	$94,539	$108,688	$115,129	$127,346
49	$122,875	$87,858	$101,093	$115,751	$122,192	$135,427
50	$127,696	$91,529	$105,280	$120,197	$126,638	$140,390
Net Excess Benefits ($1000's) (The average annual costs used for the BCR calculations are shown at the top of Table 3G)						
45	$13,624	-$10,249	-$2,023	$16,572	$10,131	$24,798
46	$18,598	-$8,621	$1,109	$20,456	$14,015	$30,186
47	$20,004	-$9,334	$1,348	$21,171	$14,730	$31,853
48	$23,733	-$9,018	$3,198	$23,788	$17,347	$36,005
49	$26,249	-$8,768	$4,467	$25,566	$19,125	$38,801
50	$25,785	-$10,382	$3,369	$24,727	$18,286	$38,479
BCRs Based Range of SNWW LNG. Market Shares Range and Variation in Crude Petroleum Loaded Draft Utilization (The average annual costs used for the BCR calculations are shown at the top of Table 3G)						
45	1.2	0.9	.9	1.1	1.2	1.4
46	1.2	0.9	1.0	1.2	1.3	1.4
47	1.2	0.9	1.0	1.2	1.3	1.4
48	1.3	0.9	1.0	1.2	1.3	1.4
49	1.3	0.9	1.0	1.2	1.3	1.4
50	1.3	0.9	1.0	1.2	1.2	1.4

for existing condition lightening are identified in the Appendix (Table 112). Determination of the least costly method of shipment was based on comparison of direct shipment, lightering, and lightening costs using the Corps' EGM deep-draft vessel operating cost and optimal lightering turnaround data published in the Skaugen PetroTrans "Introduction to Lightering" along with periodic inquiries to the Skaugen PetroTrans company and other oil company personnel. Table 5A displays lightering cost components by major trade route for the segment from the foreign port of origin to the Gulf of Mexico lightering zone used in the Corps analysis.

	TABLE 5A **Lightering Cost for Traditional 325,000 DWT Vessel**
325,000	Mother Vessel DWT
0.97	Max load Ratio
315,250	Fully-loaded cargo capacity
15	Speed (knots)
$2,114	Hourly Cost at Sea (Economic Guidance Memorandum)
$1,377	Hourly Cost in Port Economic Guidance Memorandum)
24,917	Mideast Round Trip Mileage Via Cape to Lightering Zone
19,509	Mideast Round Trip Mileage Via Suez to Lightering Zone
11,488	Africa/North Sea Round Trip Mileage to Lightering zone
3,805	Venezuela Round Trip Mileage to Lightering Zone
1,220	Mexico Round Trip Mileage to Lightering Zone
$82,710	Loading Cost at Origin Port (based on loading rate of 5,250 tons per hour)
$3,593,602	Total Transportation Cost (Middle East via Cape)
$2,831,596	Total Transportation Cost (Middle East via Suez)
$1,701,409	Total Transportation Cost (Africa/North Sea)
$618,847	Total Transportation Cost (Venezuela/Eastern South America)
$254,612	Total Transportation Cost (Mexico)
$11.40	Middle East Cost Per Ton via Cape
$8.98	Middle East Cost Per Ton via Suez
$5.40	Africa/North Sea Cost/ton
$1.96	Venezuela/Eastern South America Cost/ton
$0.81	Mexico Cost/ton

Table 5B displays the number of shuttles needed to fully load a 325,000 DWT vessel and Table 5C lists the number of hours needed to offload the 325,000 DWT vessel based on a range of shuttle vessels from 90,000 to 135,000 DWT. Based on per-ton transportation costs, this range represents the maximum efficiencies. Use of smaller shuttles is not cost effective when lightering (see Tables 5C-5H). In order to illustrate this point, a 42,500 DWT tanker is included in the Tables 5B-5G. Tables 5B-5E provide input data and Tables 5F and 5G display the cost per ton lightering cost for the Middle East and Africa/Mediterranean/ North Sea routing, respectively. The cost for direct shipment is presented in Tables 5H and 5I. Table 5H presents the direct shipment cost for Africa/North Sea/Mediterranean and Middle East routings. Table 5I presents the direct shipment cost for Mexico and Venezuela/Eastern South America.

TABLE 5B
Number of Shuttles Needed to Unload a 325,000 DWT Tanker

Channel Depth ft.	Shuttle Vessel DWT							
	42,500	90,000	110,000	115,000	120,000	125,000	130,000	135,000
40	9.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0
43	9.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0
44	9.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0
45	9.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
46	9.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
47	9.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
48	9.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0
49	9.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0
50	9.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0

TABLE 5C
Number of Hours to Offload 325,000 DWT Tanker Based on Channel Depth Alternative and Shuttle DWT

Channel Depth ft.	Shuttle Vessel DWT							
	42,500	90,000	110,000	115,000	120,000	125,000	130,000	135,000
40	67.0	64.0	70.1	71.9	73.6	60.2	61.4	62.5
43	67.0	71.1	62.5	64.1	65.6	67.1	68.5	69.8
44	67.0	73.4	64.6	66.3	67.9	69.4	70.9	72.2
45	67.0	60.6	66.8	68.5	70.2	71.7	73.2	74.7
46	67.0	62.5	68.9	70.7	72.4	74.1	75.6	77.1
47	67.0	64.4	71.1	72.9	74.7	76.4	78.0	79.5
48	67.0	65.1	73.2	75.1	76.9	78.7	60.3	61.5
49	67.0	65.1	75.3	77.3	79.2	60.7	62.1	63.3
50	67.0	65.1	77.5	79.5	61.1	62.5	63.8	65.1

TABLE 5D
Cost to Offload 325,000 DWT Tanker Based on Channel Depth Alternative and Shuttle DWT

Channel Depth ft.	Shuttle Vessel DWT							
	42,500	90,000	110,000	115,000	120,000	125,000	130,000	135,000
40	$141,668	$135,300	$148,148	$151,936	$155,527	$127,137	$129,693	$132,092
43	$141,668	$150,220	$132,089	$135,492	$138,736	$141,823	$144,752	$147,522
44	$141,668	$155,194	$136,613	$140,139	$143,508	$146,718	$149,771	$152,665
45	$141,668	$128,134	$141,137	$144,787	$148,280	$151,614	$154,790	$157,809
46	$141,668	$132,113	$145,660	$149,435	$153,051	$156,509	$159,810	$162,952
47	$141,668	$136,091	$150,184	$154,082	$157,823	$161,405	$164,829	$168,095
48	$141,668	$137,683	$154,708	$158,730	$162,594	$166,300	$127,386	$129,929
49	$141,668	$137,683	$159,232	$163,378	$167,366	$128,397	$131,151	$133,786
50	$141,668	$137,683	$168,279	$176,532	$138,589	$144,778	$150,968	$157,158

TABLE 5E
Cost for Shuttle Travel Time Set-Up/Associated Logistics,
Based on Channel Depth Alternative and Shuttle DWT (Middle East Routings)

Channel Depth ft.	Shuttle Vessel DWT							
	42,500	90,000	110,000	115,000	120,000	125,000	130,000	135,000
40	$266,308	$147,949	$147,949	$147,949	$147,949	$118,359	$118,359	$118,359
43	$266,308	$147,949	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359
44	$266,308	$147,949	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359
45	$266,308	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359
46	$266,308	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359
47	$266,308	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359	$118,359
48	$266,308	$118,359	$118,359	$118,359	$118,359	$118,359	$88,769	$88,769
49	$266,308	$118,359	$118,359	$118,359	$118,359	$88,769	$88,769	$88,769
50	$266,308	$118,359	$118,359	$118,359	$88,769	$88,769	$88,769	$88,769

TABLE 5F
Total Cost Per Ton for Mother and Shuttle Vessels based on Vessel Range
and Channel Depth Alternative (Middle East Routings)

Channel Depth ft.	Shuttle Vessel DWT							
	42,500	90,000	110,000	115,000	120,000	125,000	130,000	135,000
40	$15.21	$14.34	$14.40	$14.45	$14.45	$14.25	$14.24	$14.25
43	$15.22	$14.24	$14.10	$14.15	$14.15	$14.14	$14.14	$14.15
44	$15.22	$14.21	$14.07	$14.12	$14.13	$14.12	$14.11	$14.12
45	$15.22	$13.99	$14.05	$14.10	$14.10	$14.10	$14.09	$14.10
46	$15.22	$13.96	$14.02	$14.07	$14.08	$14.07	$14.07	$14.08
47	$15.22	$13.94	$14.00	$14.05	$14.05	$14.05	$14.04	$14.06
48	$15.22	$13.93	$13.98	$14.03	$14.04	$14.03	$13.80	$13.81
49	$15.22	$13.93	$13.97	$14.02	$14.02	$13.79	$13.78	$13.79
50	$15.22	$13.93	$13.96	$14.02	$13.80	$13.80	$13.81	$13.83

TABLE 5G
Total Cost Per Ton for Mother and Shuttle Vessels based on Vessel Range
and Channel Depth Alternative (Africa, North Sea, and Mediterranean Routings)

Channel Depth ft.	Shuttle Vessel DWT							
	42,500	90,000	110,000	115,000	120,000	125,000	130,000	135,000
40	$9.21	$8.34	$8.40	$8.45	$8.45	$8.25	$8.24	$8.25
43	$9.21	$8.24	$8.10	$8.15	$8.15	$8.14	$8.13	$8.14
44	$9.21	$8.21	$8.07	$8.12	$8.12	$8.12	$8.11	$8.12
45	$9.21	$7.99	$8.05	$8.10	$8.10	$8.09	$8.09	$8.10
46	$9.21	$7.96	$8.02	$8.07	$8.07	$8.07	$8.06	$8.07
47	$9.21	$7.94	$8.00	$8.05	$8.05	$8.05	$8.04	$8.05
48	$9.21	$7.93	$7.98	$8.03	$8.03	$8.03	$7.80	$7.81
49	$9.21	$7.93	$7.97	$8.02	$8.02	$7.78	$7.78	$7.79
50	$9.21	$7.93	$7.96	$8.02	$7.80	$7.80	$7.81	$7.83

TABLE 5H Africa/North Sea/Mediterranean and Middle East Direct Shipment Transportation Cost							
Africa/North Sea/Mediterranean							
	40	45	46	47	48	49	50
70000	$16.04	$13.59	$13.19	$12.81	$12.81	$12.81	$12.81
75000	$15.40	$12.40	$11.95	$11.52	$11.13	$10.78	$10.44
80000	$14.29	$12.11	$11.75	$11.75	$11.75	$11.75	$11.75
85000	$14.21	$12.03	$11.66	$11.42	$11.42	$11.42	$11.42
90000	$14.00	$11.86	$11.50	$11.17	$11.04	$11.04	$11.04
100000	$13.57	$11.51	$11.18	$10.86	$10.55	$10.27	$10.21
105000	$13.84	$11.68	$11.32	$10.99	$10.67	$10.38	$10.09
110000	$13.70	$11.56	$11.21	$10.88	$10.58	$10.29	$10.01
120000	$13.60	$11.47	$11.12	$10.79	$10.49	$10.20	$9.92
135000	$13.48	$11.35	$11.00	$10.67	$10.37	$10.08	$9.80
150000	$13.55	$11.36	$11.00	$10.67	$10.36	$10.07	$9.79
165000	$13.55	$11.36	$11.00	$10.67	$10.36	$10.07	$9.79
Middle East							
	40	45	46	47	48	49	50
80000	$23.58	$19.93	$19.33	$19.33	$19.33	$19.33	$19.33
90000	$22.52	$19.10	$18.53	$18.00	$17.80	$17.80	$17.80
100000	$22.61	$19.09	$18.51	$17.96	$17.45	$16.96	$16.87
110000	$22.52	$18.95	$18.36	$17.81	$17.30	$16.82	$16.36
120000	$22.31	$18.75	$18.17	$17.63	$17.12	$16.64	$16.18
135000	$22.12	$18.55	$17.97	$17.42	$16.91	$16.43	$15.97
150000	$22.21	$18.55	$17.96	$17.40	$16.88	$16.40	$15.93
165000	$22.21	$18.55	$17.96	$17.40	$16.88	$16.40	$15.93
175000	$20.86	$17.33	$16.76	$16.23	$15.73	$15.26	$14.82
325000	$24.93	$20.04	$19.29	$18.59	$17.95	$17.36	$16.81

TABLE 5I Mexico and Venezuela/Eastern South America Direct Shipment Transportation Cost							
Mexico							
	40	45	46	47	48	49	50
70000	$3.17	$2.69	$2.61	$2.54	$2.54	$2.54	$2.54
75000	$3.20	$2.68	$2.59	$2.51	$2.44	$2.44	$2.44
80000	$2.86	$2.43	$2.36	$2.36	$2.36	$2.36	$2.36
85000	$2.81	$2.40	$2.33	$2.28	$2.28	$2.28	$2.28
90000	$2.77	$2.37	$2.30	$2.23	$2.21	$2.21	$2.21
100000	$2.79	$2.38	$2.31	$2.25	$2.19	$2.13	$2.11
105000	$2.78	$2.37	$2.30	$2.24	$2.18	$2.12	$2.06
110000	$2.78	$2.37	$2.30	$2.23	$2.17	$2.12	$2.06
120000	$2.80	$2.38	$2.31	$2.25	$2.19	$2.13	$2.08
135000	$2.76	$2.34	$2.27	$2.21	$2.15	$2.10	$2.04
150000	$2.78	$2.35	$2.28	$2.21	$2.15	$2.10	$2.04
165000	$2.78	$2.35	$2.28	$2.21	$2.15	$2.10	$2.04
Venezuela and Eastern South America							
	40	45	46	47	48	49	50
70000	$8.46	$7.18	$6.97	$6.76	$6.76	$6.76	$6.76
75000	$8.56	$7.14	$6.91	$6.70	$6.49	$6.49	$6.49
80000	$7.63	$6.46	$6.26	$6.26	$6.26	$6.26	$6.26
85000	$7.50	$6.36	$6.17	$6.04	$6.04	$6.04	$6.04
90000	$7.07	$6.04	$5.87	$5.71	$5.65	$5.65	$5.65
100000	$7.35	$7.18	$6.97	$6.76	$6.76	$6.76	$6.76
105000	$7.33	$6.20	$6.01	$5.84	$5.67	$5.52	$5.37
110000	$7.32	$6.18	$6.00	$5.82	$5.66	$5.51	$5.35
120000	$7.29	$6.15	$5.97	$5.79	$5.63	$5.47	$5.32
135000	$7.22	$6.07	$5.89	$5.71	$5.55	$5.40	$5.25
150000	$7.25	$6.08	$5.89	$5.71	$5.55	$5.39	$5.24
165000	$7.25	$6.08	$5.89	$5.71	$5.55	$5.39	$5.24

Table 5J presents the lightening cost for the Africa/North Sea/Mediterranean route. Lightening represents a less costly shipping method than direct shipment for Africa/North Sea/Mediterranean routing; however, it is less competitive than lightering. As noted in the Appendix, lightening was historically the most common choice for Africa and the North Sea movements; however, it has become more common for the Africa/North Sea/ Mediterranean routes in recent years due to structural changes in oil production off the coast of West Africa. For this reason, the Africa/North Sea/Mediterranean cost calculations reflect lightering (Appendix, Table 111). Use of an average between lightering and lightening cost for this route may have been a more appropriate choice.

TABLE 5J
SNWW Crude Petroleum Lightening Cost

DWT: 165,000		Hourly Cost at Sea: $1,439 (Appendix, p. 148)				Transportation Cost Per Ton: $7.02 (Table 5A)	
Fully loaded cargo: 160,050 short tons		Hourly Cost in Port: $922 (Appendix p. 148)					
Channel Depth	40 ft	45ft	46ft	47ft	48ft	49ft	50ft
Maximum Cargo	88,690	106,894	110,535	110,535	114,176	121,458	117,817
Cargo Offloaded	71,360	53,156	49,515	49,515	45,874	38,592	42,233
Shuttle DWT Needed	77,500	60,000	56,667	58,000	50,000	42,500	47,500
Hourly at Sea Cost	$1,044	$952	$923	$923	$865	$816	$849
Hourly in Port Cost	$682	$622	$599	$599	$554	$518	$542
Mother Vessel (MV) Unloading Cost Based on Standard Unloading Rate of 5,250 short tons/hr multiplied by the MV At Sea Cost, Offshore Lightened Cargo							
	$19,559	$14,570	$13,572	$13,572	$12,574	$10,578	$11,576
Mother Vessel (MV) Waiting Time and Associated Logistics							
4hrs Minimum	$34,536	$34,536	$34,536	$34,536	$34,536	$34,536	$34,536
8 hrs Most Likely	$17,268	$17,268	$17,268	$17,268	$17,268	$17,268	$17,268
12 hrs Maximum	$51,804	$51,804	$51,804	$51,804	$51,804	$51,804	$51,804
MV Travel Cost from Offshore Lightering Zone to Dockside (Estimated Travel Time is 12 hours)							
	$34,536	$34,536	$34,536	$34,536	$34,536	$34,536	$34,536
Pilot Cost	$46,194	$50,282	$50,754	$51,225	$52,200	$53,174	$53,174
Tug Cost	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
MV Unloading Cost for Remaining Cargo In Port (Based on Unloading Rate of 5,250, Hourly Port Cost, and 2 Hours for Customs)							
	$17,420	$20,617	$21,256	$21,256	$21,895	$23,174	$22,535
Total Cost for Mother Vessel (Sum of the Above Cost Divided by the Offshore Lightened Cargo)							
Minimum	$8.66	$8.40	$8.36	$8.36	$8.32	$8.25	$8.29
Most Likely	$8.72	$8.45	$8.41	$8.41	$8.37	$8.29	$8.34
Maximum	$9.11	$8.78	$8.72	$8.72	$8.68	$8.58	$8.63
Shuttle Vessel Transportation Cost to the Lightering Zone							
	$25,050	$22,848	$22,152	$22,152	$20,760	$19,572	$20,364
Shuttle Cost While Lightering							
	$14,187	$9,639	$8,705	$8,705	$7,558	$5,995	$6,826
Unloaded Cost in Port and Associated Logistics for Shuttle Vessel							
	$16,374	$14,928	$14,384	$14,384	$13,296	$12,420	$13,004
Pilot Cost	$27,795	$24,996	$24,594	$24,594	$23,508	$21,781	$22,337
Tug Cost	$8,000	$8,000	$4,000	$4,000	$4,000	$4,000	$4,000
Supply Vessel Transportation Cost to Lightering Zone							
	$11,864	$11,864	$11,864	$11,864	$11,864	$11,864	$11,864
Supply Vessel While Lightering							
	$13,659	$10,621	$10,014	$10,014	$9,406	$8,191	$8,799
Total Cost/Ton for Lightening Operation (Includes Mother Vessel, Shuttle, and Supply Vessel) a/ b/							
Minimum	$10.30	$10.34	$10.29	$10.29	$10.29	$10.42	$10.35
Most Likely	$10.36	$10.39	$10.34	$10.34	$10.34	$10.47	$10.40
Maximum	$10.75	$10.71	$10.65	$10.66	$10.65	$10.75	$10.69

a/ Maximum cost reductions occur at the 46-foot channel depth.

b/ There are some differences between the costs per ton shown here and what is presented in the Economic Appendix (Table 112), with these costs being slightly less that those presented in the table; however, lightening was still found to be higher relative to lightering.

The remainder of this comment response addresses uncertainty pertaining to the trade route shipments of Venezuelan and other new routes such as Brazil. Application of the FY2008 EGM costs and the lightering company operational expectations of optimal turnaround times indicated that the resulting costs per ton suggested uncertainties. This uncertainty increased based on the release of the FY2008 vessel operating cost release, which showed a 17 percent drop in hourly costs for foreign flag tankers shown in the Appendix. Uncertainties associated with the transportation cost application are particularly high for routings that include Venezuela and Brazil because they have relatively short travel distance compared to the Middle East routes. For the Middle East, the relatively low FY2008 EGM costs showed that lightering is less costly than direct shipment. Additionally, the cost analyses for Africa crude showed that lightering is less costly than direct shipment, although by a comparatively smaller margin. However, the application for the Venezuelan routing revealed cost incentives to lighter which were not found using the higher vessel operating costs for the established optimal lightering turnaround time assumptions. As indicated, the cost of direct shipment is close to that for lightering and specifically relates to the operational assumptions based on optimal turnaround times and seamless logistics from the lightering company. The lightering company and industry indicate that it is not cost effective to lighter Venezuelan products.

Given the uncertainty associated with lightering logistics and associated transfer times, a sensitivity analysis was prepared evaluating the effect of minimum and maximum turnaround times. Table 5K displays columns showing both the mother vessel offshore unloading times and waiting times used for the analysis presented in the Economic Appendix, as well as the times for this sensitivity analysis. The times used in the Appendix suggest that multiple shuttles would be loaded simultaneously using innovations to be developed over the 2010-2069 future. However, these innovations were found not to be realistic for existing or future conditions. In the sensitivity analysis the offshore times are considered reasonable, given standard unloading time. For instance using a standard unloading rate of 5,250 tons per hour, it would take 60 hours to unload (lighter) a 325,000 DWT tanker ((325,000 * 0.97 capacity)/(5,250 short tons per hour). This sensitivity is included because of concerns that assumptions based on optimal offshore turnaround time, optimal scheduling of shuttle arrivals, and perhaps lower than realistic vessel operating cost, such as the Corps' FY08 tanker vessel operating costs being 17 percent lower than the FY07 release, result in criteria that is unrealistically conservative. The sensitivity was found to be representative of actual conditions while by comparison the times used for the base are not realistic.

An additional component modified for this sensitivity was to separate Venezuela products from those from Brazil. While shipments of crude oil from Brazil to SNWW are presently less than 1 percent, future expectations are that this will change. The Appendix analysis included Venezuela and Brazil as one

TABLE 5K Mother Vessel Combined Time Offloading and Waiting Between Shuttles				
	Mother Vessel Offshore Hours (Appendix)		Mother Vessel Offshore Hours (Sensitivity)	
Component	**Lightering**	*Lightening*	**Lightering**	*Lightening*
Minimum (hrs)	**8**	*8*	**60**	*24*
Most Likely (hrs) *	**12**	*12*	**60 ***	*31 **
Maximum (hrs)	**36**	*36*	**168**	*120*
Hours Used for Calculation	**12**	*12*	**96 ***	*30 **

*The most likely time for the mother vessel for **lightering** is based on a 325,000 DWT tanker, a cargo to short ton ratio of 0.97, and an unloading rate of 5,250 short tons per hour. The most likely time for the mother vessel for *lightening* is based on a 165,000 DWT tanker, a cargo to short ton ratio of 0.97, and an unloading rate of 5,250 short tons per hour. The hours used for calculation are based on a @risk triangular distribution using the minimum, most likely, and maximum values shown. The maximum values used as input into the @risk distribution are noted quotes from the lightering company.

region. Table 5L displays the transportation cost with Brazil separated out from Venezuela. Table 5M displays the results of using the routing shown in Table 5L and the mother vessel sensitivity-based times from Table 5J (i.e. 96 hours offshore for the lightering mother vessel and 30 hours offshore for the lightening mother vessels).

TABLE 5L
SNWW Crude Petroleum Imports Transportation Cost ($1,000) by Channel Depth Alternative
(same as Table 111, Economic Appendix)

Trade Route and Cost/Ton	40	45	46	47	48	49	50
Mexico	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Cost/Ton Beaumont	$2.76	$2.34	$2.28	$2.21	$2.15	$2.11	$2.07
Cost/Ton Port Arthur	$2.77	$2.37	$2.30	$2.23	$2.18	$2.14	$2.11
Venezuela & E South America	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Cost/Ton Beaumont	$7.22	$6.09	$5.91	$5.73	$5.58	$5.45	$5.34
Cost/Ton Port Arthur	$7.28	$6.17	$5.98	$5.81	$5.67	$5.55	$5.47
Africa/North Sea	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered
Cost/Ton Beaumont	$8.41	$8.18	$8.13	$8.12	$8.05	$8.01	$8.01
Cost/Ton Port Arthur	$8.46	$8.19	$8.13	$8.12	$8.12	$8.11	$8.08
Middle East	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered
Cost/Ton Beaumont	$14.43	$14.20	$14.15	$14.13	$14.06	$14.03	$14.03
Cost/Ton Port Arthur	$14.48	$14.19	$14.13	$14.11	$14.11	$14.10	$14.06

TABLE 5L-1
SNWW Economic Summary Data
Average Annual Costs and Benefits, Net Excess Benefits and BCRs by Channel Depth Alternative
(As Included in Table 141, Economic Appendix)

Cost Component	45	46	47	48	49	50
Total Annual Cost ($1,000)	$70,217	$77,258	$84,299	$91,341	$96,626	$101,911
Average Annual Benefits ($1,000)	$83,841	$95,856	$104,30	$115,074	$122,875	$127,696
Net Excess Benefits ($1,000)	$13,624	$18,598	$20,004	$23,733	$26,249	$25,785
B/C Ratios	1.2	1.2	1.2	1.3	1.3	1.3

TABLE 5M
SNWW Crude Petroleum Imports Transportation Cost ($1,000) by Channel Depth Alternative
Separate Breakout of Venezuela and Brazil, with 100% of Brail Imports Lightered and
Sensitivity of Realistic Offshore Transfer Times

Trade Route and Cost/Ton	40	45	46	47	48	49	50
Mexico	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Cost/Ton Beaumont	$2.76	$2.34	$2.28	$2.21	$2.15	$2.11	$2.07
Cost/Ton Port Arthur	$2.77	$2.37	$2.30	$2.23	$2.18	$2.14	$2.11
Venezuela	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Cost/Ton Beaumont	$4.87	$4.58	$4.44	$4.31	$4.20	$4.10	$4.02
Cost/Ton Port Arthur	$4.89	$4.60	$4.46	$4.33	$4.23	$4.14	$4.08
Brazil	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered	Lighter
Cost/Ton Beaumont	$6.68	$6.50	$6.47	$6.46	$6.40	$6.37	$6.37
Cost/Ton Port Arthur	$6.72	$6.51	$6.47	$6.46	$6.45	$6.45	$6.42
Africa/North Sea	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered	Lighter
Cost/Ton Beaumont	$8.41	$8.18	$8.13	$8.12	$8.05	$8.01	$8.01
Cost/Ton Port Arthur	$8.46	$8.19	$8.13	$8.12	$8.12	$8.11	$8.08
Middle East	Lightered	Lightered	Lightered	Lightered	Lightered	Lightered	Lighter
Cost/Ton Beaumont	$14.43	$14.20	$14.15	$14.13	$14.06	$14.03	$14.0
Cost/Ton Port Arthur	$14.48	$14.19	$14.13	$14.11	$14.11	$14.10	$14.0

TABLE 5M-1
SNWW Economic Summary Data
Average Annual Costs and Benefits, Net Excess Benefits and BCRs by Channel Depth Alternative
Based on Inclusion of a Separate Breakout of Venezuela and Brazil, with 100% of Brail Imports Lightered

Cost Component	45	46	47	48	49	50
Total Annual Cost ($1,000)	$70,217	$77,258	$84,299	$91,341	$96,626	$101,911
Average Annual Benefits ($1,000)	$91,523	$105,287	$112,44	$126,830	$135,987	$142,323
Net Excess Benefits ($1,000)	$21,306	$28,029	$28,150	$35,489	$39,361	$40,412
B/C Ratios	1.3	1.4	1.3	1.4	1.4	1.4

Table 5N summarizes the data aggregated and incorporates the critical sensitivities evaluated under Comment 3. It was found in preparation of the response to Comment 4 that the duration of the VLCC offshore times used in the Appendix analysis was unrealistically low. For this aspect of the analysis, the sensitivity was found to be representative of actual conditions.

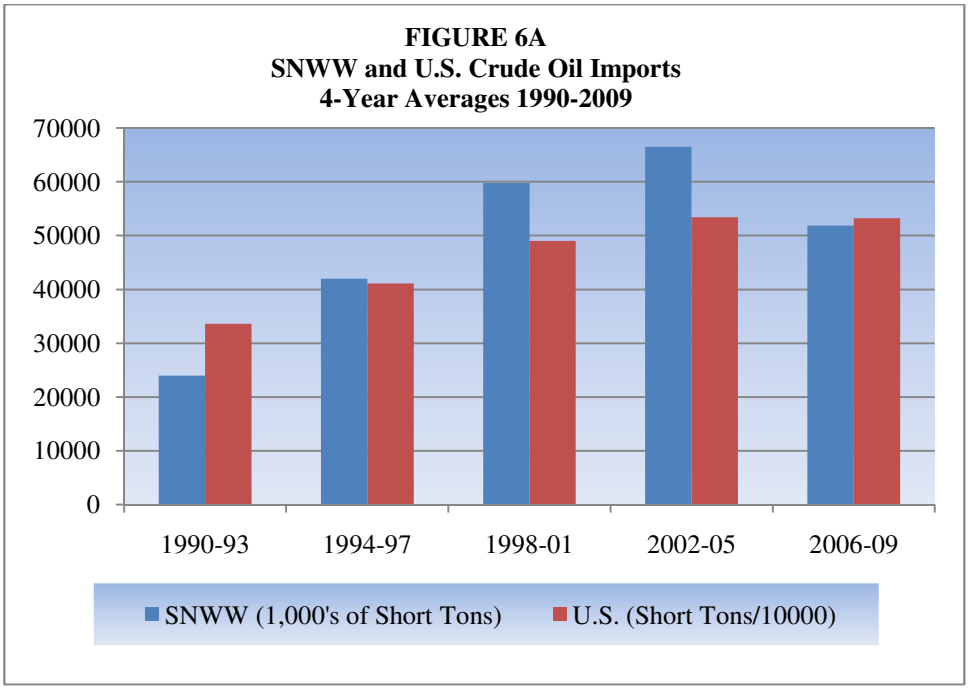
In conclusion, the results of the data and the additional sensitivities presented provide sufficient justification to reasonably conclude that the recommended plan for the 48-foot depth is economically justified.

TABLE 5N
SNWW Combined Analysis of LNG Market Sensitivity and Crude Oil Vessel Utilization Share

	Scenario Description					
	Economic Appendix (Table 141)	Half of the LNG Market And 50% of Crude Petroleum Loaded to Drafts Over 40 ft	Half of the LNG Market And 70% of Crude Petroleum Loaded to Drafts Over 40 ft	Half the LNG Market And 70% of Crude Petroleum Loaded to Drafts Over 40 ft	Economic Appendix LNG Market And 80% of Crude Petroleum Loaded to Drafts Over 40 ft	Economic Appendix LNG Market And 80% of Crude Petroleum Loaded to Drafts Over 40 ft (Same as Table 4D)
		Separate Breakout of Venezuela and Brazil, with 100% of Brail Imports Lightered	Separate Breakout of Venezuela and Brazil, with 100% of Brail Imports Lightered	Separate Breakout of Venezuela and Brazil, with 100% of Brail Imports Lightered and Inclusion of Sensitivity Realistic Offshore Transfer Time Sensitivity	Separate Breakout of Venezuela and Brazil, with 100% of Brail Imports Lightered and Inclusion of Sensitivity Realistic Offshore Transfer Time Sensitivity	Separate Breakout of Venezuela and Brazil, with 100% of Brail Imports Lightered and Inclusion of Sensitivity Realistic Offshore Transfer Time Sensitivity
Channel Depth (ft)	Average Annual Benefits Calculations ($1,000's) at 4.375% Based on Range of SNWW LNG Market Shares, 2019-2069					
45	$83,841	$64,936	$67,644	$80,944	$88,558	$91,523
46	$95,856	$74,458	$77,669	$93,737	$101,748	$105,287
47	$104,303	$81,033	$84,508	$100,576	$108,719	$112,449
48	$115,074	$89,251	$93,249	$113,762	$122,392	$126,830
49	$122,875	$95,196	$99,514	$122,248	$131,152	$135,987
50	$127,696	$98,699	$103,129	$128,154	$137,234	$142,323
	Net Excess Benefits ($1000's) (The Average Annual Costs Used for the BCR Calculations are Shown at the top of Table 4A)					
45	$13,624	-$5,281	-$2,573	$10,727	$18,341	$21,306
46	$18,598	-$2,800	$411	$16,479	$24,490	$28,029
47	$20,004	-$3,266	$209	$16,277	$24,420	$28,150
48	$23,733	-$2,090	$1,908	$22,421	$31,051	$35,489
49	$26,249	-$1,430	$2,888	$25,622	$34,526	$39,361
50	$25,785	-$3,212	$1,218	$26,243	$35,323	$40,412
	BCRs Based Range of SNWW LNG. Market Shares Range and Variation in Crude Petroleum Loaded Draft Utilization (The Average Annual Costs Used for the BCR Calculations are Shown at the top of Table 4A)					
45	1.2	0.9	.9	1.2	1.3	1.3
46	1.2	0.9	1.0	1.2	1.3	1.4
47	1.2	0.9	1.0	1.2	1.3	1.3
48	1.3	0.9	1.0	1.2	1.3	1.4
49	1.3	0.9	1.0	1.3	1.4	1.4
50	1.3	0.9	1.0	1.3	1.3	1.4

6.0 CRUDE PETROLEUM MARKET SHARE AND TONNAGE FORECAST (IEPR COMMENT 6)

In overall terms and in spite of a recent decline in the SNWW share of the U.S. total, comparison of overall regional imports using 4-year averages from 1990-2009 shows that SNWW imports grew by 117 percent in comparison to a U.S. increase of 58 percent. During the period from 2004 to 2009, SNWW's refinery capacity increased from 6 percent to 6.5 percent (Economic Appendix, Table 10). Port Arthur refinery capacity in 2009 is nearly 13 percent higher than in 2004, with additional expansions scheduled. Motiva announced plans for a 325,000 barrel-per-day (BPD) refinery expansion in Port Arthur in December 2007. Additionally, expansion of the Motiva-Port Arthur refinery is currently underway and expected to be complete by 2012. Motiva's current capacity of 285,000 BBD will increase to 610,000 BBD until completion.



Source: Aggregated from U.S. Army Corps of Engineers, Waterborne Commerce of the U.S and U.S. Department of Energy, Energy Information Administration data.

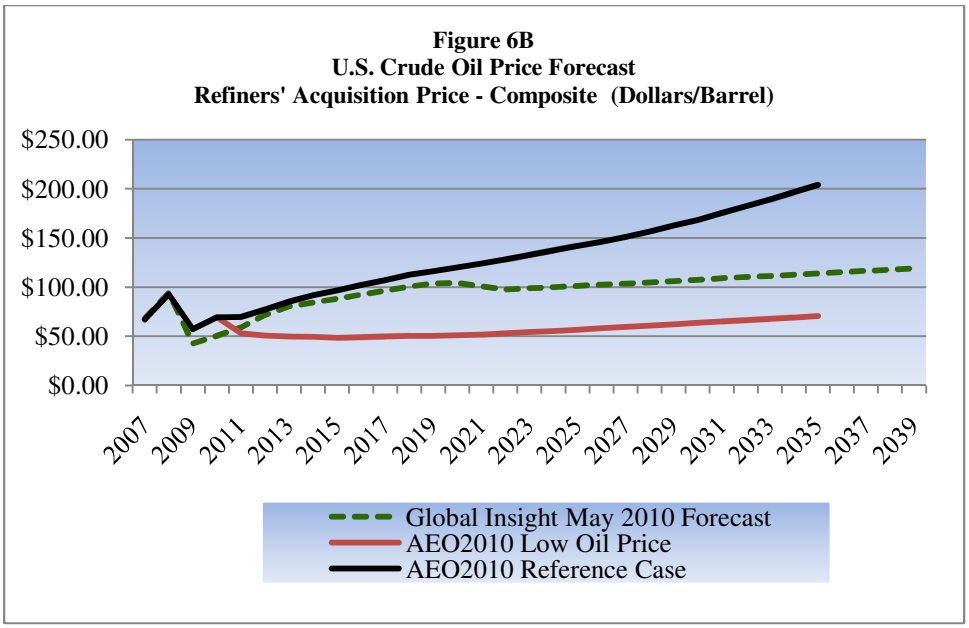
Regarding expectations concerning the region's percentage share of the U.S. market, SNWW's relative share has been affected by a combination of factors, both regional and national. Regionally, the share has been affected by hurricanes. Additionally, its relative share of the U.S. total has also been affected by the large influx of Canadian crude to the U.S. Midwest. Presently less than 1 percent of Canadian crude is transported to SNWW, with the majority of that being transported by vessel. Expansion of the Keystone TransCanada Pipeline to the U.S. Gulf Coast ports that include Port Arthur and Houston remains uncertain. SNWW refinery representatives do not foresee increases in their receipt of Canadian crude. While industry is noncommittal, interest in current pipeline delivery and the TransCanada Pipeline

Expansion was noted to be limited to the companies that buy excess oil for resale and transmittal to various SNWW, Texas City, and Houston refineries. This market is characteristically uncertain and small and the Gulf Coast represents a relatively high transmittal cost in comparison to markets in the U.S. Midwest. Texas imports of Canadian crude for 2005-2009 by pipeline and vessel averaged 1.1 percent, with a low of 0.6 percent in 2008 and a high of 1.5 percent in 2008. This issue's conclusion is that long-term expectations concerning the specific volume of Canadian crude that could be pipelined into the study region will remain uncertain in the short-term. Realization would depend upon high oil prices, among other factors. But with falling demand, falling crude oil prices, and carbon emission concerns, forecasts of future Canadian oil sands production have declined, as have expectations of likely volumes reaching the Gulf Coast in the near future.

The U.S. Department of Energy's Annual Energy Outlook 2007 (AEO 2007) forecast was used for the March 2007 Economic Appendix provided for IEPR. During the review period, the Galveston District continued to review new forecasts as they were released. The SNWW crude oil imports forecasts in the 2008 and 2009 draft reports reflect forecast modifications that are more conservative than the AEO 2007. The AEO 2008 showed a significant change from the AEO 2007 and from Global Insight's 2008 forecast release. The AEO 2008 release occurred at the same time that Motiva Port Arthur refinery expansion was announced. The Motiva expansion and SNWW's existing role as the largest waterway port of entry for petroleum suggested that Global Insight's slightly higher forecast was likely to be more reflective of long-term regional trends. Global Insight's 2008 forecast was subsequently used in the 2008 draft report and their 2009 forecast was used in current report.

In regard to differences between the AEO and Global Insight, the major difference between the two is that AEO forecasts much higher domestic crude oil production throughout the projection period than other noted forecasters. As noted in the AEO website, their forecast not only shows higher domestic production, it also shows a rapid increase in domestic production. Other differences pertain to the forecast price of crude oil. The figure below provides a comparison of the AEO 2010 Reference and low oil price based forecast with Global Insight's May 2010 price forecast release.

Table 6A displays the U.S. oil import data evaluated during 2008-09 preparation of the Appendix and since its submittal. Table 6B presents regression equation outputs using the AEO 2010 Reference and Low Price case scenarios. The regression equations were prepared using 1990-2007 and 1990-2008 base data.



Source: Global Insight, May 2010 and U.S. Department of Energy, 2010 Annual Energy Outlook.

TABLE 6A

SNWW Crude Petroleum Imports Forecast Projections

Year	AEO Reference			AEO 2010	Purvin & Gertz			Global Insight		
	2008	2009	2010		2008	2009	2010	2008	2009	2010
2007	10.0	10.0	10.0	10.0	n/a	10.0	10.0		10.0	10.0
2015	10.2	8.1	8.9	10.1	n/a	n/a	11.8	12.0	11.1	9.7
2025	11.0	6.7		11.7	n/a	12.4	12.3	13.7	12.1	10.6
2030	11.9	7.0	8.7	12.7	n/a	12.7		14.5	12.5	11.7
2035	n/a	n/a	8.7	13.6	n/a	n/a	n/a	n/a	12.9	n/a

Source: U.S. Department of Energy, AEO2008, 2008, and 2010. Global Insight 2035 forecast value was obtained from non-published back-up data obtained from Global Insight

TABLE 6B SNWW Crude Petroleum Imports Forecast Projections Millions of Barrels/Day				
Year	1990-2008 SNWW as a Function of U.S. Imports Adjusted R Square: .28 F Statistic: 8.17 Standard Error of Y Estimate: 14046.6		1990-2007 SNWW as a Function of U.S. Imports Adjusted R Square: .88 F Statistic: 129.99 Standard Error of Y Estimate: 6020.9	
	AEO 2010	AEO 2010	AEO 2010	AEO 2010
2015	53,150	57,849	55,338	74,582
2019	52,680	60,355	54,080	82,689
2025	51,975	64,115	52,192	94,850
2029	52,132	65,681	52,612	99,917
2030	52,366	68,031	53,241	107,518
2035	52,366	71,555	53,241	118,919
Source: U.S. Department of Energy, AEO2008, 2008, and 2010. Global Insight 2035 forecast value was obtained from non-published back-up data obtained from Global Insight				

A comparison table of the BCRs based on the alternative forecasts was not prepared. It is recognized that SNWW import forecast is higher than all of the AEO 2009 and AEO 2010 projections, with the exception of the AEO 2010 Low Price scenario; however, the forecast for SNWW falls within the range of forecasts published by other recognized forecasters. As previously indicated, the Motiva expansion and SNWW's existing role as the largest waterway port of entry for petroleum suggested that the higher forecast would most reasonably reflect long-term trends for the study area.

Appendix 3

Baseline Cost Estimate

Sabine-Neches Navigation Channel Improvement Project

Engineering Appendix
Chapter 13.0
Cost Estimates

Attachment 13.1 – Narrative
Attachment 13.2 – MII Estimate
Attachment 13.3 – CSRA
Attachment 13.4 – Total Project Cost Summary
Attachment 13.5 – ATR Certification of Cost Estimate (To Be Provided)
Attachment 13.6 – 50 Year O&M (To Be Provided)

Revised
June 2010

ATTACHMENT 13.1 - Narrative

SABINE-NECHES NAVIGATION CHANNEL
IMPROVEMENT PROJECT

This MII estimate was prepared for the Feasibility Study of deepening the Sabine Neches Waterway to a depth of 48 feet. The work consists of deepening the navigation channel from the existing inland reaches to the Port of Beaumont from 40 to 48 ft; and extending the existing entrance channel by 13.2 miles into the Gulf of Mexico to a depth of 50 ft. The plan also consists of: 1) bend easing in the Sabine-Neches Canal and Neches River channel; 2) widening up to an additional 183 feet the Taylors Bayou Entrance channel and turning basins; and 3) Constructing new and enlarging/deepening existing turning and anchorage basins on the Neches River Channel. The entire plan involves dredging about 406,464 feet of channel. Quantities and design features were developed by the Galveston District (SWG) Engineering Branch.

This estimate was revised July 2009 using the latest price levels and the labor rates. During the update the marine fuel price was locked in at $2.60/gal, (see attachment 13.2). This updated Mii estimate reflects changes in the scope. The major changes in scope are the removal of the widening of the entrance, removal of five turning basins, removal of two Beneficial Use (BU) sites, reduction of one BU, and the removal of the oyster reef. The estimate was escalated to October 2009 price levels in the Total Project Cost Summary Sheet (TPCS), (see attachment 13.4). The estimate was divided into 15 contracts, with each contract being subdivided into Non-Federal and Federal Costs. The costs were further organized in accordance with the work breakdown structure. The midpoint date of each account code for each of the construction contracts was provided by the project manager for developing the fully funded costs. The estimate was prepared in accordance with ER 1110-2-1302, dated 15 September 2008. The costs were escalated in accordance with the above Engineering Regulation and EM 1110-2-1304 dated 31 March 2009. All this data was input into the TPCS. The baseline estimate provides for all pertinent elements for a complete project ready for operations.

The original Independent Technical Review (ITR) of the cost estimate, construction schedules, and contingencies was performed in June 2006 by Mobile District, some minor revision were performed to the estimate in response to the comments. In July 2007 new requirements were published for the development of contingencies in Civil Works. A formal cost risk analysis for development of project contingences was done with the results presented in the Total Project Cost Summary Sheet (TPCS). Crystal Ball software was used to conduct the Cost Risk Analysis.

A formal Cost Risk Analyses was performed with the cooperation of the PDT and Cost Engineering Directory of Expertise (DX) of the Walla Walla District in August 2009. The risks were quantified and a cost risk model developed to determine a contingency at 80% confidence level (CL), (see attachment 13.3). For Hopper dredge work a 33% contingency was used for the 80% CL and for Pipeline dredge work a 30% contingency was used for the 80%. The estimate was escalated to October 2009 price level. The contingencies were used along with the updated estimate to revise the TPCS. An ITR Certification of Cost Estimate was provided by Cost Engineering DX for Civil Works, (see attachment 13.5). The Operation and Maintenance estimate was prepared in July 2009, with an effective pricing date of October 2009, (see attachment 13.6).

ACCOUNT CODE 01 – LANDS AND DAMAGES: Costs for this Account Code were provided by SWG, Real Estate Division.

ACCOUNT CODE 02 -- RELOCATIONS: A total of 42 pipelines would require relocation and 6 would require removal. The relocated lines were assumed to be directionally drilled, and bundled when possible. It is assumed that the lines which are currently abandoned in place will be removed from the limits of the new channel and disposed off-site. Relocation work is assumed to take place prior to dredging the new channel.

ACCOUNT CODE 12 -- NAVIGATION PORTS AND HARBORS: Dredge quantities were developed by the design engineer. It was assumed that the first 5 contracts would be done using one large hopper dredge per contract. The material from the hopper dredge would be placed in open water disposal. The remainder of the channel was assumed to be dredged using a 30" pipeline, with the material going into existing placement areas (PA's) or new PA's located along the waterway. The dredging cost was developed using CEDEP. The dredge production rates were reduced to account for the stiffer "new work" material to be encountered. The cost for mobilization and demobilization was developed using CEDEP, and assuming the pipeline dredge was based in New Orleans. The Dredging estimates were based on standard operating practices for the Galveston District which assumed conventional contracting practices of large business IFB's.

Included under the hopper dredge cost is the cost for Sea Turtle Protection. Included in this item are: 1) cost for two trawlers per hopper, 2) a sea turtle protection device fitted to the hopper, and 3) 24 hour monitoring survey.

The cost for creating a PA was included under this code of account. Part of the cost for creating a PA included clearing, grubbing, and stripping the area; as well as turfing the outside of the new levee. Labor rates and overhead costs were adjusted to reflect Region 6. Soil characteristics were provided by SWG, Engineering Division, Geotechnical and Structures Section.

Also, included under this account code were bridge dolphin fender systems. They are required for the MLK Hwy 82 Bridge located at Station 105+00 on the Sabine Neches Canal; as well as Hwy 87, (twin bridges), located at Station 93+00 on the Neches River. The cost for this work was provided by TXDOT. The cost for the Taylors Bayou sheet Pile Wall was also included under this account code.

Navigational aids are placed in accordance with U.S. Coast Guard Standards and all the quantities and cost data were provided by the Coast Guard.

ACCOUNT CODE 18 – CULTURAL RESOUCRCE PRESERVATION: Cost for this account code was developed by the archeologist in SWG, Environmental Section, Planning and Environmental Branch.

ACCOUNT CODE 30 -- ENGINEERING AND DESIGN: The cost for this account was developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager. In addition, the costs for survey and soil borings were provided by SWG, General Engineering Section and Geotechnical & Structures Sections in Engineering & Construction Division.

ACCOUNT CODE 31 -- CONSTRUCTION MANAGEMENT: The cost for this account was developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager.

ATTACHMENT 13.2 - MII Estimate

July 2009 - SNWW - LPP
Feasibility Study

Estimated by	J. Lockhart
Designed by	CESWG-EC-PS
Prepared by	U.S. Army Corps of Engineers Galveston District
Preparation Date	7/10/2009
Effective Date of Pricing	10/1/2008
Estimated Construction Time	Days

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Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
Project Cost Summary Report			**693,752,318**	**700,812,057**	**700,812,057**
Expenditures for Study	**LS**	**1.00**	**13,249,000**	**13,249,000**	**13,249,000**
Reconnaissance Phase	**LS**	**1.00**	**125,000**	**125,000**	**125,000**
Feasibility Phase	**LS**	**1.00**	**13,124,000**	**13,124,000**	**13,124,000**
01 Contract 1 - Sabine Bank Sta 165+000 to 132+000	**LS**	**1.00**	**52,355,825**	**52,724,883**	**52,724,883**
0101 Non-Federal Costs	**LS**	**1.00**	**1,299,615**	**1,668,673**	**1,668,673**
010102 Relocations	**LS**	**1.00**	**1,299,615**	**1,668,673**	**1,668,673**
0102 Federal Costs	**LS**	**1.00**	**51,056,210**	**51,056,210**	**51,056,210**
010212 Navigation Ports and Harbors	**LS**	**1.00**	**51,056,210**	**51,056,210**	**51,056,210**
02 Contract 2 - Sabine Bank Sta 132+000 to 95+734	**LS**	**1.00**	**24,449,335**	**24,449,335**	**24,449,335**
0202 Federal Costs	**LS**	**1.00**	**24,449,335**	**24,449,335**	**24,449,335**
020212 Navigation Ports and Harbors	**LS**	**1.00**	**24,449,335**	**24,449,335**	**24,449,335**
03 Contract 3 - Sabine Bank Ch Sta 95+734 to 53+000	**LS**	**1.00**	**27,962,068**	**28,182,119**	**28,182,119**
0301 Non-Federal Costs	**LS**	**1.00**	**774,897**	**994,948**	**994,948**
030102 Relocations	**LS**	**1.00**	**774,897**	**994,948**	**994,948**
0302 Federal Costs	**LS**	**1.00**	**27,187,171**	**27,187,171**	**27,187,171**
030212 Navigation Ports and Harbors	**LS**	**1.00**	**27,187,171**	**27,187,171**	**27,187,171**
04 Contract 4 - Sab Pass Outer Bar Sta 53+000 to 0+000	**LS**	**1.00**	**47,013,937**	**47,380,443**	**47,380,443**
0401 Non-Federal Costs	**LS**	**1.00**	**1,290,627**	**1,657,133**	**1,657,133**
040102 Relocations	**LS**	**1.00**	**1,290,627**	**1,657,133**	**1,657,133**
0402 Federal Costs	**LS**	**1.00**	**45,723,310**	**45,723,310**	**45,723,310**
040212 Navigation Ports and Harbors	**LS**	**1.00**	**45,723,310**	**45,723,310**	**45,723,310**
05 Contract 5 - Sabine Pass Jetty Ch Sta -214+88 to 0+00	**LS**	**1.00**	**15,498,540**	**15,498,540**	**15,498,540**
0502 Federal Costs	**LS**	**1.00**	**15,498,540**	**15,498,540**	**15,498,540**
050212 Navigation Ports and Harbors	**LS**	**1.00**	**15,498,540**	**15,498,540**	**15,498,540**
06 Contract 6 - Sab Pass Ch Sta 0+00 to 296+25	**LS**	**1.00**	**40,131,460**	**40,780,690**	**40,780,690**

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
0601 Non-Federal Costs	LS	1.00	2,286,220	2,935,449	2,935,449
060102 Relocations	LS	1.00	2,286,220	2,935,449	2,935,449
0602 Federal Costs	LS	1.00	37,845,240	37,845,240	37,845,240
060212 Navigation Ports and Harbors	LS	1.00	36,885,240	36,885,240	36,885,240
060218 Cultural Resources	LS	1.00	960,000	960,000	960,000
07 Contract 7 - Pt Arthur Canal Sta 0+00 to 325+84, Taylor Bayou 0+00 to 106+24	LS	1.00	76,938,758	76,938,758	76,938,758
0701 Non-Federal Costs	LS	1.00	879,710	879,710	879,710
070112 NavigationPorts & Harbor	EA	1.00	879,710	879,710	879,710
0702 Federal Costs	LS	1.00	76,059,048	76,059,048	76,059,048
070212 Navigation Ports and Harbors	LS	1.00	76,059,048	76,059,048	76,059,048
08 Contract 8 - Sabine-Neches Canal Sta 0+00 to 170+00	LS	1.00	34,136,504	34,289,928	34,289,928
0801 Non-Federal Costs	LS	1.00	540,272	693,696	693,696
080102 Relocations	LS	1.00	540,272	693,696	693,696
0802 Federal Costs	LS	1.00	33,596,232	33,596,232	33,596,232
080212 Navigation Ports and Harbors	LS	1.00	33,596,232	33,596,232	33,596,232
09 Contract 9 - Sabine-Neches Canal Sta 170+00 to 592+93	LS	1.00	51,839,330	51,963,375	51,963,375
0901 Non-Federal Costs	LS	1.00	436,817	560,862	560,862
090102 Relocations	LS	1.00	436,817	560,862	560,862
0902 Federal Costs	LS	1.00	51,402,513	51,402,513	51,402,513
09212 Navigation Ports and Harbors	LS	1.00	51,402,513	51,402,513	51,402,513
10 Contract 10 - Neches River Ch Sta 0+00 to 292+00	LS	1.00	71,281,746	72,991,198	72,991,198
1001 Non-Federal Costs	LS	1.00	7,417,357	9,126,809	9,126,809
100102 Relocations	LS	1.00	6,019,727	7,729,179	7,729,179
100112 NavigationPorts & Harbor	EA	1.00	1,397,630	1,397,630	1,397,630
1002 Federal Costs	LS	1.00	63,864,389	63,864,389	63,864,389
100212 Navigation Ports and Harbors	LS	1.00	63,864,389	63,864,389	63,864,389

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
11 Contract 11 - Neches River Ch Sta 292+00 to 716+00	LS	1.00	94,177,162	97,645,135	97,645,135
1101 Non-Federal Costs	LS	1.00	17,449,580	20,917,554	20,917,554
110102 Relocations	LS	1.00	12,212,250	15,680,224	15,680,224
110112 NavigationPorts & Harbor	EA	1.00	5,237,330	5,237,330	5,237,330
1102 Federal Costs	LS	1.00	76,727,582	76,727,582	76,727,582
110212 Navigation Ports and Harbors	LS	1.00	76,727,582	76,727,582	76,727,582
12 Contract 12 - Neches River Ch Sta 716+00 to 980+00	LS	1.00	85,111,124	85,111,124	85,111,124
1201 Non-Federal Costs	LS	1.00	8,064,890	8,064,890	8,064,890
120112 NavigationPorts & Harbor	EA	1.00	8,064,890	8,064,890	8,064,890
1202 Federal Costs	LS	1.00	77,046,234	77,046,234	77,046,234
120212 Navigation Ports and Harbors	LS	1.00	77,046,234	77,046,234	77,046,234
13 Contract 13 - Dredging Sabine Lake	LS	1.00	21,495,876	21,495,876	21,495,876
1302 Federal Costs	LS	1.00	21,495,876	21,495,876	21,495,876
13060212 Fish and Wildlife Facilities	EA	1.00	21,495,876	21,495,876	21,495,876
14 Contract 14 - Channel to Orange	LS	1.00	906,758	906,758	906,758
1402 Federal Costs	LS	1.00	906,758	906,758	906,758
140206 Fish and Wildlife Facilities	LS	1.00	906,758	906,758	906,758
15 Contract 15 - GIWW East of Orange	LS	1.00	37,204,894	37,204,894	37,204,894
1502 Federal Costs	LS	1.00	37,204,894	37,204,894	37,204,894
150206 Fish and Wildlife Facilities	LS	1.00	37,204,894	37,204,894	37,204,894

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Project Cost Summary Report **1**
Expenditures for Study 1
Reconnaissance Phase 1
Feasibility Phase 1
01 Contract 1 - Sabine Bank Sta 165+000 to 132+000 1
0101 Non-Federal Costs 1
010102 Relocations 1
0102 Federal Costs 1
010212 Navigation Ports and Harbors 1
02 Contract 2 - Sabine Bank Sta 132+000 to 95+734 1
0202 Federal Costs 1
020212 Navigation Ports and Harbors 1
03 Contract 3 - Sabine Bank Ch Sta 95+734 to 53+000 1
0301 Non-Federal Costs 1
030102 Relocations 1
0302 Federal Costs 1
030212 Navigation Ports and Harbors 1
04 Contract 4 - Sab Pass Outer Bar Sta 53+000 to 0+000 1
0401 Non-Federal Costs 1
040102 Relocations 1
0402 Federal Costs 1
040212 Navigation Ports and Harbors 1
05 Contract 5 - Sabine Pass Jetty Ch Sta -214+88 to 0+00 1
0502 Federal Costs 1
050212 Navigation Ports and Harbors 1
06 Contract 6 - Sab Pass Ch Sta 0+00 to 296+25 1
0601 Non-Federal Costs 1
0601 Non-Federal Costs 2
060102 Relocations 2
0602 Federal Costs 2
060212 Navigation Ports and Harbors 2
060218 Cultural Resources 2
07 Contract 7 - Pt Arthur Canal Sta 0+00 to 325+84, Taylor Bayou 0+00 to 106+24 2
0701 Non-Federal Costs 2
070112 NavigationPorts & Harbor 2
0702 Federal Costs 2
070212 Navigation Ports and Harbors 2
08 Contract 8 - Sabine-Neches Canal Sta 0+00 to 170+00 2
0801 Non-Federal Costs 2
080102 Relocations 2
0802 Federal Costs 2
080212 Navigation Ports and Harbors 2

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09 Contract 9 - Sabine-Neches Canal Sta 170+00 to 592+93 2
0901 Non-Federal Costs 2
090102 Relocations 2
0902 Federal Costs 2
09212 Navigation Ports and Harbors 2
10 Contract 10 - Neches River Ch Sta 0+00 to 292+00 2
1001 Non-Federal Costs 2
100102 Relocations 2
100112 NavigationPorts & Harbor 2
1002 Federal Costs 2
100212 Navigation Ports and Harbors 2
11 Contract 11 - Neches River Ch Sta 292+00 to 716+00 2
11 Contract 11 - Neches River Ch Sta 292+00 to 716+00 3
1101 Non-Federal Costs 3
110102 Relocations 3
110112 NavigationPorts & Harbor 3
1102 Federal Costs 3
110212 Navigation Ports and Harbors 3
12 Contract 12 - Neches River Ch Sta 716+00 to 980+00 3
1201 Non-Federal Costs 3
120112 NavigationPorts & Harbor 3
1202 Federal Costs 3
120212 Navigation Ports and Harbors 3
13 Contract 13 - Dredging Sabine Lake 3
1302 Federal Costs 3
13060212 Fish and Wildlife Facilities 3
14 Contract 14 - Channel to Orange 3
1402 Federal Costs 3
140206 Fish and Wildlife Facilities 3
15 Contract 15 - GIWW East of Orange 3
1502 Federal Costs 3
150206 Fish and Wildlife Facilities 3

ATTACHMENT 13.3 – CSRA

US Army Corps
of Engineers®

SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT

FEASIBILITY RISK ANALYSIS
FOR
GALVESTON DISTRICT, TEXAS

Prepared for:

U.S. Army Corps of Engineers, Galveston District

Prepared by:

U.S. Army Corps of Engineers, Walla Walla District
Engineering and Construction Division, Cost Engineering Branch

August 14, 2009

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EXECUTIVE SUMMARY

PURPOSE

The purpose of this report is to document the results of the cost and schedule risk analysis (CSRA) performed for the Sabine-Neches Waterway (SNWW) Channel Improvement Project (CIP), located along the border between Texas and Louisiana. The CSRA reflects a feasibility level study under development by the U.S. Army Corps of Engineers (USACE), Galveston District.

BACKGROUND

The single alternative plan selected for recommendation is also the national economic development (NED) plan and the locally preferred plan (LPP). The recommended plan calls for the following modifications to the existing SNWW:

- Deepening of the SNWW to Beaumont to 48 feet.
- Widening the SNWW by 700 feet from offshore in the Gulf of Mexico to the Port Arthur Canal.
- Deepening and widening of Taylors Bayou channels and turning basins.
- Construction of several turning and anchorage basins on the Neches River Channel.
- Tapering Sabine Bank Channel from 800 feet wide (Station 23+300) to 700 feet wide.

SCOPE

The scope of the risk analysis report is to reflect the feasibility study and to calculate and present the cost contingencies at the 80 percent (P80) confidence level using the risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all construction features at feasibility level development.

The major project construction scope is comprised of dredging, utilizing both hopper and pipeline dredges depending upon location in relationship to the Gulf and inland waterway. The project scope also includes some efforts contributing to sea turtle protection, navigational aids, and mitigation such as plantings and relocations by the sponsor(s). Within the feasibility study and in consideration of contract acquisition in accomplishing the project construction, the plan was separated into 15 distinct contract estimates. In each contract, dredging is the major effort, consequently, carrying the greatest risks. Separating the project into separate contracts results in the ability to more efficiently fund, procure, manage, and construct the separate contracts, thereby, reducing risks. The contracts studied within the CSRA are:

- Contract 1: Sabine Bank – Sta 165+00 to 132+00.
- Contract 2: Sabine Bank – Sta 132+00 to 95+734.
- Contract 3: Sabine Bank Channel – Sta 95+734 to 53+000.
- Contract 4: Sabine Pass Outer Bar Jetty – Sta 53+000 to 0+000.
- Contract 5: Sabine Pass Outer Bar Jetty Channel Sta 214-88 to 0+00.
- Contract 6: Sabine Pass Channel Sta 0+00 to 295+60.
- Contract 7: Port Arthur Canal & Taylor Bayou.
- Contract 8: Sabine Neches Canal Sta 0+00 to 170+00.
- Contract 9: Sabine Neches Canal Sta 170+00 to 592+93.
- Contract 10: Neches River Channel Sta 0+00 to 292+00.
- Contract 11: Neches River Channel Sta 292+00 to 716+00.
- Contract 12: Neches River Channel Sta 716+00 to 980+00.
- Contract 13: Dredging Sabine Lake.
- Contract 14: Channel to Orange.
- Contract 15: GIWW East of Orange.

RISK ANALYSIS PROCESS

As required by USACE, the CSRA was developed using the Crystal Ball software. The Crystal Ball software relies on Excel-based spreadsheets for its model development. All 15 contracts within the study consist of dredging work and were estimated using the USACE Cost Engineering Dredge Estimating Program (CEDEP), which is Excel based. Those same Excel-based estimates were used as the model basis for the Crystal Ball risk analysis, incorporating both cost and schedule.

Specifically related to this project, it became apparent that the contracts related to dredging carried similar risks with a separate distinction made regarding the use of hopper dredges and pipeline dredges in certain contracts. For this reason, the risk analysis utilized the same risk events identified within the risk register to support the risk models and resulting contingencies. The study did recognize that the limited availability of hopper dredges and their use further into the Gulf present a higher degree of some risks as compared to the pipeline dredging work. This resulted in slightly higher contingencies for the hopper dredges.

CONTINGENCY RESULTS

The USACE Cost Engineering Directory of Expertise (DX) for Civil Works recommends risk analyses output reflect the P80 confidence level in successfully completing the project. The following table reflects those results for the fifteen specific contracts. These contingencies are reflected within the Total Project Cost Summary.

Table ES-1. Contract Contingency Results - 80 Percent Confidence

Contract No.	Contract Description/Title	Type of Dredging Work	Contingency
Contract 1	Sabine Bank – Sta 165+00 to 132+00	Hopper	33%
Contract 2	Sabine Bank – Sta 132+00 to 95+734	Hopper	33%
Contract 3	Sabine Bank Channel – Sta 95+734 to 53+000	Hopper	33%
Contract 4	Sabine Pass Outer Bar Jetty – Sta 53+000 to 0+000	Hopper	33%
Contract 5	Sabine Pass Outer Bar Jetty Channel Sta 214-88 to 0+00	Hopper	33%
Contract 6	Sabine Pass Channel Sta 0+00 to 295+60	Pipeline	30%
Contract 7	Port Arthur Canal & Taylor Bayou	Pipeline	30%
Contract 8	Sabine Neches Canal Sta 0+00 to 170+00	Pipeline	30%
Contract 9	Sabine Neches Canal Sta 170+00 to 592+93	Pipeline	30%
Contract 10	Neches River Channel Sta 0+00 to 292+00	Pipeline	30%
Contract 11	Neches River Channel Sta 292+00 to 716+00	Pipeline	30%
Contract 12	Neches River Channel Sta 716+00 to 980+00	Pipeline	30%
Contract 13	Dredging Sabine Lake	Pipeline	30%
Contract 14	Channel to Orange	Pipeline	30%
Contract 15	GIWW East of Orange	Pipeline	30%

Note: Contingency % reflects an 80% confidence level.

Dredging Risks: The four most common risk concerns, related to dredging, carrying the greater risks were:

- Limited bid competition due to a shortage of dredge plants.
- Fuel price fluctuations, which greatly impact dredging costs.
- Limited geotechnical data of underwater materials.
- Scoping changes resulting in dredge quantity changes.

1. PURPOSE

The purpose of this report is to document the results of the cost and schedule risk analysis (CSRA) performed for the Sabine-Neches Waterway (SNWW) Channel Improvement Project (CIP), located along the border between Texas and Louisiana. The CSRA reflects a feasibility level study under development by the U.S. Army Corps of Engineers, Galveston District.

2. BACKGROUND

The single alternative plan selected for recommendation is also the national economic development (NED) plan and the locally preferred plan (LPP). The recommended plan calls for the following modifications to the existing SNWW:

- Deepening of the SNWW to Beaumont to 48 feet.
- Widening the SNWW by 700 feet from offshore in the Gulf of Mexico to the Port Arthur Canal.
- Deepening and widening of Taylors Bayou channels and turning basins.
- Construction of several turning and anchorage basins on the Neches River Channel.
- Tapering Sabine Bank Channel from 800 feet wide (Station 23+300) to 700 feet wide.

More in-depth project background information can be found within the Galveston District Feasibility Report.

3. SCOPE

The scope of the risk analysis report is to calculate and present the cost contingencies at the 80 percent confidence level using the risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all construction features.

The major project construction scope is comprised of dredging, utilizing both hopper and pipeline dredges depending upon location in relationship to the Gulf and inland waterway. The project scope also includes some efforts contributing to sea turtle protection, navigational aids, and mitigation such as plantings and relocations by the sponsor(s). Within the feasibility study and in consideration of contract acquisition in accomplishing the project construction, the plan was separated into 15 distinct contract estimates. In each contract, dredging is the major effort, consequently, carrying the greatest risks. The advantage of separating the project into separate contracts results in the ability to more efficiently fund, procure, manage, and construct the separate contracts, thereby, reducing risks. The contracts studied within the CSRA are:

- Contract 1: Sabine Bank – Sta 165+00 to 132+00.
- Contract 2: Sabine Bank – Sta 132+00 to 95+734.
- Contract 3: Sabine Bank Channel – Sta 95+734 to 53+000.
- Contract 4: Sabine Pass Outer Bar Jetty – Sta 53+000 to 0+000.
- Contract 5: Sabine Pass Outer Bar Jetty Channel Sta 214-88 to 0+00.
- Contract 6: Sabine Pass Channel Sta 0+00 to 295+60.
- Contract 7: Port Arthur Canal & Taylor Bayou.
- Contract 8: Sabine Neches Canal Sta 0+00 to 170+00.
- Contract 9: Sabine Neches Canal Sta 170+00 to 592+93.
- Contract 10: Neches River Channel Sta 0+00 to 292+00.
- Contract 11: Neches River Channel Sta 292+00 to 716+00.
- Contract 12: Neches River Channel Sta 716+00 to 980+00.
- Contract 13: Dredging Sabine Lake.
- Contract 14: Channel to Orange.
- Contract 15: GIWW East of Orange.

4. METHODOLOGY/PROCESS

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence. In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The USACE Cost Engineering Directory of Expertise (DX) for Civil Works guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the requirements and recommendations of the following documents and sources:

- Engineering Regulation ER 1110-2-1150 dated August 31, 1999.
- Engineering Regulation ER 1110-2-1302 dated September 15, 2008.
- Engineering Technical Letter 1110-2-573 dated September 30, 2008.
- Memorandum from Major General Don T. Riley (US Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.
- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering DX.

Since the 15 contracts are dredging related, with the estimates developed within the USACE Cost Engineering Dredge Estimating Program (CEDEP), which is Excel based, the risk analysis used the CEDEP as the risk model basis, incorporating both cost and schedule. Noting that the hopper dredges carry somewhat different risks than the pipeline dredges, the two methods were modeled separately. The risk analysis results are provided in section 5.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the Project Development Team (PDT) is considered a qualitative process that results in establishing a risk register document. That risk register document then serves to support the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

The qualitative risks are captured and placed within the risk register format. That format is the basis used for establishing the quantitative risks and developing the Crystal Ball risk model. Specifically related to this project, it became apparent that the contracts carry quite similar risks because the major efforts within each contract require dredging. For this reason, the risk analysis utilized the same risk events identified within the risk register to support the risk models and resulting contingencies. The study did recognize that the limited availability of hopper dredges and their use further into the Gulf present a higher degree of some risks as compared to the pipeline dredging work. This resulted in slightly higher contingencies for the hopper dredging.

4.2 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost

estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting risk analysis feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

The summary risk register in table 2 presents the risks related to the 15 contracts, considering internal and external risks. In the cases studied, the schedule analysis was incorporated into the cost analysis as another risk event related to productivity within the CEDEP estimates.

Table 2. Dredging Risk Register

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Likelihood*	Impact*	Risk Level*	Measurement / Adjustments	Risk Applied to
1	Bid Competition	Corps studies have determined an expected dredge shortage due to the many anticipated projects scheduled in the Gulf region. But a distinction must be made between hopper dredges and pipeline dredges. Pipeline dredges are more prevalent; therefore, hopper dredges carry a greater risk in bidding competition. The Acquisition planning of 15 contracts with shorter construction durations helps alleviate some of this concern.	VERY LIKELY	SIGNIFICANT	HIGH	Limited Bid Competition impacting Mobilization distance and contractor markups.	Profit & Plant Acquisition
2	Type of Dredged Material	Limited Geotechnical data of the dredged material may result in encountering unanticipated materials that could be more difficult to dredge that would impact productivity.	LIKELY	MARGINAL	MODERATE	Productivity - Duration	Production
3	Dredged Quantity (prism)	Dredging commonly results in changed quantities resulting from inadequate underwater surveys and underwater changes over time. There is potential that the dredging material prism could change.	LIKELY	MARGINAL	MODERATE	Volume - CY	Quantities
4	Scope Changes	As the designs are further developed, there is potential that the scope could change.	LIKELY	MARGINAL	MODERATE	Volume - CY	Quantities
5	Weather	Severe weather in the Gulf region can cause delays and possible remobilizations. To impact dredging, weather would have to be very severe. The severity would impact the gulf work for the hopper dredges more than the inland pipeline dredges.	UNLIKELY	SIGNIFICANT	MODERATE	Productivity - Duration	Production - Hopper
6	Schedule Constraints	Contract and environmental schedule constraints can cause delays, force acceleration, require larger dredges that may be unavailable due to competing needs. The greater schedule concern would be funding availability which studied under a different risk.	UNLIKELY	MARGINAL	LOW	Duration	N/A
7	Labor Availability/Pricing	Gulf region labor rates are fairly low when compared to national rates. Slower economy should keep the rates reasonable with little impact.	UNLIKELY	MARGINAL	LOW	Hourly Wage Rates	N/A
8	Dredge Acquisition	Corps studies have resulted in an expected dredge shortage as compared to the many anticipated projects in the Gulf region. Less competition is likely, resulting in higher bids.	LIKELY	SIGNIFICANT	HIGH	Equipment Rates	Plant Acquisition & Ownership
9	Current Fuel Prices	Fuel price fluctuations continue, but have stabilized on a steady upward trend. Dredge operations are significantly impacted by fuel usage and cost. Current estimate uses current fuel pricing.	VERY LIKELY	SIGNIFICANT	HIGH	Fuel $/Gal	Fuel
10	VE Opportunities	There seems to be little potential for efficiency gains with the dredging projects. "It is what it is."	VERY UNLIKELY	NEGLIGIBLE	LOW	Volume - CY	N/A
11	Inflation Increases	Inflationary costs could impact project costs in the long term. Volatile fuel pricing on a dredge project could exceed standard OMB inflation rates. Current estimate fuel pricing is considered conservative.	LIKELY	MARGINAL	MODERATE	Escalation comparisons	Fuel

4.3 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The following is an example of the PDT quantifying risk factor impacts by using an iterative, consensus-building approach to estimate the elements of each risk factor:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

In this study, the risk discussions focused on the similar moderate and high risks common to the 15 contracts.since the PDT was more interested in the contingency management per contract The resulting product from the PDT discussions is captured within a single risk register as presented in the section above. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.4 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. Each option-specific contingency is then

allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5. RISK ANALYSIS RESULTS

5.1 Contingency Results at 80 Percent Confidence

The Cost Engineering DX recommends risk analyses output reflect the P80 confidence level in successfully completing the project. The following table reflects those results for the fifteen specific contracts. These contingencies are reflected within the Total Project Cost Summary.

Table 3. Contract Contingency Results - 80 Percent Confidence

Contract No.	Contract Description/Title	Type of Dredging Work	Contingency
Contract 1	Sabine Bank – Sta 165+00 to 132+00	Hopper	33%
Contract 2	Sabine Bank – Sta 132+00 to 95+734	Hopper	33%
Contract 3	Sabine Bank Channel – Sta 95+734 to 53+000	Hopper	33%
Contract 4	Sabine Pass Outer Bar Jetty – Sta 53+000 to 0+000	Hopper	33%
Contract 5	Sabine Pass Outer Bar Jetty Channel Sta 214-88 to 0+00	Hopper	33%
Contract 6	Sabine Pass Channel Sta 0+00 to 295+60	Pipeline	30%
Contract 7	Port Arthur Canal & Taylor Bayou	Pipeline	30%
Contract 8	Sabine Neches Canal Sta 0+00 to 170+00	Pipeline	30%
Contract 9	Sabine Neches Canal Sta 170+00 to 592+93	Pipeline	30%
Contract 10	Neches River Channel Sta 0+00 to 292+00	Pipeline	30%
Contract 11	Neches River Channel Sta 292+00 to 716+00	Pipeline	30%
Contract 12	Neches River Channel Sta 716+00 to 980+00	Pipeline	30%
Contract 13	Dredging Sabine Lake	Pipeline	30%
Contract 14	Channel to Orange	Pipeline	30%
Contract 15	GIWW East of Orange	Pipeline	30%

Note: Contingency % reflects an 80% confidence level.

5.2 CSRA Contingency Tables

Depicted below in table 4 are the CSRA contingency results, making separate distinction between the hopper and the pipeline dredges. The tables present the contingency values and percents at a 5 percent confidence level interval. The 80 percent confidence results were applied against the dredging activities within the Total Project Cost Summary. Since the 30 and 31 Feature Accounts (Planning, Engineering and Design and the Construction Management) are based upon a percentage of the construction costs, the same contingency was applied. The 01 Feature Account of Lands and Damages received a 25 percent contingency based upon the Galveston District's Real Estate Office.

Table 4. CSRA Contingency Tables

HOPPER DREDGE CONTINGENCY TABLE	
Confidence Level	**Contingency**
0%	-35%
5%	-10%
10%	-5%
15%	-2%
20%	1%
25%	4%
30%	6%
35%	9%
40%	11%
45%	13%
50%	16%
55%	18%
60%	21%
65%	23%
70%	26%
75%	29%
80%	**33%**
85%	37%
90%	42%
95%	50%
100%	104%

PIPELINE DREDGE CONTINGENCY TABLE	
Confidence Level	**Contingency**
0%	-11%
5%	3%
10%	6%
15%	8%
20%	10%
25%	11%
30%	13%
35%	14%
40%	16%
45%	17%
50%	18%
55%	20%
60%	22%
65%	23%
70%	25%
75%	27%
80%	**30%**
85%	33%
90%	37%
95%	44%
100%	101%

5.3 Model Sensitivity Analysis and Output

The sensitivity analysis output indicates the risk events carrying the greatest potential variance in cost and schedule that also result in the greatest risks. For this report, the sensitivity results are presented, making separate distinction between the hopper dredges and the pipeline dredges.

Hopper Dredges: The greatest sensitivity related to risk concerns for the hopper dredging were concern for:

- Limited bid competition due to a shortage of hopper dredge plants reflected in greater contractor profit.
- Fuel price fluctuations, which greatly impact dredging costs.
- Limited geotechnical data of underwater materials
- Scoping changes resulting in dredge quantity changes.

Pipeline Dredges: The greatest sensitivity related to risk concerns for the pipeline dredging were concern for:

- Fuel price fluctuations that carry a greater risk for dredging activities.
- Limited bid competition resulting in greater contractor profits.
- Scoping changes resulting in dredge quantity changes.

ATTACHMENT 13.4 – Total Project Cost Summary

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer

PREPARED: 7-Oct-09

This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

Cost ($1,000)

Estimate Prepared: 31-Jul-09
Effective Price Level: 1-Oct-09

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1 OCT 11 ($K)	COST ($K)	CNTG ($K)	FULL ($K)
02	RELOCATIONS	31,921	9,706	30%	41,627	2.8%	32,830	9,983	42,813	-	34,753	10,564	45,317
06	FISH & WILDLIFE FACILITIES	59,608	17,883	30%	77,491	2.7%	61,220	18,366	79,586	-	64,699	19,410	84,109
12	NAVIGATION PORTS & HARBORS												
	Non-Federal Cost	15,580	4,674	30%	20,254	2.7%	16,002	4,799	20,801	-	16,791	5,037	21,828
	Federal Cost	579,495	178,767	31%	758,262	2.7%	595,162	183,601	778,763	-	628,569	193,887	822,456
18	CULTURAL RESOURCE PRESERVATION	960	288	30%	1,248	2.7%	986	296	1,282	-	1,068	321	1,389
	CONSTRUCTION ESTIMATE TOTALS:	687,564	211,318		**898,882**		706,200	217,045	923,245		745,880	229,219	975,099
01	LANDS AND DAMAGES												
	Non-Federal Cost	2,892	725	25%	3,617	3.1%	2,982	747	3,729	-	3,090	774	3,864
	Federal Cost	595	149	25%	744	3.0%	613	153	766	-	643	159	802
				-	-				-				
30	PLANNING, ENGINEERING & DESIGN	80,879	24,833	31%	105,712	2.7%	83,071	25,501	108,572	13,249	86,707	26,613	126,569
31	CONSTRUCTION MANAGEMENT	48,129	14,792	31%	62,921	2.7%	49,433	15,190	64,623	-	52,237	16,050	68,287
	PROJECT COST TOTALS:	820,060	251,817	31%	**1,071,877**		842,299	258,636	1,100,935	13,249	888,557	272,815	**1,174,621**

ESTIMATED FEDERAL COST:	**1,103,612**
ESTIMATED NON-FEDERAL COST:	**71,009**
ESTIMATED TOTAL PROJECT COST:	**1,174,621**

CHIEF, Professional Services, Carl Anderson

Project Management, Byron D. Williams

CHIEF, REAL ESTATE, Orlando Rosa

CHIEF, PLANNING, Dolan Dunn

CHIEF, ENGINEERING, Peter Perez

CHIEF, OPERATIONS, Johnny Rozypal

CHIEF, CONSTRUCTION, John Curtis

CHIEF, CONTRACTING, Thomas Benero

CHIEF, PM-J, William A. Wise

CHIEF, DPM, Arthur Janecka

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #1 - Sabine Bank Sta 165+000 to 132+000													
02	RELOCATIONS	1,669	551	33%	2,220	2.8%	1,717	567	2,284			1,717	567	2,284
12	NAVIGATION PORTS & HARBORS	51,056	16,848	33%	67,904	2.7%	52,436	17,304	69,740		0.9%	52,885	17,452	70,337
	CONSTRUCTION ESTIMATE TOTALS:	52,725	17,399	33%	**70,124**		54,153	17,871	72,024			54,602	18,019	72,621
01	LANDS AND DAMAGES	-	-		-					-				
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	527	174	33%	701	2.7%	542	179	721	2012Q1		542	179	721
1.0%	Planning & Environmental Compliance	527	174	33%	701	2.7%	542	179	721	2012Q1		542	179	721
5.0%	Engineering & Design	2,636	870	33%	3,506	2.7%	2,708	894	3,602	2012Q1		2,708	894	3,602
1.0%	Engineering Tech Review ITR & VE	527	174	33%	701	2.7%	542	179	721	2012Q1		542	179	721
1.0%	Contracting & Reprographics	527	174	33%	701	2.7%	542	179	721	2012Q1		542	179	721
2.0%	Engineering During Construction	1,055	348	33%	1,403	2.7%	1,083	357	1,440	2012Q3	0.9%	1,092	360	1,452
0.1%	Surveys - Hydro	28	9	33%	37	2.7%	29	9	38	2012Q3	0.9%	29	9	38
0.1%	Soil Boring & Testing	40	13	33%	53	2.7%	41	13	54	2012Q1		41	13	54
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	3,164	1,044	33%	4,208	2.7%	3,249	1,072	4,321	2012Q3	0.9%	3,277	1,081	4,358
	Project Operation:													
1.0%	Project Management	527	174	33%	701	2.7%	542	179	721	2012Q3	0.9%	547	181	728
	CONTRACT COST TOTALS:	62,284	20,553		**82,837**		63,973	21,111	85,084			64,464	21,273	**85,737**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #2 - Sabine Bank Sta 132+00 to 95+734													
12	NAVIGATION PORTS & HARBORS	24,449	8,068	33%	32,517	2.7%	25,110	8,286	33,396	2014Q1	3.6%	26,012	8,584	34,596
	CONSTRUCTION ESTIMATE TOTALS:	24,449	8,068	33%	**32,517**		25,110	8,286	33,396			26,012	8,584	34,596
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	244	81	33%	325	2.7%	251	83	334	2013Q3	2.7%	258	85	343
1.0%	Planning & Environmental Compliance	244	81	33%	325	2.7%	251	83	334	2013Q3	2.7%	258	85	343
5.0%	Engineering & Design	1,222	403	33%	1,625	2.7%	1,256	414	1,670	2013Q3	2.7%	1,290	425	1,715
1.0%	Engineering Tech Review & VE	244	81	33%	325	2.7%	251	83	334	2013Q3	2.7%	258	85	343
1.0%	Contracting & Reprographics	244	81	33%	325	2.7%	251	83	334	2013Q3	2.7%	258	85	343
2.0%	Engineering During Construction	489	161	33%	650	2.7%	502	165	667	2014Q1	3.6%	520	171	691
0.1%	Surveys - Hydro	30	10	33%	40	2.7%	31	10	41	2014Q1	3.6%	32	10	42
0.2%	Soil Boring & Testing	40	13	33%	53	2.7%	41	13	54	2013Q3	2.7%	42	13	55
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	1,467	484	33%	1,951	2.7%	1,507	497	2,004	2014Q1	3.6%	1,561	515	2,076
	Project Operation:									-				
1.0%	Project Management	244	81	33%	325	2.7%	251	83	334	2014Q1	3.6%	260	86	346
	CONTRACT COST TOTALS:	28,920	9,544		**38,464**		29,702	9,800	39,502			30,749	10,144	**40,893**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #3 -Sabine Bank Sta 95+734 to 53+000													
02	RELOCATIONS	995	328	33%	1,323	2.8%	1,023	337	1,360	2014Q3	4.5%	1,069	352	1,421
12	NAVIGATION PORTS & HARBORS	27,187	8,972	33%	36,159	2.7%	27,922	9,215	37,137	2015Q2	5.9%	29,579	9,762	39,341
	CONSTRUCTION ESTIMATE TOTALS:	28,182	9,300	33%	**37,482**		28,945	9,552	38,497			30,648	10,114	40,762
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	282	93	33%	375	2.7%	289	96	385	2014Q3	4.5%	302	100	402
1.0%	Planning & Environmental Compliance	282	93	33%	375	2.7%	289	96	385	2014Q3	4.5%	302	100	402
5.0%	Engineering & Design	1,409	465	33%	1,874	2.7%	1,447	478	1,925	2014Q3	4.5%	1,513	500	2,013
1.0%	Engineering Tech Review & VE	282	93	33%	375	2.7%	289	96	385	2014Q3	4.5%	302	100	402
1.0%	Contracting & Reprographics	282	93	33%	375	2.7%	289	96	385	2014Q3	4.5%	302	100	402
2.0%	Engineering During Construction	564	186	33%	750	2.7%	579	191	770	2015Q2	5.9%	613	202	815
0.1%	Surveys - Hydro	25	8	33%	33	2.7%	26	8	34	2015Q2	5.9%	28	8	36
0.1%	Soil Boring & Testing	23	8	33%	31	2.7%	24	8	32	2014Q3	4.5%	25	8	33
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	1,691	558	33%	2,249	2.7%	1,737	573	2,310	2015Q2	5.9%	1,840	607	2,447
	Project Operation:									-				
1.0%	Project Management	282	93	33%	375	2.7%	289	96	385	2015Q2	5.9%	306	102	408
	CONTRACT COST TOTALS:	33,303	10,990		**44,293**		34,203	11,290	45,493			36,181	11,941	**48,122**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #4 - Sabine Pass Outer Bar Jetty Ch Sta 53+000 to 0+000													
02	RELOCATIONS	1,657	547	33%	2,204	2.8%	1,704	563	2,267	2015Q3	6.4%	1,813	599	2,412
12	NAVIGATION PORTS & HARBORS	45,723	15,089	33%	60,812	2.7%	46,959	15,497	62,456	2016Q4	8.8%	51,099	16,863	67,962
	CONSTRUCTION ESTIMATE TOTALS:	47,380	15,636	33%	**63,016**		48,663	16,060	64,723			52,912	17,462	70,374
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	474	156	33%	630	2.7%	487	160	647	2015Q3	6.4%	518	170	688
1.0%	Planning & Environmental Compliance	474	156	33%	630	2.7%	487	160	647	2015Q3	6.4%	518	170	688
5.0%	Engineering & Design	2,369	782	33%	3,151	2.7%	2,433	803	3,236	2015Q3	6.4%	2,589	855	3,444
1.0%	Engineering Tech Review & VE	474	156	33%	630	2.7%	487	160	647	2015Q3	6.4%	518	170	688
1.0%	Contracting & Reprographics	474	156	33%	630	2.7%	487	160	647	2015Q3	6.4%	518	170	688
2.0%	Engineering During Construction	948	313	33%	1,261	2.7%	973	321	1,294	2016Q4	8.8%	1,059	349	1,408
0.1%	Surveys - Hydro	38	13	33%	51	2.7%	39	13	52	2016Q4	8.8%	42	14	56
0.1%	Soil Boring & Testing	35	12	33%	47	2.7%	36	12	48	2015Q3	6.4%	38	13	51
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	2,843	938	33%	3,781	2.7%	2,920	963	3,883	2016Q4	8.8%	3,177	1,048	4,225
	Project Operation:									-				
1.0%	Project Management	474	156	33%	630	2.7%	487	160	647	2016Q4	8.8%	530	174	704
	CONTRACT COST TOTALS:	55,981	18,474		**74,455**		57,499	18,972	76,471			62,419	20,595	**83,014**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #5 - Sabine Pass Outer Bar Jetty Ch Sta -214+88 to 0+00													
12	NAVIGATION PORTS & HARBORS	15,499	5,115	33%	20,614	2.7%	15,918	5,253	21,171	2017Q3	10.3%	17,554	5,793	23,347
	CONSTRUCTION ESTIMATE TOTALS:	15,499	5,115	33%	**20,614**		15,918	5,253	21,171			17,554	5,793	23,347
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	155	51	33%	206	2.7%	159	52	211	2017Q1	9.3%	174	57	231
1.0%	Planning & Environmental Compliance	155	51	33%	206	2.7%	159	52	211	2017Q1	9.3%	174	57	231
5.0%	Engineering & Design	775	256	33%	1,031	2.7%	796	263	1,059	2017Q1	9.3%	870	287	1,157
1.0%	Engineering Tech Review ITR & VE	155	51	33%	206	2.7%	159	52	211	2017Q1	9.3%	174	57	231
1.0%	Contracting & Reprographics	155	51	33%	206	2.7%	159	52	211	2017Q1	9.3%	174	57	231
2.0%	Engineering During Construction	310	102	33%	412	2.7%	318	105	423	2017Q3	10.3%	351	116	467
0.3%	Surveys - Hydro	50	17	33%	67	2.7%	51	17	68	2017Q3	10.3%	56	19	75
0.3%	Soil Boring & Testing	46	15	33%	61	2.7%	47	15	62	2017Q1	9.3%	51	16	67
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	930	307	33%	1,237	2.7%	955	315	1,270	2017Q3	10.3%	1,053	347	1,400
	Project Operation:													
1.0%	Project Management	155	51	33%	206	2.7%	159	52	211	2017Q3	10.3%	175	57	232
	CONTRACT COST TOTALS:	18,385	6,067		**24,452**		18,880	6,228	25,108			20,806	6,863	**27,669**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #6 - Sabine Pass Ch Sta 0+00 to 295+60													
02	RELOCATIONS	2,936	881	30%	3,817	2.8%	3,020	906	3,926	2016Q3	8.3%	3,272	981	4,253
12	NAVIGATION PORTS & HARBORS	36,885	11,066	30%	47,951	2.7%	37,882	11,365	49,247	2017Q1	9.3%	41,401	12,421	53,822
18	CULTURAL RESOURCE PRESERVATION	960	288	30%	1,248	2.7%	986	296	1,282	2016Q3	8.3%	1,068	321	1,389
	CONSTRUCTION ESTIMATE TOTALS:	40,781	12,235	30%	**53,016**		41,888	12,567	54,455			45,741	13,723	59,464
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
	Non-Fed Cost	827	207	25%	1,034	4.2%	862	216	1,078	2016Q1	7.4%	925	232	1,157
	Federal cost	102	26	25%	128	4.2%	106	27	133	2016Q1	7.4%	114	29	143
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	408	122	30%	530	2.7%	419	125	544	2016Q3	6.7%	447	133	580
1.0%	Planning & Environmental Compliance	408	122	30%	530	2.7%	419	125	544	2016Q3	6.7%	447	133	580
5.0%	Engineering & Design	2,039	612	30%	2,651	2.7%	2,094	629	2,723	2016Q3	6.7%	2,235	671	2,906
1.0%	Engineering Tech Review & VE	408	122	30%	530	2.7%	419	125	544	2016Q3	6.7%	447	133	580
1.0%	Contracting & Reprographics	408	122	30%	530	2.7%	419	125	544	2016Q3	6.7%	447	133	580
2.0%	Engineering During Construction	816	245	30%	1,061	2.7%	838	252	1,090	2017Q1	9.3%	916	275	1,191
1.0%	Surveys - Hydro	405	122	30%	527	2.7%	416	125	541	2017Q1	9.3%	455	137	592
1.0%	Surveys - Land	405	122	30%	527	2.7%	416	125	541	2017Q1	9.3%	455	137	592
0.2%	Soil Boring & Testing	90	27	30%	117	2.7%	92	28	120	2016Q3	6.7%	98	30	128
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	2,447	734	30%	3,181	2.7%	2,513	754	3,267	2017Q1	9.3%	2,746	824	3,570
	Project Operation:									-				
1.0%	Project Management	408	122	30%	530	2.7%	419	125	544	2017Q1	9.3%	458	137	595
	CONTRACT COST TOTALS:	49,951	14,940		**64,891**		51,320	15,348	66,668			55,931	16,727	**72,658**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #7 -Pt Arthur Canal & Taylor Bayou													
12	NAVIGATION PORTS & HARBORS									-				
	Non-Fed Cost	880	264	30%	1,144	2.7%	904	271	1,175	2013Q4	3.1%	932	280	1,212
	Federal cost	76,059	22,818	30%	98,877	2.7%	78,115	23,435	101,550	2013Q4	3.1%	80,571	24,172	104,743
	CONSTRUCTION ESTIMATE TOTALS:	76,939	23,082	30%	100,021		79,019	23,706	102,725			81,503	24,452	105,955
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
	Non-Fed Cost	639	160	25%	799	2.7%	656	164	820	2012Q4	1.3%	664	166	830
	Federal cost	64	16	25%	80	2.7%	66	16	82	2012Q4	1.3%	67	16	83
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	769	231	30%	1,000	2.7%	790	237	1,027	2012Q1		790	237	1,027
1.0%	Planning & Environmental Compliance	769	231	30%	1,000	2.7%	790	237	1,027	2012Q1		790	237	1,027
5.0%	Engineering & Design	3,847	1,154	30%	5,001	2.7%	3,951	1,185	5,136	2012Q1		3,951	1,185	5,136
1.0%	Engineering Tech Review & VE	769	231	30%	1,000	2.7%	790	237	1,027	2012Q1		790	237	1,027
1.0%	Contracting & Reprographics	769	231	30%	1,000	2.7%	790	237	1,027	2012Q1		790	237	1,027
2.0%	Engineering During Construction	1,539	462	30%	2,001	2.7%	1,580	474	2,054	2013Q4	3.1%	1,630	489	2,119
	Planning During Construction			30%						-				
0.9%	Surveys - Hydro	353	106	30%	459	2.7%	363	109	472	2013Q4	3.1%	374	112	486
0.9%	Surveys - Land	353	106	30%	459	2.7%	363	109	472	2013Q4	3.1%	374	112	486
0.2%	Soil Boring & Testing	96	29	30%	125	2.7%	99	30	129	2012Q1		99	30	129
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	4,616	1,385	30%	6,001	2.7%	4,741	1,422	6,163	2013Q4	3.1%	4,890	1,467	6,357
	Project Operation:									-				
1.0%	Project Management	769	231	30%	1,000	2.7%	790	237	1,027	2013Q4	3.1%	815	244	1,059
	CONTRACT COST TOTALS:	92,293	27,655		**119,948**		94,788	28,400	123,188			97,527	29,221	**126,748**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #8 - Sabine Neches Canal Sta 0+00 tp 170+00													
02	RELOCATIONS	694	208	30%	902	2.8%	714	214	928	2017Q1	9.3%	780	234	1,014
12	NAVIGATION PORTS & HARBORS	33,596	10,079	30%	43,675	2.7%	34,504	10,352	44,856	2018Q2	11.8%	38,562	11,569	50,131
	CONSTRUCTION ESTIMATE TOTALS:	34,290	10,287	30%	**44,577**		35,218	10,566	45,784			39,342	11,803	51,145
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
	Non-Fed Cost	70	18	25%	88	2.7%	72	18	90	2017Q2	9.8%	79	20	99
	Federal cost	60	15	25%	75	2.7%	62	15	77	2017Q2	9.8%	68	16	84
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	343	103	30%	446	2.7%	352	106	458	2017Q2	9.8%	386	116	502
1.0%	Planning & Environmental Compliance	343	103	30%	446	2.7%	352	106	458	2017Q2	9.8%	386	116	502
5.0%	Engineering & Design	1,715	514	30%	2,229	2.7%	1,761	528	2,289	2017Q2	9.8%	1,933	580	2,513
1.0%	Engineering Tech Review & VE	343	103	30%	446	2.7%	352	106	458	2017Q2	9.8%	386	116	502
1.0%	Contracting & Reprographics	343	103	30%	446	2.7%	352	106	458	2017Q2	9.8%	386	116	502
2.0%	Engineering During Construction	686	206	30%	892	2.7%	704	212	916	2018Q2	11.8%	787	237	1,024
0.1%	Surveys - Hydro	13	4	30%	17	2.7%	13	4	17	2017Q2	11.8%	15	4	19
0.3%	Soil Boring & Testing	52	16	30%	68	2.7%	53	16	69	2018Q2	9.8%	58	18	76
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	2,057	617	30%	2,674	2.7%	2,113	634	2,747	2018Q2	11.8%	2,361	709	3,070
	Project Operation:									-				
1.0%	Project Management	343	103	30%	446	2.7%	352	106	458	2018Q2	11.8%	393	118	511
	CONTRACT COST TOTALS:	40,657	12,192		**52,849**		41,756	12,523	54,279			46,580	13,969	**60,549**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #9 - Sabine Neches Canal Sta 170+00 to 592+93													
02	RELOCATIONS	561	168	30%	729	2.8%	577	173	750	2014Q1	6.8%	616	185	801
12	NAVIGATION PORTS & HARBORS	51,403	15,421	30%	66,824	2.7%	52,793	15,838	68,631	2015Q3	6.4%	56,179	16,854	73,033
	CONSTRUCTION ESTIMATE TOTALS:	51,964	15,589	30%	**67,553**		53,370	16,011	69,381			56,795	17,039	73,834
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
	Non-Fed Cost	70	18	25%	88	2.7%	72	18	90	2014Q3	4.5%	75	19	94
	Federal cost	60	15	25%	75	2.7%	62	15	77	2014Q3	4.5%	65	16	81
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	520	156	30%	676	2.7%	534	160	694	2014Q1	3.6%	553	166	719
1.0%	Planning & Environmental Compliance	520	156	30%	676	2.7%	534	160	694	2014Q1	3.6%	553	166	719
5.0%	Engineering & Design	2,598	779	30%	3,377	2.7%	2,668	800	3,468	2014Q1	3.6%	2,764	829	3,593
1.0%	Engineering Tech Review & VE	520	156	30%	676	2.7%	534	160	694	2014Q1	3.6%	553	166	719
1.0%	Contracting & Reprographics	520	156	30%	676	2.7%	534	160	694	2014Q1	3.6%	553	166	719
2.0%	Engineering During Construction	1,039	312	30%	1,351	2.7%	1,067	320	1,387	2015Q3	6.4%	1,135	341	1,476
0.2%	Surveys - Hydro	80	24	30%	104	2.7%	82	25	107	2015Q3	6.4%	87	27	114
0.2%	Surveys - Land	80	24	30%	104	2.7%	82	25	107	2015Q3	6.4%	87	27	114
0.1%	Soil Boring & Testing	70	21	30%	91	2.7%	72	22	94	2014Q1	3.6%	75	23	98
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	3,118	935	30%	4,053	2.7%	3,202	960	4,162	2015Q3	6.4%	3,407	1,022	4,429
	Project Operation:									-				
1.0%	Project Management	520	156	30%	676	2.7%	534	160	694	2015Q3	6.4%	568	170	738
	CONTRACT COST TOTALS:	61,678	18,497		**80,175**		63,347	18,996	82,343			67,270	20,177	**87,447**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #10 - Neches River Channel Sta 0+00 to 292+00													
02	RELOCATIONS	7,729	2,319	30%	10,048	2.8%	7,949	2,385	10,334	2012Q3	0.9%	8,017	2,405	10,422
12	NAVIGATION PORTS & HARBORS													
	Non-Fed Cost	1,398	419	30%	1,817	2.7%	1,436	430	1,866	2013Q3	2.7%	1,475	442	1,917
	Federal cost	63,864	19,159	30%	83,023	2.7%	65,591	19,677	85,268	2013Q3	2.7%	67,351	20,205	87,556
	CONSTRUCTION ESTIMATE TOTALS:	72,991	21,897	30%	94,888		74,976	22,492	97,468			76,843	23,052	99,895
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
	Non-Fed Cost	110	28	25%	138	2.7%	113	29	142	2012Q3	0.9%	114	29	143
	Federal cost	85	21	25%	106	2.7%	87	22	109	2012Q3	0.9%	88	22	110
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	730	219	30%	949	2.7%	750	225	975	2012Q3	0.9%	756	227	983
1.0%	Planning & Environmental Compliance	730	219	30%	949	2.7%	750	225	975	2012Q3	0.9%	756	227	983
5.0%	Engineering & Design	3,650	1,095	30%	4,745	2.7%	3,748	1,125	4,873	2012Q3	0.9%	3,780	1,135	4,915
1.0%	Engineering Tech Review & VE	730	219	30%	949	2.7%	750	225	975	2012Q3	0.9%	756	227	983
1.0%	Contracting & Reprographics	730	219	30%	949	2.7%	750	225	975	2012Q3	0.9%	756	227	983
2.0%	Engineering During Construction	1,460	438	30%	1,898	2.7%	1,499	450	1,949	2013Q3	2.7%	1,539	462	2,001
0.3%	Surveys - Hydro	213	64	30%	277	2.7%	219	66	285	2013Q3	2.7%	225	68	293
0.3%	Surveys - Land	213	64	30%	277	2.7%	219	66	285	2013Q3	2.7%	225	68	293
0.2%	Soil Boring & Testing	179	54	30%	233	2.7%	184	55	239	2012Q3	0.9%	186	55	241
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	4,379	1,314	30%	5,693	2.7%	4,498	1,350	5,848	2013Q3	2.7%	4,619	1,386	6,005
	Project Operation:									-				
1.0%	Project Management	730	219	30%	949	2.7%	750	225	975	2013Q3	2.7%	770	231	1,001
	CONTRACT COST TOTALS:	86,929	26,070		**112,999**		89,293	26,780	116,073			91,413	27,416	**118,829**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #11 - Neches River Channel Sta 292+00 to 716+00													
02	RELOCATIONS	15,680	4,704	30%	20,384	2.8%	16,126	4,838	20,964	2016Q3	8.3%	17,469	5,241	22,710
12	NAVIGATION PORTS & HARBORS													
	Non-Fed Cost	5,237	1,571	30%	6,808	2.7%	5,379	1,613	6,992	2017Q1	9.3%	5,879	1,763	7,642
	Federal cost	76,728	23,018	30%	99,746	2.7%	78,803	23,640	102,443	2017Q1	9.3%	86,123	25,836	111,959
	CONSTRUCTION ESTIMATE TOTALS:	97,645	29,293	30%	126,938		100,308	30,091	130,399			109,471	32,840	142,311
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
	Non-Fed Cost	233	58	25%	291	2.7%	239	60	299	2016Q1	7.4%	257	64	321
	Federal cost	127	32	25%	159	2.7%	130	33	163	2016Q1	7.4%	140	35	175
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	976	293	30%	1,269	2.7%	1,003	301	1,304	2016Q3	8.3%	1,087	326	1,413
1.0%	Planning & Environmental Compliance	976	293	30%	1,269	2.7%	1,003	301	1,304	2016Q3	8.3%	1,087	326	1,413
5.0%	Engineering & Design	4,882	1,465	30%	6,347	2.7%	5,014	1,505	6,519	2016Q3	8.3%	5,432	1,630	7,062
1.0%	Engineering Tech Review & VE	976	293	30%	1,269	2.7%	1,003	301	1,304	2016Q3	8.3%	1,087	326	1,413
1.0%	Contracting & Reprographics	976	293	30%	1,269	2.7%	1,003	301	1,304	2016Q3	8.3%	1,087	326	1,413
2.0%	Engineering During Construction	1,953	586	30%	2,539	2.7%	2,006	602	2,608	2017Q1	9.3%	2,192	658	2,850
0.3%	Surveys - Hydro	278	83	30%	361	2.7%	286	85	371	2017Q1	9.3%	313	93	406
0.3%	Surveys - Land	278	83	30%	361	2.7%	286	85	371	2017Q1	9.3%	313	93	406
0.3%	Soil Boring & Testing	327	98	30%	425	2.7%	336	101	437	2016Q3	8.3%	364	109	473
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	5,859	1,758	30%	7,617	2.7%	6,017	1,806	7,823	2017Q1	9.3%	6,576	1,974	8,550
	Project Operation:									-				
1.0%	Project Management	976	293	30%	1,269	2.7%	1,003	301	1,304	2017Q1	9.3%	1,096	329	1,425
	CONTRACT COST TOTALS:	116,464	34,921		**151,385**		119,637	35,873	155,510			130,502	39,129	**169,631**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #12 - Neches River Channel Sta 292+00 to 716+00													
12	NAVIGATION PORTS & HARBORS													
	Non-Fed Cost	8,065	2,420	30%	10,485	2.7%	8,283	2,485	10,768	2013Q3	2.7%	8,505	2,552	11,057
	Federal cost	77,046	23,114	30%	100,160	2.7%	79,129	23,739	102,868	2013Q3	2.7%	81,253	24,376	105,629
	CONSTRUCTION ESTIMATE TOTALS:	85,111	25,534	30%	110,645		87,412	26,224	113,636			89,758	26,928	116,686
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
	Non-Fed Cost	943	236	25%	1,179	2.7%	968	242	1,210	2012Q3	0.9%	976	244	1,220
	Federal cost	97	24	25%	121	2.7%	100	25	125	2012Q3	0.9%	101	25	126
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	851	255	30%	1,106	2.7%	874	262	1,136	2013Q1	1.8%	889	267	1,156
1.0%	Planning & Environmental Compliance	851	255	30%	1,106	2.7%	874	262	1,136	2013Q1	1.8%	889	267	1,156
5.0%	Engineering & Design	4,256	1,277	30%	5,533	2.7%	4,371	1,312	5,683	2013Q1	1.8%	4,448	1,335	5,783
1.0%	Engineering Tech Review & VE	851	255	30%	1,106	2.7%	874	262	1,136	2013Q1	1.8%	889	267	1,156
1.0%	Contracting & Reprographics	851	255	30%	1,106	2.7%	874	262	1,136	2013Q1	1.8%	889	267	1,156
2.0%	Engineering During Construction	1,702	511	30%	2,213	2.7%	1,748	525	2,273	2013Q3	2.7%	1,795	539	2,334
0.2%	Surveys - Hydro	153	46	30%	199	2.7%	157	47	204	2013Q3	2.7%	161	48	209
0.2%	Surveys - Land	153	46	30%	199	2.7%	157	47	204	2013Q3	2.7%	161	48	209
0.2%	Soil Boring & Testing	153	46	30%	199	2.7%	157	47	204	2013Q1	1.8%	160	48	208
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	5,107	1,532	30%	6,639	2.7%	5,245	1,573	6,818	2013Q3	2.7%	5,386	1,615	7,001
	Project Operation:									-				
1.0%	Project Management	851	255	30%	1,106	2.7%	874	262	1,136	2013Q3	2.7%	897	269	1,166
	CONTRACT COST TOTALS:	101,930	30,527		**132,457**		104,685	31,352	136,037			107,399	32,167	**139,566**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #13 - Dredging Sabine Lake													
06	FISH & WILDLIFE FACILITIES	21,496	6,449	30%	27,945	2.7%	22,077	6,623	28,700	2016Q2	7.8%	23,808	7,142	30,950
	CONSTRUCTION ESTIMATE TOTALS:	21,496	6,449	30%	**27,945**		22,077	6,623	28,700			23,808	7,142	30,950
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	215	64	30%	279	2.7%	221	66	287	2015Q4	6.9%	236	71	307
1.0%	Planning & Environmental Compliance	215	64	30%	279	2.7%	221	66	287	2015Q4	6.9%	236	71	307
5.0%	Engineering & Design	1,075	322	30%	1,397	2.7%	1,104	331	1,435	2015Q4	6.9%	1,180	354	1,534
1.0%	Engineering Tech Review & VE	215	64	30%	279	2.7%	221	66	287	2015Q4	6.9%	236	71	307
1.0%	Contracting & Reprographics	215	64	30%	279	2.7%	221	66	287	2015Q4	6.9%	236	71	307
2.0%	Engineering During Construction	430	129	30%	559	2.7%	442	132	574	2016Q2	7.8%	477	142	619
0.6%	Surveys - Hydro	130	39	30%	169	2.7%	134	40	174	2016Q2	7.8%	145	43	188
0.6%	Surveys - Land	130	39	30%	169	2.7%	134	40	174	2016Q2	7.8%	145	43	188
0.4%	Soil Boring & Testing	76	23	30%	99	2.7%	78	24	102	2015Q4	6.9%	83	26	109
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	1,290	387	30%	1,677	2.7%	1,325	397	1,722	2016Q2	7.8%	1,429	428	1,857
	Project Operation:									-				
1.0%	Project Management	215	64	30%	279	2.7%	221	66	287	2016Q2	7.8%	238	71	309
	CONTRACT COST TOTALS:	25,701	7,708		**33,409**		26,399	7,917	34,316			28,449	8,533	**36,982**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
Effective Price Level: 2011(Oct - Dec)

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #14 - Channel to Orange													
06	FISH & WILDLIFE FACILITIES	907	272	30%	1,179	2.7%	932	279	1,211	2013Q1	1.8%	948	284	1,232
	CONSTRUCTION ESTIMATE TOTALS:	907	272	30%	**1,179**		932	279	1,211			948	284	1,232
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	9	3	30%	12	2.7%	9	3	12	2012Q3	0.9%	9	3	12
1.0%	Planning & Environmental Compliance	9	3	30%	12	2.7%	9	3	12	2012Q3	0.9%	9	3	12
5.0%	Engineering & Design	45	14	30%	59	2.7%	47	14	61	2012Q3	0.9%	47	14	61
1.0%	Engineering Tech Review & VE	9	3	30%	12	2.7%	9	3	12	2012Q3	0.9%	9	3	12
1.0%	Contracting & Reprographics	9	3	30%	12	2.7%	9	3	12	2012Q3	0.9%	9	3	12
2.0%	Engineering During Construction	18	5	30%	23	2.7%	19	5	24	2013Q1	1.8%	19	5	24
0.2%	Surveys - Land	40	12	30%	52	2.7%	41	12	53	2013Q1	1.8%	42	12	54
0.7%	Soil Boring & Testing	153	46	30%	199	2.7%	157	47	204	2012Q3	0.9%	158	47	205
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	54	16	30%	70	2.7%	56	16	72	2013Q1	1.8%	57	16	73
	Project Operation:									-				
1.0%	Project Management	9	3	30%	12	2.7%	9	3	12	2013Q1	1.8%	9	3	12
	CONTRACT COST TOTALS:	1,263	380		**1,643**		1,297	388	1,685			1,316	393	**1,709**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP SNWW Feasibility Report
LOCATION: Sabine-Neches Waterway, Texas & LA
This Estimate reflects the scope and schedule in feasibility report; Project Feasibility Report

DISTRICT: Galveston District
POC: Jackie Lockhart, Cost Engineer
PREPARED: 7-Oct-09

Estimate Prepared: 2009(Jul - Sep)
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Program Year (Budget EC): 2012
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FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	Contract #15 - GIWW East of Orange													
06	FISH & WILDLIFE FACILITIES	37,205	11,162	30%	48,367	2.7%	38,211	11,464	49,675	2014Q3	4.5%	39,943	11,984	51,927
	CONSTRUCTION ESTIMATE TOTALS:	37,205	11,162	30%	**48,367**		38,211	11,464	49,675			39,943	11,984	51,927
01	LANDS AND DAMAGES	-	-		-		-	-	-	-				
22	FEASIBILITY STUDIES									-				
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	372	112	30%	484	2.7%	382	115	497	2014Q1	3.6%	396	119	515
1.0%	Planning & Environmental Compliance	372	112	30%	484	2.7%	382	115	497	2014Q1	3.6%	396	119	515
5.0%	Engineering & Design	1,860	558	30%	2,418	2.7%	1,911	573	2,484	2014Q1	3.6%	1,980	594	2,574
1.0%	Engineering Tech Review & VE	372	112	30%	484	2.7%	382	115	497	2014Q1	3.6%	396	119	515
1.0%	Contracting & Reprographics	372	112	30%	484	2.7%	382	115	497	2014Q1	3.6%	396	119	515
2.0%	Engineering During Construction	744	223	30%	967	2.7%	764	229	993	2014Q3	4.5%	799	239	1,038
0.6%	Surveys - Hydro	133	40	30%	173	2.7%	137	41	178	2014Q3	4.5%	143	43	186
0.6%	Surveys - Land	133	40	30%	173	2.7%	137	41	178	2014Q3	4.5%	143	43	186
0.7%	Soil Boring & Testing	153	46	30%	199	2.7%	157	47	204	2014Q1	3.6%	163	49	212
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	2,232	670	30%	2,902	2.7%	2,293	688	2,981	2014Q3	4.5%	2,397	719	3,116
	Project Operation:									-				
1.0%	Project Management	372	112	30%	484	2.7%	382	115	497	2014Q3	4.5%	399	120	519
	CONTRACT COST TOTALS:	44,321	13,299		**57,620**		45,520	13,658	59,178			47,551	14,267	**61,818**

ATTACHMENT 13.5 – ITR Certification of Cost Estimate

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENTS
USACE - GALVESTON DISTRICT
DRAFT FEASIBILITY REPORT

COST ENGINEERING DX TPCS CERTIFICATION

As of 19 October 2009, the Walla Walla District, Cost Engineering Directory of Expertise (Dx) for Civil Works, certifies the feasibility level Sabine-Neches Waterway Channel Improvement Project developed by Galveston District for the values:

2012 Budget Amount:	$1,100,935,000
Fully Funded Amount:	$1,174,621,000

The Walla Walla Cost Dx representatives have provided an adequate Agency Technical Review (ATR) of the 2012 Budget and Total Project Cost, studying the project scope, report, cost estimates, schedules, escalation, and contingencies in accordance with ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

19Oct09
DATE

Kim Callan, PE, CCE, PM1
CH, Cost Engineering Dx
Walla Walla District

ATTACHMENT 13.6 – 50 year O&M

SABINE NECHES WATERWAY
50 Year O&M Cost Estimates
FEASIBILITY REPORT
October 2009 Price Levels

16-Jul-09

	Cont 1, Sect D	Cont 1, Sect C	Cont 2, Sect B	Cont 2, Sect C	Cont 3, Sect 1	Cont 4, Sect 2	Cont 4, Sect 3	Cont 5, Sect 4
O&M Costs								
Year 1							23,146,350	
Year 2						14,195,088	23,146,350	
Year 3							23,146,350	
Year 4	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 5							23,146,350	11,491,050
Year 6						14,195,088	23,146,350	
Year 7							23,146,350	
Year 8	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 9							23,146,350	
Year 10						14,195,088	23,146,350	11,491,050
Year 11							23,146,350	
Year 12	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 13							23,146,350	
Year 14						14,195,088	23,146,350	
Year 15							23,146,350	11,491,050
Year 16	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 17							23,146,350	
Year 18						14,195,088	23,146,350	
Year 19							23,146,350	
Year 20	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	11,491,050
Year 21							23,146,350	
Year 22						14,195,088	23,146,350	
Year 23							23,146,350	
Year 24	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 25							23,146,350	11,491,050
Year 26						14,195,088	23,146,350	
Year 27							23,146,350	
Year 28	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 29							23,146,350	
Year 30						14,195,088	23,146,350	11,491,050
Year 31							23,146,350	
Year 32	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 33							23,146,350	
Year 34						14,195,088	23,146,350	
Year 35							23,146,350	11,491,050
Year 36	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 37							23,146,350	

SABINE NECHES WATERWAY
50 Year O&M Cost Estimates
FEASIBILITY REPORT
October 2009 Price Levels

16-Jul-09

Year 38						14,195,088	23,146,350	
Year 39							23,146,350	
Year 40	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	11,491,050
Year 41							23,146,350	
Year 42						14,195,088	23,146,350	
Year 43							23,146,350	
Year 44	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 45							23,146,350	11,491,050
Year 46						14,195,088	23,146,350	
Year 47							23,146,350	
Year 48	3,951,450	4,729,563	4,642,063	4,706,563	7,168,800	14,195,088	23,146,350	
Year 49							23,146,350	
Year 50						14,195,088	23,146,350	11,491,050
TOTAL O&M:	**$ 47,417,400**	**$ 56,754,756**	**$ 55,704,756**	**$ 56,478,756**	**$ 86,025,600**	**$ 354,877,200**	**$ 1,157,317,500**	**$ 114,910,500**

SABINE NECHES WATERWAY
50 Year O&M Cost Estimates
FEASIBILITY REPORT
October 2009 Price Levels

16-Jul-09

O&M Costs	Cont 6, Sect 5	Cont 6, Sect 6	Cont 7, Sect 7 & 8	Cont 8, Sect 9	Cont 9, Sect 10
Year 1					
Year 2			11,674,475	13,483,950	
Year 3	5,998,834	3,795,355	11,781,573		
Year 4			11,674,475	13,483,950	15,633,038
Year 5					
Year 6	5,998,834	3,795,355	25,865,236	13,483,950	
Year 7					
Year 8			11,674,475	13,483,950	13,555,575
Year 9	5,998,834	3,795,355	11,781,573		
Year 10			11,674,475	13,483,950	
Year 11					
Year 12	5,998,834	4,640,280	25,265,523	13,483,950	13,555,575
Year 13					
Year 14			12,810,570	13,483,950	
Year 15	5,998,834	4,601,556	11,781,573		
Year 16			11,674,475	13,483,950	13,555,575
Year 17					
Year 18	5,998,834	5,271,667	25,265,523	13,483,950	
Year 19					
Year 20			11,674,475	13,483,950	15,633,038
Year 21	5,998,834	3,795,355	11,781,573		
Year 22			12,924,638	13,483,950	
Year 23					
Year 24	5,998,834	3,795,355	25,265,523	13,483,950	13,555,575
Year 25					
Year 26			11,674,475	13,483,950	
Year 27	5,998,834	3,795,355	11,781,573		
Year 28			12,810,570	13,483,950	13,555,575
Year 29					
Year 30	5,998,834	3,795,355	25,865,236	13,483,950	
Year 31					
Year 32			11,674,475	13,483,950	13,555,575
Year 33	5,998,834	4,640,280	11,781,573		
Year 34			11,674,475	13,483,950	
Year 35					
Year 36	5,998,834	5,271,667	25,265,523	13,483,950	13,555,575
Year 37					
Year 38			11,674,475	13,483,950	
Year 39	5,998,834	3,795,355	11,781,573		

SABINE NECHES WATERWAY
50 Year O&M Cost Estimates
FEASIBILITY REPORT
October 2009 Price Levels

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Year 40			12,810,570	13,483,950	15,633,038
Year 41					
Year 42	5,998,834	3,795,355	25,265,523	15,946,526	
Year 43					
Year 44			11,674,475	13,483,950	13,555,575
Year 45	5,998,834	3,795,355	11,781,573		
Year 46			11,674,475	13,483,950	
Year 47					
Year 48	5,998,834	3,795,355	25,865,236	13,483,950	13,555,575
Year 49					
Year 50			11,674,475	13,483,950	
TOTAL O&M:	**$ 95,981,344**	**$ 66,174,355**	**$ 501,300,430**	**$ 339,561,326**	**$ 168,899,289**

SABINE NECHES WATERWAY
50 Year O&M Cost Estimates
FEASIBILITY REPORT
October 2009 Price Levels

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O&M Costs	Sect 11	Sect 12	13	14	15	16	17	Sect 18	Ch to
Year 1									
Year 2									
Year 3	3,468,888	2,548,425	6,984,125						
Year 4				6,781,075					
Year 5									1,300,948
Year 6	3,468,888	3,404,112	6,957,700		6,471,263	11,980,713	2,570,550	14,148,036	
Year 7									
Year 8				6,781,075					
Year 9	3,468,888	2,548,425	6,957,700						
Year 10									1,300,948
Year 11									
Year 12	4,291,626	2,548,425	6,957,700	6,781,075	6,471,263	11,980,713	2,570,550	9,102,051	
Year 13									
Year 14									
Year 15	3,468,888	2,548,425	6,957,700						1,300,948
Year 16				6,781,075					
Year 17									
Year 18	3,468,888	3,404,112	6,957,700		6,471,263	11,980,713	2,570,550	10,265,926	
Year 19									
Year 20				6,781,075					1,300,948
Year 21	3,468,888	2,548,425	6,957,700						
Year 22									
Year 23									
Year 24	3,468,888	2,548,425	6,957,700	6,781,075	6,471,263	11,980,713	3,939,400	8,068,850	
Year 25									1,300,948
Year 26									
Year 27	4,350,638	2,548,425	6,957,700						
Year 28				6,781,075					
Year 29									
Year 30	3,468,888	3,404,112	6,957,700		6,884,838	11,980,713	2,570,550	11,159,575	1,300,948
Year 31									
Year 32				7,484,001					
Year 33	3,468,888	2,548,425	9,005,826						
Year 34									1,300,948
Year 35									
Year 36	4,526,938	2,548,425	6,957,700	7,484,001	6,471,263	11,980,713	2,570,550	8,068,850	
Year 37									
Year 38									
Year 39	3,468,888	2,548,425	6,957,700						

SABINE NECHES WATERWAY
50 Year O&M Cost Estimates
FEASIBILITY REPORT
October 2009 Price Levels

16-Jul-09

Year 40				7,484,001					
Year 41									
Year 42	3,468,888	3,404,112	6,957,700		6,471,263	11,980,713	2,570,550	11,252,425	
Year 43									
Year 44				7,484,001					
Year 45	3,468,888	2,548,425	6,957,700						
Year 46									
Year 47									
Year 48	3,468,888	2,548,425	9,005,826	7,484,001	6,884,838	11,980,713	2,570,550	8,068,850	
Year 49									
Year 50									
TOTAL O&M:	**$ 58,264,746**	**$ 44,197,548**	**$ 115,445,877**	**$ 84,887,530**	**$ 52,597,254**	**$ 95,845,704**	**$ 21,933,250**	**$ 80,134,563**	**$ 9,106,636**

Appendix 4

Real Estate Plan

GALVESTON DISTRICT
REAL ESTATE PLAN

SABINE-NECHES WATERWAY TEXAS & LOUISIANA

CHANNEL IMPROVEMENT PROJECT

JEFFERSON COUNTY, TEXAS & CAMERON PARISH, LOUISIANA

March 2011

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CESWG-RE

CESWG-PE-PL
Project Manager: Byron D. Williams
CESWG-RE-A
Prepared by: Salvatore Arcidiacono/Randy Richardson/Carlos Hidalgo
CESWG-RE
Submitted by: Orlando Rosas

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REAL ESTATE PLAN
SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
JEFFERSON COUNTY, TEXAS

1. General Background. This Real Estate Plan (REP) is the real estate work product of the U.S. Army Corps of Engineers, Galveston District, Real Estate Division (the "District") that supports project plan formulation for the Sabine-Neches Waterway Channel Improvement Project ("CIP"). It identifies and describes the lands, easements, and rights-of-way (LER) required for the construction, operation and maintenance of the proposed project, including those required for relocations, borrow material, and dredged or excavated material disposal. The REP also identifies and describes the facility/utility relocations that are necessary to implement the CIP. Further, the REP describes the estimated LER value, together with the estimated administrative and incidental costs attributable to providing project LER, and the acquisition process.

2. Project Type & Applicability. The feasibility study was conducted in response to the 5 June 1997 congressional resolution from the Committee on Environmental and Public Works, House of Representatives. The resolution states:

"The Secretary of the Army shall review previous reports on the Sabine-Neches Waterway published as Senate Document No. 80, 83rd Congress, Second Session: House Document No. 553, 87th Congress, Second Session; and other pertinent reports to determine the feasibility of modifying the channels serving the ports of Beaumont, Port Arthur, and Orange, Texas in the interest of commercial navigation."

3. Project Location. The Sabine-Neches Waterway is an approximate 64 existing mile federally authorized and maintained waterway located in Jefferson/Orange Counties in southeast Texas and Cameron Parish, Louisiana. The area surrounding the waterway is generally referred to as the "Golden Triangle" and is delineated by three major Texas seaports of Port Arthur, Beaumont and Orange. The Sabine-Neches Waterway provides deep-water navigation to these seaports, as well as for some shallow-draft tributary channels. The Sabine Pass, Sabine Lake, and Sabine River together form part of the boundary between the states of Texas and Louisiana. *(See Exhibit "C" Map Sheet PA Index)*

4. Scope and Content. The Sabine-Neches Waterway is a system of artificially widened and/or deepened channels that have been dredged from offshore through portions of the Sabine River and Lake, and the Neches River in Texas. The waterway is made up of 7 existing project reaches. From the Gulf of Mexico working upstream the reaches are: 1) Sabine Bank Channel, 2) Sabine Pass Outer Bar Channel, 3) Sabine Pass Jetty Channel, 4) Sabine Pass Channel, 5) Port Arthur Canal, 6) Sabine Neches Canal and 7) Neches River Channel. *(See Exhibit "C" Map Sheet PA Index).* The only connection with the Gulf of Mexico is a long narrow pass called Sabine Pass through which all tidal interchange occurs. Sabine Pass has been stabilized by jetties that extend more than 4 miles into the Gulf of Mexico. These jetties were constructed for navigational purposes. Proposed channel will have 8 reaches.

The feasibility report focused on alternatives from 45 feet to 50 feet for deepening of the Sabine-Neches Waterway from offshore to the Port of Beaumont. The alternatives were to deepen either 45, 46, 47, 48, 49, or 50 feet from the Gulf to Port of Beaumont, with up to 8 turning basins and selective widening. The Recommended Plan consists of a 49-foot deep navigation channel from the Gulf to the Port of Beaumont, with selective widening and 4 turning/anchorage basins.

5. <u>Purpose</u> The purpose of the REP is to identify the real estate requirements for the CIP and to estimate the costs of acquisition. The plan will also identify the estate to be acquired in the various tracts. In 2002, the local sponsor, the Jefferson County Navigation District, was renamed the Jefferson County Waterway and Navigation District (JCWND) and in 2007 the JCWND was renamed to the Sabine Neches Navigation District (SNND); the designation which is used throughout this report. The SNND already owns a majority of the lands needed for the CIP. The Sponsor will receive credit for the fair market value of any additional lands required, at the time they are made available to the Government for construction. The Sponsor will also receive credit for the administrative costs of acquisition for all lands acquired within 5 (five) years preceding the signing of the Project Cooperation Agreement (PCA).

6. <u>Real Estate Requirements.</u> The CIP Sponsor is required to furnish the lands, easements, and rights of way (LER) for the proposed cost-shared project. The real estate requirements must support construction as well as operation and maintenance of the project after completion. Of the eight reaches for the CIP starting with reaches one and two, **Sabine Bank Channel and Sabine Bank Extension**, all of the dredged material from this reach Sta53+000 to Sta165+000 will be deposited in offshore placement areas "A", "B","C","D", and offshore Site No. 1, *(See Exhibit "C" Map Sheet PA Index).* Reach three, **Sabine Pass Outer Bar Channel,** Sta53+000 to Sta0+000; all of the dredged material from this reach will be deposited in offshore Sites No. 2 and 3. *(See Exhibit "C" Map Sheet PA Index)* Reach four, **Sabine Pass Jetty Channel**, Sta0+000 to Sta215+29; the dredged material from this reach will all be deposited in offshore Site No. 4. *(See Exhibit "C" Map Sheet PA Index)* All of the placement areas which will be used for these three reaches are in navigable water and will be used by virtue of Navigation Servitude; therefore no real estate interests will be required. Reach five, **Sabine Pass Channel**, Sta0+000 to Sta295+00; the dredged material from this reach will be deposited in Placement Area Nos. 5 North, 5 South, 5C and 5B, an upland site containing 1,025.00 acres. This placement area will be acquired in fee. *(See Exhibit "C" Map Sheet PA 9).* Reach six, **Port Arthur Canal,** Sta0+00 to Sta326+24; the dredged material from this reach will be deposited in Placement areas 8 and 9, two upland sites. Placement area No. 8 contains 3,571.00 acres and is available by virtue Navigation Servitude, therefore no real estate interests is required. Placement area No. 9 contains 381.00 acres and is at the intersection of the Port Arthur Canal and the Gulf Intracoastal Waterway. Placement area 9a contains 166 acres will be acquired in fee. *(See Exhibit "C" Map Sheet PA 10).* Reach seven, **Sabine-Neches Canal**, Sta0+00 to Sta592+91; the dredged material from this reach will be deposited in Placement areas 8 and 11. These placement areas are along the Sabine- Neches Canal and were in navigable waters at one time. These Placement areas are now upland sites and are available by virtue of Navigation Servitude. Placement area 8 contains 3,571.00 acres and Placement area 11 contains 2,173.00 acres *(See Exhibit "C" Map Sheet PA 10 & 11).*

Neches River Channel is broken down into three reaches. Sta0+00 to Sta292+00, the material dredged from this reach will be deposited into placement areas 12, 13, 14, and 16 which total 1,051.00 acres and 17 which has 324 acres of upland placement areas. All of these placement areas with the exception of area 17 are owned by the local sponsor and therefore no real estate interests will be required. Placement area 17 will be acquired in fee. The second reach, Sta292+00 to Sta716+00, the material dredged from this reach will be deposited in placement areas 18, 18A, 21, 23, 23A and 24 which total 1,744.00 acres of upland placement areas. All of these areas are owned by the sponsor and therefore no real estate interests will be required. The third reach, Sta716+00 to Sta980+00, the material dredged from this reach will be deposited in placement areas 24A-187 acres, 25-643 acres, 25A-172 acres, 26-201 acres, 27A-129 acres, 27C-87 acres and 27D-55 acres. All these areas with the exception of placement area 26 and 27A, C and D are all owned by the local sponsor and therefore no real estate interests will be required. Placement areas 26 and 27A, C and D will be acquired in fee. *(See Exhibit "C" Map Sheet PA 14)*. Within these three reaches, there are 4 turning basins of which only two will require the acquisition of land totaling 12.10 acres that will be acquired in perpetual channel improvement easement. *(See Exhibit "C" Map Sheet PA 14)*. All of the placement areas currently owned by the local sponsor were acquired for the original SNWW project under a local cooperation agreement which required the sponsor to provide all LERRDs necessary for the project.

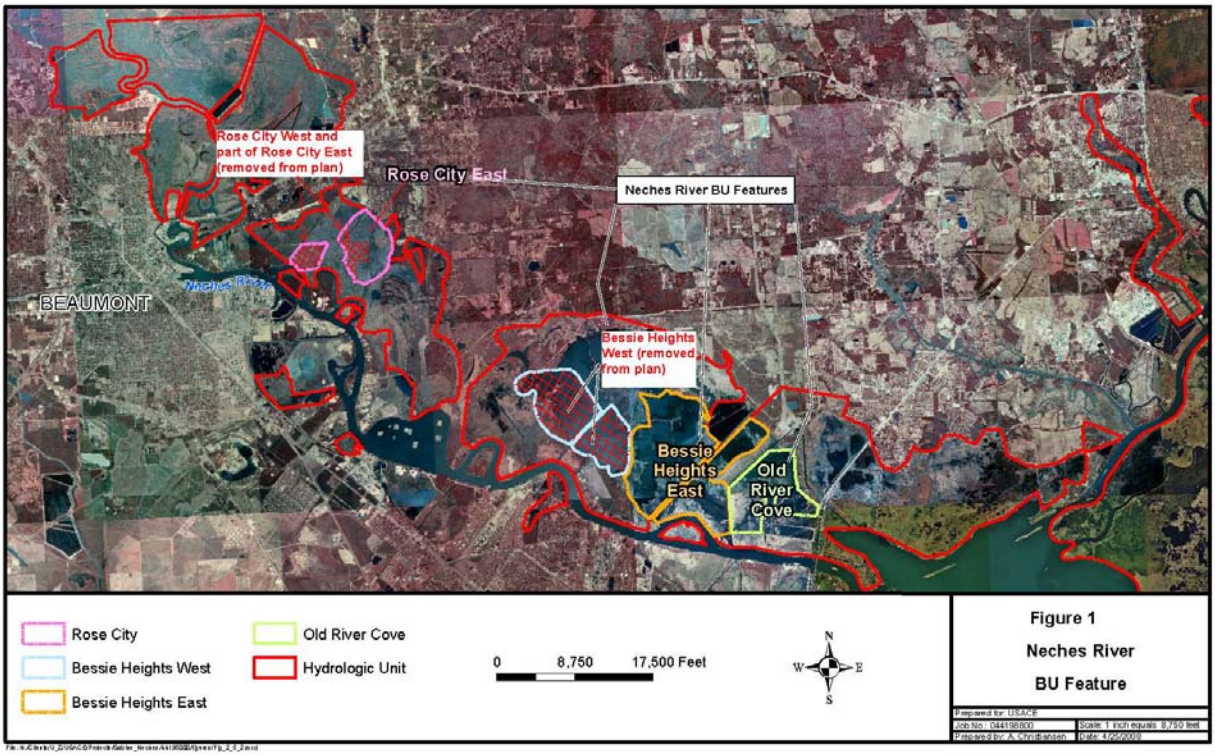
All DMMP beneficial use (BU) features proposed for inclusion in the DMMP of the Preferred Alternative are described in Table 2.4-13. Three former marsh areas on the Neches River (Rose City East, Bessie Heights East, and Old River Cove) would be combined into one large management feature called the Neches River BU Feature (see Figure 2.5-2). In the Gulf Shore BU Feature, maintenance material would be used to nourish Gulf shorelines at Texas and Louisiana Points (see Figure 2.5-3). The DMMP BU features are not being pursued as separable elements of an ecosystem restoration plan under Section 204 or 207 authorities. They are not ecosystem restoration measures, and as such, do not target a specific historical condition for the level of restoration. They are least-cost, environmentally acceptable placement features and are included as GNF of the DMMP.

The Neches River BU Feature would take advantage of new work material provided by the channel deepening project to build hydraulic containment levees within degraded, former marsh areas at Rose City East, Bessie Heights East, and Old River Cove. Each of these areas is referred to as a component of the overall Neches River BU Feature. Marsh would be created in each component using only new work, or a combination of new work and maintenance material. The Old River Cove component would be filled during initial construction with new work material, alone. In the Bessie Heights East component, maintenance material would be placed incrementally in 7 maintenance cycles over 28 years. At the Rose City East component, new work material would be used to construct containment levees and ridges, and then the marsh would be completed with the placement of maintenance material during the first maintenance cycle following construction. For the Neches River BU Feature as a whole, 2,853 acres of emergent marsh would be restored in areas that are now open water; 871 acres of improved shallow water habitat would be created by the formation of shallower ponds and interconnecting channels within the restored marshes; and 1,234 acres of existing fringing marsh would be nourished

Table 2.4-13
DMMP BU Features, SNWW Preferred Alternative

Beneficial Use Features	No.	Description	Size of Influence Area
Rose City East (component of Neches River BU Measure)	TX 3-1 East	Restoring 345 acres fresh marsh, 72 acres of shallow water, and nourishing 151 acres of existing marsh in two construction events. New work material from Neches River Channel will be used to restore 225-acre marsh, construct hydraulic containment levees and higher elevation features. Maintenance material from the first maintenance cycle will be used to restore an additional 120 acres of marsh.	Influence area – 568 acres
Bessie Heights East (component of Neches River BU Measure)	TX 5-2	Restores 679 acres of brackish and 1,190 acres of intermediate marsh, 660 acres of shallow water habitat and nourishes 651 acres of existing marsh. Marsh will be constructed with maintenance material from Neches River Channel for 28 years. New work material is used to build hydraulic containment levee.	Influence area – 3,180 acres
Old River Cove (component of Neches River BU Measure)	TX 6-1	Restores 639 acres of brackish marsh, 139 acres of shallow water habitat, and nourishes 432 acres of existing marsh with new work material from Neches River Channel. New work material used to construct hydraulic containment levee.	Influence area – 1,210 acres
Gulf Shore BU Feature (Texas and Louisiana Points)	TX 8-11 LA 5-2/6-2	Nourish 3 miles of Gulf shoreline on both sides of Sabine Pass, from 0.5 to 3.5 miles from East and West Jetties, using maintenance material from Sabine Pass Channel. Unconfined placement of maintenance material along shoreline every 3 years for 50-year period of analysis (8 placement episodes). Assume 50:50 split of material between Texas and Louisiana accomplished by alternating placement in Texas and Louisiana.	Affected shoreline 6.0 miles total

by winnowing fine-grained material from unconfined flows of dredged material effluent. The size of the Neches River BU Feature components and the magnitude of their ecological benefits are made possible by the large amounts of dredged material which would be generated by the proposed project, and extensive opportunities for beneficial use in the project area. The Gulf Shore Nourishment Feature would use material from regular maintenance dredging of the eastern section of the Sabine Pass Channel to nourish eroding marsh, and possibly create new saline marsh, along a total of 6 miles of shoreline on both sides of Sabine Pass at Louisiana and Texas Points. Material would be hydraulically pumped along a 3-mile reach of shoreline, from 0.5 to 3.5 miles from each jetty. The unconfined placement of material during each 3-year dredging cycle would alternate between Texas and Louisiana, so that materials would be placed on each state's shoreline every 6 years, for a total of 16 placement events over the 50-year period of analysis. Historic dredging records indicate that the material from Sabine Pass would average 51 percent silt, 31 percent clay, and 18 percent sand. The material would be hydraulically pumped into the near shore zone and some material would be expected to flow over existing marsh while the remainder flows into the nearshore waters. This mix of materials does not contain typical beach quality sand; however, resource agencies, which are listed in Table 1.6-1 of the FEIS, have ageed that returning the material to the littoral system would have a net beneficial effect, regardless of the material type.



The estates for the above mentioned tracts to be acquired are listed as below:

Fee Estate- Estate No. 1 Fee for Placement Areas
The fee simple title to (the land described in Schedule A) (Tract Nos. 5, 9, 17, 26, 27A, C and D), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; excepting and excluding from the taking all interests in coal, oil and gas or other minerals which are outstanding in parties other than surface owners and all appurtenant rights for the exploration, development and removal of said coal, oil and gas so excluded.

Channel Improvement Easement- Estate No. 8 for Turning Basins
A perpetual assignable right and easement to construct, operate, and maintain channel improvement works on, over, and across (the land described in Schedule A) (Tracts 1 through 8) for turning basins and for the purposes as authorized by the Act of Congress approved Water Resources Development Act 1999 (P.L. 106-53 SEC. 556), including the right to clear, cut fell, remove and dispose of any and all timber, trees, underbrush, buildings, improvements and /or other obstructions there from; to excavate; dredge, cut away, and remove any or all of said land and to place thereon dredged or excavated material; and for such other purposes as may be required in connection with said work of improvement; reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

7. Borrow Material. The proposed CIP does not require any borrow material.

8. Access/Staging Area. The proposed CIP does not require any access/staging areas. All of the proposed work will be performed within the existing right-of-way of the Sabine-Neches Waterway and existing roads and highways within the project area. No credit will be allowed for access/staging areas since these areas have already been provided for the previous project.

9. Recreation Features. The proposed project does not have any recreation features.

10. Induced Flooding. There is no induced flooding anticipated due to the construction of the project. The proposed CIP will be constructed within the existing right-of-way of the Sabine-Neches Waterway.

11. Mitigation and DMMP BU sites. The proposed CIP contains several mitigation and DMMP BU sites located within the project area. These sites consist of marsh creation, marsh nourishment and shore nourishment. Exhibit C shows the labeled sites on the Texas side and on the Louisiana side. *(See Exhibit "C" Map Sheet M 1)*.

12. Federally Owned Land & Existing Federal Project. Some of the DMMP BU and mitigation sites are located on federally-owned land. The Gulf Shore BU Feature will nourish shoreline owned by the Texas Point National Wildlife Refuge. Two of the mitigation sites (LA 2-18B and LA 2Add B) are located in the Sabine National Wildlife Refuge.

13. Navigation Servitude. Navigation Servitude emanated from the Commerce Clause of the Constitution of the United States, Article I; Section 8, Clause 3. The servitude gives the Federal Government the right to use the "Navigable Waters" of the United States without compensation for navigation projects. These are non-transferable rights, and are not considered interest in real property. The CIP has 3,003 acres of mitigation and 3,294 acres of marsh restoration sites. These sites are marsh areas and are under the mean high water mark. Therefore, there is no real estate requirements associated with the mitigation effort, marsh restoration sites, or nourishment areas since the Government will exercise Navigation Servitude on the required submerged lands. A separate contract will be let for the construction of these sites.

14. Public Law 91-646 Relocations. There are no residential houses, businesses, or farms that would be required for relocation associated with PL 91-646.

15. Assessment of Project Sponsor Land Acquisition Capabilities. The sponsor has the authority and capability to furnish lands, easements and rights of way in accordance with the Feasibility Cost-Sharing Agreement. The sponsor is highly capable of performing the real estate acquisition required by this project. A copy of the capability assessment is attached as *Exhibit "A"*.

16. Baseline Cost Estimate for Real Estate. The cost estimate below reflects estimated Federal and Non-Federal real estate costs for the proposed 8 reaches which consists of a total of 14 contracts (see cost estimate) for the proposed navigation project. These costs

include land payments, acquisition administrative costs, surveying, mapping and administrative costs. The real estate costs for the CIP are estimated below:

REAL ESTATE

01/02 LANDS AND DAMAGES/RELOCATIONS

CONSTRUCTION CONTRACT #1 -NON-FEDERAL COSTS
Sabine Bank Sta. 165+000 to 132+000

	Amount
Utility Relocations (50% of total Utility Relocations)	$834,500
Contingency (33%)	$275,500
Total Costs	$1,110,000

CONSTRUCTION CONTRACT #3 -NON-FEDERAL COSTS
Sabine Bank Sta. 95+734 to 53+000

	Amount
Utility Relocations (50% of total Utility Relocations)	$497,500
Contingency (33%)	$164,000
Total Costs	$661,500

CONSTRUCTION CONTRACT #4 -NON-FEDERAL COSTS
Sabine Pass Outer Bar Jetty Channel Sta. 53+000 to 0+000

	Amount
Utility Relocations (50% of total Utility Relocations)	$828,500
Contingency (33%)	$273,500
Total Costs	$1,102,000

CONSTRUCTION CONTRACT #6 -NON-FEDERAL COSTS
Sabine Pass Channel Sta. 0+00 to 295+60

	Amount
Land Payments (MCACES line 11501)	$700,000
Incidental Land Acquisition Expenses (total of MCACES lines 102, 103,105,112,113, 117)	$127,000
Utility Relocations (50% of total Utility Relocations)	$1,468,000
Contingency (25%-30%)	$647,500
Total Costs	$2,942,500

CONSTRUCTION CONTRACT #6 -FEDERAL COSTS
Sabine Pass Channel Sta. 0+00 to 295+60

	Amount
Administrative Expenses for Assistance, Review and Approval of NFS Land Acquisition (total of MCACES lines 102, 103,105,112, 113, 117)	$102,000
Contingency (25%)	$26,000
Total Costs	$128,000

CONSTRUCTION CONTRACT #7 -NON-FEDERAL COSTS
Port Arthur Channel Sta. 0+00 to 326+24

	Amount
Land Payments (MCACES line 11501)	$560,000
Incidental Land Acquisition Expenses (total of MCACES lines 102, 105,112,113,117)	$79,000
Contingency (25%)	$159,750
Total Costs	$799,000

CONSTRUCTION CONTRACT #7 -FEDERAL COSTS
Port Arthur Channel Sta. 0+00 to 326+24

	Amount
Administrative Expenses for Assistance, Review and Approval of NFS Land Acquisition (total of MCACES lines 102, 105,108,112, 113, 117)	$64,000
Contingency (25%)	$16,000
Total Costs	$80,000

CONSTRUCTION CONTRACT #8 & 9 -NON-FEDERAL COSTS
Sabine-Neches Canal Sta. 0+00 to 592+91

	Amount
Incidental Land Acquisition Expenses (total of MCACES lines 112,113,117)	$140,000
Utility Relocations (50% of total Utility Relocations)	$627,500
Contingency (25%-30%)	$224,000
Total Costs	$991,500

CONSTRUCTION CONTRACT #8 & 9 -FEDERAL COSTS
Sabine-Neches Canal Sta. 0+00 to 592+91

	Amount
Administrative Expenses for Assistance, Review and Approval of NFS Land Acquisition (total of MCACES lines 108, 112, 113, 117)	$120,000
Contingency (25%)	$30,000
Total Costs	$150,000

CONSTRUCTION CONTRACT #10 -NON-FEDERAL COSTS
Neches River Channel Sta. 0+00 to 292+00

	Amount
Land Payments (MCACES line 11501)	$20,000
Incidental Land Acquisition Expenses (total of MCACES lines 112,113,117)	$90,000
Utility Relocations (50% of total Utility Relocations)	$3,864,500
Contingency (25% - 30%)	$1,187,500
Total Costs	$5,162,000

CONSTRUCTION CONTRACT #10 -FEDERAL COSTS
Neches River Channel Sta. 0+00 to 292+00

	Amount
Administrative Expenses for Assistance, Review and Approval of NFS Land Acquisition (total of MCACES lines 108, 112, 113, 117)	$85,000
Contingency (25%)	$21,000
Total Costs	$106,000

CONSTRUCTION CONTRACT #11 -NON-FEDERAL COSTS
Neches River Channel Sta. 292+00 to 716+00

	Amount
Land Payments (MCACES line 11501)	$135,000
Incidental Land Acquisition Expenses (total of MCACES lines 102,105,112,113,117)	$98,000
Utility Relocations (50% of total Utility Relocations)	$7,840,000
Contingency (25% - 30%)	$2,410,000
Total Costs	$10,483,000

CONSTRUCTION CONTRACT #11 -FEDERAL COSTS
Neches River Channel Sta. 292+00 to 716+00

	Amount
Administrative Expenses for Assistance, Review and Approval of NFS Land Acquisition (total of MCACES lines 102,105,108, 112, 113, 117)	$127,000
Contingency (25%)	$32,000
Total Costs	$159,000

CONSTRUCTION CONTRACT #12 -NON-FEDERAL COSTS
Neches River Channel Sta. 716+00 to 980+00

	Amount
Land Payments (MCACES line 11501)	$775,000
Incidental Land Acquisition Expenses (total of MCACES lines 102,105,112,113,117)	$168,000
Contingency (25% - 30%)	$236,000
Total Costs	$1,179,000

CONSTRUCTION CONTRACT #12 -FEDERAL COSTS
Neches River Channel Sta. 716+00 to 980+00

	Amount
Administrative Expenses for Assistance, Review and Approval of NFS Land Acquisition (total of MCACES lines 102,105, 112, 113, 117)	$97,000
Contingency (25%)	$24,000
Total Costs	$121,000

Note: There are some administrative costs, both Federal and non-Federal costs, for utility relocations that are not presented separately in the tables. For those tables, the administrative costs for utility relocations are included as part of the contingency for that contract.

TOTAL--NON-FEDERAL LER plus UTILITY RELOCATION COSTS	**$24,430,500**
LER Costs	$3,617,000
Utility Relocation Costs	$20,813,500
TOTAL -- FEDERAL COSTS	**$744,000**

17. Acquisition Schedule. The acquisition of the LER necessary for the CIP is the responsibility of the sponsor, however, for the current project, the Sponsor owns all the lands required with the exception of six tracts which they are in the process of acquiring. Therefore, there is no need for an acquisition schedule. Significant time delays may be encountered if condemnation proceedings are required for land acquisitions.

18. Mineral Activity. Sabine Lake and the surrounding area along with the mitigation and the marsh restoration sites have considerable mineral activity. Mineral rights have not been transferred with property in the project area. Mineral rights need not be acquired with any lands required for the project. The State of Texas owns the mineral rights in most of the submerged lands in the project area. The Government's surface rights in the submerged lands required for the project emanates from the navigation servitude. The Navigation Servitude is the dominant estate and takes precedence over the mineral estate in the required submerged lands.

19. Relocation of Facilities/Utilities. A total of 104 pipelines have been identified crossing the SNWW navigation channels. Of the 104 pipelines, 46 require adjustment to meet the minimum required vertical and horizontal clearances for the Channel Improvement Project (CIP). (See Exhibit "D").

Pursuant to Section 101(a) of the Water Resources Development Act of 1986 (WRDA 86), as amended, the Sponsor is responsible for performing, or assuring the performance, of all relocations, including utility relocations, which are necessary for the CIP. All relocations, including utility relocations, are to be accomplished at no cost to the Federal Government.

Because the recommended plan consists of a 48-foot deep navigation channel, the CIP is a deep draft project. Therefore, in accordance with Section 101(a)(4) of WRDA 86, for all relocations of pipelines that are classified as "utility relocations," one-half of the cost of each such relocation shall be borne by the owner of the facility being relocated and one-half of the cost of each such relocation shall be borne by the Sponsor.

Consistent with the legislative history for Section 101 of WRDA 86, any pipeline, cable, or related facility located within the channel that must be relocated for the CIP is considered a utility relocation for the purpose of applying the cost sharing rule in Section 101(a)(4) of WRDA 86, as amended.

The Galveston District has concluded preliminarily that 41 of the 46 lines located within the channel must be relocated. Applying the definition of "utility" discussed above, such 41 relocations are classified as utility relocations for which the Sponsor must perform or assure performance with relocation costs to be shared equally between the Sponsor and the pipeline owners pursuant to Section 101(a)(4) of WRDA 86. Such relocation costs will not include any cost for upgrading or improving such facilities, which is to be borne by the facility owner.

If, following authorization of the CIP, the Sponsor is unable to reach an agreement with a pipeline owner as to the relocation of a particular pipeline, the Sponsor may request that the Corps exercise the navigation servitude, and revoke any existing Section 10 permit, to compel the owner to remove its line. The Corps will exercise the navigation servitude if the Sponsor has made a good-faith effort to negotiate with the pipeline owner for relocation of the line and

the Sponsor has made a showing that it has no authority to compel the relocation of the facility by the pipeline owner.

The exercise by the Corps of the navigation servitude, however, would not affect the cost-sharing formula for utility relocations established by the Congress in Section 101(a)(4) of WRDA 86. The Corps will not exercise the navigation servitude unless the Sponsor agrees in writing that such action will be at no cost to the Federal Government and will not affect the Sponsor's responsibility for payment of relocation costs under Section101(a)(4) . In addition, the Sponsor will be responsible for payment of the Corps' administrative costs associated with exercise of the navigation servitude.

For relocations that are not classified as "utility relocations," whether the Sponsor owes compensation to the facility owner turns on principles of just compensation under State law and whether any permits, licenses, or rights-of-way instruments have special provisions that as a matter of law may offset what compensation may otherwise be due. For such relocations, the Sponsor will negotiate with the pipeline or facility owners as to the amount of compensation that is required. As in the case of utility relocations, these relocations will be accomplished at no cost to the Federal Government.

The Galveston District also has concluded preliminarily that it will not be necessary to relocate 5 of the 46 lines because they are no longer necessary. Although such lines will need to be removed to construct the CIP, no replacement lines will be necessary. If an owner of such a line can be located, the Sponsor will contact the owner to reach a determination as to whether the owner has an interest in the existing line for which compensation is owed by the Sponsor. If the owner has a compensable interest, the Sponsor, as part of its requirement to provide lands, easements, and rights-of-way required for the CIP, will be responsible for acquiring this interest, at no cost to the Federal Government. The Sponsor will receive credit toward its additional 10 percent cash payment required by Section 101(a)(2) of WRDA 86 for the value of the interest acquired, and the Corps will revoke any existing Section 10 permit and remove the line as part of construction of the CIP, with the costs of the removal shared by the Corps and Sponsor as part of the costs of the general navigation features. If no compensation is owed to the owner of the line, or if the owner cannot be located, then the Corps will revoke any existing Section 10 permit and remove the line as part of construction of the CIP, with the costs of the removal shared by the Corps and Sponsor as part of the costs of the general navigation features.

The Sponsor will receive credit toward its additional 10 percent cash payment required by Section 101(a)(2) for the value of relocations provided under Section 101(a)(3) and for the costs of utility relocations borne by the Sponsor under Section 101(a)(4). Such credit will include any payment made by the Sponsor to the Corps associated with the Corps' exercise of the navigation servitude.

20. <u>HTRW or Other Environmental Contaminants.</u> HTRW is suspected in the vicinity of placement area 17 (Neches River Channel). Sponsor shall perform, or ensure performance of, any investigations for hazardous substances that the Government or the sponsor determines to be necessary to identify the existence and extent of any hazardous substances regulated under CERCLA (42 U.S.C. Sections 9601-9675), that may exist in, on, or under lands, easements and rights-of-way that the Government determines to be necessary for the construction or operation and maintenance of the general navigation

features. All cost for such investigations shall be included in total cost of construction of the general navigation features and cost shared in the Project Cooperation Agreement (PCA).

21. <u>Attitudes of the Landowner.</u> The sponsor is the owner of the majority of the CIP lands. As owners they are supportive and in favor of the project. No resistance to the project by the landowner is expected.

22. <u>Sponsor Notification of Risks.</u> A letter was transmitted to the Sabine Neches Navigation District (formerly Jefferson County Waterway and Navigation District) on the 24 of February 2003, advising them if for any reason, the Project Cooperation Agreement (PCA) never gets signed or if Congress fails to authorize or fund the CIP, any land they acquired or money they spent in their effort to acquire land will be at their sole risk. *(See Exhibit "B")*

EXHIBIT "A"

APPENDIX 12-E

ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? (yes/~~no~~)
b. Does the sponsor have the power of eminent domain for this project? (yes/~~no~~)
c. Does the sponsor have "quick-take" authority for this project? (~~yes~~/no)
d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? (yes/~~no~~)
e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? (yes/~~no~~)

II. Human Resources Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? (~~yes~~/no)
b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training? (yes/~~no~~)
c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? (yes/~~no~~)
d. Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? (yes/~~no~~)
e. Can the sponsor obtain contractor support, if required in a timely fashion? (yes/~~no~~)
f. Will the sponsor likely request USACE assistance in acquiring real estate? (yes/~~no~~) (If "yes," provide description)
    1. Condemnation of tract in Louisiana that has been ongoing for 7-8 years.
    2. Use of Navigational Servitude in pipeline removals and relocations.

III. Other Project Variables:

a. Will the sponsor's staff be located within reasonable proximity to the project site? (yes/~~no~~)
b. Has the sponsor approved the project/real estate schedule/milestones? (yes/~~no~~)

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects? **YES**

APPENDIX 12-E

b. With regard to this project, the sponsor is anticipated to be: (highly capable / fully capable / moderately capable / marginally capable / insufficiently capable. If sponsor is believed to be "insufficiently capable", provide explanation. **HIGHLY CAPABLE**

V. Coordination:

a. Has this assessment been coordinated with the sponsor? (yes/~~no~~) **YES**

b. Does the sponsor concur with this assessment? (yes/~~no~~) (If "no", provide explanation) **YES**

Prepared by:

Randall Reese
General Manager
Sabine-Neches Navigation District

Reviewed and approved by:

Orlando Rosas
Chief, Real Estate Division

EXHIBIT "B"

February 24, 2003

Real Estate Division

Subject: Proposed Sabine Neches Waterway Project, Jefferson County, Texas

Mr. Paul Beard
Chairman
Jefferson County Navigation District
P.O. Box 778
Nederland, Texas 77627

Dear Mr. Beard:

It is our understanding, that you may begin acquiring rights-of-way and relocating pipelines in connection with the Sabine Neches Waterway Project prior to execution of the Project Cooperation Agreement (PCA) with the Federal Government. We appreciate your support for this proposed project but our regulations require us to inform you that **IF FOR ANY REASON, THE PCA NEVER GETS SIGNED OR IF CONGRESS FAILS TO AUTHORIZE OR FUND THE PROJECT, ANY LAND YOU ACQUIRED OR ANY MONEY YOU SPEND IN YOUR EFFORTS TO ACQUIRE LAND WILL BE AT THE SOLE RISK OF THE JEFFERSON COUNTY NAVIGATION DISTRICT.** Furthermore, for any property that qualifies for Federal participation in the project, your acquisition efforts must be in compliance with all of the provisions of P.L. 91-646, the Federal Relocation Assistance Law.

It has recently been determined that relocation of pipelines or utilities are considered as part of the Lands, Easements, and Rights-of-Way (LERRS) and can be accomplished prior to PCA execution at the sole risk of the Sponsor. It is also required that all relocations be supported by engineering cost estimates that meet project requirements as well as attorney's reports or opinions verifying that the pipeline or utility companies have compensable interests in the real property.

Please ensure that good records are kept regarding purchase price and real estate administrative expenses such as title evidence, surveys and appraisal fees. This will be necessary for you to receive credit in the event of Federal Authorization. Be advised that regulations dictate that credit will not be given for real estate administrative costs for properties acquired 5 years prior to execution of a PCA.

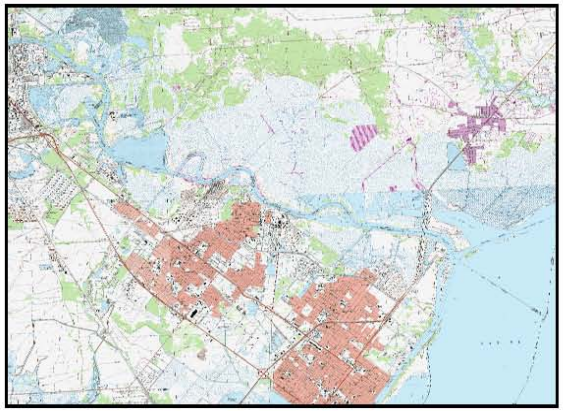
If you have any questions on any of the above please call Mr. Sal Arcidiacono of my staff at (409) 766-3803.

Sincerely,

Richard W. Harrison
Chief Real Estate Division

CF:
CESWG-PM-J, Ms. Lizette Richardson

SABINE-NECHES WATERWAY
TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
REAL ESTATE MAPS 2006



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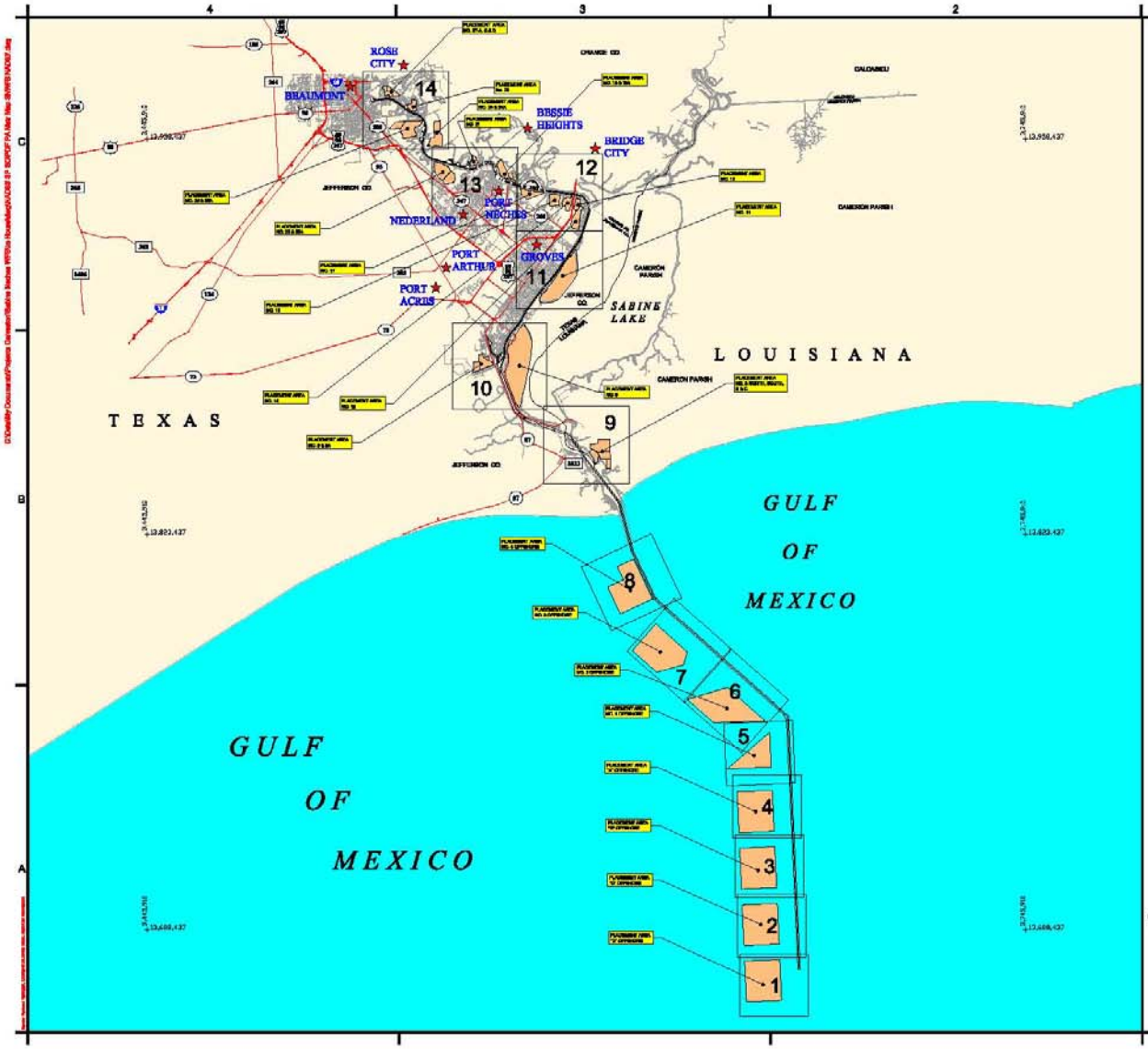
UNITED STATES ARMY CORPS
OF
ENGINEERS
GALVESTON DISTRICT

SABINE-NECHES WATERWAY TEXAS & LOUISIANA CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006



TEXAS VICINITY MAP

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

NOTE: The data is only a representation of features on the earth compiled by computer program from raw data obtained from different sources and is not necessarily, in whole or in part, based upon any physical recording, study or survey, professional or otherwise, of the covered property. This information is not intended as a substitute for a field survey by a licensed professional or any other use or application that requires legal or engineering accuracy.

SCALE: 1" = 20,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED BY:
REAL ESTATE DIVISION
CADASTRAL SECTION
2000 FORT POINT ROAD
GALVESTON, TEXAS 77550

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Index

KEY PLAN
NO SCALE

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

USACE EXISTING PLACEMENT AREAS

USACE PROPOSED PLACEMENT AREAS

JOINT PROPERTY LINE

0 500' 1,000' 2,000' 3,000'
SCALE: 1" = 1,000'

SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

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GALVESTON, TEXAS

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GALVESTON, TEXAS 77550

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
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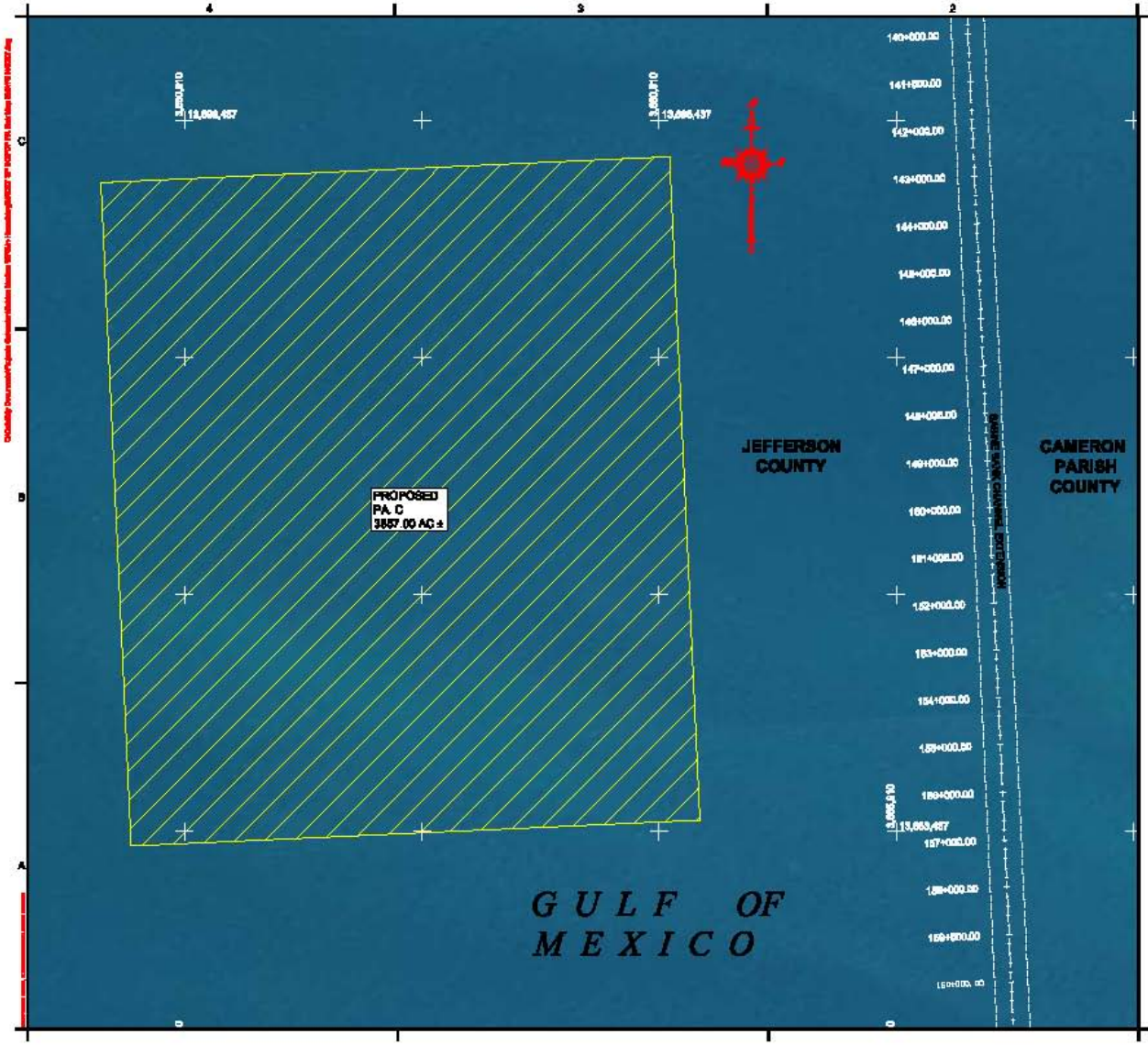
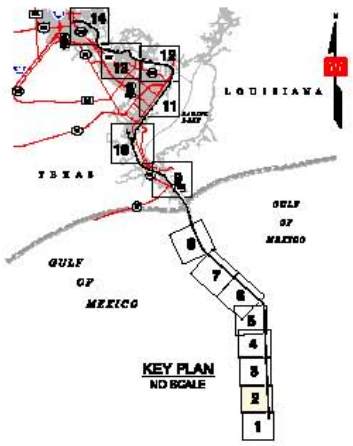
PA Sheet 1 of 14





KEY PLAN
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PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

- SABINE DISPOSED PLACEMENT AREAS
- SABINE PROPOSED PLACEMENT AREAS
- ZONE PROPERTY LINE

SCALE: 1" = 1,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

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Galveston District

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GALVESTON, TEXAS

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GALVESTON, TEXAS

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
DRYTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet
subgroup
number:
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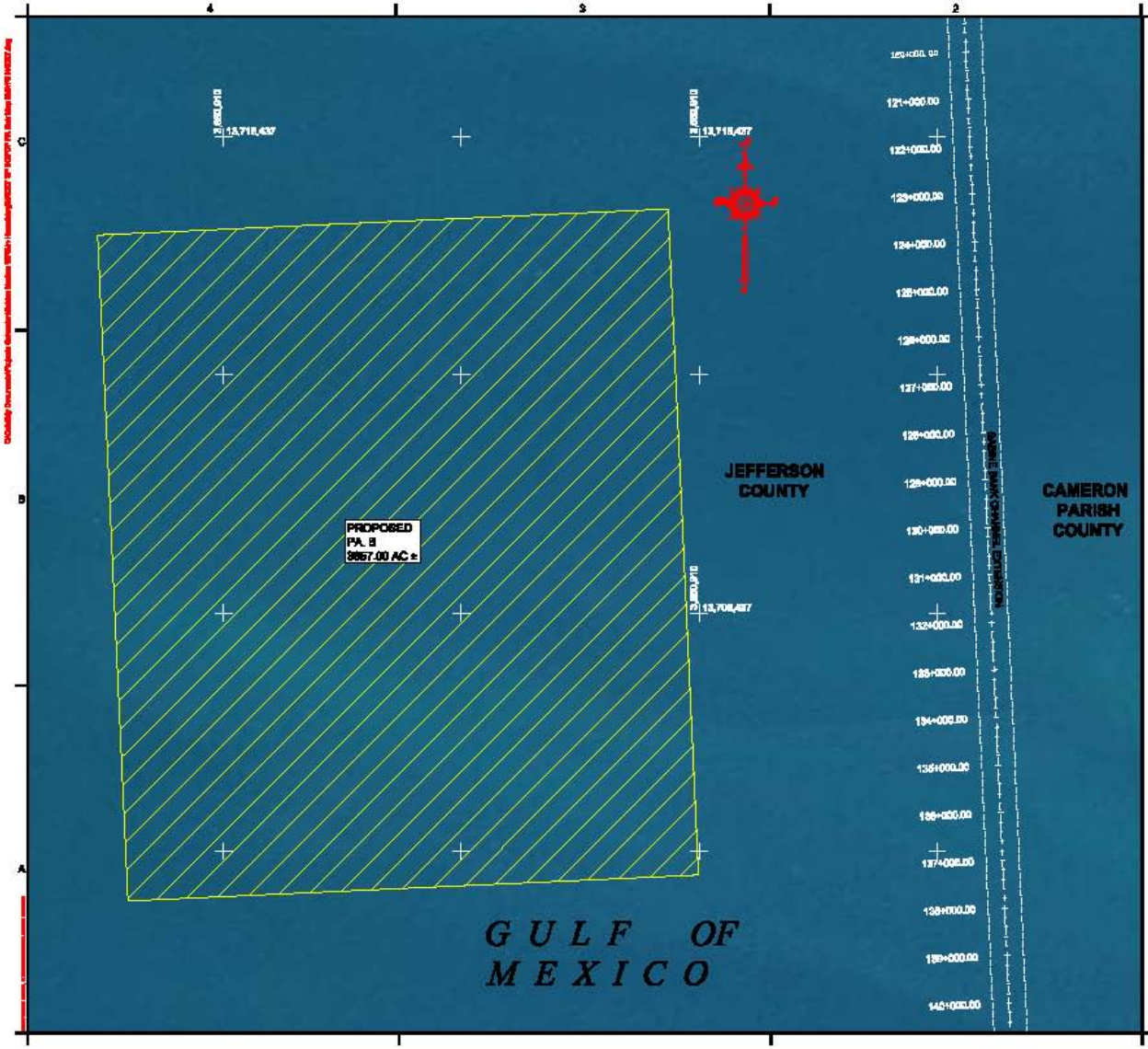

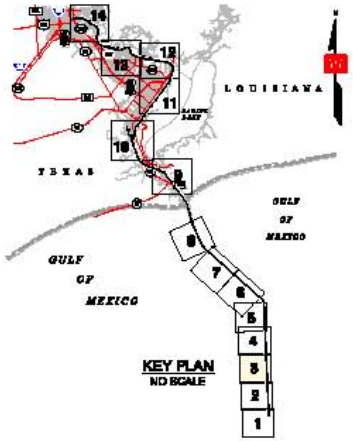

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
REAL ESTATE MAPS 2006
JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

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GALVESTON, TEXAS

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CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
DRYTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet
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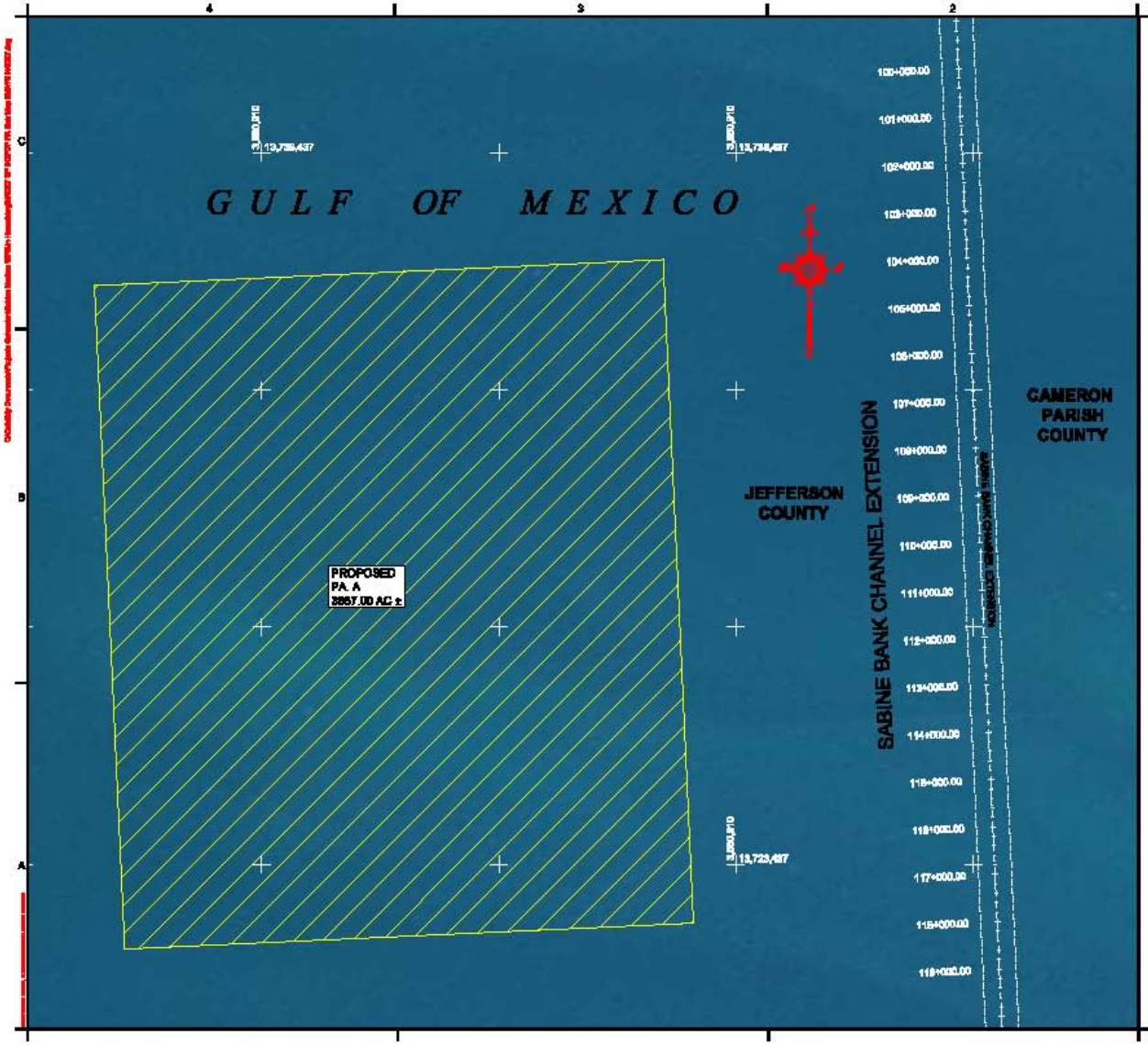

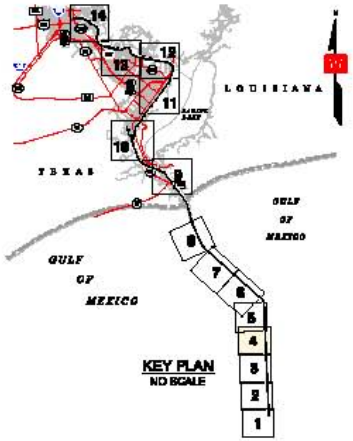

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

- BASIS DEMITED PLACEMENT AREAS
- BASIS PROPOSED PLACEMENT AREAS
- ZONE PROPERTY LINE

SCALE: 1" = 1,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

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TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet sequence number:
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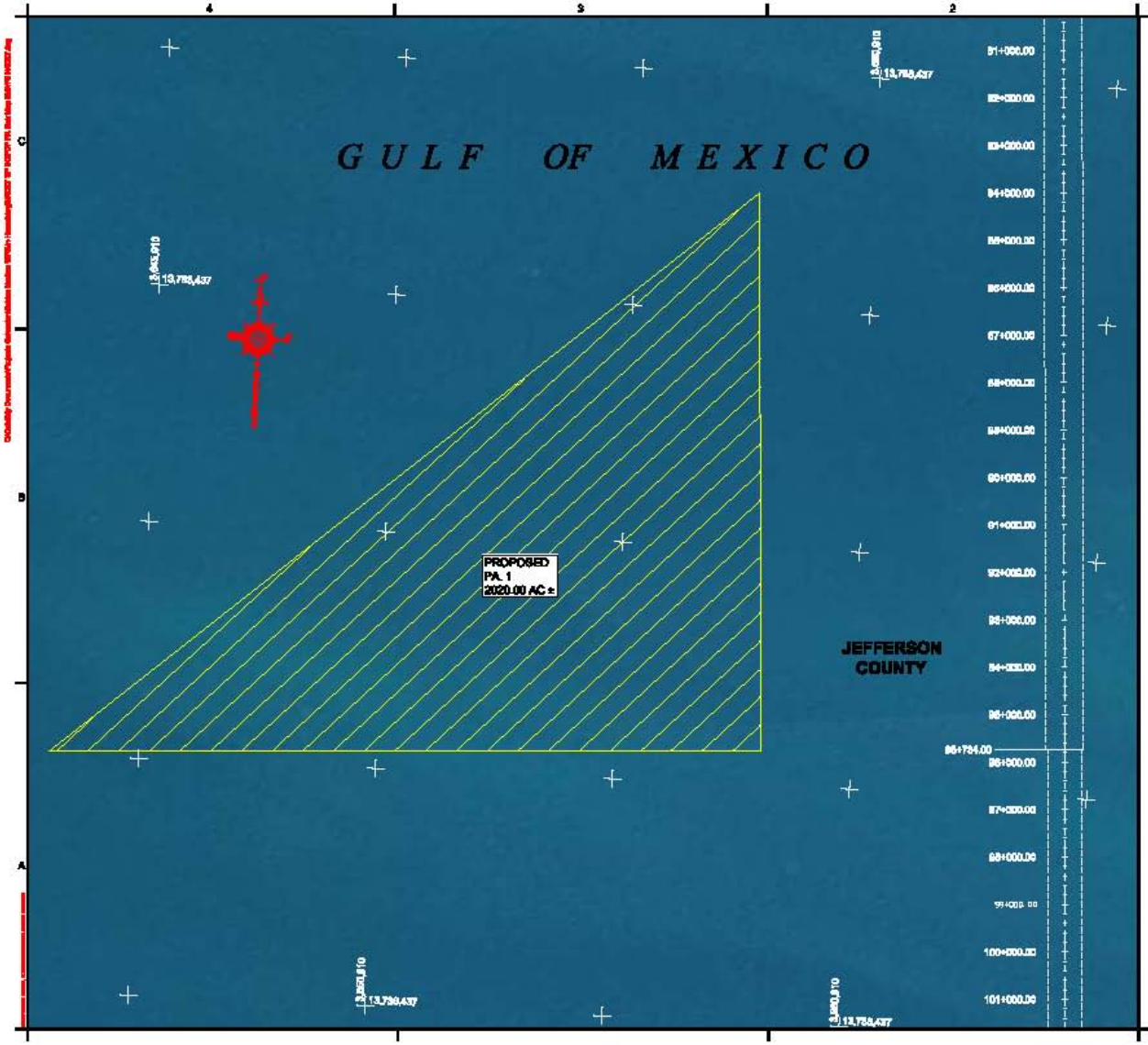

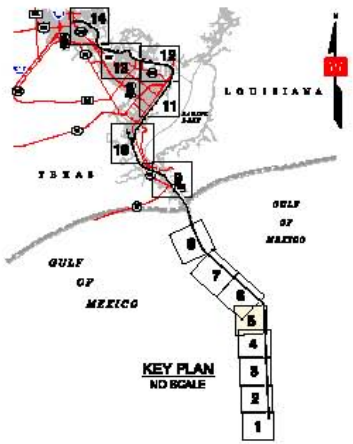

KEY PLAN
NO SCALE

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

- SABINE RESTRICTED PLACEMENT AREAS
- SABINE PROPOSED PLACEMENT AREAS
- JCMD PROPERTY LINE

SCALE: 1" = 1,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

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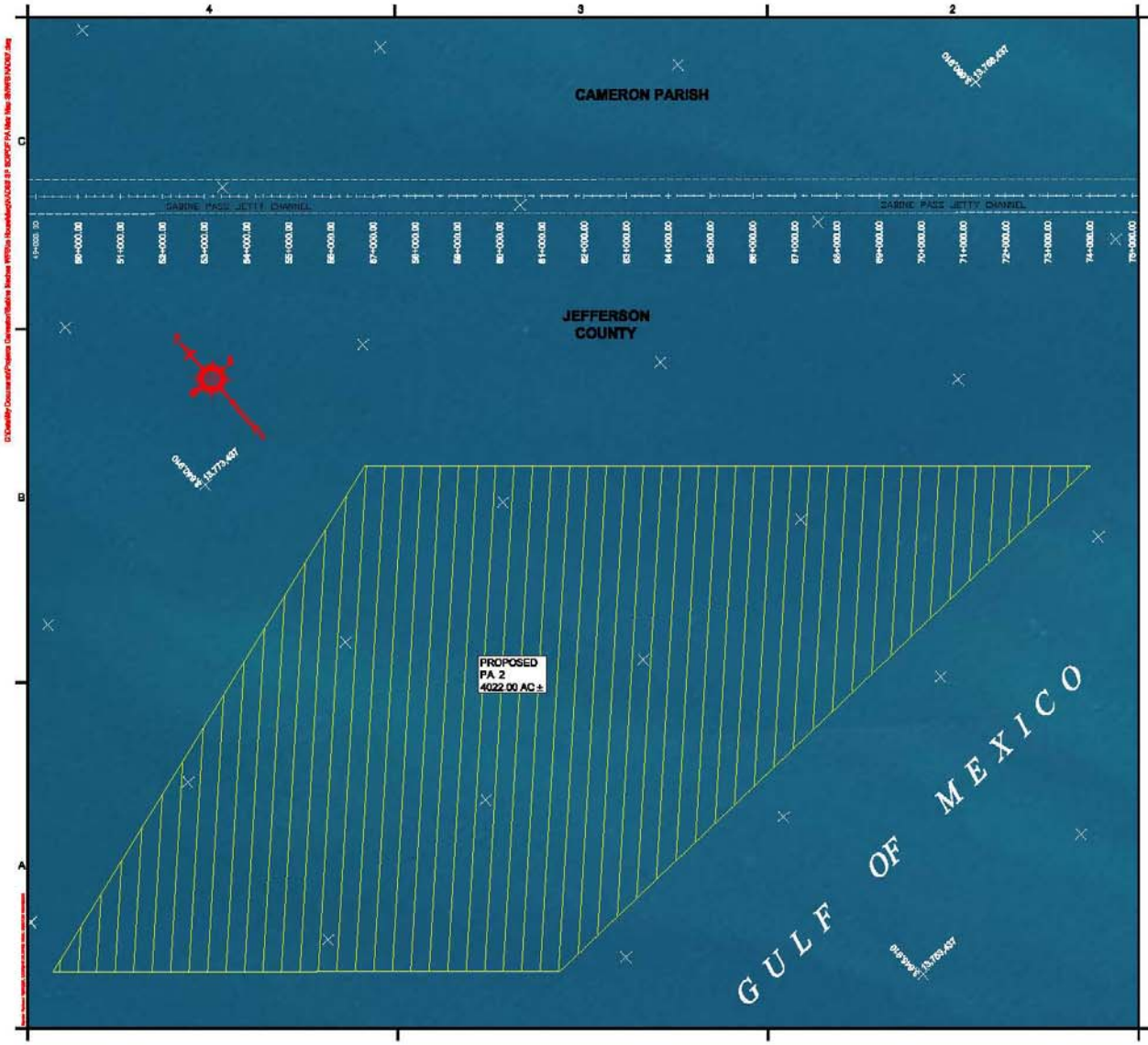
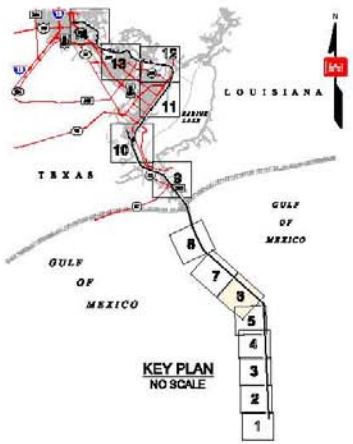
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
DRYTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet
subgroup
number:
PA Sht 5





DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

USACE EXISTING PLACEMENT AREAS

USACE PROPOSED PLACEMENT AREAS

JOND PROPERTY LINE

SCALE: 1" = 1,800'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

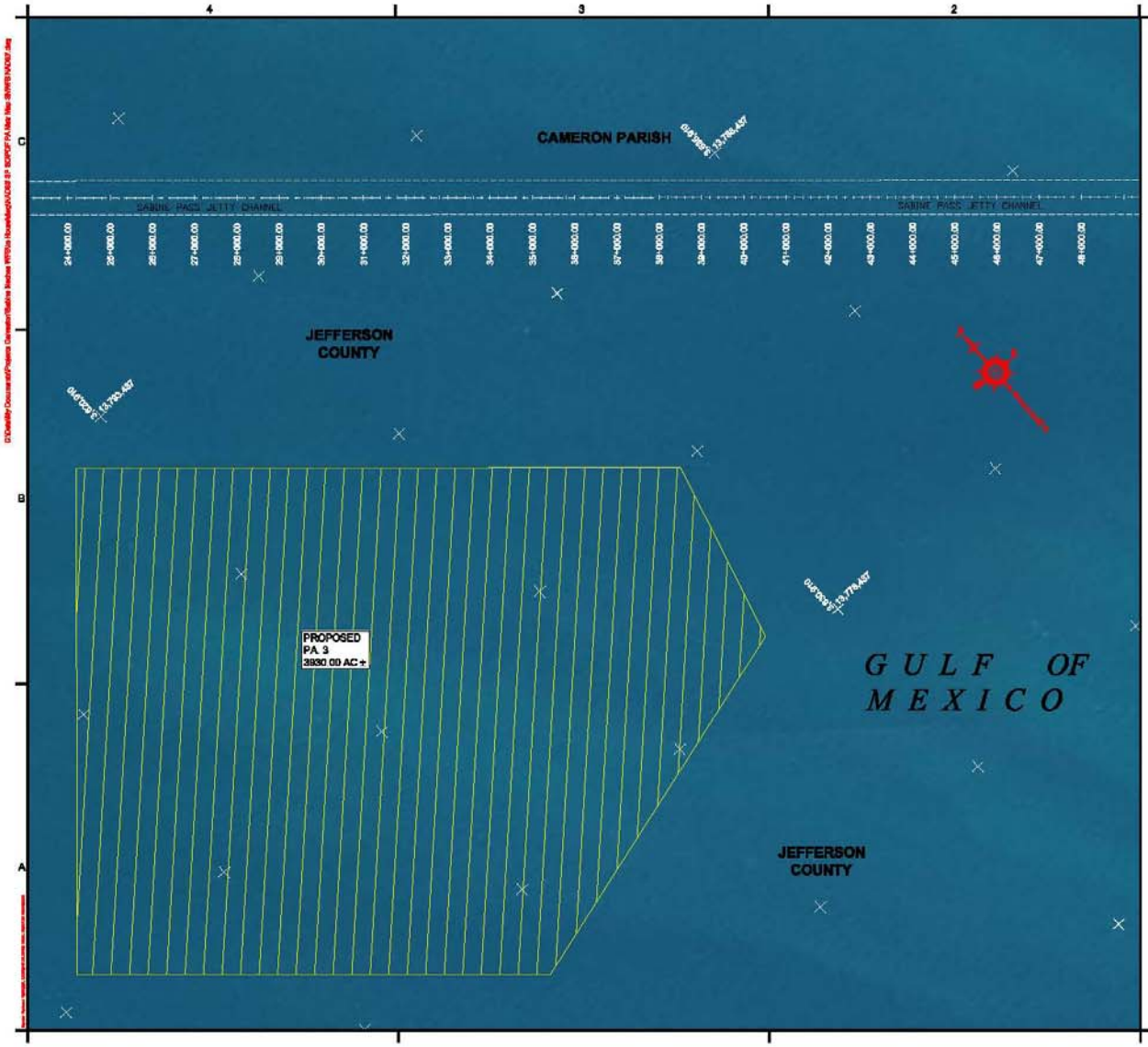
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

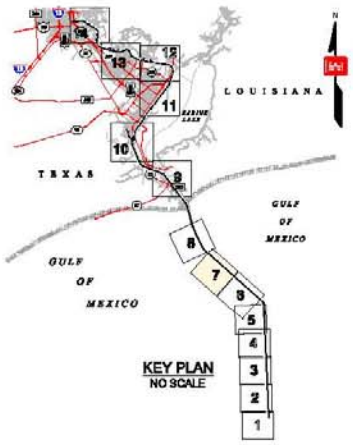
PREPARED BY:
REAL ESTATE DIVISION
COASTAL BOTTOM
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 6
PA Sheet 6 of 14





KEY PLAN
NO SCALE

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

USACE EXISTING PLACEMENT AREAS

USACE PROPOSED PLACEMENT AREAS

JOND PROPERTY LINE

0 500' 1,000' 2,000' 3,000'
SCALE: 1" = 1,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED BY:
REAL ESTATE DIVISION
CONTRACTING OFFICER
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
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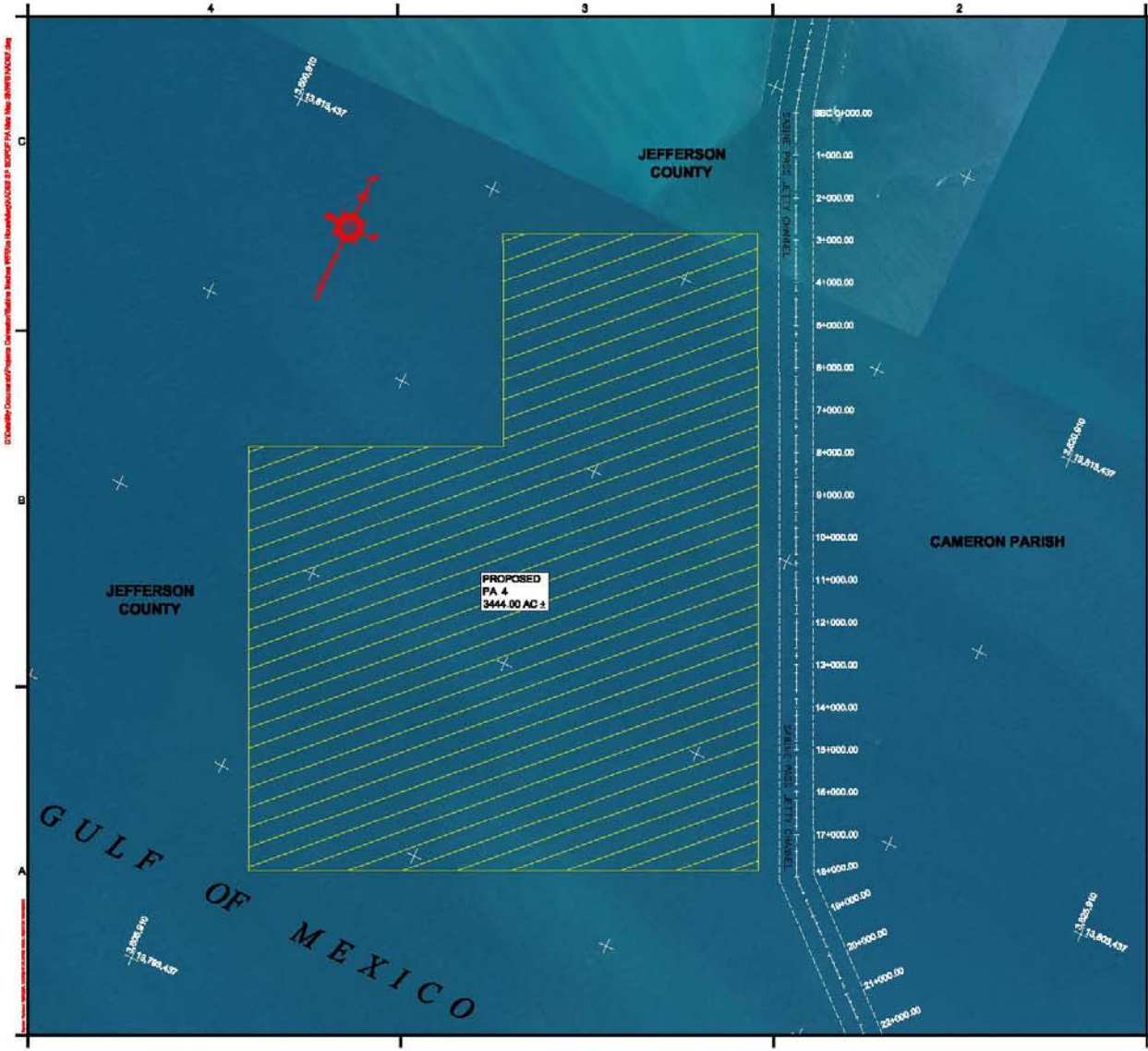
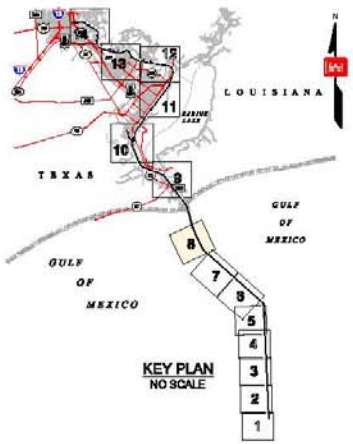
PA Sheet 7 of 14





KEY PLAN
NO SCALE

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

USACE EXISTING PLACEMENT AREAS

USACE PROPOSED PLACEMENT AREAS

JOND PROPERTY LINE

0 900' 1,800' 2,700' 3,600'
SCALE: 1" = 1,800'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

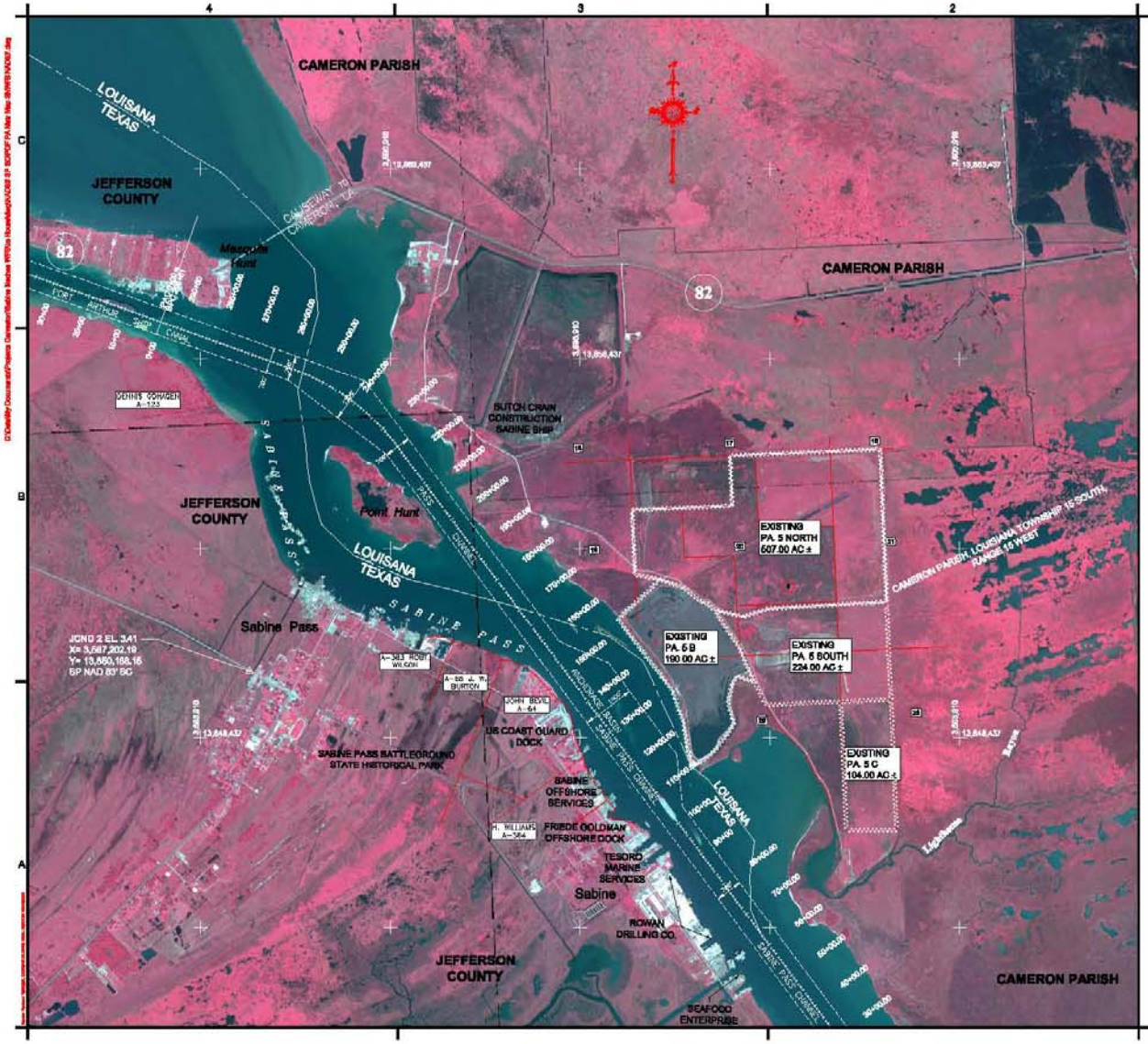
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

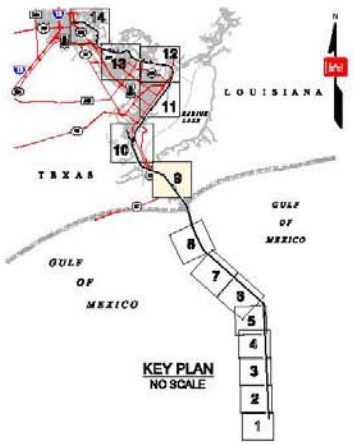
PREPARED BY:
REAL ESTATE DIVISION
COASTAL BOTTOM
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 8
PA Sheet 8 of 14





KEY PLAN
NO SCALE

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

USACE EXISTING PLACEMENT AREAS

USACE PROPOSED PLACEMENT AREAS

JGND PROPERTY LINE

0 1,000' 2,000' 3,000' 4,000'
SCALE: 1" = 2,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

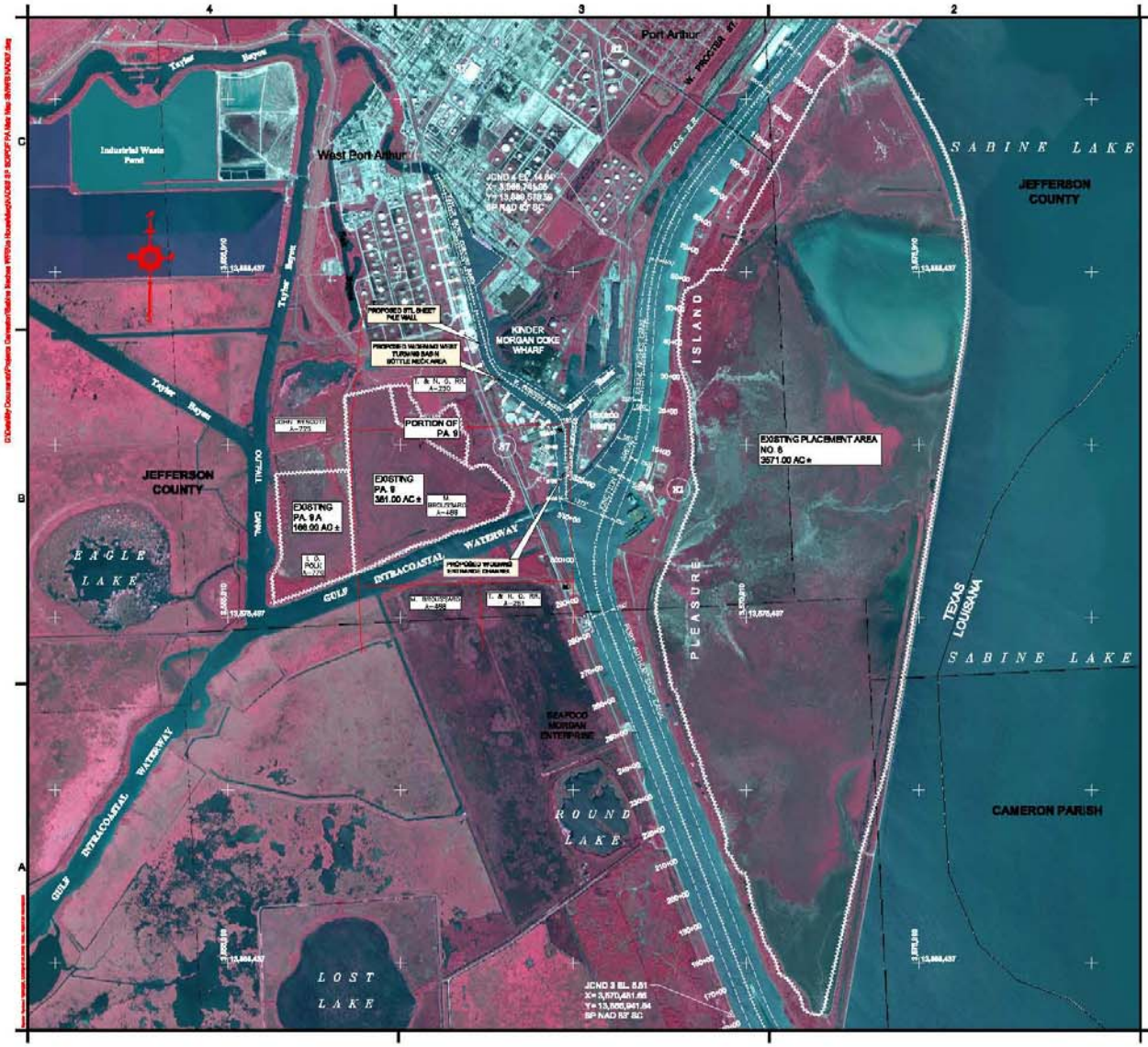
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

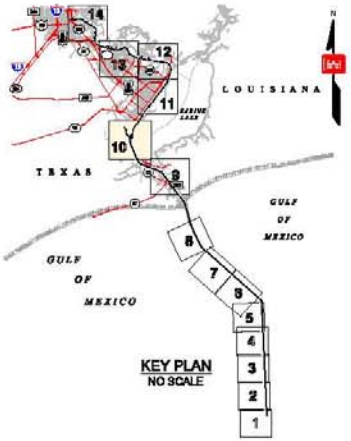
PREPARED BY:
IRISH ENGINEERING & SURVEYING
CONSULTING SERVICES
GALVESTON, TEXAS 77550

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 9
PA Sheet 9 of 14





KEY PLAN
NO SCALE

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

USACE EXISTING PLACEMENT AREAS

USACE PROPOSED PLACEMENT AREAS

JCND PROPERTY LINE

0 1,100' 2,200' 3,300' 4,400'
SCALE: 1" = 2,200'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

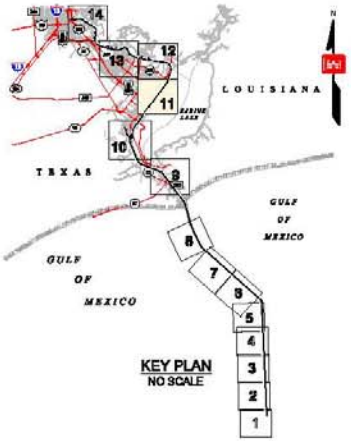
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED BY:
REAL ESTATE DIVISION
COASTAL INFO CTR
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 10
PA Sheet 10 of 14



DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

USACE EXISTING PLACEMENT AREAS

USACE PROPOSED PLACEMENT AREAS

JOND PROPERTY LINE

0 1,000' 2,000' 3,000' 4,000'
SCALE: 1" = 2,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

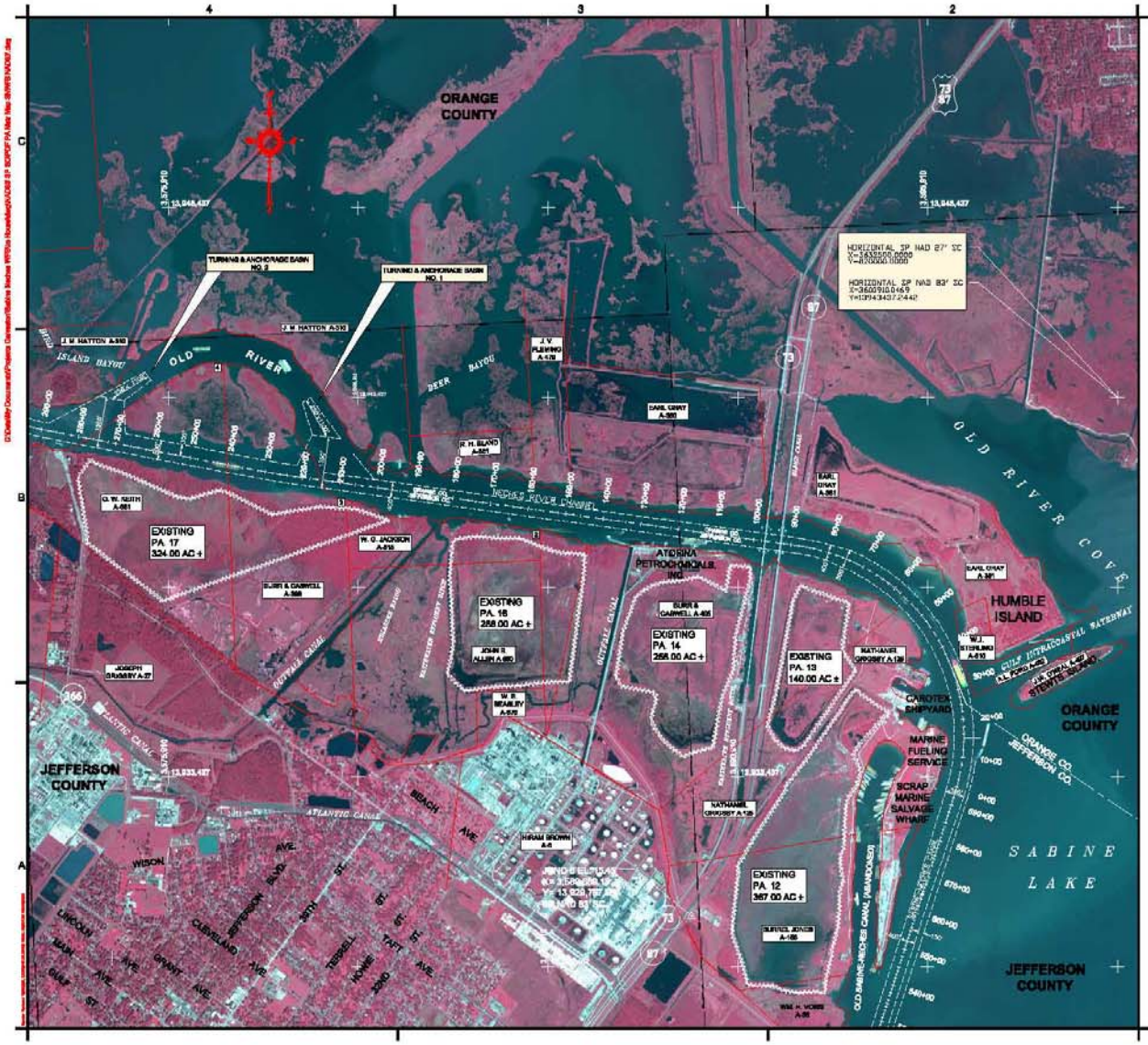
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

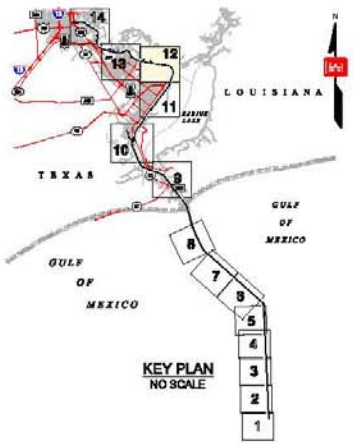
PREPARED BY:
REAL ESTATE DIVISION
COASTAL BEND CO.
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 11
PA Sheet 11 of 14





DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

- USACE EXISTING PLACEMENT AREAS
- USACE PROPOSED PLACEMENT AREAS
- JOND PROPERTY LINE

0 1,000' 2,000' 3,000' 4,000'
SCALE: 1" = 2,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

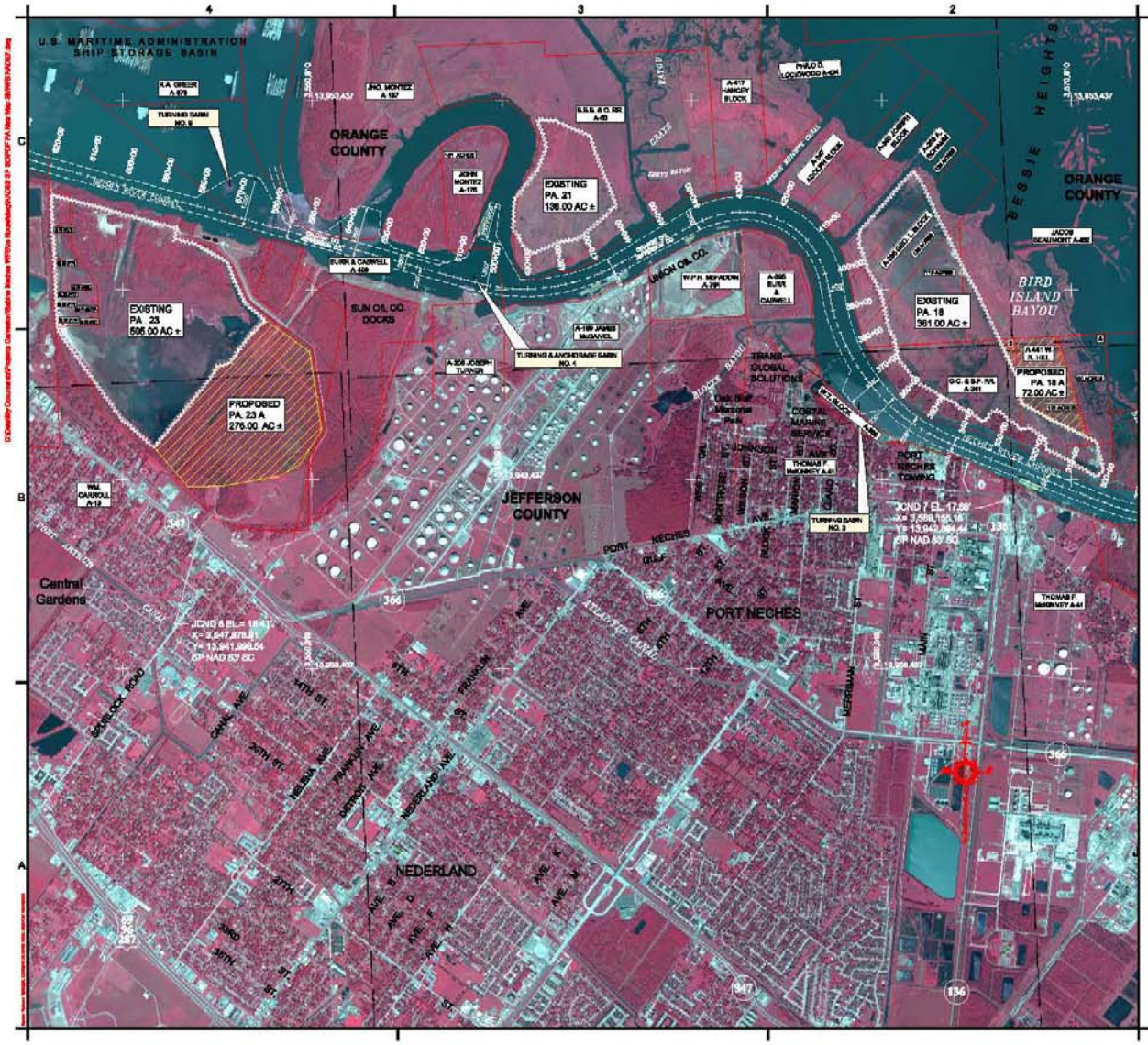
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

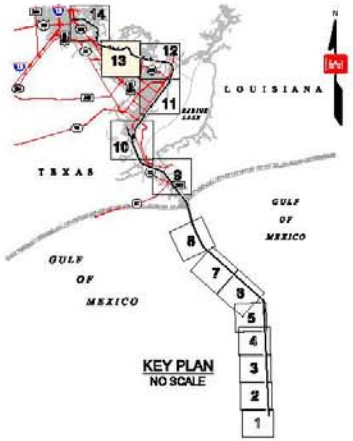
PREPARED BY:
REAL ESTATE DIVISION
CARTOGRAPHIC SECTION
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 12
PA Sheet 12 of 14





DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

- USACE EXISTING PLACEMENT AREAS
- USACE PROPOSED PLACEMENT AREAS
- JCND PROPERTY LINE

0 1,000' 2,000' 3,000' 4,000'
SCALE: 1" = 2,000'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

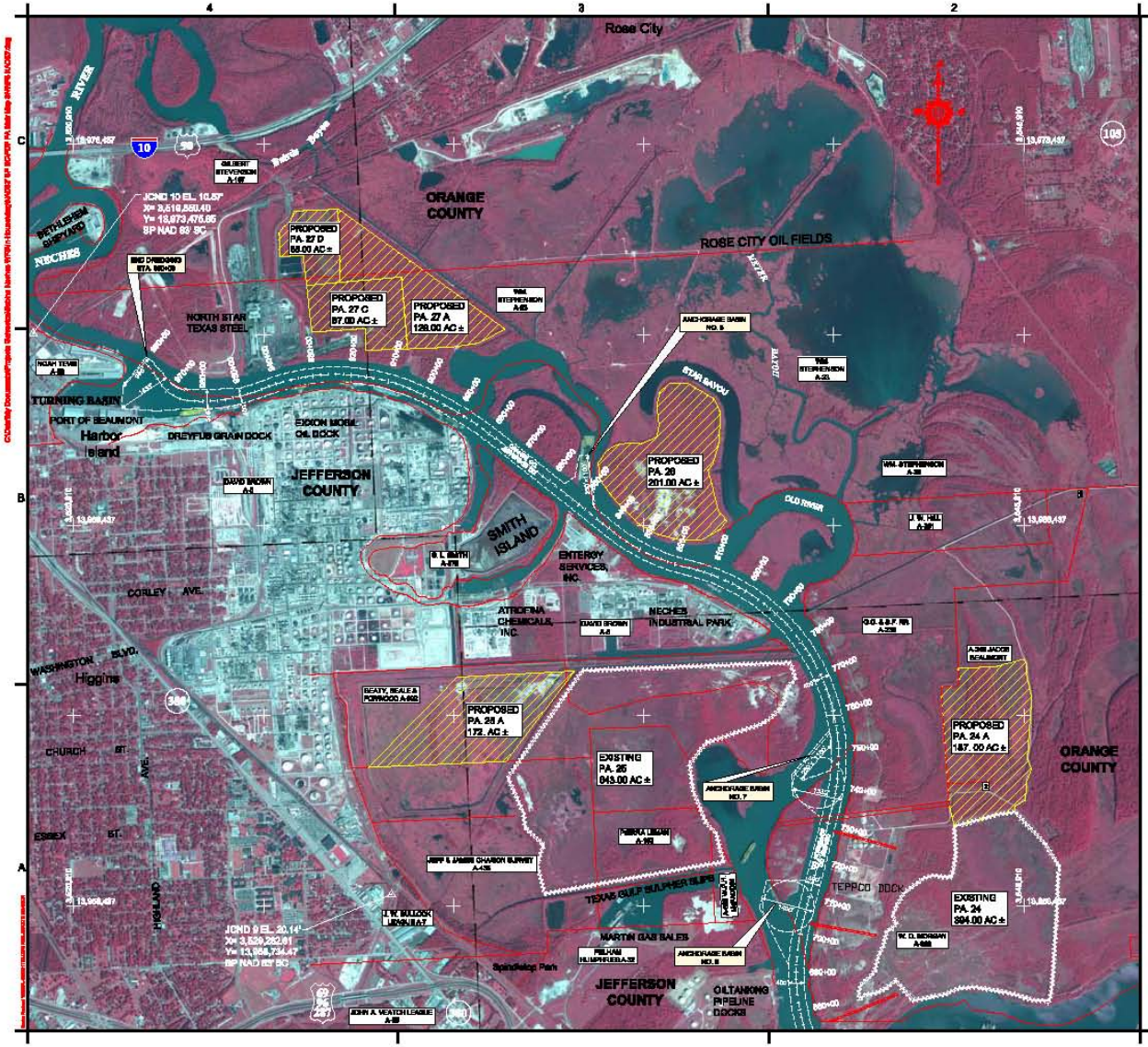
US Army Corps of Engineers
Galveston District

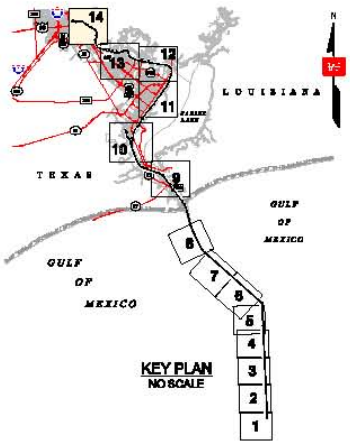
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED BY:
IRISH & ASSOCIATES
CADASTRAL SECTION
1000 GALVESTON, FOURTH FLOOR
GALVESTON, TEXAS 77550

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA
SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 13
PA Sheet 13 of 14





KEY PLAN
NO SCALE

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

- USACE EXISTING PLACEMENT AREAS
- USACE PROPOSED PLACEMENT AREAS
- JCND PROPERTY LINE

SCALE: 1" = 2,500'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

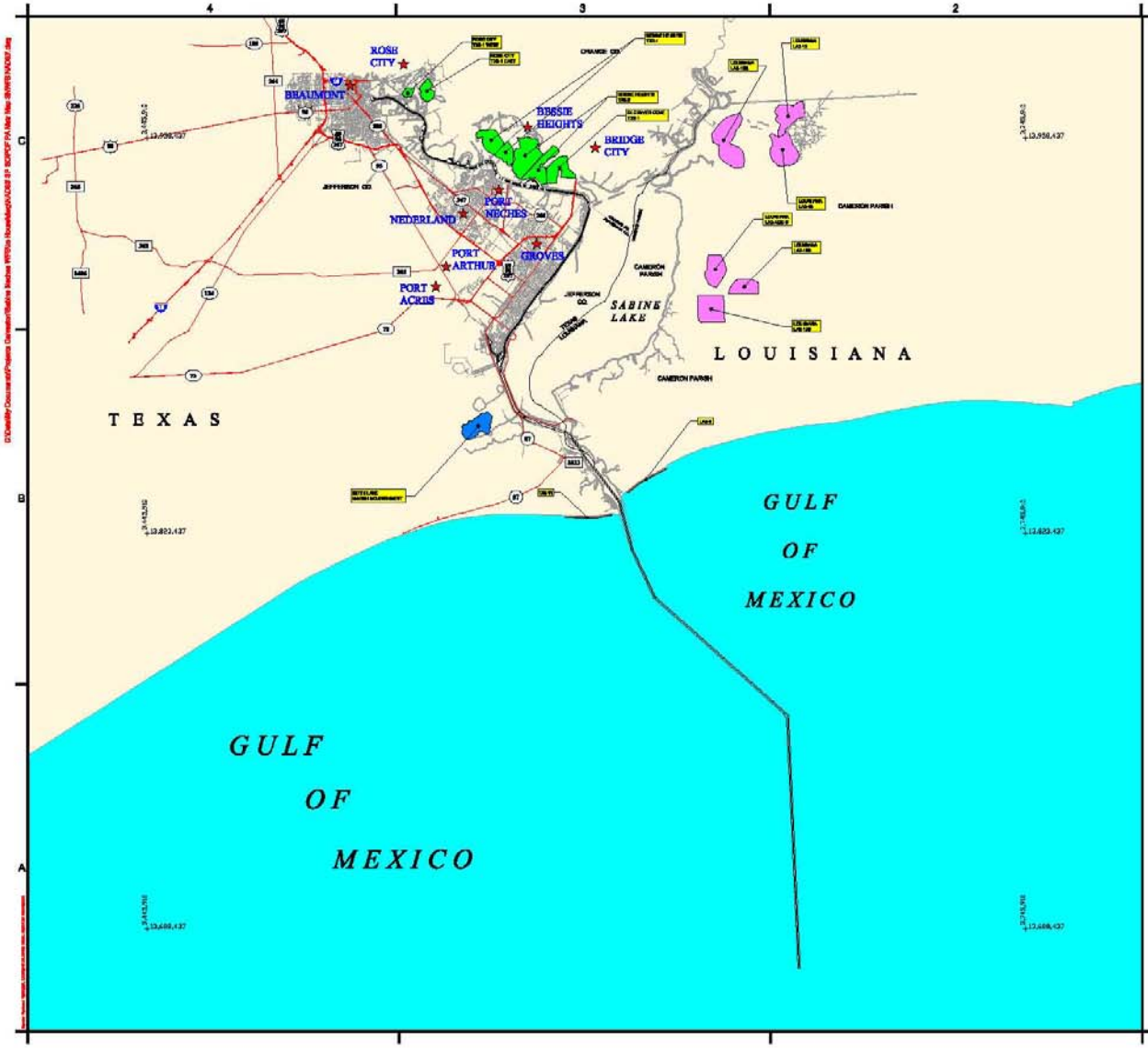
DEPARTMENT OF THE ARMY
GALVESTON DISTRICT
GALVESTON, TEXAS

PREPARED BY:
REAL ESTATE DIVISION
QUANTITAL SECTION
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
EXISTING & PROPOSED PLACEMENT AREAS
REAL ESTATE MAPS 2006

Sheet reference number:
PA Sht 14
PA Sheet 14 of 14



TEXAS VICINITY MAP

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

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LEGEND

- JCND PROPERTY LINE
- MITIGATION

DMMP ENVIRONMENTAL FEATURES

- MARSH RESTORATION
- SHORE NOURISHMENT
- KEITH LAKE MARSH NOURISHMENT

SCALE: 1" = 2,500'

SABINE-NECHES WATERWAY CHANNEL IMPROVEMENT PROJECT REAL ESTATE MAPS 2006

JEFFERSON & ORANGE COUNTIES, TEXAS
CAMERON PARISH, LOUISIANA

US Army Corps of Engineers
Galveston District

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED BY:
REAL ESTATE DIVISION
CONTINTAL SECTION
GALVESTON DISTRICT
GALVESTON, TEXAS 77553

TEXAS & LOUISIANA
CHANNEL IMPROVEMENT PROJECT
TEXAS & LOUISIANA

SABINE-NECHES WATERWAY
DMMP FEATURES AND MITIGATION SITES
REAL ESTATE MAPS 2006

Sheet reference number:
M Sht 1
1 of 1

EXHIBIT "D"

SNWW PIPELINES

STATION	OWNER	DESCRIPTION/ STATUS	SIZE (inches)	DEPTH (feet)
184+65	Air Liquide Large Industries U.S. L.P.	NITROGEN	8	50
184+65	Air Liquide Large Industries U.S. L.P.	OXYGEN	8	50
184+65	Air Liquide Large Industries U.S. L.P.	SPARE	8	50
294+61	Air Products & Chemical, Inc.	HYDROGEN GAS	10	51
185+65	Ameripol Synpol Corporation	BUTADIENE	4	52
180+00	Chevron Phillips Chemical Company, LLC	ETHYLENE GAS	8	?
185+65	Chevron Pipe Line Co.	ETHYLENE GAS	8	52
293+52	Chevron Pipe Line Co.	GAS	18	53
294+24	Chevron Pipe Line Co.	ETHYLENE	16	50
183+40	City of Port Arthur	WATER/ INACTIVE	10	?
546+32	Colonial Pipeline Company	REFINED PRODUCTS	36	48
544+68	Colonial Pipeline Company	REFINED PRODUCTS	40	52
291+26	DCP Midstream, LLC	NATURAL GAS	8	58
294+56	DCP Midstream, LLC	PETROLEUM	8	50
671+65	DCP Midstream, LLC	NATURAL GAS/ DUPLICATE	30	52
152+000	Dynegy Midstream Services, L.P.	STATUS UNKNOWN	?	?

SNWW PIPELINES (cont'd)

STATION	OWNER	DESCRIPTION/ STATUS	SIZE (inches)	DEPTH (feet)
659+50	E.I. DuPont de Nemours	PROPYLENE	4	50
291+26	E.I. DuPont de Nemours	ETHANES	8	58
659+50	E.I. DuPont de Nemours	ETHYLENE GAS	8	50
591+70	El Paso Corporation	INACTIVE	6	50
788+55	Entergy Texas, Inc.	WATER/ INACTIVE	18	50
667+35	Enterprise Products Partners, L.P.	SPARE	30	55
667+70	Enterprise TE Products Pipeline Company LLC	REFINED PRODUCTS	20	52
667+70	Enterprise TE Products Pipeline Company LLC	REFINED PRODUCTS	20	52
667+35	Enterprise TE Products Pipeline Company LLC	SPARE	8	55
659+50	Enterprise TE Products Pipeline Company LLC	REFINED PRODUCTS	8	50
287+37	Explorer Pipeline Company	REFINED PRODUCTS	12	55
291+26	Flint Hills Resources Port Arthur LLC	ETHYLENE	8	58
4+000	Gulf South Pipeline Company, L.P.	NATURAL GAS	16	61
659+50	Investa, B.V.	HYDROGEN GAS	8	50
659+50	Investa, B.V.	AMMONIA	4	50
291+26	Kinder Morgan Tejas Pipeline, L.L.C.	NATURAL GAS	24	50
242+33	Kinder Morgan Tejas Pipeline, LLC	NATURAL GAS	30	55

SNWW PIPELINES (cont'd)

STATION	OWNER	DESCRIPTION/ STATUS	SIZE (inches)	DEPTH (feet)
99+30	Kinder Morgan Tejas Pipeline, LLC	NATURAL GAS/ INACTIVE	16	45
291+26	Kinder Morgan Tejas Pipeline, LLC	NATURAL GAS	26	50
288+46	Kinder Morgan Texas Pipeline, L.P.	NATURAL GAS	20	50
288+46	Kinder Morgan Texas Pipeline, L.P.	NATURAL GAS	16	50
666+50	Kinder Morgan Texas Pipeline, L.P.	INACTIVE	8	?
664+32	Maritime Administration	Power	?	51
294+02	Shell Pipeline Company, L.P.	CRUDE OIL	22	50
294+76	Shell Pipeline Company, L.P.	PETROLEUM/ IDLE	6	50
667+35	Texas Oil & Chemical Co., Inc.	SPARE	12	55
56+582	Targa NGL Pipeline Company, LLC	NATURAL GAS	10	61
82+500	Targa NGL Pipeline Company, LLC	NATURAL GAS Liquids	12	61
25+000	Tennessee Gas Pipeline Company	NATURAL GAS	30	61
185+65	TPC Group, Inc.	BUTADIENE	4	52