Report to Congress for Future Water Resources Development (WRRDA 7001) Submission Package

Proposal Name: Trinity River & Tributaries Channel to Liberty Navigation Improvements Study

Submission Date: 08/10/2017

Proposal ID Number: f09414c0-255c-4672-bde6-b3d6a5dd9e70

Purpose of Proposal: The Trinity River Authority (TRA) of Texas, pursuant to WRRDA 2014 Sec.7001, r equests that the US Army Corps of Engineers (USACE) conduct a feasibility study to re-establish and imp rove to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project. The his toric navigation features of the TR&T project consist of the Federally authorized shallow-draft three-chan nel navigation system to include the Channel to Liberty, Anahuac, and Channel to Smith Point channels. The Anahuac Channel, extends 5.6 miles from Upper Trinity Bay to the Trinity River mouth. Channel to Liberty proceeds 41.4 miles from the Trinity River mouth to Port of Liberty. Channel to Smith Point chan nel extends from the Houston Ship Channel along Trinity Bay's east shore to 1-mile south of Anahuac, TX. Historically, commodities transported by barge via the Channel to Liberty and the Anahuac channels inclu ded agricultural chemicals, industrial chemicals, and iron and steel products. Since the mid-1990s barge tra nsported commodity tonnage has significantly declined, due in part to the irregularity in channel maintena nce. A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, capital goods, and energy (ACE) activities in the six-county region that could benefit from a reliable and improve d TR&T navigation system, as global demand for movement of goods and resources drive the growth of fut ure production within the Basin. Movement of ACE commodities through the Basin currently rely on truc k or rail transport. Improvements in efficiency and tonnage of commodity throughput with transportation cost savings could be achieved by barges using a reliable and improved navigation system. The proposed st udy is directly aligned with USACE's navigation mission, and tied to USACE's ecosystem restoration missi on by beneficially using dredged material. Opportunities exist to incorporate Regional Sediment Managem ent and Engineering-With-Nature concepts.

1. Administrative Details

Proposal Name: Trinity River & Tributaries Channel to Liberty Navigation Improvements Study

by Agency: Trinity River Authority of Texas

Locations: TX

Date Submitted: 08/10/2017

Confirmation Number: f09414c0-255c-4672-bde6-b3d6a5dd9e70

Supporting Documents

File Name	Date Uploaded
CLCND.pdf	08/10/2017
Moffatt-2015-Trinity Draft-Market Analysis.pdf	08/10/2017
Port of Liberty.pdf	08/10/2017
TRA Final Letter.pdf	08/10/2017
State Rep Bailes.pdf	08/10/2017
State Rep Faircloth.pdf	08/10/2017
Trinity River Report - August 9 2017-Draft Rev 1a with Appendices.pdf	08/10/2017
City of Liberty.pdf	08/10/2017
Project Map.pdf	08/10/2017

2. Provide the name of the primary sponsor and all non-Federal interests that have contributed or are expected to contribute toward the non-Federal share of the proposed feasibility study or modification.

Sponsor	**Letter of Support**
Trinity River Authority of Texas(Primary)	The Trinity River Authority of Texas (Authority), is pleased to submit a proposal for a feasibility study for the Port of Liberty for the 2018 US Army Corps of Engineers (USACE) Report to Congress on Future Water Resources Development. The Authority is currently collaborating with USACE on a "Planning Assistance to States" grant. Inclusion in the Chiefs Report would allow continued partnerships to assess the potential for cargo traffic on the river. The Authority is a conservation and reclamation district that provides water and wastewater treatment, along with recreation and reservoir facilities, within the nearly 18,000 square-mile Trinity River basin. The Authority also maintains a master plan for basin-wide development, and serves as a conduit for tax-exempt financing for municipal projects and as a local sponsor for federal water projects. The Port of Liberty is located in the town of Liberty, Texas approximately forty river miles from the Trinity Bay on the Gulf of Mexico. The Port previously serviced barges until 1992. The Port is strategically located between the Port of Houston and the Port of Beaumont. Texas ports are responsible for over 30% of the Texas gross domestic product and are integral to Texas manufacturing and energy. However, Texas ports and manufacturing face an unprecedented competitive threat as ports in neighboring states are beating Texas in the race to improve their depth and infrastructure to meet the opportunities created by the new, deeper Panama Canal. Texas cannot afford to fall behind. The Authority will act as the non-Federal primary sponsor for the feasibility study. The Authority will contribute necessary financial support, provide staff and consultant resources, and coordinate stakeholder and community understanding and engagement. The Authority expects potentially complex solutions will be identified through the feasibility study, and is committed to pursuing and implementing a long-term plan to re-open the Port of Liberty.

State of Texas Representative Ernest B ailes (District 18)	I express my support for The Trinity River Authority of T exas (TRA) WRRDA 7001 Proposal, “Trinity River & Tr ibutaries Channel to Liberty Navigation Improvements St udy.” The Study would consist of a feasibility study to re-establish and improve the navigation features of the Trini ty River & Tributaries (TR&T) project. A recent market analysis of the Lower Trinity River Basin (Basin) reporte d robust agriculture, energy, and manufacturing activities in a six-county region that could benefit from a reliable an d improved TR&T navigation system, as global demand f or movement of goods and resources drive the growth of f uture production within the Basin. I sincerely hope that t he Army Corps of Engineers will give serious consideratio n to including this proposal in the 2018 Report to Congres s on Water Resources Development.
Chambers-Liberty Counties Navigatio n District	The Chambers-Liberty Counties Navigation District (CLC ND) expresses its support for The Trinity River Authorit y of Texas (TRA) WRRDA 7001 Proposal, ”Trinity River & Tributaries Channel to Liberty Navigation Improvemen ts Study.” The Study would consist of a feasibility study t o re-establish and improve to Liberty, Texas the navigatio n features of the Trinity River & Tributaries (TR&T) pro ject. A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, energy and ma nufacturing activities in a six · county region that could be nefit from a reliable and improved TR&T navigation syste m, as global demand for movement of goods and resources drive the growth of future production within the Basin. T he CLCND sincerely hopes that the Army Corps of Engin eers will give serious consideration to including this propo sal in the 2018 Report to Congress on Water Resources D evelopment.
Port of Liberty Commission	The Port of Liberty Commission expresses its support for The Trinity River Authority of Texas (TRA) WRRDA 70 01 Proposal, ”Trinity River & Tributaries Channel to Libe rty Navigation Improvements Study.” The Study would c onsist of a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity Rive r & Tributaries (TR& T) project. A recent market analysi s of the Lower Trinity River Basin (Basin) reported robust agriculture, energy and manufacturing activities in a six-c ounty region that could benefit from a reliable and improv ed TR&T navigation system, as global demand for movem ent of goods and resources drive the growth of future prod uction within the Basin. The Port of Liberty Commission sincerely hopes that the Army Corps of Engineers will giv e serious consideration to including this proposal in the 20 18 Report to Congress on Water Resources Development.

State of Texas Representative Wayne Faircloth (District 23)	I express my support for The Trinity River Authority of T exas (TRA) WRRDA 7001 Proposal, "Trinity River & Tr ibutaries Channel to Liberty Navigation Improvements St udy." The Study would consist of a feasibility study to re-establish and improve to Liberty, Texas the navigation fe atures of the Trinity River & Tributaries (TR&T) project. A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, energy and manufactu ring activities in a six-county region that could benefit fro m a reliable and improved TR&T navigation system, as gl obal demand for movement of goods and resources drive t he growth of future production within the Basin. I sincere ly hope that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Repor t to Congress on Water Resources Development.
City of Liberty, Texas	The City of Liberty, Texas expresses its support for The T rinity River Authority of Texas (TRA) WRRDA 7001 Pro posal, "Trinity River & Tributaries Channel to Liberty N avigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve to Libert y, Texas the navigation features of the Trinity River & Tr ibutaries (TR&T) project. A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agricul ture, energy and manufacturing activities in a six-county r egion that could benefit from a reliable and improved TR & T navigation system, as global demand for movement o f goods and resources drive the growth of future productio n within the Basin. The City of Liberty sincerely hopes th at the Army Corps of Engineers will give serious considera tion to including this proposal in the 2018 Report to Cong ress on Water Resources Development.

3. State if this proposal is for a feasibility study, a modification to an authorized USACE feasibility study or a modification to an authorized USACE project. If it is a proposal for a modification, provide the authorized water resources development feasibility study or project name.

[x] Feasibility Study

4. Clearly articulate the specific project purpose(s) of the proposed study or modification. Demonstrate that the proposal is related to USACE mission and authorities and specifically address why additional or new authorization is needed.

The Trinity River Authority (TRA) of Texas, pursuant to WRRDA 2014 Sec.7001, requests that the US A rmy Corps of Engineers (USACE) conduct a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project. The historic navigation feature s of the TR&T project consist of the Federally authorized shallow-draft three-channel navigation system to include the Channel to Liberty, Anahuac, and Channel to Smith Point channels. The Anahuac Channel, e xtends 5.6 miles from Upper Trinity Bay to the Trinity River mouth. Channel to Liberty proceeds 41.4 mil es from the Trinity River mouth to Port of Liberty. Channel to Smith Point channel extends from the Hou ston Ship Channel along Trinity Bay's east shore to 1-mile south of Anahuac, TX. Historically, commoditi es transported by barge via the Channel to Liberty and the Anahuac channels included agricultural chemic als, industrial chemicals, and iron and steel products. Since the mid-1990s barge transported commodity to nnage has significantly declined, due in part to the irregularity in channel maintenance. A recent market a nalysis of the Lower Trinity River Basin (Basin) reported robust agriculture, capital goods, and energy (A CE) activities in the six-county region that could benefit from a reliable and improved TR&T navigation s ystem, as global demand for movement of goods and resources drive the growth of future production within the Basin. Movement of ACE commodities through the Basin currently rely on truck or rail transport. Im provements in efficiency and tonnage of commodity throughput with transportation cost savings could be a chieved by barges using a reliable and improved navigation system. The proposed study is directly aligned with USACE's navigation mission, and tied to USACE's ecosystem restoration mission by beneficially usin g dredged material. Opportunities exist to incorporate Regional Sediment Management and Engineering-W ith-Nature concepts.

5. To the extent practicable, provide an estimate of the total cost, and the Federal and non-Federal share of those costs, of the proposed study and, separately, an estimate of the cost of construction or modification.

	Federal	**Non-Federal**	**Total**
Study	$1,500,000	$1,500,000	$3,000,000
Construction	$11,520,000	$2,880,000	$14,400,000

Explanation (if necessary)

The cost for the feasibility study will be shared 50% Federal and 50% Non-Federal. The Non-Federal stud y cost share contribution may be provided as cash, in-kind services, or a mix of both. The Non-Federal cos t share for construction of General Navigation Features (GNF) for Commercial Navigation with shallow-dr aft navigation channel depths up to 20-ft is 10%, with an additional 10% of the GNF construction costs to be paid over a period not to exceed 30-years. Operations and Maintenance (O&M) of GNF for shallow-dr aft navigation channels is 100% Federal cost. The initial Construction cost for improvements of GNF is est imated at a total of $14,400,000, which is the incremental cost above the existing maintenance requirement s. Subsequent incremental future O&M total estimated cost for the GNF improved channel over a period of 50-years is $120,000,000.

6. To the extent practicable, describe the anticipated monetary and nonmonetary benefits of the proposal including benefits to the protection of human life and property; improvement to transportation; the national economy; the environment; or the national security interests of the United States.

Manufacturing activity in the Lower Trinity River Basin (Basin) is concentrated in few large industries inc luding fabricated metal products, chemicals, non-metallic mineral products and wood products. These indu stries, with the exception of wood, serve to support/supply the oil & gas sector. Additionally, the presence of underground salt domes offers the potential for oil and natural gas storage. The Trinity River & Tributa ries (TR&T) navigation system could potentially serve as a gateway for barge traffic at Liberty, Texas, by offering substantially lower transportation costs on a per-ton-basis, as compared to movement of cargo by r ail or truck. A preliminary comparative cost analysis compared the cost of shipping a ton of agricultural pr oduct from Liberty via barge vs. truck to some of the major Gulf Coast ports. Based on this analysis, the cost of shipping a ton of agricultural product to New Orleans via a 1- or 3-barge tow in-lieu of goods carried on trucks would offer an estimated per ton-savings of $8.25/ton or $19.09/ton, respectively. Deeper and wi der channels for the TR&T navigation system would improve estimated transportation cost savings by red ucing light loading and other operational inefficiencies, and attract future waterborne transport of products to support the oil and gas industry, such as: manufactured steel products, estimated at potentially 400,000 tons/year; and, mineral products, estimated in-excess of 1,000,000 tons/year. In addition, an improved nav igation channel system would improve navigation safety with wider channels to allow for better barge tow maneuverability; lower carbon emissions within the Basin by reducing truck and rail traffic; and, provide f or ecosystem restoration through the beneficial use of dredged material. Optimization analysis of net bene fits will include evaluation of channel geometry alternatives with a selected barge tow design configuration.

7. Does local support exist? If 'Yes', describe the local support for the proposal.

[x] Yes

Local Support Description

The TRA supports this proposed feasibility study. The TRA is charged with "Acting as local sponsor for f ederal water projects". The TRA is prepared to contribute the non-Federal Sponsor share of the Feasibilit y Study costs, and understands the obligations of a non-Federal sponsor if a project is recommended for au thorization/construction. In addition, this proposal is closely aligned with TRA's primary function to work and coordinate with other entities to implement water related programs that serve the needs of Texas resid ents.

8. Does the primary sponsor named in (2.) above have the financial ability to provide for the required cost share?

[x] Yes

Other Non-Federal Sponsors Letter(s) of Support

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CLCND.pdf

CHAMBERS-LIBERTY COUNTIES NAVIGATION DISTRICT

211 Miller Street
P.O. Box 518
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CLCND

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August 2, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen,

I am writing to express my support for The Trinity River Authority of Texas (TRA) WRRDA 7001 Proposal, "Trinity River & Tributaries Channel to Liberty Navigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project.

A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, energy and manufacturing activities in a six-county region that could benefit from a reliable and improved TR&T navigation system, as global demand for movement of goods and resources drive the growth of future production within the Basin.

I sincerely hope that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Sincerely,

Mary Beth Stengler

Mary Beth Stengler,
General Manager

JAY KNIGHT
COUNTY JUDGE

1923 SAM HOUSTON
LIBERTY, TEXAS 77575

THE COUNTY OF LIBERTY

Est. 1836

August 2, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen,

Please accept this letter as an indication of my support for The Trinity River Authority of Texas (TRA) WRRDA 7001 Proposal, "Trinity River & Tributaries Channel to Liberty Navigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project.

A recently completed market analysis of the Lower Trinity River Basin reported robust activity in agriculture, energy and manufacturing in a six-county region, which includes Liberty County, that could benefit from a reliable and improved TR&T navigation system, as global demand for movement of goods and resources drive the growth of future production within the Basin.

My sincere wish is that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Sincerely,

Jay H. Knight
County Judge
Liberty County Texas

936/336-4665 jay.knight@co.liberty.tx.us FAX: 936/336-4518

Additional Proposal Information

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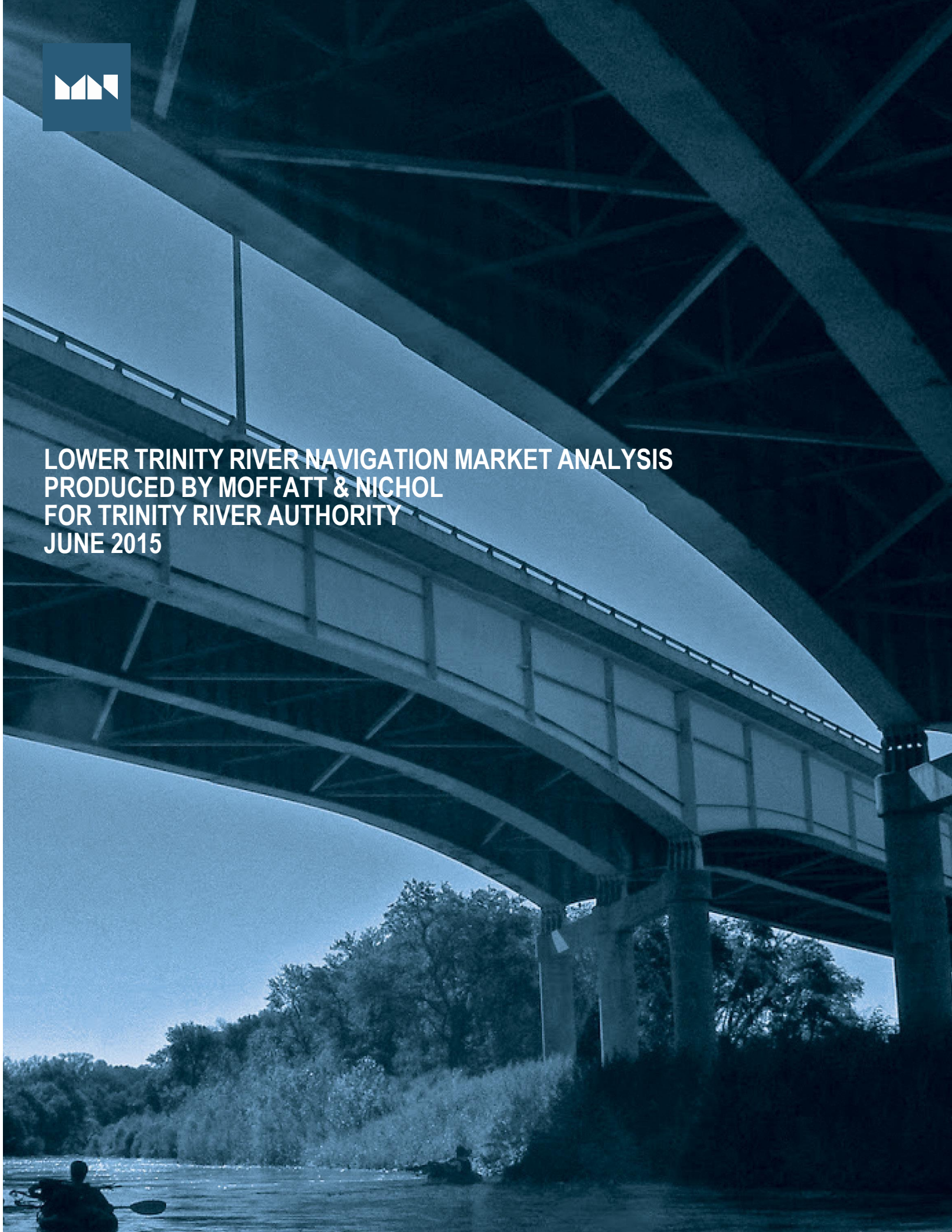
Moffatt_2015_Trinity Draft_Market Analysis.pdf



LOWER TRINITY RIVER NAVIGATION MARKET ANALYSIS
PRODUCED BY MOFFATT & NICHOL
FOR TRINITY RIVER AUTHORITY
JUNE 2015

DOCUMENT VERIFICATION

Client	Trinity River Authority
Project name	Lower Trinity River Navigation Market Analysis
Document title	Report
Document sub-title	–
Status	Report
Date	June 2015
Project number	8367
File reference	–

Revision	Description	Issued by	Date	Checked
00	Draft Report	BK	June 23, 2015	DLB/HK

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TABLE OF CONTENTS

Document Verification i
Table of Contents ii
Disclaimer iii
Glossary iv
1. Executive Summary 1
1.1. Objectives 1
1.2. Key Findings 1
2. Background 2
2.1. Overview of Existing Literature 2
2.1.1. Trinity River Project General Design Memorandum (1981) 2
3. Economic & Trade Overview 3
3.1. Texas Demographics/Economic Overview 3
3.1.1. Demographics 3
3.1.2. Texas Economics 4
3.1.3. Manufacturing in Texas 5
3.2. US Export Trade Growth & Texas Port Share 7
3.2.1. All Goods 7
3.2.1. Non-Energy Goods 8
4. Lower Trinity River Basin Economic & Trade Overview 9
4.1. The Study Region 9
4.2. Economy of the Trinity River Basin 10
4.3. Characteristics of the Study Region 11
5. Regional Waterway Freight Flows 14
5.1. Freight Movement on Local Waterways: Beaumont 15
5.2. Intercoastal Sabine-to-Galveston 16
5.3. Intercoastal Galveston-to-Corpus Christi 17
6. Cost Comparison 18
7. Conclusions 19
8. Appendix: Global Trends Supporting Agriculture 20
8.1. US & Global Trade Trends 20

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This study is qualified in its entirety by, and should be considered in light of, these limitations, conditions and considerations.

GLOSSARY

CAGR	Compound Annual Growth Rate
CPI	Consumer Price Index
FAK	Freight All Kinds
FCL	Full Container Load
ft	Feet
FY	Full Year
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GT	Gross Tonnage
ha	Hectare (= 10,000 m2)
KPI	Key Performance Indicator
LCMA	Least Cost Market Analysis
LCL	Less than Container Load
LOA	Length Overall
m	Meter
m2	Square Meters
mph	Moves per Hour
P&L	Profit and Loss Account
p.a.	Per annum
pd	Per day
STS	Ship-to-Shore Crane (Quay Crane)
RH	Right Hand
RTG	Rubber-Tyred Gantry
RS	Reach Stacker
TEU	Twenty-Foot Equivalent Unit
TGS	TEU Ground Slots
THC	Terminal Handling Charge
Tonnes	Metric Tonnes
ULCS/s	Ultra Large Containership/s (10,000+TEU)
USD	United States Dollar(s)
YOY	Year on Year
YTD	Year to Date

1. EXECUTIVE SUMMARY

1.1. OBJECTIVES

The Trinity River Authority decided to explore the feasibility of developing a port facility to once again handle cargo on the river. The first step is to determine whether there is a market for cargo to use the waterway, taking advantage of geographic location, existing infrastructure, and being economically competitive to other facilities and freight movement alternatives in the region.

1.2. KEY FINDINGS

In determining whether there is sufficient economic activity to potentially support the development of a port facility in Liberty, or in another location along the Lower Trinity River, the answer is, yes, there is; but additional analysis on the physical attributes of the Trinity River is recommended. This is based on the following observations:

- **Texas is Projected to Remain a Leader of Growth**

The Texan economy has been a leader of growth in the US. While the performance of the energy (oil & gas) sector has certainly been a source of strength in the overall economy, other sectors including manufacturing have become the largest in terms of overall output (GDP). Within the manufacturing sector there is a diversified set of high value (motor vehicles/parts, machinery) and lower value industries (chemicals) which help support overall growth during cyclical periods in any given particular sector. Access to natural resources, a growing population and exposure to the burgeoning North/South trade routes all suggest that the long-term growth outlook for Texas remains strong.

- **Lower Trinity River Economic Base Appears Supportive**

Agriculture, Energy and Manufacturing (ACE) activity already exists in the six-county region studied. Production from these sectors in particular are foreseen to be drivers of growth in the future. As global demand for resources will continue to grow (the world needs energy and food), the Lower Trinity River region could become a hub of production/servicing of these types of goods. Given the size of the labor force, there is potential for this activity to increase as a result of the development of a port facility. It is recommended to review the original Army Corps of Engineers studies to determine the feasibility of previous plans and consider alterations to them, given changes in the area's population as well as level and pattern of economic activities.

- **Additional Analysis on the Navigability of the Lower Trinity River is Required**

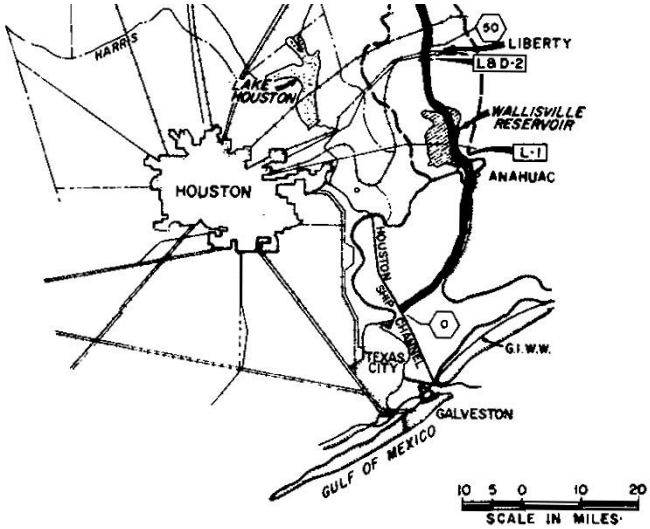
Given the positive assessment of the initial market review, MN would recommend that the TRA continue the investigation with a focus on the navigability of the river. This allows for further refinement of the business development plan, by allowing for the identification of the capacity of the river to accommodate trade (barge tow size, water depth etc.) as well as the cost of maintaining navigable channels (dredging requirements). This analysis would eventually help with the most beneficial site selection (relative to the cost of maintaining/building new infrastructure), and advance the project's development.

2. BACKGROUND

2.1. OVERVIEW OF EXISTING LITERATURE

2.1.1. TRINITY RIVER PROJECT GENERAL DESIGN MEMORANDUM (1981)

The Fort Worth Division of the USACE completed a report in 1981 reviewing the economic and environmental impacts of several alternative plans for waterway improvements in and around the Trinity River from Dallas to the Houston Shipping Channel based on analysis in its 1965 report. The report concluded that construction and operation of a new multi-purpose channel from a point 4.5 miles north of Liberty to the Houston Shipping Channel along with environmental mitigations was feasible. Specifically:



"The recommended plan includes a 200-foot bottom width multi-purpose channel from Houston Ship Channel to RM 45 (4.5 miles above Liberty). The channel would be initially excavated to a depth of 12 feet and maintained at an operating depth of 9 feet from the ship channel to the headwaters of Wallisville Lake. From this point to RM 45, the channel would have an average depth of 30 feet (8 to 10 feet less than the existing river). The channel would provide a modern navigation system to the Port of Liberty, capable of accommodating tows operating in the Gulf Intracoastal Waterway with little or no re-staging. The plan would also provide for substantial reduction of flood damages in the Liberty area and to a lesser degree in the developed areas downstream of Liberty. The plan includes the acquisition of 11,693 acres of land to mitigate loss of wildlife habitat and a development and operation plan for the east shore disposal area to preserve the existing shoreline habitat and enhance productivity through the creation of additional marsh areas."

2.1.1.1. Navigability

The Trinity River is, by well-established precedent and legal definition, a navigable waterway of the United States from its mouth to Fort Worth and has been officially so designated. Therefore, any action with regard to the river flow may not foreclose on the option for this navigability. In this regard, House Document No. 276 included the Board of Engineers for River and Harbors (BERH) viewpoint that, in event of delay of the navigation features of the authorized project for any reason, any channel work on the Trinity River should follow the same alignment as that required for navigation.

TABLE 2.1: MULTIPLE-PURPOSE CHANNEL TO LIBERTY PERTINENT DATA AND APPORTIONMENT OF COSTS

Limits	Upstream	Navigation terminates at Port of Liberty. Flood control channel terminates 4-1/2 miles upstream of Liberty at RM 45
	Downstream	Navigation channel ties into Houston Ship Channel at station 470+o0. Flood control channel terminates in Wallisville Lake
Length		Navigation channel 46.5 miles Flood control channel 14.4 miles
Channel Design Data		Navigation, 200-foot bottom width and a 9-foot operating depth with 2 feet of advance maintenance and 1 foot of allowable overdepth
	Flood control	200-foot bottom width and approximately 30 feet deep (8 to 10 feet less than the natural channel)
Land Requirements	Flood plain	1,597 acres
	Channel	898 acres
	Material disposal	1,915 acres
	Mitigation	11,693 acres

3. ECONOMIC & TRADE OVERVIEW

Long-term demographic and macroeconomic trends broadly signal continued strength within the Texan economy. This growth is expected to continue to support trade flows to/from/through the State, and thereby adding impetus for developing port infrastructure which is suitable to serving these needs.

3.1. TEXAS DEMOGRAPHICS/ECONOMIC OVERVIEW

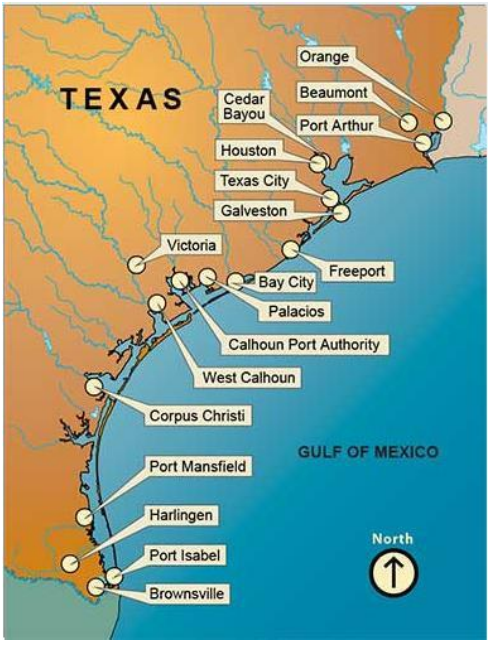
Texas is a leader of population, economic and trade growth in the US and this trend is expected to continue to support demand for goods-movement infrastructure in the state. Mexico, China and Saudi Arabia are the largest exporters to Texas. Goods imported from Mexico through Texas in 2012 totalled almost $100 billion. With regards to China, Texas is only second to California in terms of the value of goods imported, which stood at $41 billion in 2012.

The Port of Houston is the largest gateway for trade through the state of Texas. Statistics for the Port of Houston in 2014 are:

- 1st ranked US port in foreign tonnage
- 6th ranked US container port by total TEUs in 2014
- Largest Texas port with 46% of market share by tonnage and 95% market share in containers by total TEUs in 2014
- Largest Gulf Coast container port, handling 67% of US Gulf Coast container traffic in 2014
- 2nd ranked US port in terms of total foreign cargo value (based on US Dept. of Commerce, Bureau of Census).

In addition to the Port of Houston, there are 17 other sea ports on the Gulf of Mexico that would allow trade through Texas. The Texas ports are shown in Figure 3.1.

FIGURE 3.1: TEXAS PORTS IN THE GULF OF MEXICO



3.1.1. DEMOGRAPHICS

Texas is the second most populous state in the US with 27 million residents, and currently accounts for 8.2% of the total US population. With projected growth of 1.6% per year, roughly double the national average, Texas is projected to retain this rank and account for 9.2% of the US total by 2030 (roughly 1-in-10 US citizens will live in Texas). This data is presented in Table 3.1. This population will continue to act as a growing source of demand for not only consumer-related products, but will also serve as the work force for the goods producing/exporting industries within Texas' manufacturing, mining and agriculture sectors. The demand on Texas' goods-

movement infrastructure will continue to put pressure on port, road, rail, pipeline and storage infrastructure that serve the regional population and industry centers.

TABLE 3.1: POPULATION GROWTH FORECASTS BY STATE (MILLION)

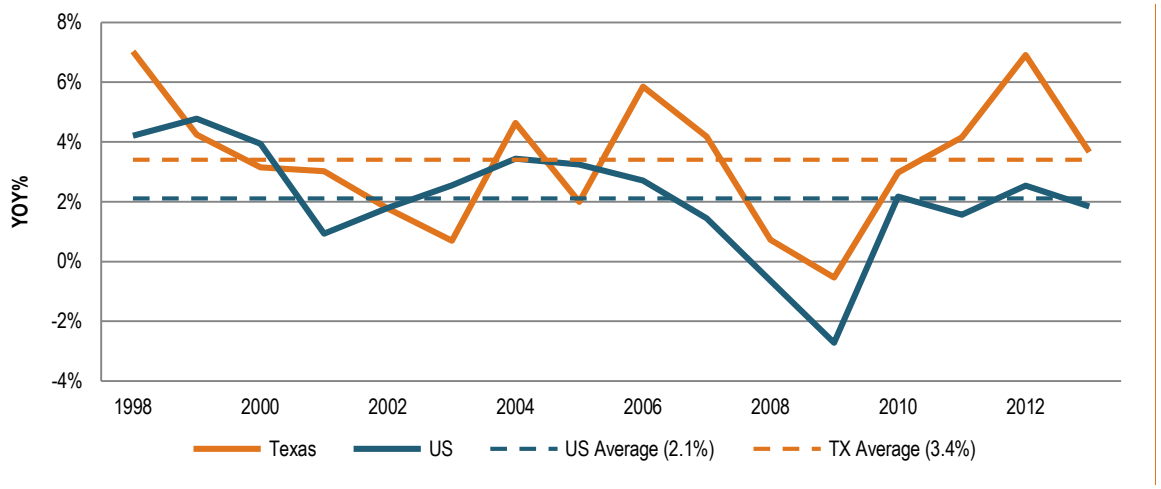
	2015	2020	2025	2030	CAGR
Total US	322	336	349	364	0.8%
California	40	42	44	46	1.0%
Texas	**27**	**29**	**31**	**33**	**1.5%**
% of US	*8.2%*	*8.5%*	*8.8%*	*9.2%*	
Florida	21	23	26	29	2.0%
New York	20	20	20	19	0.0%
Illinois	13	13	13	13	0.2%
Other	202	209	215	222	0.6%

Source: US Census Bureau

3.1.2. TEXAS ECONOMICS

GDP growth over the long-term can generally be thought of as population growth plus productivity growth. GDP growth in Texas has consistently outperformed the US as a whole over much of the past 15 years, averaging 3.4% (inflation adjusted) as presented in Figure 3.2. This is more than a full percentage-point above the national average growth rate of 2.1% attributed to higher population and productivity growth. The comparative strength has a broad base, and has materialized across a number of goods-producing and service sectors. Based on the outlook for stronger population growth relative to the US, Texas will likely continue to outperform.

FIGURE 3.2: TEXAS GDP GROWTH VS. US



Source: BEA; MN

Labor is more expensive and capital and raw materials are cheaper in the US compared to fast growing emerging market economies such as China. The US has comparative (and competitive) advantages in the production of goods that use little labor. Table 3.2 shows the list of goods that the US has been prone to export. They can be summarized as the ACE goods - Agriculture, Capital goods and Energy. Texas has comparative advantages in all of these goods and is a major supplier to the US and global economies.

TABLE 3.2: TOP 10 HIGH POTENTIAL US NET EXPORTS[1]

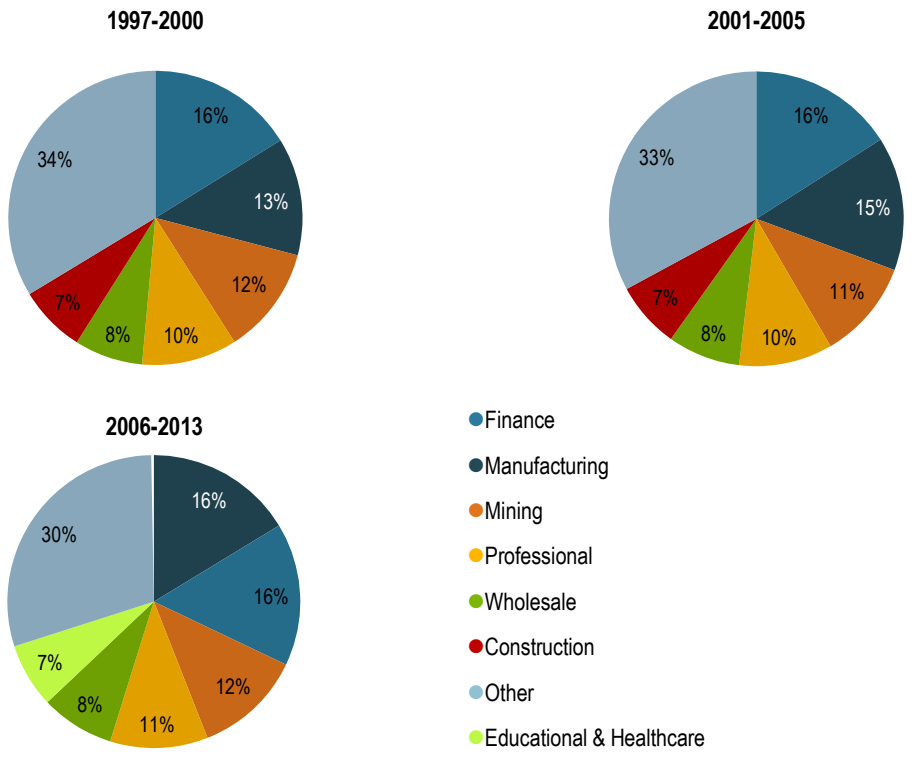
Containerized	Score	Bulk/Breakbulk	Score
Wood, Pulp, Scrap and Waste	9.4	Oil Seeds (Soy)	32.7
Oil Seeds (Soy)	1.1	Meat and Other Edible Animal Parts	28.7
Raw Hides and Leather	0.8	Cereal Grains	3.9
Cotton (Untreated, Yarn and Woven Fabric)	0.7	Animal Feed	3.4
Animal Feed	0.7	Wood and Charcoal	0.4
Meat and Other Edible Animal Parts	0.3	Crude Oil and Refined Petroleum/Natural Gas Products	0.4
Plastics, Feedstock and Manufactured Goods	0.2	Live Animals	0.3
Iron and Steel	0.1	Wood, Pulp, Scrap and Waste	0.2
Paper and Paperboard	0.1	Fish and Crustaceans	0.2
Chemical Products	0.1	Dairy Products including Eggs and Honey	0.1
Cereals	0.1	Organic Chemicals	0.1
Organic Chemicals	0.1	Plastics, Feedstock and Manufactured Goods	0.1

Source: BLS; US Census; MN

3.1.3. MANUFACTURING IN TEXAS

Manufacturing and not mining, has been leading the economic growth in Texas that goes beyond oil & gas-related manufacturing. Manufacturing now accounts for the largest contributing sector to Texas' overall GDP and has risen from 13% in the beginning of the 2000s to 16% by 2013. This is shown in Figure 3.3.

FIGURE 3.3: SHARE OF EMPLOYMENT BY SECTOR

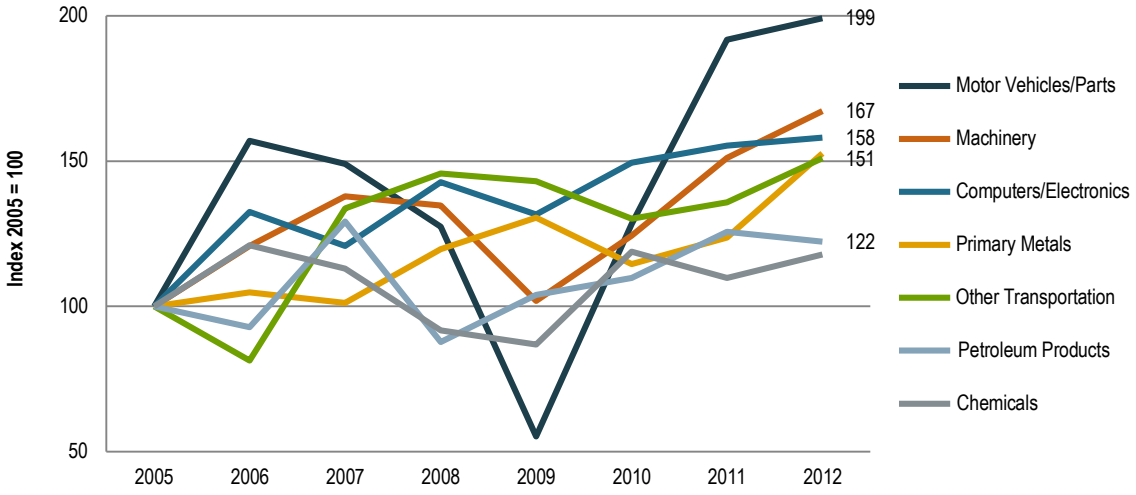


Source: BEA; MN

[1] Based on relative comparative advantage as defined by Bela Belassi.

Durable goods manufacturing operations have been the strongest performers. Since 2005, output from the state's motor vehicles/parts manufacturing has roughly doubled in value (real terms). Other strong performers include the machinery industry, computers/electronics and primary metals manufacturers. Manufacturing of petroleum products (still the single largest manufacturing industry, 15% of the total value) has been able to increase by just over 20%. Manufacturing chemicals is closely aligned with the petroleum product manufacturing industry. These trends are presented in Figure 3.4.

FIGURE 3.4: MANUFACTURING INDUSTRIES GROWTH INDICES



Source: BEA; MN

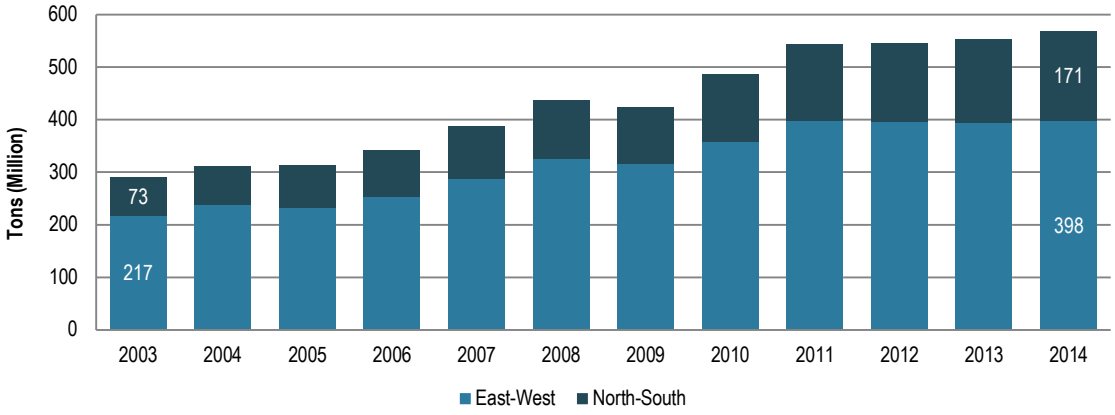
3.2. US EXPORT TRADE GROWTH & TEXAS PORT SHARE

North-South trade is growing faster than East-West for the US as a whole and Texas ports are the largest gateways for these volumes. Though the trade volume through Texas ports is not driven just off the trade with Latin America, but increasingly with markets throughout Asia, the Mediterranean, Middle East and Africa. Furthermore, many of the more recent developments have been in terminals to meet the needs of other non-energy-related commodities including fertilizers, mineral and agricultural products. Continued growth on these routes will necessitate further advancement in port infrastructure to accommodate a variety of cargo types (liquid and dry bulk, break bulk and containers).

3.2.1. ALL GOODS

US trade volume on the North-South routes are growing faster than on the major traditional East-West routes, and Texas is a vital gateway for these flows. North-South trade has been growing faster than East-West volumes in both total and non-energy tonnage (that excludes petroleum products, gas and coal). In both the total (All-Goods) and non-energy volumes the Texas ports serve as either the primary or second largest gateways for trade. Since 2003, the North-South volumes have grown at a CAGR of 8.1% as compared to the East-West CAGR of 5.7%. The trade route direction volumes are shown in Figure 3.5.

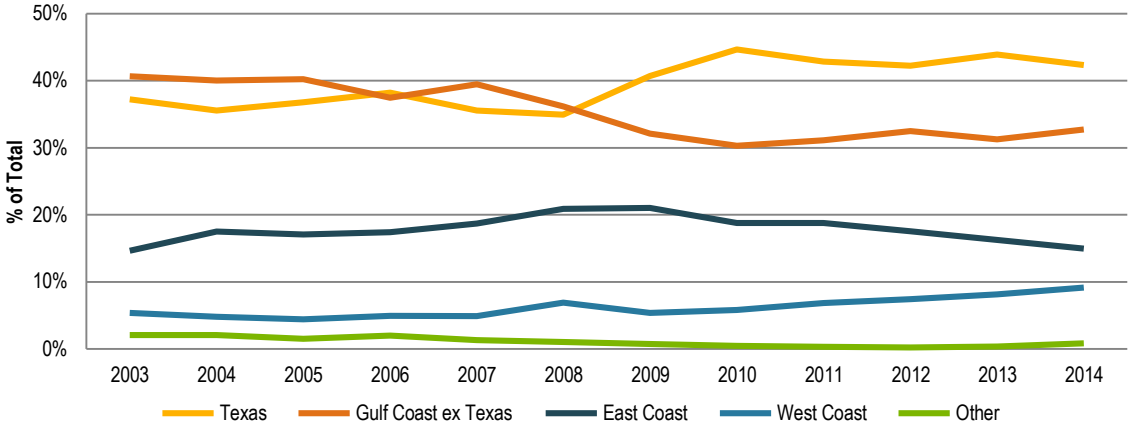
FIGURE 3.5: US MARITIME EXPORT TRADE BY ROUTES – ALL GOODS



Source: US Census; MN

Figure 3.6 shows the share for coast-wide ports, for US exports that include energy products. From 2008, Texas ports dominated the largest share of exports by weight.

FIGURE 3.6: EXPORT PORTS BY COAST

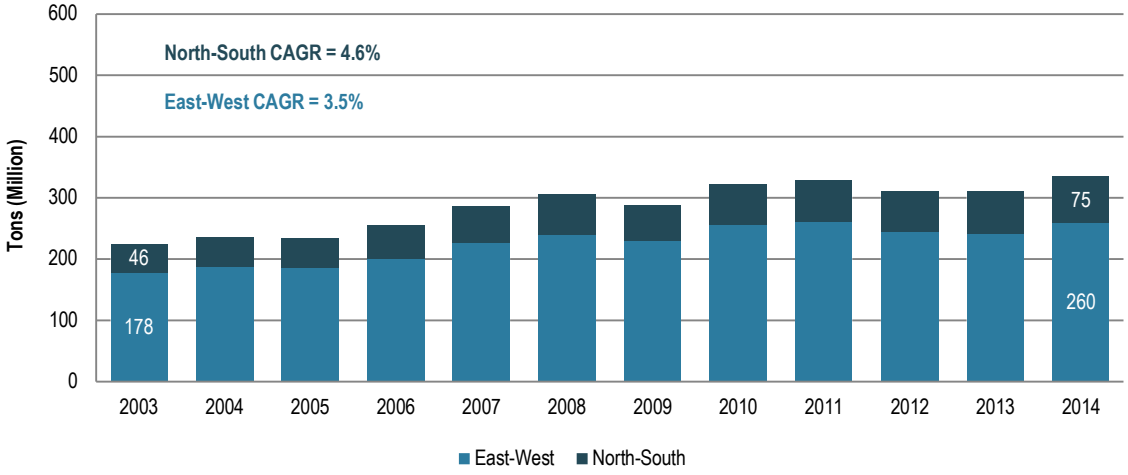


Source: US Census; MN

3.2.1. NON-ENERGY GOODS

When considering non-energy products, the CAGR growth falls to 4.6% for the North-South routes and 3.5% for the East-West routes respectively.

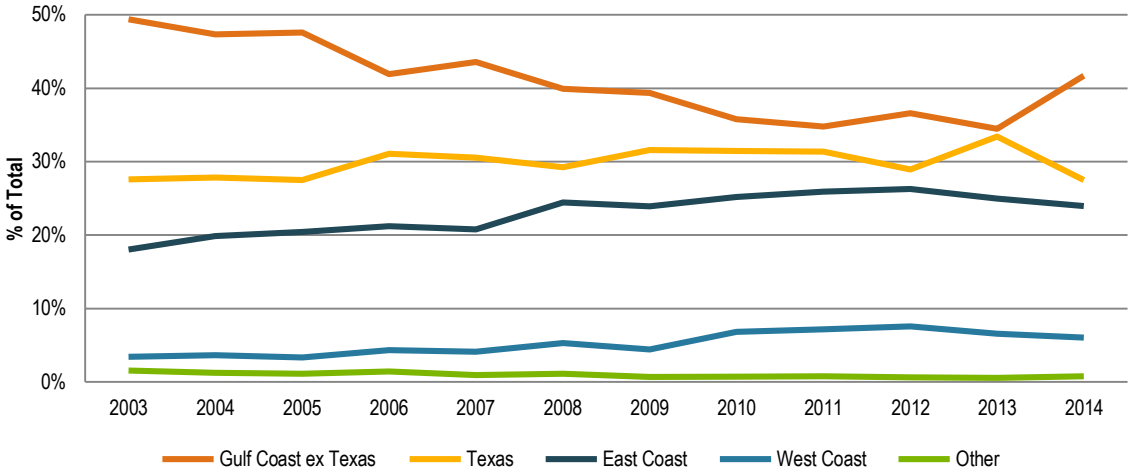
FIGURE 3.7: US MARITIME EXPORT TRADE BY ROUTES – EXCLUDING ENERGY



Source: US Census; MN

Even without Energy goods, Texas is an important gateway for exports. As recently as 2013 Texas ports almost equalled other Gulf Coast ports in leading exports. As of 2014 it was still above the East Coast ports. The history of exports of non-energy products is shown in Figure 3.8.

FIGURE 3.8: EXPORT PORTS BY COAST FOR NON-ENERGY GOODS



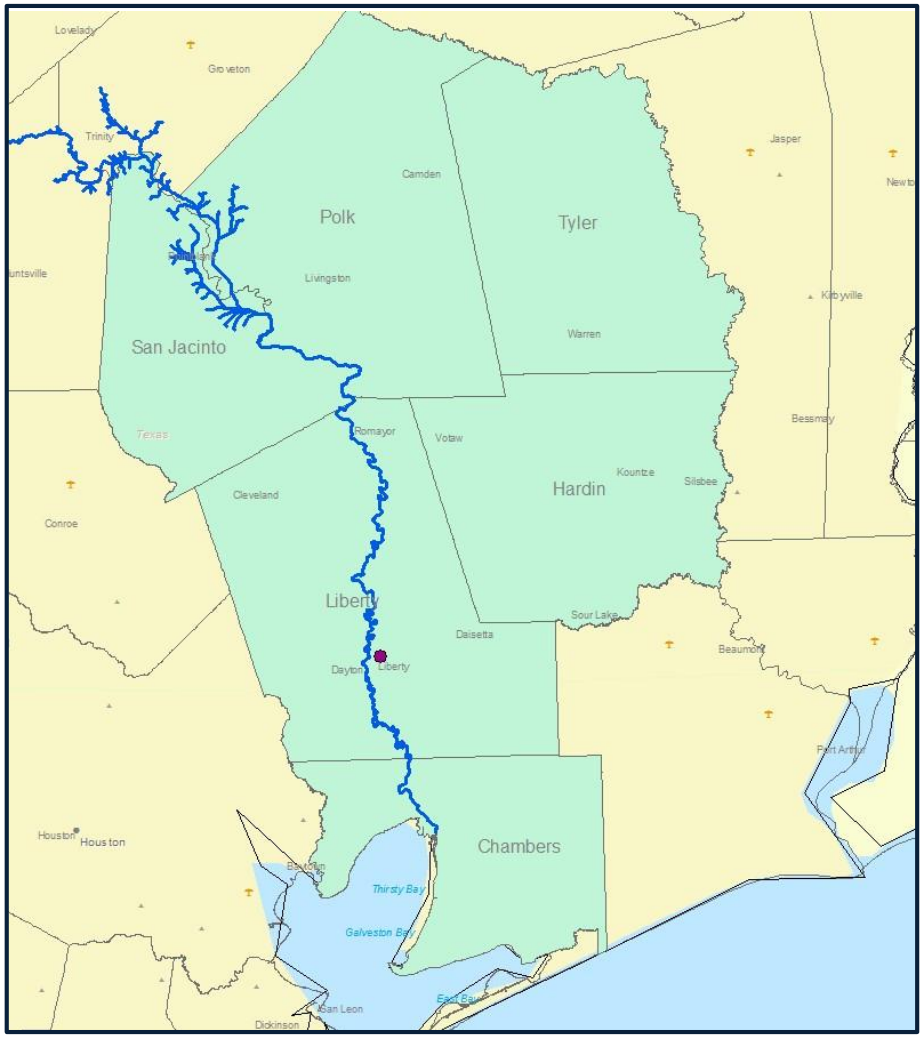
Source: US Census; MN

4. LOWER TRINITY RIVER BASIN ECONOMIC & TRADE OVERVIEW

4.1. THE STUDY REGION

The Lower Trinity River Basin, for the purpose of this study, includes the counties of: San Jacinto, Polk, Tyler, Liberty, Hardin and Chambers. These counties are shown in green in Figure 4.1. It is the economic activity within these respective counties which are assumed to have potentially the most direct impact on goods which could be redirected through a port facility in Liberty.

FIGURE 4.1: THE REGION OF ANALYSES



Source: MN

4.2. ECONOMY OF THE TRINITY RIVER BASIN

The Trinity River Basin, relative to Texas as a whole, is more dependent on goods-production to drive economic growth – these activities act as a source of freight movements to and from the region.

- Employment in goods-related industries account for 37% of total jobs in the basin compared to 26% state-wide, this implies a location quotient (LQ) of 1.4 shown in Table 4.1.
- The top sectors are manufacturing, construction and agriculture (which includes wood product manufacturing)
    - Agricultural activity consists predominantly of rice and nursery plants/trees.
- Production (and consumption of input materials) from these sectors results in shipments of diversified raw bulk and break bulk commodities throughout the basin.

Manufacturing activity in the basin, as measured by employment, is concentrated in few large industries including fabricated metal products, chemicals, non-metallic mineral products and wood products. All of these, with the exception of wood, to a large extent serve as support/supply industries for the oil & gas sector. Some companies within each of these sub-sectors are:

- Oil & gas supply/support (tubes, drilling fluids etc.): Boomerang, MI Swaco, InSteel, and Liberty Materials
- Chemicals (Miscellaneous): Huntsman.

Additionally, the presence of underground salt domes offers the potential for:

- Oil & natural gas storage: Kinder Morgan, Spectra Energy.

TABLE 4.1: PERCENTAGE OF EMPLOYMENT BY INDUSTRY: TRINITY RIVER BASIN VS. TEXAS

	Industry	Basin	Texas	Basin LQ
% of Total	Goods	37%	26%	1.4
% of Goods	NAICS 11 Agriculture, forestry, fishing and hunting	4%	2%	1.8
	NAICS 21 Mining, quarrying, and oil and gas extraction	12%	12%	1.0
	NAICS 22 Utilities	2%	2%	0.8
	NAICS 23 Construction	31%	25%	1.2
	NAICS 31-33 Manufacturing	43%	36%	1.2
	NAICS 42 Wholesale trade	8%	23%	0.4
% of Total	Service	63%	74%	0.9
% of Services	NAICS 44-45 Retail trade	30%	18%	1.7
	NAICS 48-49 Transportation and warehousing	6%	6%	1.1
	NAICS 51 Information	1%	3%	0.5
	NAICS 52 Finance and insurance	4%	7%	0.6
	NAICS 53 Real estate and rental and leasing	5%	3%	1.6
	NAICS 54 Professional and technical services	4%	9%	0.4
	NAICS 55 Management of companies and enterprises	0%	1%	0.0
	NAICS 56 Administrative and waste services	2%	11%	0.2
	NAICS 61 Educational services	0%	2%	0.1
	NAICS 62 Health care and social assistance	22%	19%	1.1
	NAICS 71 Arts, entertainment, and recreation	1%	2%	0.8
	NAICS 72 Accommodation and food services	18%	15%	1.2
	NAICS 81 Other services, except public administration	6%	5%	1.4
	NAICS 99 Unclassified	0%	0%	0.5
	Grand Total	100%	100%	

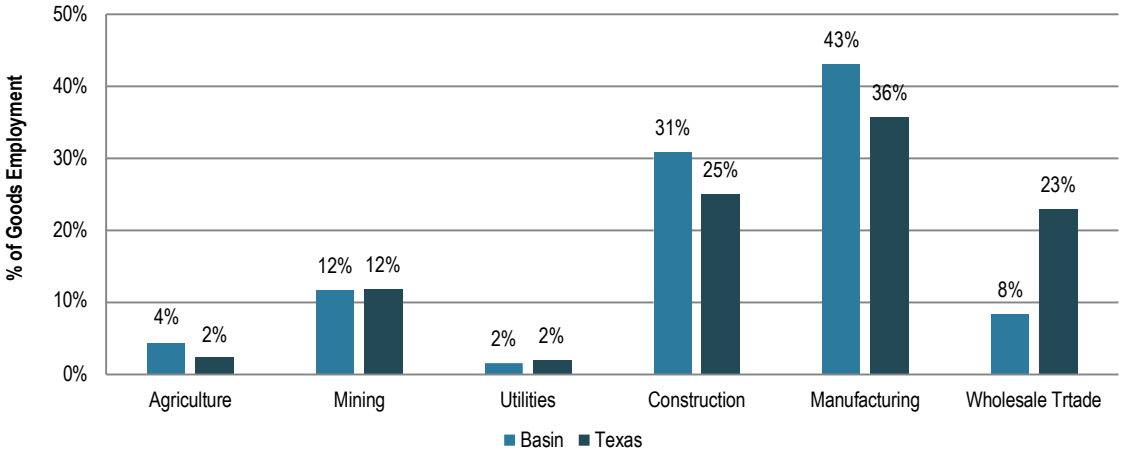
Source: US Census Bureau; BLS; Moffatt & Nichol

4.3. CHARACTERISTICS OF THE STUDY REGION

Liberty and the surrounding counties in particular are home to some of the largest production concentrations of agriculture (food and timber), manufactured goods and oil & gas service products in Texas. These types of products are generally shipped in bulk, using barges as a primary source of inland transportation. A port facility in the region could fit in well with these respective industries logistic needs.

As noted in the 1981 USACE report, the East Texas region is surrounded by growing urban areas driven by agriculture, energy and manufacturing. Economic analysis reveals that Liberty counts both manufacturing and services (essential and discretionary) to the largely rural area surrounding it as part of its base activity and employment. This is corroborated by the data presented in Figure 4.2 that shows construction and mining have a larger share of the total employments in the basin as compared to the state.

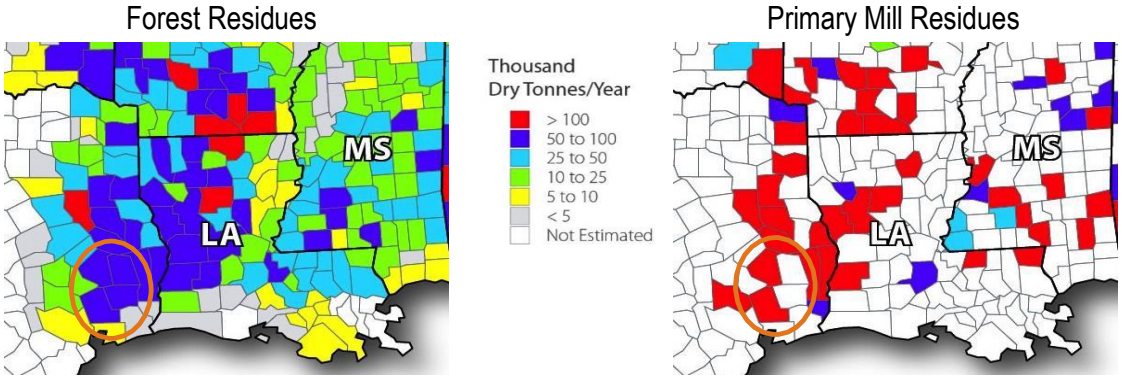
FIGURE 4.2: PERCENTAGE OF GOODS-RELATED EMPLOYMENT



Source: US Census Bureau; BLS; MN

A number of data sources, indicate that the majority of the basin is identified as forest areas. This in turn supports a robust timber and wood products industry. Companies such as Batson Lumber, located some 20 miles from Liberty, have been in operation since 2007 producing mixed hardwood or solid oak lumber in addition to pine pole and posts. Liberty's local market is a potential source for biomass (German Pellet Mill is already operational and exporting), and as shown in Figure 4.3 the basin supports some of the highest concentrations of forest residue and Primary Mill residues, which are the dominant feedstock into wood pellets. Wood pellet exports are quickly gaining traction out of the US Southeast and Gulf Coast ports.

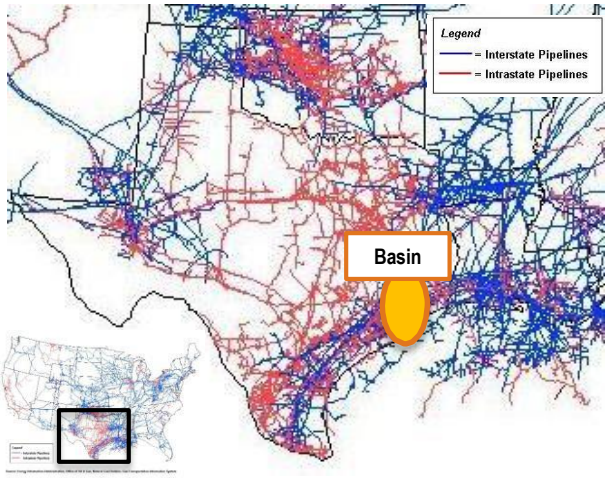
FIGURE 4.3: FOREST AND MILL RESIDUES IN THE TRINITY BASIN



Source: National Renewable Energy Laboratory

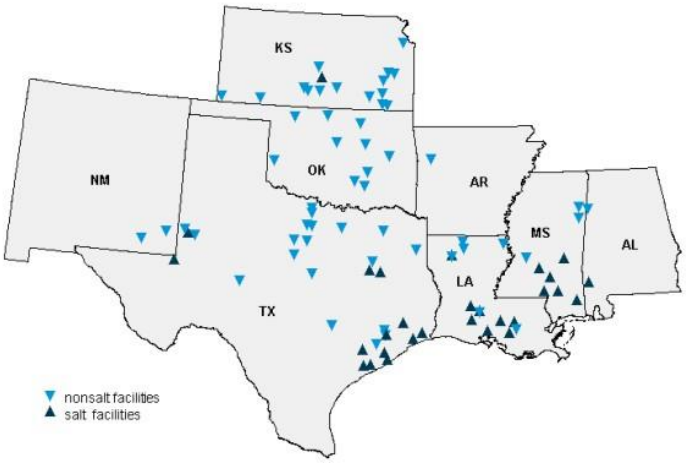
In addition to local wood/forest product resources, the Liberty area sits in the heart of the production, transportation and storage of oil and natural gas. The Oil & Gas pipe network is shown in Figure 4.4. This is one of the largest contributing sectors to Texas and US GDP growth, and as such, it requires a significant amount capital investment in order to ensure that it remains efficient across all spectrums. There are multiple angles from which a Trinity River port could participate. This includes serving as a point of consolidation for pipe, fluids and other goods which are produced locally and serve the offshore platforms. Additionally, local salt domes have been converted into underground storage facilities. Salt and non-salt facilities are shown in Figure 4.5. A Trinity River port could serve as a hub of construction and maintenance related heavy-load equipment for these facilities.

FIGURE 4.4: OIL AND GAS PIPELINE NETWORK



Source: EIA; MN

FIGURE 4.5: LOCATION OF NATURAL GAS STORAGE FACILITIES



Source: EIA; MN

Trinity River port would serve local markets (point of consolidation) being that it sits in the middle of Houston and Beaumont as seen in Figure 4.6. These are two of the largest ports in terms of total tonnage not only in Texas but the US as a whole. This is due to their high volumes of energy, agriculture, chemicals and base metal products which are handled. These types of goods, as will be addressed in the following sections, are suitable for transfer via barge and/or shallow draft vessels. They are of comparatively lower value and can therefore absorb longer transportation times in favor of reduced transportation costs (per unit).

While a Trinity River Port will not serve on the scale as some of the larger terminals within these respective ports, there does appear to be a number of "local"-to-Liberty type operations which could utilize a smaller scale barge service. Further diligence including interviews with potential shippers/cargo owners would be recommended to gauge the level of interest.

FIGURE 4.6: DISTANCE TO HOUSTON AND BEAUMONT FROM PROJECT SITE

Source: MN

5. REGIONAL WATERWAY FREIGHT FLOWS

Analysis of freight movement on the Inland Coastal Waterway (ICWW) in the region suggests that demand for chemicals, crude materials including sand, gravel and scrap metal, farm products and manufactured goods (iron and steel shapes) support a high level of barge/shallow draft vessel activity. These types of goods could also potentially support port activity at Liberty.

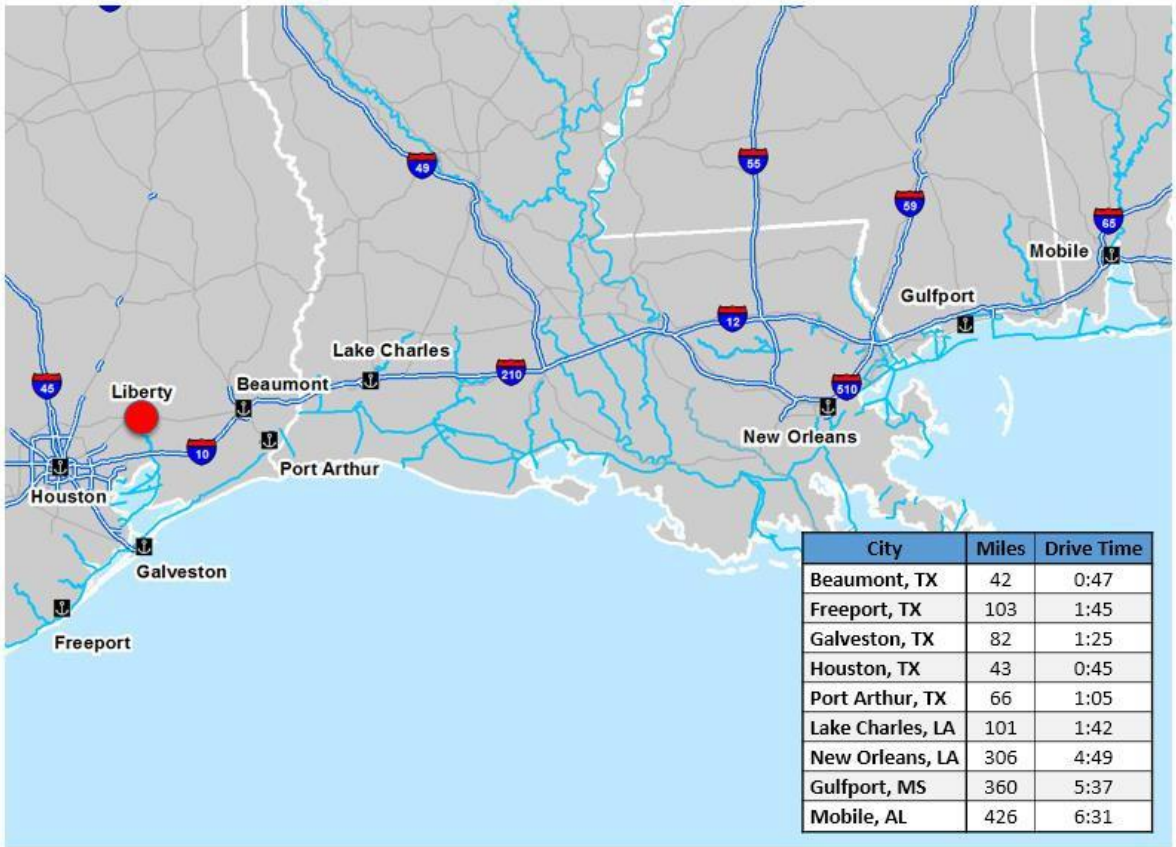
As part of the analysis to evaluate the potential for a Liberty-based port development, one useful exercise is to examine the existing trade flows of the ICWW in the region. This network of canals supports a vast amount of goods transfer between US Coastal ports (East and Gulf) for domestic consumption as well as for eventual export to foreign markets. This system connects most of the major Gulf coast ports to one another, and allows for efficient transportation of barge, and small-vessel carried commodities.

The three segments under review in this section include the:

- Beaumont channel,
- Sabine-to-Galveston,
- Galveston-to-Corpus Christi

The intention of work presented in this section is to provide insight into trade flows currently transiting the ICWW, and whether or not the same and/or compatible goods could potentially be sourced through Liberty. The analysis removes the petroleum based products to focus on non-petroleum based products. The petroleum-goods are by far the largest (in terms of volume) and distort the data such that information on smaller (comparatively) volumes are difficult to observe.

FIGURE 5.1: REGIONAL WATERWAY NETWORK



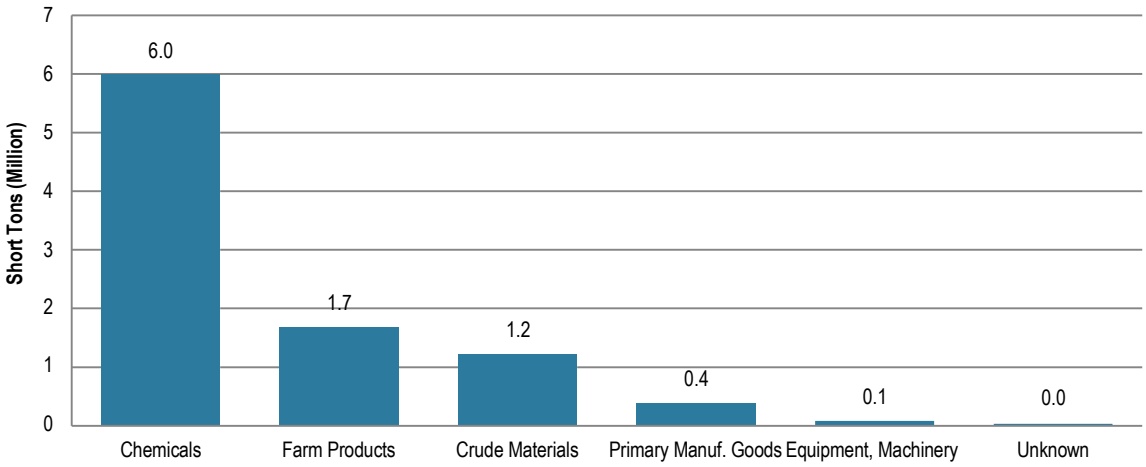
City	Miles	Drive Time
Beaumont, TX	42	0:47
Freeport, TX	103	1:45
Galveston, TX	82	1:25
Houston, TX	43	0:45
Port Arthur, TX	66	1:05
Lake Charles, LA	101	1:42
New Orleans, LA	306	4:49
Gulfport, MS	360	5:37
Mobile, AL	426	6:31

Source: MN

5.1. FREIGHT MOVEMENT ON LOCAL WATERWAYS: BEAUMONT

Beaumont commodities are heavily weighted towards chemicals, farm products and crude materials. These commodities are generally low value and can offset longer/slower transportation systems through shipping in high volumes (bulk). Beaumont shipments (imports & exports) of nonpetroleum products average 9 million tons per year (including petro-goods, the total jumps to 73 million). Chemicals are the single largest commodity and consist of miscellaneous industrial and agriculture-related goods. Farm products are predominantly exports of wheat destined to foreign markets (Caribbean and Latin America). Crude materials include a combination of sand/gravel and limestone as well as waste paper and scrap iron. This distribution is presented in Figure 5.2.

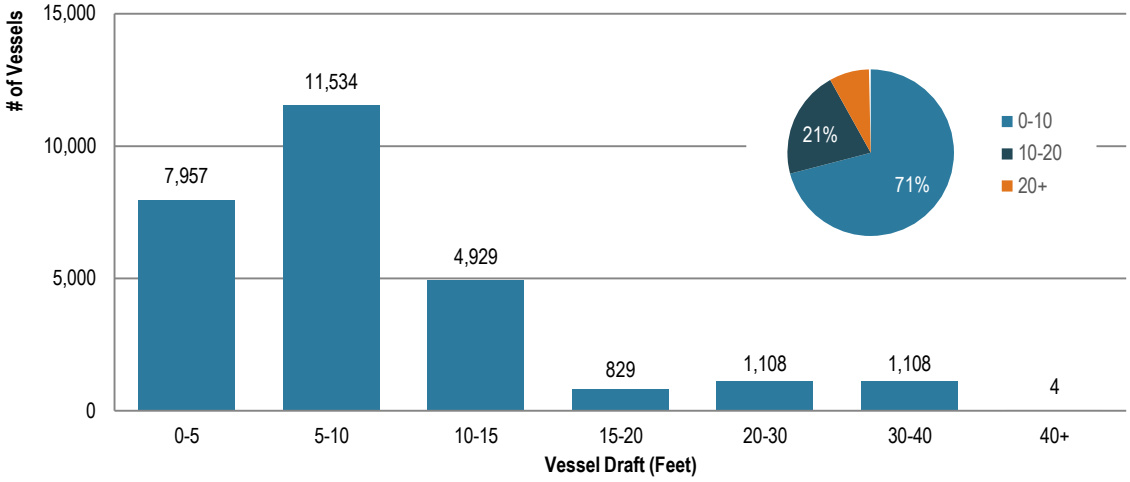
FIGURE 5.2: AVERAGE ANNUAL SHIPMENTS BY COMMODITY (2012)



Source: USACE; MN

Vessel characteristics suggest that a high percentage of the cargo shipments are handled on barge (shallow draft 10-feet or less) shown in Figure 5.3. However, there is a sizable share (roughly 30%) of total vessel traffic that is "deeper" draft and is indicative of the port's role in serving international markets in addition to domestic ones.

FIGURE 5.3: NUMBER OF VESSEL TRIPS BY DRAFT

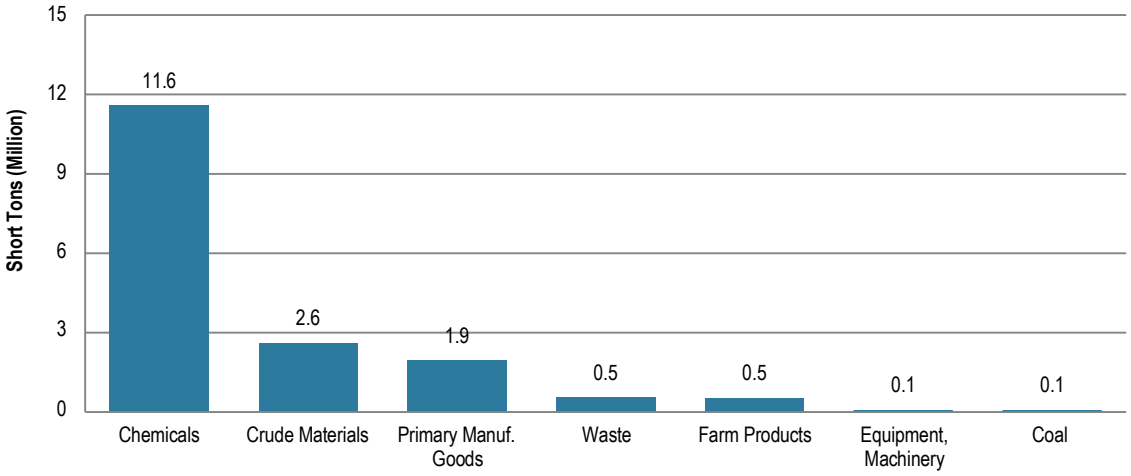


Source: USACE; MN

5.2. INTERCOASTAL SABINE-TO-GALVESTON

This segment of the ICWW is located northeast of Houston. Total shipments of non-petroleum products approach roughly 20 million tons annually. Of these goods, chemicals account for over half the total volume. These include mostly volumes of other hydrocarbons, other refining related products and alcohols. Crude materials include large volumes of scrap metal and aluminium ore. Shipments of primary manufactured shapes include plates and sheets of iron and steel, as well as pipes and tubes. Additionally there are sizable volumes of cement, sand and gravel. Shipments of farm related products include rice and vegetable oils. This distribution is presented in Figure 5.4.

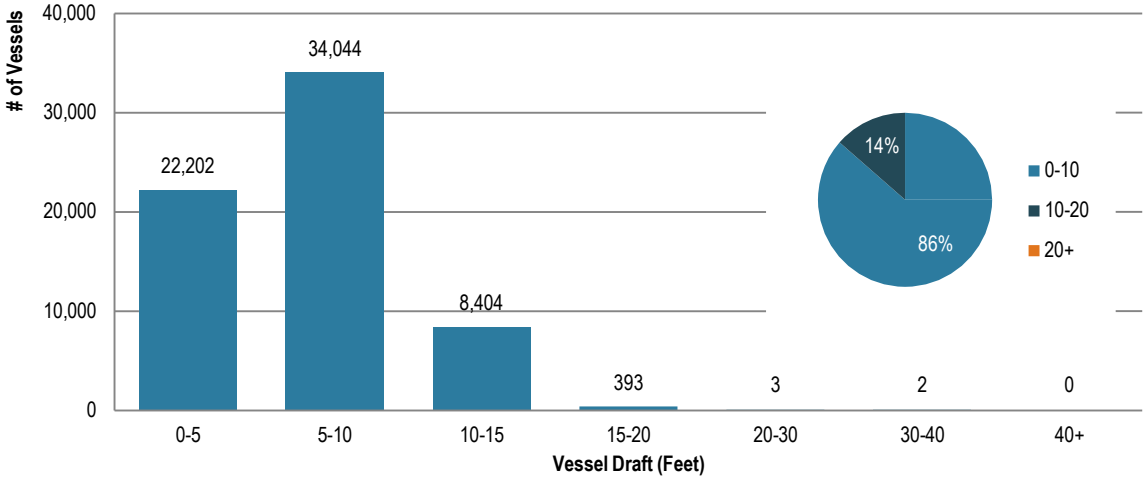
FIGURE 5.4: AVERAGE ANNUAL SHIPMENTS BY COMMODITY



Source: USACE; MN

By vessel size, 86% of the transferred volume is carried by vessels drafting 10-feet or less (Figure 5.5). The maintained depth of the segment is 12-feet. Nevertheless, given the comparatively low value of the types of goods being shipped it is not surprising that these classes of vessels are being used.

FIGURE 5.5: NUMBER OF VESSEL TRIPS BY DRAFT

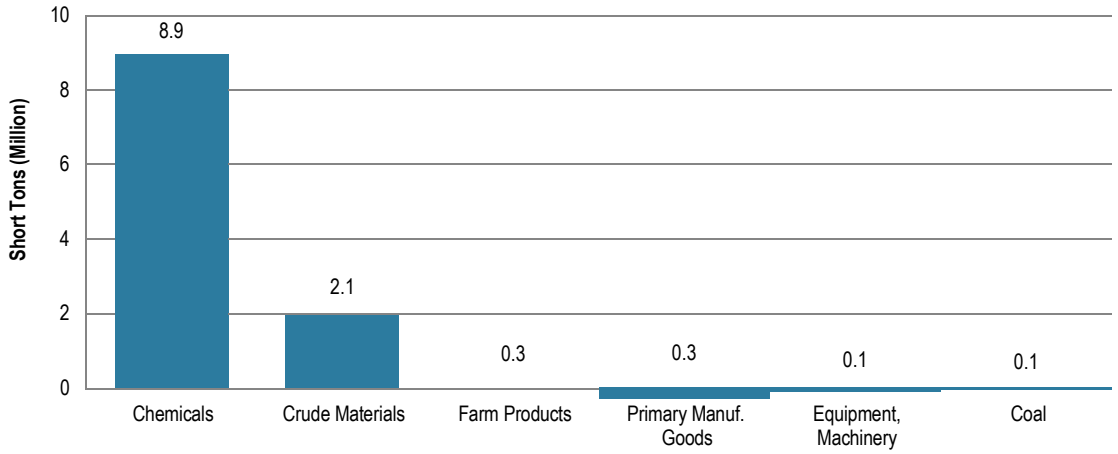


Source: USACE; MN

5.3. INTERCOASTAL GALVESTON-TO-CORPUS CHRISTI

This segment of the Intercoastal Waterway (south-west of Houston), is a major thoroughfare for chemical products and crude materials. Total volume of nonpetroleum products averages roughly 12 million tons per year. Approximately 9 million tons of this total are chemical products, and include a high volume of hydrocarbons and sulphuric acid, which are largely associated with regional refining activity. Under crude materials the top commodities include sand and gravel, and aluminium ore. Farm products include shipments of rice and sugar, and manufactured products are largely iron and steel plates. This data is shown in Figure 5.6.

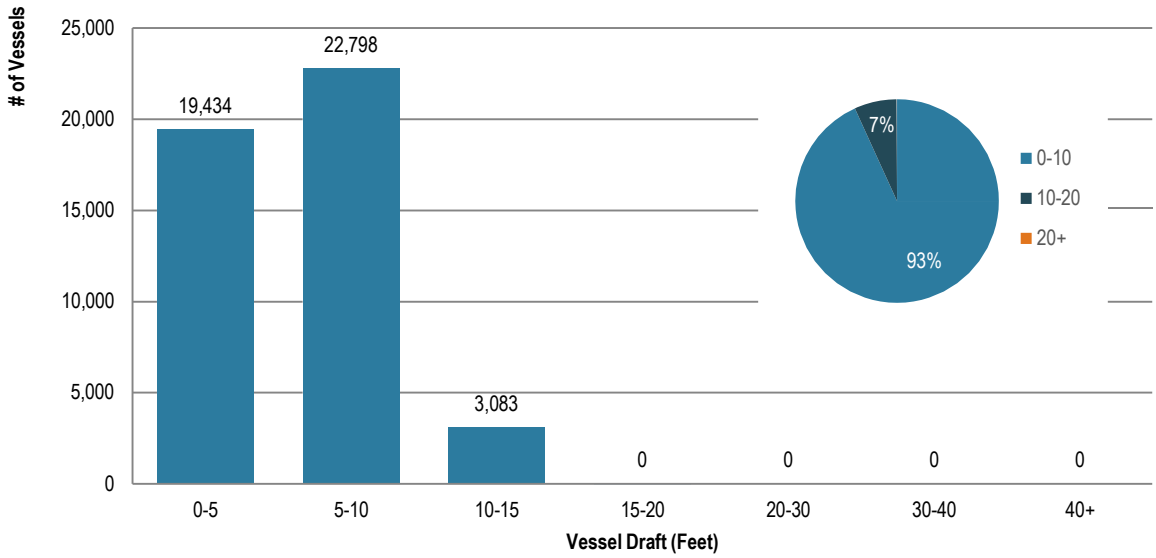
FIGURE 5.6: AVERAGE ANNUAL SHIPMENTS BY COMMODITY



Source: USACE; MN

Again, as with most of the traffic on the other segments, the majority of volume is handled in comparatively shallow draft vessels (either barge or small bulk carrier) as seen in Figure 5.7.

FIGURE 5.7: NUMBER OF VESSEL TRIPS BY DRAFT



Source: USACE; MN

6. COST COMPARISON

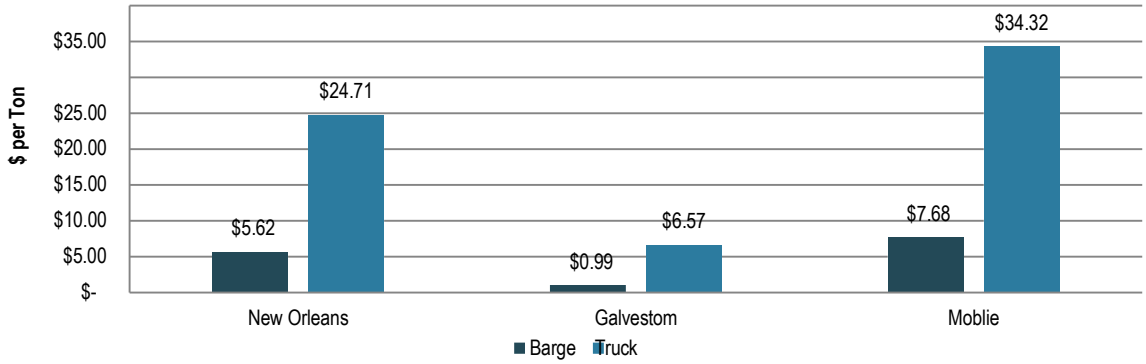
The potential to serve as a gateway for barge traffic, which would offer significantly lower transportation costs on a per-ton basis, could help support development of a port facility on the Trinity River. Further analysis is required to fully assess the navigability, and costs needed to improve navigability of barges on the Trinity River.

One of the arguments which could potentially support the development of a port facility on the Trinity River, is that shipping via barge from Liberty could significantly reduce the cost of transportation on a per-ton basis. MN conducted a high-level comparative cost analysis to compare the cost of shipping a ton of agriculture product from Liberty via barge vs. truck to some of the major Gulf Coast ports.

Based on this analysis the cost of shipping a ton of agriculture product to New Orleans via barge would total $5.62/ton if a 3-barge tow could be accommodated on the Trinity River (Figure 6.1). If only a single barge is used, the cost increases to $16.46 (Figure 6.2). In both instances the option to ship by barge would offer a per-ton savings on the $24.71/ton estimate of carrying the good by truck.

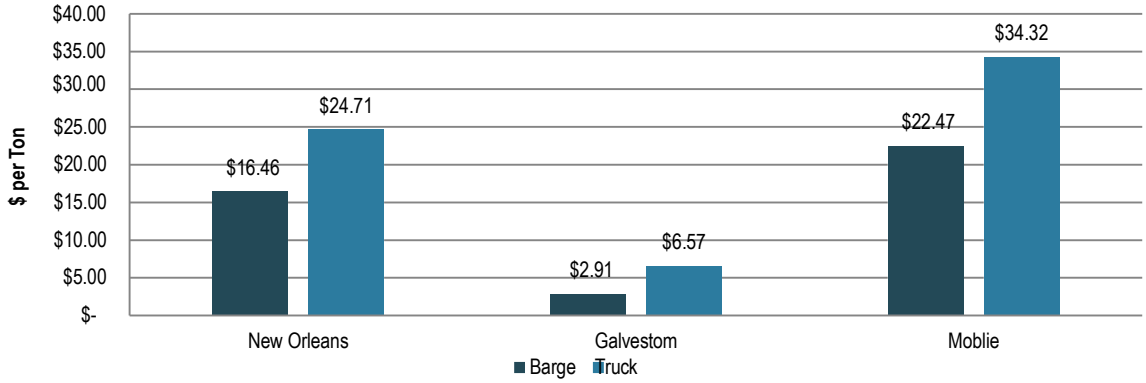
The difference between a single and 3-barge tow is significant, and therefore MN would recommend that additional analysis be conducted in order to ensure/identify the navigable capacity of the Trinity River. This cost of maintaining a channel (depth, length) ought to be compared against the projected benefits (financial and liveability/quality-of-life), once a firm business plan is developed.

FIGURE 6.1: COST ESTIMATES FOR A 3-BARGE TOW



Source: MN

FIGURE 6.2: COST ESTIMATES FOR A SINGLE BARGE



Source: MN

7. CONCLUSIONS

In determining whether there is sufficient economic activity to potentially support the development of a port facility in Liberty, or in another location along the Lower Trinity River, the answer is, yes, there is. The potential to leverage access to existing agriculture, timber and base metal shape manufacturers (among others) would appear to suggest that port facility in this region could potentially serve as a logistics hub for these industries. This is due to the relative low value of these bulk commodities which are currently transported in large quantity by barge on the ICWW.

Evaluating both the ability for the Trinity River to accommodate barge traffic, and the level of capital needed to improve navigability would be the next logical step in the evaluation of the Port development process.

- **Texas is Projected to Remain a Leader of Growth**

The Texan economy has been a leader of growth in the US. While the performance of the energy (oil & gas) sector has certainly been a source of strength in the overall economy, other sectors including Manufacturing have become the largest in terms of overall output (GDP). Within the manufacturing sector there is a diversified set of high value (motor vehicles/parts, machinery) and lower value industries (chemicals) which help support overall growth during cyclical periods in any given particular sector. Access to natural resources, a growing population and exposure to the burgeoning North/South trade routes all suggest that the long-term growth outlook for Texas remains strong.

- **Lower Trinity River Economic Base Appears Supportive**

Agriculture, Energy and Manufacturing (ACE) activity already exists in the six-county region studied. Production from these sectors in particular are foreseen to be drivers of growth in the future. As global demand for resources will continue to grow (the world needs energy and food), the Lower Trinity River region could become a hub of production/servicing of these types of goods. Given the size of the labor force, there is potential for this activity to increase as a result of the development of a port facility. It is recommended to review the original Army Corps of Engineers studies to determine the feasibility of previous plans and consider alterations to them, given changes in the area's population as well as level and pattern of economic activities.

- **Additional Analysis on the Navigability of the Lower Trinity River is Required**

Given the positive assessment of the initial market review, MN would recommend that the TRA continue the investigation with a focus on the navigability of the Trinity River. This would allow for further refinement of the business development plan, by allowing for the identification of the capacity of the Trinity River to accommodate trade (barge tow size, water depth etc.) as well as the cost of maintaining navigable channels (dredging requirements). This analysis would eventually help with the most beneficial site selection (relative to the cost of maintaining/building new infrastructure), and advance the project's development.

8. APPENDIX: GLOBAL TRENDS SUPPORTING AGRICULTURE

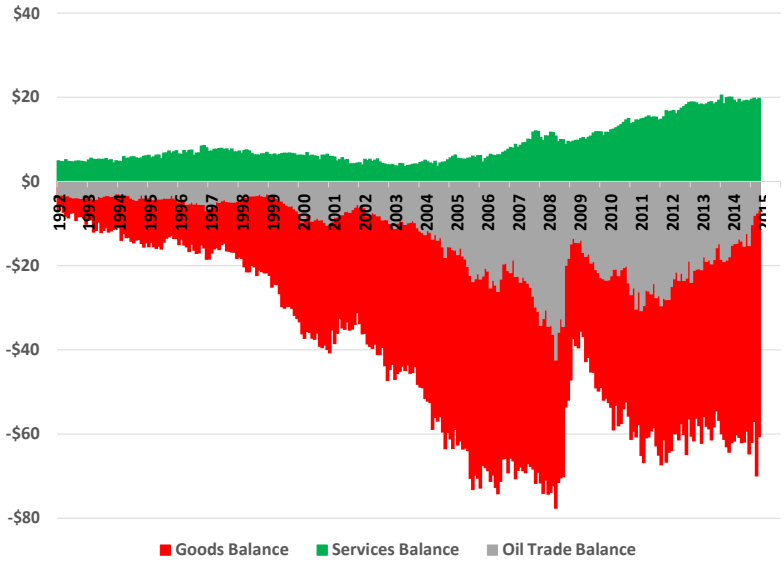
Growing global demand for food (agriculture), capital goods and energy is set to accelerate. All three of the ACE types of goods are produced and exported by Texas. To continue growing these exports more infrastructure will be needed so as to avoid congestion. Thus the Trinity River, if improved for navigation purposes, along with port facilities has the potential to contribute to Texas export and therefore economic growth.

8.1. US & GLOBAL TRADE TRENDS

The US has helped the world economy develop, particularly emerging market economies, by allowing its trade balance to be in deficit. This is not sustainable in the long run. Reducing the trade deficit is important for employment and therefore economic growth. The decreasing US oil trade deficit has directly helped strengthen the US goods balance and in the process helped employment recover from the deep 2007-2009 recession. However, a further reduction in the deficit is needed in order for US economic prospects to improve. This will most likely require growth in exports. Texas is already contributing to US export growth; however more could be done, particularly in terms of infrastructure investment in order to support that. There is potential for improvements to the Trinity River along with a river terminal in Liberty or on a more southern location to support US export growth and domestic freight flows.

The two main components of the deficit are shown in the chart below – the services surplus and the goods deficit. The US economy, like most developed economies, is driven by services. Thus it is not a surprise that there is a services surplus. However, the US has developed a substantial goods trade deficit since the late 1990s when China joined the World Trade Organization. Most of the goods trade deficit increase is due to China.

FIGURE 8.1: US TRADE DEFICIT



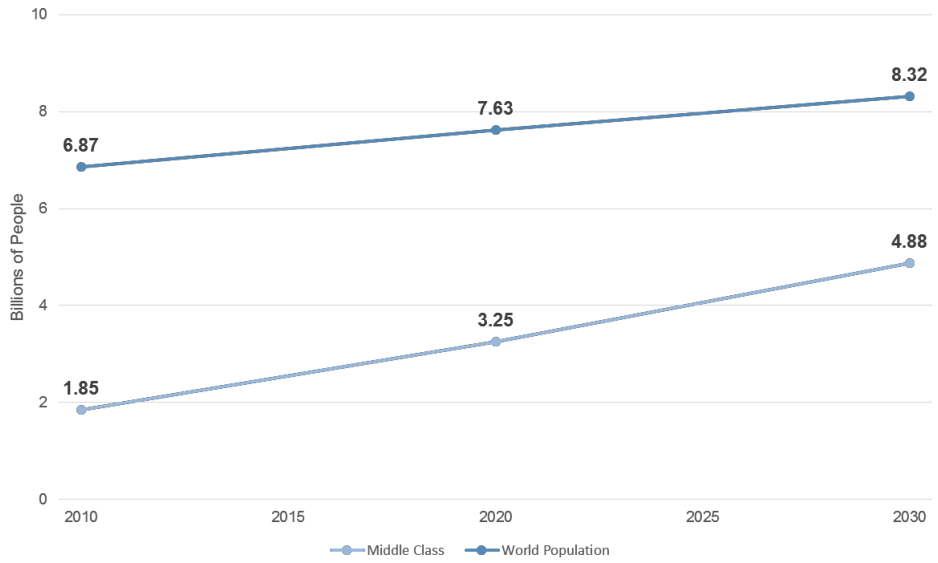
Source: US Census Bureau, MN

The goods trade deficit has averaged $60.5 billion per month in 2013 and $725 billion per month in 2015, which is equivalent to 4% of US GDP. This is below the average level of $67.5 billion per month during the 2005 to 2007 pre-recession period. The oil trade deficit averaged $22 billion per month in 2005 to 2007 but in the last two years has averaged $16.2 billion per month. Since 2008, domestic oil production has risen to levels close to that of the peak production period in 1968 and natural gas production is the highest in US history. Therefore, it is thanks to the development of hydraulic fracturing that the US has been able to improve its trade deficit.

Despite the competitive reaction from OPEC countries, it is anticipated that US oil and natural gas production will continue to increase. This should help reduce the goods trade deficit further. But even if the average level oil trade deficit declined from the current $16.2 billion level, the overall goods trade deficit would be $45 billion and still exceed the services trade deficit, which only averages $19 billion.

It is unlikely that the level of the value of imported goods will decline. These are mostly consumer goods and downstream industrial inputs for consumer products including automobiles and houses. Given that the US population is aging and that the global middle class is growing, particularly in Asian emerging economies, it is unlikely that consumer goods manufacturers would prefer to locate manufacturing operations in the US.

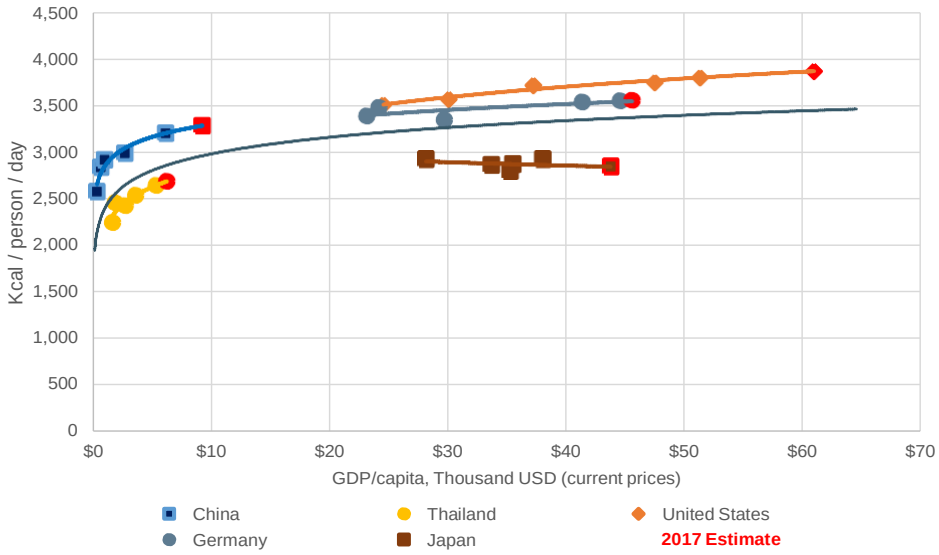
FIGURE 8.2: ESTIMATES AND FORECASTS OF THE GLOBAL MIDDLE CLASS POPULATION



Source: OECD

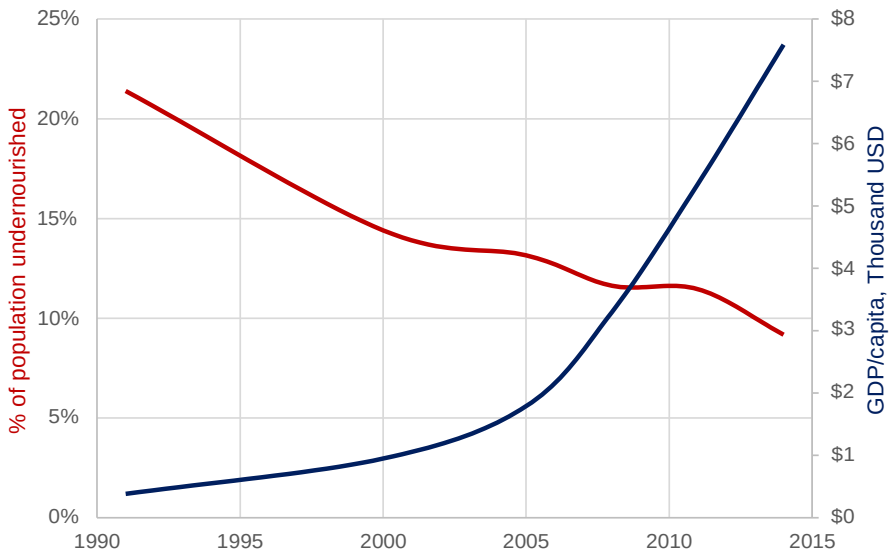
As such the US is likely to remain dependent on imported consumer goods. However, in addition to energy, US agricultural and capital goods are highly competitive in the world market. Demand for agricultural goods is rising in economies, such as China, that are growing at a high rate. This is shown in Figure 8.3 that depicts food consumption per capita plotted against income per capita for various countries over the 1990 to 2012 time period. China has been catching up with developed economies but there is still a substantial gap.

FIGURE 8.3: FOOD CONSUMPTION VS GDP/CAPITA, 1990-2012



Source: FAO, IMF WEO, MN

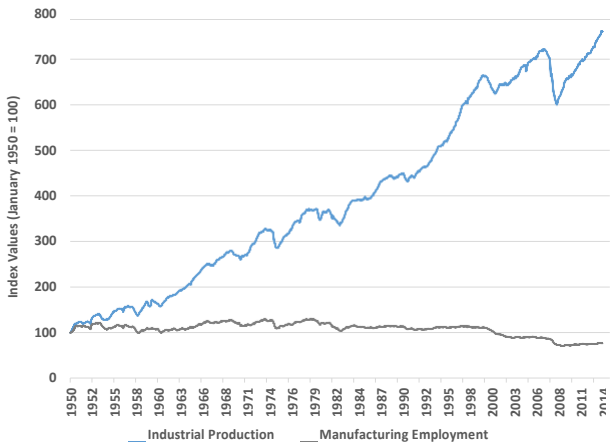
FIGURE 8.4: PERCENT OF CHINA'S POPULATION UNDERNOURISHED



Source: FAO, IMF WEO, MN

Manufacturing of high end capital goods such as oil drilling and exploration equipment (particularly for deep sea locations), transportation machinery such as airplanes, construction and agricultural production equipment utilizing GPS to improve accuracy and maximize farm yields represent another industry where the US is globally competitive. These industries are more capital intensive than labor intensive, meaning that manufacturing is highly automated and does not require large payrolls. This is important because US labor is relatively more expensive than in developing economies like China but capital is cheaper. The US has sustained growth in manufacturing output despite offshoring trends that have prevailed since at least the 1970s. The chart below shows that manufactured goods output has increased seven-fold since 1950 but employment in manufacturing has declined by 20%. However the growth in manufactured goods output is not homogeneous across all types of goods. The US does not produce consumer electronics like televisions and toasters but instead increasingly specializes in high-end industrial machinery.

FIGURE 8.5: INDUSTRIAL PRODUCTION AND MANUFACTRUTING EMPLOYMENT



The kind of manufactured goods that the US can competitively export are in high demand in emerging market economies. These countries need to build more infrastructure for transportation, energy, water, communications and education. Most of these countries have a large gap compared to developed economies. For example, the World Bank estimates that despite decades of heavy investment in capital goods, China's capital per worker is still less than 10% of that ratio in the US.

The growing global middle class is a target of opportunity for US agricultural, capital goods and energy exports. All three of these types of goods are produced and exported by Texas, as discussed below. To continue growing these exports more infrastructure will be needed so as to avoid congestion. Thus the Trinity River, if improved for navigation purposes, along with port facilities has the potential to contribute to Texas export and therefore economic growth.

Moffatt & Nichol, New York
529 5th Avenue, New York NY 10017, USA
Telephone: +1 212-768-7454

Other Non-Federal Sponsors Letter(s) of Support

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Port of Liberty.pdf

PORT OF LIBERTY
COMMISSION

P.O. Box 3007
Liberty, Texas 77575

Dennis Beasley, President
Denise Barkis, Vice-President
John Hebert, Secretary
Mary Anne Campbell, Acting Port Director

936-336-5736
Fax: 936-336-1159
P. O. Box 3007
Liberty, Texas 77575

August 3, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen,

I am writing to express my support for The Trinity River Authority of Texas (TRA) WRRDA 7001 Proposal, "Trinity River & Tributaries Channel to Liberty Navigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project.

A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, energy and manufacturing activities in a six-county region that could benefit from a reliable and improved TR&T navigation system, as global demand for movement of goods and resources drive the growth of future production within the Basin.

I sincerely hope that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Sincerely,

Dennis Beasley

Dennis Beasley, President
Port of Liberty Board of Commissioners

Primary Sponsor Letter of Support

(As uploaded)

TRA Final Letter.pdf

Trinity River Authority of Texas

General Office

August 9, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen:

On behalf of the Trinity River Authority of Texas (Authority), I am pleased to submit a proposal for a feasibility study for the Port of Liberty for the 2018 United States Army Corps of Engineers (USACE) Report to Congress on Future Water Resources Development. The Authority is currently collaborating with the USACE on a "Planning Assistance to States" grant. Inclusion in the Chief's Report would allow continued partnerships to assess the potential for cargo traffic on the river.

The Trinity River Authority of Texas is a conservation and reclamation district that provides water and wastewater treatment, along with recreation and reservoir facilities, within the nearly 18,000 square-mile Trinity River basin. The Authority also maintains a master plan for basin-wide development, and serves as a conduit for tax-exempt financing for municipal projects and as a local sponsor for federal water projects.

The Port of Liberty is located in the town of Liberty, Texas approximately forty river miles from the Trinity Bay on the Gulf of Mexico. The Port previously serviced barges until 1992. The Port is strategically located between the Port of Houston and the Port of Beaumont.

Texas ports are responsible for over thirty percent of the Texas gross domestic product and are integral to Texas manufacturing and energy. However, Texas ports and manufacturing face an unprecedented competitive threat as ports in neighboring states are beating Texas in the race to improve their depth and infrastructure to meet the opportunities created by the new, deeper Panama Canal. Texas cannot afford to fall behind.

The Authority will act as the non-Federal primary sponsor for the feasibility study. The Authority will contribute necessary financial support, provide staff and consultant resources, and coordinate stakeholder and community understanding and engagement. The Authority expects potentially complex solutions will be identified through the feasibility study, and is committed to thoroughly pursuing and implementing a long-term plan to re-open the Port of Liberty.

P.O. Box 60
Arlington, Texas 76004
Metro (817) 467-4343
TeleFax (817) 465-0970

We sincerely hope that the Corps will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Sincerely,

J. KEVIN WARD
General Manager

Other Non-Federal Sponsors Letter(s) of Support

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State Rep Bailes.pdf

STATE OF TEXAS
HOUSE OF REPRESENTATIVES
ERNEST BAILES
District 18

August 3, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen,

I am writing to express my support for The Trinity River Authority of Texas (TRA) WRRDA 7001 Proposal, "Trinity River & Tributaries Channel to Liberty Navigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve the navigation features of the Trinity River & Tributaries (TR&T) project.

A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, energy, and manufacturing activities in a six-county region that could benefit from a reliable and improved TR&T navigation system, as global demand for movement of goods and resources drive the growth of future production within the Basin.

I sincerely hope that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Respectfully,

Ernest J. Bailes, IV

Ernest Bailes

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Other Non-Federal Sponsors Letter(s) of Support

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State Rep Faircloth.pdf

STATE REPRESENTATIVE
WAYNE FAIRCLOTH

DISTRICT 23
CHAMBERS AND GALVESTON COUNTIES

August 7, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen,

I am writing to express my support for The Trinity River Authority of Texas (TRA) WRRDA 7001 Proposal, "Trinity River & Tributaries Channel to Liberty Navigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project.

A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, energy and manufacturing activities in a six-county region that could benefit from a reliable and improved TR&T navigation system, as global demand for movement of goods and resources drive the growth of future production within the Basin.

I sincerely hope that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Sincerely,

Wayne Faircloth
State Representative, House District 23

E2.812 • P.O. BOX 2910 • AUSTIN, TEXAS 78768-2910 • (512) 463-0502
WAYNE.FAIRCLOTH@HOUSE.TEXAS.GOV • WWW.HOUSE.TEXAS.GOV

Additional Proposal Information

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Trinity River Report - August 9 2017_Draft Rev 1a with Appendices.pdf

Innovative approaches
Practical results
Outstanding service

Job No.: TR116566

PORT OF LIBERTY
TRINITY RIVER NAVIGATION

(DRAFT)

Revision 1.0
August 9, 2017

Trinity River Authority
5300 S. Collins
Arlington, Texas 76018

Prepared by:

Freese and Nichols, Inc.
10431 Morado Circle, Suite 300
Austin, Texas 78759

August 2017

EXECUTIVE SUMMARY

This Long-Term Port of Liberty Navigation Development Plan report has been prepared as part of a cooperative agreement executed on May 31, 2016, between the Trinity River Authority (TRA) and the U.S. Army Corps of Engineers (USACE) Galveston District under the Planning Assistance to States (PAS) Program.

This report provides a review of the Trinity River and Tributaries navigation system. The historic navigation features of the Trinity River and Tributaries project consist of the federally authorized shallow-draft three-channel navigation system to include the Channel to Liberty, Anahuac, and Channel to Smith Point channels. The Anahuac Channel extends 5.6 miles from Upper Trinity Bay to the Trinity River mouth. The Channel to Liberty proceeds 41.4 miles from the Trinity River mouth to the Port of Liberty. The Channel to Smith Point channel extends from the Houston Ship Channel along Trinity Bay's east shore to 1 mile south of Anahuac, Texas. Both the Channel to Liberty and Anahuac navigation channels are authorized to a depth of -6 feet (ft) Mean Low Tide (MLT) and are typically maintained at width of 100 ft. The Channel to Smith Point navigation channel is authorized at a depth of -9-ft MLT and is typically maintained at a width of 150 ft.

Commodities historically transported by barge via the Channel to Liberty and the Anahuac Channel have included agricultural chemicals, industrial chemicals, and iron and steel products. Since the mid-1990s, barge transported commodity tonnage has significantly declined due in part to the irregularity in channel maintenance.

Global demand for movement of goods and resources is the main driver for the growth of future production within the Lower Trinity River Basin. A recent market analysis of the Lower Trinity River Basin reported robust Agriculture, Capital Goods, and Energy (ACE) activities in the six-county region that potentially could benefit from a reliable and improved Trinity River and Tributaries navigation system. Currently, movement of ACE commodities through the Lower Trinity River Basin depends on truck or rail transport. Improvements in efficiency and tonnage of commodity throughput with transportation cost savings could be achieved by barges using a reliable and improved navigation system.

Based on the bathymetric survey of the Channel to Liberty and the Anahuac Channel performed by TRA and the Texas Water Development Board (TWDB) in January 2017, coarse estimations of dredged material quantities were determined to reestablish a channel geometry with a depth of -6-ft Mean Lower Low Water (MLLW) and a width of 100 ft ("6 X 100") and an improved channel geometry of -9-ft MLLW and a width of 130 ft ("9 X 130"). Total initial and maintenance dredged material quantities for the two channel geometries are outlined below.

Estimated Dredged Material Volumes (cy) (Channel to Liberty & Anahuac Navigation Channels)		
Dredging Period	**Channel Geometry**	
	"6 X 100"	**"9 X 130"**
Initial Dredging	1,487,477	3,730,900
20-Year Maintenance (Total)	7,000,000	14,700,000
50-Year Maintenance (Total)	17,000,000	35,700,000

The initial maintenance cost for the “6 X 100” channel geometry is $10,900,000, and the initial construction cost for improvements to the “9 X 130” channel geometry of the General Navigation Features (GNF) is estimated at a total of $14,400,000, which is the incremental cost above the initial existing maintenance requirements. Subsequent maintenance cost for the “6 X 100” channel geometry for a 20-year period is $53,900,000 and for a 50-year period is $131,000,000. Future incremental Operations and Maintenance (O&M) total estimated cost for the GNF improved channel “9 X 130” over a period of 20 years and 50 years is $49,500,000 and $120,000,000, respectively.

The non-Federal cost share for construction of GNF for commercial navigation with shallow-draft navigation channel depths up to 20 ft is 10 percent, with an additional 10 percent of the GNF construction costs to be paid over a period not to exceed 30 years. O&M of GNF for shallow-draft navigation channels is 100 percent Federal cost.

Future dredged material placement areas for sediments dredged from the Channel to Liberty and Anahuac navigation channels are anticipated to be similar to the placement areas used in the past. For the Channel to Liberty, the dredged material placement areas easements have expired, and therefore, the easements will need to be reacquired. The status of the Anahuac Channel dredged material placement areas is governed by navigation servitude and therefore should be available for future use.

Sedimentation rate analysis and environmental considerations for the dredging of the Channel to Liberty and Anahuac navigation channels will be provided by USACE Galveston District in a separate report as one of its technical contributions to the Long-Term Port of Liberty Navigation Development Plan PAS study.

Contents

Page

Executive Summary ii
List of Figures vi
List of Tables vii
Acronyms and Abbreviations viii

1.0 INTRODUCTION 1-1
1.1 AUTHORITY 1-1
1.2 PROJECT AREA 1-1

2.0 AUTHORIZATIONS & DE-AUTHORIZATIONS 2-1
2.1 PROJECT AUTHORIZATIONS 2-1

3.0 HISTORY PORT OF COMMODITIES MOVEMENT 3-1

4.0 HISTORY OF DREDGE OPERATIONS 4-1
4.1 CHANNEL DREDGING – CHANNEL TO LIBERTY 4-1
4.2 PLACEMENT AREAS – CHANNEL TO LIBERTY 4-1
4.3 PLACEMENT AREAS – ANAHUAC CHANNEL 4-3
4.4 PLACEMENT AREAS - CHANNEL TO SMITH POINT 4-4

5.0 HISTORIC MAINTENANCE DREDGING COSTS 5-1

6.0 HISTORIC DREDGE MATERIAL QUALITY 6-1

7.0 CURRENT RIVER GEOMETRY 7-2

8.0 SEDIMENTATION RATE ANALYSIS 8-1

9.0 SUMMARY REVIEW OF PORT OF LIBERTY MARKET ANALYSIS 9-1
9.1 FUTURE WATERBORNE COMMERCE PROSPECTS 9-1
9.2 CONSIDERATIONS FOR TRANSPORATION COST SAVINGS 9-3
9.3 ADDITIONAL BENEFITS 9-4

10.0 NAVIGATION CHANNEL GEOMETRY 10-1
10.1 WALLISVILLE LOCK AND DAM COMPLEX 10-1
10.1.1 Introduction 10-1
10.1.2 Navigation Lock and Salinity Barrier Structure 10-2
10.1.3 Lock Operations 10-2
10.2 BARGE TOW DESIGN CONFIGURATION 10-2
10.3 NAVIGATION CHANNEL GEOMETRY & ALIGNMENT 10-3

11.0 FUTURE DREDGED MATERIAL VOLUME ESTIMATES 11-1
11.1 INITIAL DREDGED MATERIAL QUANTITIES 11-1
11.2 FUTURE MAINTENANCE DREDGING REQUIREMENT 11-4

Page

12.0 DREDGED MATERIAL PLACEMENT AREAS 12-1
12.1 FUTURE PLACEMENT AREAS – CHANNEL TO LIBERTY 12-1
12.2 FUTURE PLACEMENT AREAS – ANAHUAC CHANNEL 12-1
12.3 ADDITIONAL NEW PLACEMENT AREAS 12-1
13.0 ENVIRONMENTAL CONSIDERATIONS 13-1
14.0 PROJECT COSTS 14-1
14.1 INITIAL CONSTRUCTION COSTS 14-1
14.2 FUTURE MAINTENANCE DREDGING COSTS 14-2
15.0 RECOMMENDATIONS 15-1
16.0 REFERENCES 16-1

Appendices:

A Port of Liberty Bathymetric Survey, Phase 1 (2017)
B Estimated Dredged Material Volume Calculations

Figures

Page

1-1 Trinity River and Tributaries Navigation Channels 1-3
1-2 Channel to Liberty Navigation Channel and Historic DMPAs 1-4
1-3 Anahuac Navigation Channel and Historic DMPAs 1-5
7-1 Channel to Liberty and Anahuac Channel Bathymetry 7-3
7-2 Channel to Liberty Bathymetry 7-4
7-3 Anahuac Channel Bathymetry 7-5
10-1 Wallisville Lock & Dam Complex and Structure A 10-1
10-2 Example Barge Tow Configurations 10-3
10-3 Channel to Liberty Existing Navigation Channel Maintenance Alignment 10-4
10-4 Anahuac Channel Existing Navigation Channel Maintenance Alignment 10-5
10-5 Channel to Liberty Overlay Historic and New Channel Maintenance Centerlines 10-6
10-6 Typical Navigation Channel Geometry Cross-Section 10-7
11-1 Channel to Liberty Segmented Areas for Dredged Material Volume Calculations 11-3

Tables

Page

1-1 Trinity River Navigation System Channels and Dimensions 1-2
2-1 Trinity River and Tributaries Navigation Project Authorizations 2-1
3-1 Channel to Liberty Commerce – Calendar Years 2012 to 2015 3-1
4-1 Dredging Quantities by Channel Reach 4-2
4-2 Real Estate Status and Ownership for Placement Areas along Channel to Liberty 4-3
4-3 Real Estate Status and Ownership for Placement Areas along Anahuac Channel 4-4
5-1 Historic Maintenance Dredging Costs by Channel Reach 5-1
9-1 List of Potential Shippers and/or Users 9-2
10-1 Predominant Barge and Tow Types, Characteristics, and Dimensions 10-2
10-2 Recorded Minimum Channel Widths for Tow Sizes 10-7
11-1 Initial Dredged Material Quantities by Channel Geometry Alternative 11-2
11-2 Future Maintenance Dredged Material Quantities by Channel Geometry Alternative Per Dredging Cycle 11-4
11-3 Total Future Maintenance Dredged Material Quantities by Channel Geometry Alternative 11-4
14-1 Initial Dredging Cost Estimates by Channel Geometry Alternative 14-1
14-2 Per Cycle Maintenance Dredging Cost Estimates by Channel Geometry Alternative 14-2
14-3 Total Maintenance Dredging Cost Estimates by Channel Geometry Alternative (20 years) 14-2
14-4 Total Maintenance Dredging Cost Estimates by Channel Geometry Alternative (50 years) 14-3

Acronyms and Abbreviations

ACE	Agricultural, Capital Goods, and Energy
Basin	Lower Trinity River Basin
BUS	Beneficial Use Site
BUS	Beneficial Use Sites
CLCND	Chambers-Liberty Counties Navigation District
CY	Cubic Yards
DMPA	Dredged Material Placement Area
EDC	Engineering During Construction
EPA	U.S. Environmental Protection Agency
ERDC	Engineer Research and Development Center
ERW	Electric Resistance Weld
FNI	Freese and Nichols, Inc.
ft	foot/feet
GIWW	Gulf Intracoastal Waterway
GNF	General Navigation Features
IWR	Institute for Water
LERRD	Land, Easements, Rights-of-Way, Relocation, and Disposal
LP	Line Pipe
M&N	Moffatt & Nichol
MLLW	Mean Lower Low Water
MLT	Mean Low Tide
Mob/Demob	Mobilization/Demobilization
NEPA	National Environmental Policy Act
O&M	Operation and Maintenance
OCTG	Oil Country Tubular Goods
PA	Placement Area
PAS	Planning Assistance to States
S&A	Supervision & Administration
TRA	Trinity River Authority
TWDB	Texas Water Development Board
USACE	U.S. Army Corps of Engineers
USC	United States Code
WRDA	Water Resources Development Act

1.0 INTRODUCTION

This Long-Term Port of Liberty Navigation Development Plan report has been prepared as part of a cooperative agreement executed on May 31, 2016, between the Trinity River Authority (TRA) and the U.S. Army Corps of Engineers (USACE) Galveston District under the Planning Assistance to States (PAS) Program. Sedimentation and associated shoals within the Lower Trinity River Basin currently hinder the use of the river for commercial navigation purposes (USACE, 2016a). This report provides an evaluation of the potential to reestablish commercial operations at the Port of Liberty in Liberty, Texas.

1.1 AUTHORITY

Section 22 of the Water Resources Development Act (WRDA) of 1974 (Public Law 93-51), as amended, provides authority to the USACE to assist states, local governments, Native American tribes, and other non-Federal entities in the preparation of comprehensive plans for the development and conservation of water and related land resources of drainage basins located within the boundaries of the state. Expenditures in any one state cannot exceed $5,000,000 in any one year, as referenced in 42 United States Code (USC) 1962d-16(c) (1). Section 319 of WRDA 1990 authorizes the USACE to establish, collect, and expend appropriate fees from states and other non-Federal public bodies to recover approximately 50 percent of the total cost of providing assistance under the PAS Program.

1.2 PROJECT AREA

The project area for this assessment is along the Trinity River from the Town of Liberty, Texas, to its mouth in the Trinity Bay (referred to as the Channel to Liberty) and the adjacent inactive dredged material and debris placement areas. The Channel to Liberty channel historically is a component of the Federally authorized three-channel, 47-mile Trinity River and Tributaries shallow draft navigation system, beginning with the existing authorized Anahuac Channel, which extends for 5.6 miles from the 6-foot (ft) depth contour in upper Trinity Bay to the mouth of Trinity River at Anahuac, Texas. From the mouth of the Trinity River, the Channel to Liberty proceeds for 41.4 miles along the meanders of the Trinity River to the Port of Liberty. The Trinity River and Tributaries navigation system also includes an existing authorized 9-ft depth channel (Channel to Smith Point) extending from the Houston Ship Channel along the east shore of the Trinity Bay to a point 1 mile south of Anahuac, Texas (USACE, 2012a). The USACE serves as the Federal agent responsible for channel maintenance, with the Chambers-Liberty Counties Navigation District (CLCND) acting as USACE's non-federal sponsor for maintenance of the three navigation channels (CLCND, 2017). Authorized dimensions for maintenance for each navigation channel are provided in Table 1-1.

Table 1-1
Trinity River Navigation System Channels and Dimensions (USACE, 2012a)

Channel	Depth (ft)*	Width (ft)
Channel to Liberty	6	100
Anahuac Channel	6	100
Channel to Smith Point	9	150

*Datum: Mean Low Tide (MLT) (USACE, 1975)

Channel depths displayed in Table 1-1 are referenced to the Mean Low Tide (MLT) Datum. Until recently, the USACE Galveston District has used MLT as the vertical datum control for navigation projects, but it is currently in the process of transitioning to the Mean Lower Low Water (MLLW) datum, with implications of changes to channel depths. As an example, for the Houston, Galveston, and Texas City navigation channels and berthing areas, datum conversion from MLT to MLLW has introduced channel depth changes ranging from 1 to 1.5 ft (USACE, 2015).

The locations of the Trinity River and Tributaries navigation channels are shown on Figure 1-1. Figure 1-2 displays the location of the Channel to Liberty navigation channel and its historic dredged material placement areas (DMPAs) and clearing and snagging operations debris placement areas. Figure 1-3 displays the location of the Anahuac navigation channel and its historic dredged material DMPAs.

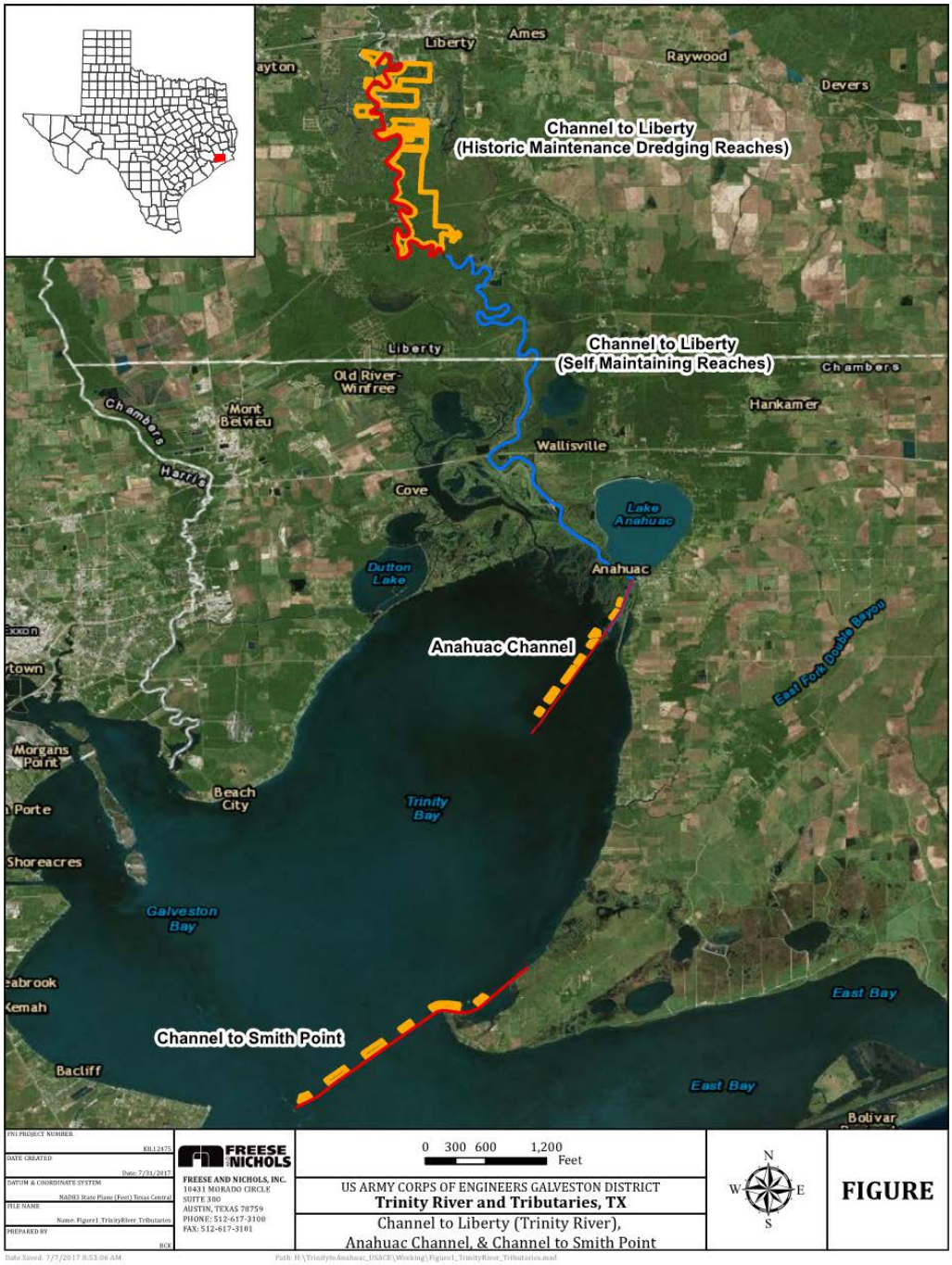

Figure 1-1: Trinity River and Tributaries Navigation Channels

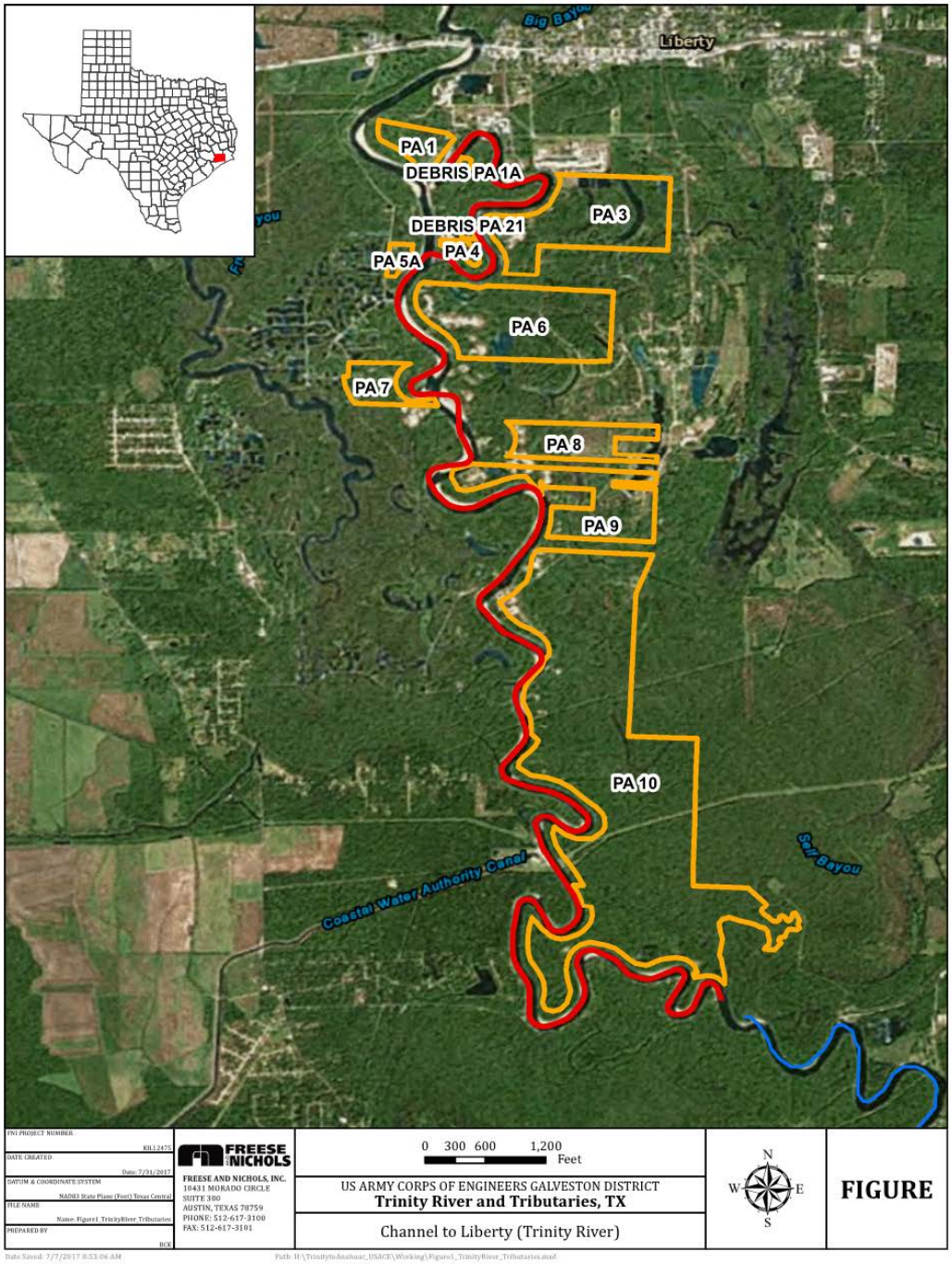

Figure 1-2: Channel to Liberty Navigation Channel and Historic DMPAs

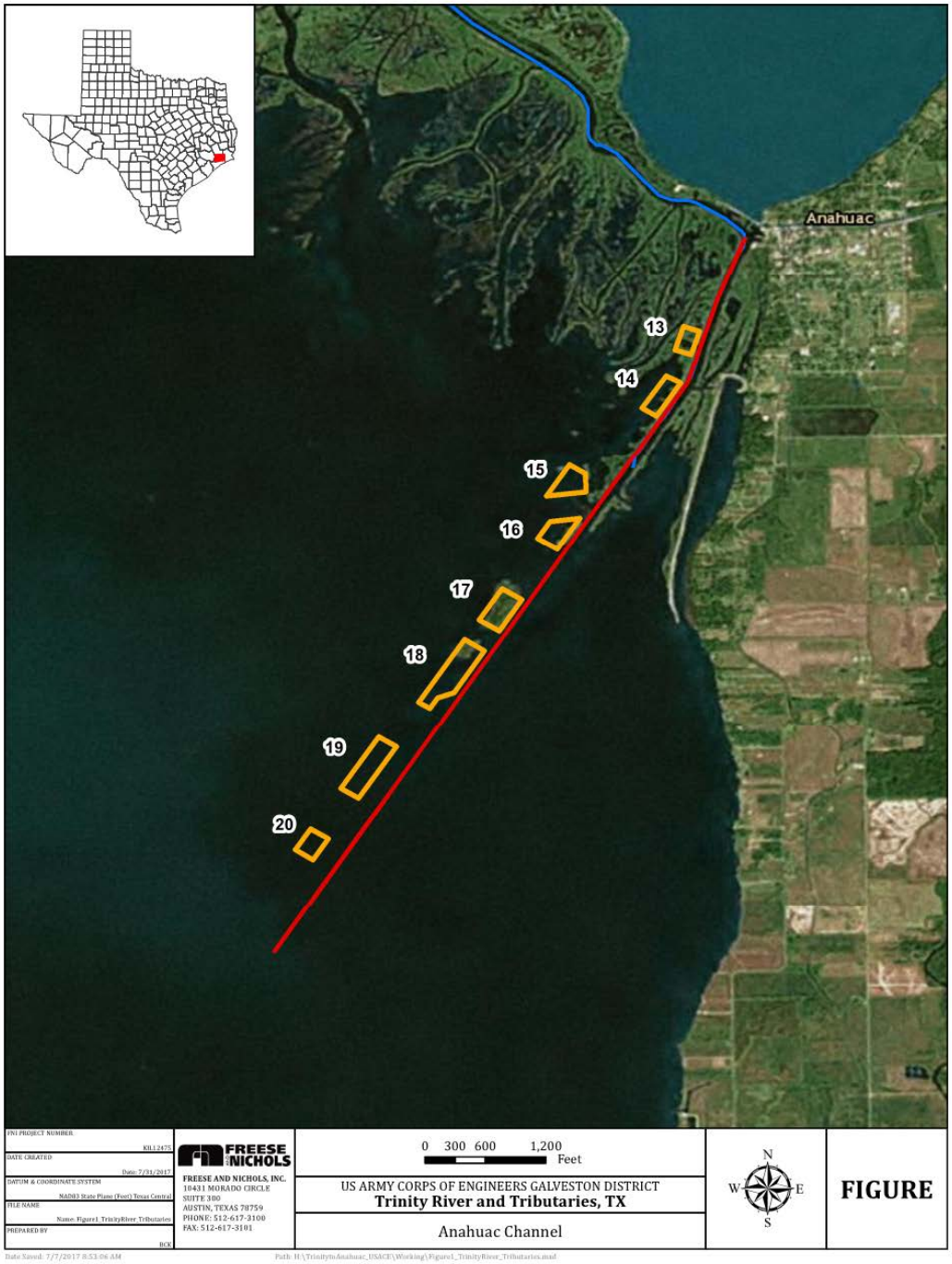

Figure 1-3: Anahuac Navigation Channel and Historic DMPAs

2.0 AUTHORIZATIONS & DE-AUTHORIZATIONS

2.1 PROJECT AUTHORIZATIONS

The Trinity River and Tributaries Navigation project and proposed project features have evolved through a number of authorizations and modifications dating back to 1878, when Congress first authorized the deepening of the channel at the mouth of the Trinity River and the removal of obstructions upstream to the town of Liberty, Texas. Subsequent actions included the construction of the Anahuac Channel, the Channel to Smith Point, and the Wallisville Lock and Reservoir (USACE, 2012b).

Table 2-1 summarizes the authorizations, deauthorizations, and project feature descriptions of the Trinity River and Tributaries Shallow-Draft Navigation System.

Table 2-1
Trinity River and Tributaries Navigation Project Authorizations

Dates	Project and Work Authorized	Documents	Act
18 JUN 1878	Deepening the channel at the mouth of the Trinity River and removing obstructions to Liberty. Dredge a channel 5 feet deep and 100 feet wide across the bar obstructing the entrance to the river.	Report of the Secretary of War, Two Houses of Congress, Volume II, Part I, 1878	45th Congress, 3rd Session, Act to Improve Rivers and Harbors, 1878
3 MAR 1905	Appropriations to improve Trinity River Anahuac Channel. No project dimensions were specified, therefore a channel 7 feet deep, 80 feet wide, and 12,238 feet long was dredged in 1905 (USACE, 2012b)	N/A	58th Congress, 3rd Session, River and Harbor Act, 1905
25 JUL 1912	Continue improvements to Trinity River and Anahuac Channel to obtain a depth of six feet between the mouth and Dallas by the construction of locks and dams.	Annual Report of Chief of Engineers, 1911	62nd Congress, Session II Chapter 253, 37 Stat. 101 - River & Harbor Act, 1912
22 SEP 1922	Reexamined project improvements for Trinity River with recommendation to provide a channel 6 feet deep, and of navigable width from mouth to Liberty by dredging and snagging, and abandon existing project for locks and dams.	Report of Chief of Engineers, 1921. House Document 989, 66th Congress, 3rd Session.	67th Congress, 2nd Session, Ch. 427, River & Harbor Act, 1922
2 MAR 1945	Improvements to Trinity River and Tributaries, Texas for navigation, flood control, and allied purposes.	House Document No. 403, 77th Congress, 1st Session	Public Law 79-14. 79th Congress, 1st Session - River & Harbor Act, 1945

Dates	Project and Work Authorized	Documents	Act
24 JUL 1946	Modification provides for a navigation channel 9 feet deep and 150 feet wide from Houston Ship Channel near Red Fish Reef along easterly shore of Galveston Bay with protective embankment to mouth of Trinity River near Anahuac.	House Document 634, 79th Congress, 2nd Session	Public Law 79-525, 2nd Session, River & Harbor Act, 1946
JUN 1962	Recommended a multiple-purpose channel improvement from the Houston Ship Channel to Fort Worth for inclusion in the comprehensive plan to provide for barge navigation from the Houston Ship Channel to Fort Worth and to provide discharge capacity. A system of navigation dams would provide a series of slackwater pools between major main stem reservoirs and navigation locks would lift and lower vessel traffic between navigation pools.	Comprehensive Survey Report on the Trinity River and Tributaries, USACE Fort Worth and Galveston, 1962	N/A
27 OCT 1965	Directive to reevaluate design for navigation and for the Chief of Engineers to submit to Congress a reevaluation based on current criteria.	House Document 276, 89th Congress, 1st Session.	Public Law 89-298, 89th Congress, 1st Session - Rivers and Harbors Act 1965
29 OCT 1981	Channel to Liberty, recommended a 200-foot bottom width multiple-purpose channel from the Houston Ship Channel to RM 45 (4.5 miles above Liberty). The channel would be initially excavated to a depth of 12 feet and maintained at an operating depth of 9 feet from the ship channel to the headwaters of Wallisville Lake. From this point to RM 45, the channel would have an average depth of 30 feet (8 to 10 feet less than the existing river).	General Design Memorandum, Project Memorandum No. 4, Trinity River Project, TX - Final Trinity River Project Report. 1981	N/A
26 JUN 2003	Deauthorized Unconstructed Channel to Liberty Improvements, Trinity River Project	Federal Register Notice, Vol. 68, No. 123, June 26, 2003	Public Law 99–662, 99th Congress, Water Resources Development Act of 1986, Section 1001(b)(2)

Dates	Project and Work Authorized	Documents	Act
25 MAR 2016	Deauthorized Trinity River and Tributaries, TX (Navigation Channel Above Liberty)	Federal Register Notice, Vol. 81, No. 58, March 25, 2016	Public Law 113-121, 113th Congress, Water Resources Reform and Development Act of 2014, Section 6001(d)

Additional authorizations included the construction of certain-named dam and lock features for the Trinity River project, as adopted by various River and Harbor Acts, dated June 13, 1902; March 3, 1905; March 2, 1907; June 25, 1910; July 25, 1912 (increased the channel depth to 6 ft); March 4, 1913; and July 27, 1916. The provisions of all these acts for improvements, as pertaining to lock and dam construction, were repealed by the River and Harbor Act of 1922 (USACE, 1932).

It is noted that in the Federal Register Notice of June 26, 2003, the deauthorization language of projects specifically states the following for "unconstructed" water resources projects:

> *"Section 1001(b)(2), 33 U.S.C. 579a(b)(2), requires the Secretary of the Army to submit to the Congress a biennial list of unconstructed water resources projects and separable elements of projects for which no obligations of funds have been incurred for planning, design or construction during the prior seven full fiscal years. If funds are not obligated within thirty months from the date the list was submitted, the project/separable element is deauthorized."*

The 2003 *Federal Register* published the deauthorization of the Channel to Liberty, Trinity River Project as governed by the stated language. However, the language directs the deauthorization to unconstructed projects and separable elements. The -6-ft MLT Channel to Liberty navigation channel has received appropriations for construction and subsequent maintenance by previous Congressional actions. Therefore, it is concluded that the -6-ft MLT Channel to Liberty navigation channel has not been deauthorized, but that all subsequent recommendations for unconstructed navigation improvements (widening and deepening) to the -6-ft MLT channel have been deauthorized.

3.0 HISTORY PORT OF COMMODITIES MOVEMENT

Historically, commodities transported by barge via the Channel to Liberty and the Anahuac navigation channels included agricultural chemicals, industrial chemicals, and iron and steel products. During the years of 1959 and 1960, over 1 million tons of down-bound liquid sulfur and up-bound shell were carried on barges on the Anahuac Channel. Liquid sulfur would have been transported on a portion of the lower Channel to Liberty as well, since Texas Gulf Sulphur Company operated its sulfur cut at River Mile 13.9. Tonnage throughput declined considerably thereafter, with only approximately 160,000 tons transported by 1983. A dramatic uptick in tonnage throughput occurred in 1989 with the movement by barge of approximately 320,000 tons of up-bound limestone as a new commodity (USACE, 2012b).

The transport of commodities on the Channel to Liberty had a similar mix of commodity movements since barge traffic and commodities for both Anahuac and Channel to Liberty navigation channels flowed from and to the town of Liberty, Texas. As with the Anahuac channel, a new product, limestone, was transported to Liberty in 1989 in the amount of approximately 285,000 tons (USACE, 2012b).

However, by the early to mid-1990s the only commerce reported on the Anahuac Channel was less than 1,000 tons of machinery. During this same period, the only commerce reported on the Channel to Liberty channel was 21,000 tons of nitrogenous fertilizer, sand, and gravel; 39,000 tons of waterway improvement materials; and under 1,000 tons of machinery in 1996 (USACE, 2012b).

Since 2006 there have been no reports of commerce on the Anahuac Channel, and no reports of commerce on the Channel to Liberty from 2006 to 2009 (USACE, 2012b). Recently, USACE's Institute for Water Resources (IWR) reported that a nominal tonnage of commodities was recently transported on the Channel to Liberty channel from 2012 to 2015 as listed in Table 3-1. Most likely this material from the 2012-2015 period was used by the USACE construction contractor to shore up the area near the I-10 bridge on the Wallisville project.

Table 3-1
Channel to Liberty Commerce – Calendar Years 2012 to 2015

Calendar Year	Total Tons (x1000)	Tons By Commodity (x1000)	
2012	30.3	26.0	Iron & Steel Scrap
		1.10	Iron & Steel Plates & Sheets
		3.20	Fabricated Metal Products
2013	12.5	11.0	Iron & Steel Scrap
		1.50	Fabricated Metal Products
2014	0.20	0.10	Iron & Steel Plates & Sheets
		0.10	Fabricated Metal Products
2015	16.0	16.0	Iron & Steel Scrap

Source: USACE IWR Waterborne Commerce of the United States Calendar Years 2012, 2013, 2014, and 2015, Part 2.

4.0 HISTORY OF DREDGE OPERATIONS

Throughout the over a century lifespan of the Trinity River and Tributaries Navigation Channel system, as many as 23 placement area sites have been utilized for depositing maintenance dredged materials from navigation projects. Federal involvement in the Trinity River and Tributaries Navigation Channel project started with the June 1878 authorization for dredging from the mouth of the Trinity River to the Port of Liberty. Following this authorization, subsequent River and Harbor Acts included the authorization for constructions of the Anahuac Channel in 1905, the Channel to Smith Point in the 1940s, and the construction of the Wallisville Lock and Reservoir in 1966 (USACE, 2012b).

Dredging and placement of dredged material originally started when the river was opened for navigation through dredge operations. The requirement for maintenance of the river is primarily the result of flood-caused shoaling. Additional sources of shoal material include sediments derived from upland erosion, river bed and bank erosion, contributions from sewer and drainage outfalls, industrial and municipal discharges, sediments deposited during previous dredging operations, and existing bay bottom sediments (USACE, 1975). During construction and maintenance of the authorized channels, dredged material from the river was removed and was placed adjacent to the channel, which created placement areas that served as protective embankments paralleling the channel and bay shoreline.

4.1 CHANNEL DREDGING – CHANNEL TO LIBERTY

Table 4-1 below outlines the dredging quantities by reach segmented by channel stations for the Channel to Liberty, Anahuac Channel, and Channel to Smith Point navigation channels. From the compiled data, assumptions regarding average annual maintenance volumes for each reach between channel stations and dredging frequencies were determined.

4.2 PLACEMENT AREAS – CHANNEL TO LIBERTY

The Channel to Liberty navigation channel historically has been supported by 12 upland unconfined placement areas adjacent to the Trinity River that receive maintenance dredged material and debris. There are currently no levees on the upland unconfined placement areas, and therefore, no engineering limit on the amount of material that may be placed within these designated placement areas. Receiving appropriate environmental resource agency approvals and acquiring the appropriate real estate easements are two controlling factors for availability of the sites for future activities to place dredged maintenance material. Although all easements on the upland unconfined placement areas are expired, it is understood through communication with the City of Liberty and the CLCND that requiring easements is possible through coordination with existing land owners (Freese and Nichols, Inc. (FNI), 2017).

Table 4-1
Dredging Quantities by Channel Reach (USACE, 2012b)

Reach	Stations		Total Dredge Quantities (CY)	Yearly Average (CY)	Dredged Quantities Per Cycle (CY)	Average Dredged Cycle (Years)
Channel to Liberty	-2+00 A	0+25 A	423,316	12,828	51,311	4.0
	0+00	25+00	230,772	6,993	61,539	8.8
	25+00	70+00	253,623	7,686	84,541	11.0
	70+00	135+00	520,462	15,772	86,744	5.5
	135+00	165+00	355,700	10,779	59,283	5.5
	165+00	175+00	157,994	4,788	14,363	3.0
	175+00	220+00	1,194,960	36,211	99,580	2.8
	220+00	260+00	386,064	11,699	38,606	3.3
	260+00	285+00	729,266	22,099	104,181	4.7
	285+00	375+00	1,057,051	32,032	105,705	3.3
	375+00	840+00	1,755,585	53,200	250,798	4.7
Anahuac Channel	55+00	0+00	97,000	1,796	113,167	63.0
	100+00	55+00	5,379	100	6,275.5	63.0
	130+00	100+00	1,599,901	29,628	622,184	21.0
	160+00	130+00	546,086	10,113	49,008	4.8
	190+00	160+00	1,053,814	19,515	49,178	2.5
	235+00	190+00	1,764,063	32,668	57,169	1.8
	280+00	235+00	149,173	2,762	3,955	1.4
	340+00	280+00	1,614,890	29,905	75,362	2.5
Channel to Smith Point	220+00	300+00	535,045	17,835	17,835	10.0
	300+00	375+00	337,763	11,259	11,259	15.0
	375+00	395+00	91,595	3,053	3,053	30.0

CY = cubic yards

Table 4-2 details the real estate status and ownership for each Channel to Liberty upland unconfined placement area.

Table 4-2
Real Estate Status and Ownership for Placement Areas along Channel to Liberty (USACE, 2012b)

PA	Type of PA	Underlying Fee Owner	Type of Easement
1	Upland Unconfined	Private Owners	EXPIRED
2	Upland Unconfined	Private Owners	EXPIRED
3	Upland Unconfined	Private Owners	EXPIRED
4	Upland Unconfined	Private Owners	EXPIRED
5	Upland Unconfined	Private Owners	EXPIRED
6	Upland Unconfined	Private Owners	EXPIRED
7	Upland Unconfined	Private Owners	EXPIRED
8	Upland Unconfined	Private Owners	EXPIRED
9	Upland Unconfined	Private Owners	EXPIRED
10	Upland Unconfined	Private Owners	EXPIRED
11	Upland Unconfined	United States of America	Owned in Fee
12	Upland Unconfined	Private Owners	EXPIRED

4.3 PLACEMENT AREAS – ANAHUAC CHANNEL

The Anahuac Channel has eight placement areas available for maintenance dredging. Of these eight placement areas, seven are open-water sites, and one is an upland unconfined placement area.

Historically, there has been no engineering limit on the amount of dredged maintenance material that can be placed in the placement areas paralleling the Anahuac Channel. The upland unconfined placement area (PA No. 13) has been described as “potentially having unlimited capacity for receiving dredged maintenance material” (USACE, 2012b).

Table 4-3 details the real estate status and ownership for each Anahuac Channel upland unconfined and open water placement area.

Table 4-3
Real Estate Status and Ownership for Placement Areas along Anahuac Channel (USACE, 2012b)

PA	Type of PA	Underlying Fee Owner	Type of Easement
13	Upland Unconfined	United States of America	Navigation Servitude
14	Open Water	United States of America	Navigation Servitude
15	Open Water	United States of America	Navigation Servitude
16	Open Water	United States of America	Navigation Servitude
17	Open Water	United States of America	Navigation Servitude
18	Open Water	United States of America	Navigation Servitude
19	Open Water	United States of America	Navigation Servitude
20	Open Water	United States of America	Navigation Servitude

4.4 PLACEMENT AREAS - CHANNEL TO SMITH POINT

Three open water placement areas (PAs 21, 22, and 23) have historically been utilized for maintenance dredged material along the Channel to Smith Point navigation channel.

From 1998 to 2003, four Beneficial Use Sites (BUS) were established to receive dredged material and involved converting the PAs to BUS. In 1998, BUS 3 was established between PAs 21 and 22 during an emergency dredging of the channel. For the 2003 dredging cycle, BUS 1 replaced PA 23 and BUS 2 replaced PA 22. Following the 2003 dredging and placement cycle, BUS 4 was established and located northeast of BUS 1 as a mitigation site designed as an oyster reef pad to replace oyster reefs damaged by the 2003 dredge operations.

In 2008, Hurricane Ike damaged BUS 2's confining geotextile tubes. Therefore, in order to use BUS 2 in the future, repairs or replacement to the retaining structures will be required (USACE, 2012c).

5.0 HISTORIC MAINTENANCE DREDGING COSTS

Historic maintenance dredging costs for the Anahuac Channel and the Channel to Liberty reaches were obtained from the USACE Galveston District Dredge Database (database) for the Trinity River and Tributaries (Table 5-1). Due to the structure of the database, some information could not be decoupled for the two reaches and was left as combined data (Anahuac Channel & Channel to Liberty). In addition, the Channel to Smith Point data is embedded with data for dredging of the Houston Ship Channel; therefore, the Channel to Smith Point historic dredged material volumes is not readily available and not reported.

Table 5-1
Historic Maintenance Dredging Costs by Channel Reach (USACE, 2016c)

Channel Reach	Fiscal Year	Contract Type	Total Quantity of Dredge Quantity (CY)	Total Cost of Project	Total Cost Per Cubic Yard
Anahuac Channel	1964	Maintenance Dredging	253,874.00	$50,667.48	$0.22
	1967	Maintenance Dredging	187,300.00	$37,693.67	$0.20
	1968	Maintenance Dredging	115,125.00	$44,061.24	$0.21
	1969	Maintenance Dredging	70,456.00	$45,642.70	$0.33
	1974	Maintenance Dredging	277,278.00	$71,651.13	$0.16
	1975	Maintenance Dredging	148,513.00	$108,774.64	$0.45
	1980	Maintenance Dredging	74,137.00	$98,658.02	$0.58
	1982	Maintenance Dredging	96,775.00	$103,435.03	$0.61
	1984	Maintenance Dredging	201,696.00	$316,781.60	$0.93
	1992	Maintenance Dredging	394,859.00	$1,673,648.27	$2.39
	2003	Maintenance Dredging	154,137.00	$215,499.15	$0.82

Channel Reach	Fiscal Year	Contract Type	Total Quantity of Dredge Quantity (CY)	Total Cost of Project	Total Cost Per Cubic Yard
Anahuac Channel & Channel to Liberty	1966	Maintenance Dredging	103,853.00	$44,867.40	$0.25
	1970	Maintenance Dredging	208,657.00	$110,280.48	$0.38
	1971	Maintenance Dredging	350,018.00	$95,828.36	$0.18
	1972	Maintenance Dredging	222,977.00	$108,099.16	$0.36
	1977	Maintenance Dredging	503,762.00	$719,271.50	$1.06
	1985	Maintenance Dredging	842,974.00	$2,630,421.04	$2.44
	1990	Maintenance Dredging	-	$1,852,663.45	$1.97
	1994	Maintenance Dredging	249,700.00	$1,372,736.10	$1.88
	2000	Maintenance Dredging	97,000.00	$622,604.14	-
Channel to Liberty	1968	Maintenance Dredging	1,259,000.00	$522,840.52	$0.33
	1967	Maintenance Dredging	13,700.00	$10,055.10	$0.52
	1969	Maintenance Dredging	673,000.00	$263,155.58	$0.36
	1970	Maintenance Dredging	313,219.00	$21,728,083.00	$0.58
	1974	Maintenance Dredging	540,123.00	$423,539.52	$0.68
	1987	Maintenance Dredging	155,179.00	$193,047.52	$0.92
	1969	Maintenance Dredging	131,461.00	$586,928.55	$2.07
	1998	Maintenance Dredging	52,255.00	$229,498.00	$2.20

6.0 HISTORIC DREDGE MATERIAL QUALITY

Trinity Bay is bounded by a modern delta system of the Trinity River on the northeast, Pleistocene fluvial-deltaic systems on the northwest and southeast, a marsh system northeast of Smith Point, and a Pleistocene barrier system forming the higher area northeast of Smith Point. The Trinity River valley in the vicinity of the project is composed of alluvial materials of Quaternary origin consisting of sands, clays, silts, or other mixtures. The alluvial materials have depths of 30 ft and greater and overlie a heavy clay formation of Pleistocene Age (USACE, 1975).

Historically, maintenance dredged material in the Channel to Liberty reach has been composed of poorly graded white sand with small amounts of gravel. These sediments are relatively free of silts, although silty clays are predominant downstream throughout the Anahuac Channel (USACE, 1975).

Within the Anahuac navigation channel, chemistry test results of sediments sampled for historic dredged material evaluation revealed some of the sediment samples contained volatile solids, nitrogen compounds, oil and grease, mercury, and zinc (USACE, 1975). For Channel to Liberty, sediment and water were last sampled for a maintenance dredging project in 1994. The samples were tested for a variety of heavy metals, pesticides, and organic compounds and were found to be below detection limits or within acceptable concentrations. In addition, the grain size analysis of the samples showed that sediments in the channel contain a large percentage of sand, which are less likely to bind contaminants (USACE, 1994).

A potential environmental effect associated with dredging is the possible resuspension of the pollutants associated with the shoaled material. Due to the high degree of development around the Galveston Bay system, nearly all the channels contain polluted sediments, and nearly all sediments taken from anywhere in the bay system contain elevated level of pollutants. As a result, pollutant resuspension is most likely unavoidable, particularly with the Anahuac Channel.

Prior to performing future dredging activities within the Channel to Liberty and Anahuac navigation channels, a comprehensive sediment and water quality sampling and testing program may be necessary to ascertain the dredged material's physical and chemical quality, and to evaluate the dredged material suitability for disposal within open water and unconfined upland environments. It is anticipated that the need for pre-dredge sediment and water quality sampling and testing will be determined by the USACE in consultation with the US Environmental Protection Agency (EPA).

7.0 CURRENT RIVER GEOMETRY

The Lower Trinity River in Texas flows 180 river kilometers from Livingston Dam in Livingston, Texas, to the Trinity River delta. The Channel to Liberty reach from Liberty, Texas, to Moss Bluff has historically required maintenance dredging in order to maintain the authorized channel depth of 6 ft MLT and a width of 100 ft. Large sand bars and channel bends dominate this section of the channel. High rates of lateral migration persist downstream until the transport of sand and gravel is influenced by the backwater hydraulics connected with the shoreline at Trinity Bay (Smith, 2012). This downstream section from Moss Bluff to Anahuac, Texas, is known to be self-maintaining and is comprised of very small point bars and has the deepest flows and lower rates of channel migration in comparison to the more northern reaches of the Lower Trinity River.

A bathymetric survey on the Trinity River from Liberty, Texas, to the river mouth and into the Anahuac navigation channel was performed by TRA and the TWDB in January 2017. The surveys were conducted at a coarse scale and consisted of three-longitudinal survey transects (center, 1/3 left, and 1/3 right), with a minimum of four cross-section survey transects per river mile. Findings of the survey are reported in TRA (2017a; Appendix A). Bed elevations derived from the survey are presented on Figures 7-1 and 7-2 for the Trinity River from Liberty to the river mouth, and on Figure 7-3 for the Anahuac navigation channel.

Results of the survey were used to estimate future dredged material volume requirements for two channel geometry alternatives as presented in Section 11.0 and Appendix B (RPS Group, 2017) of this report.

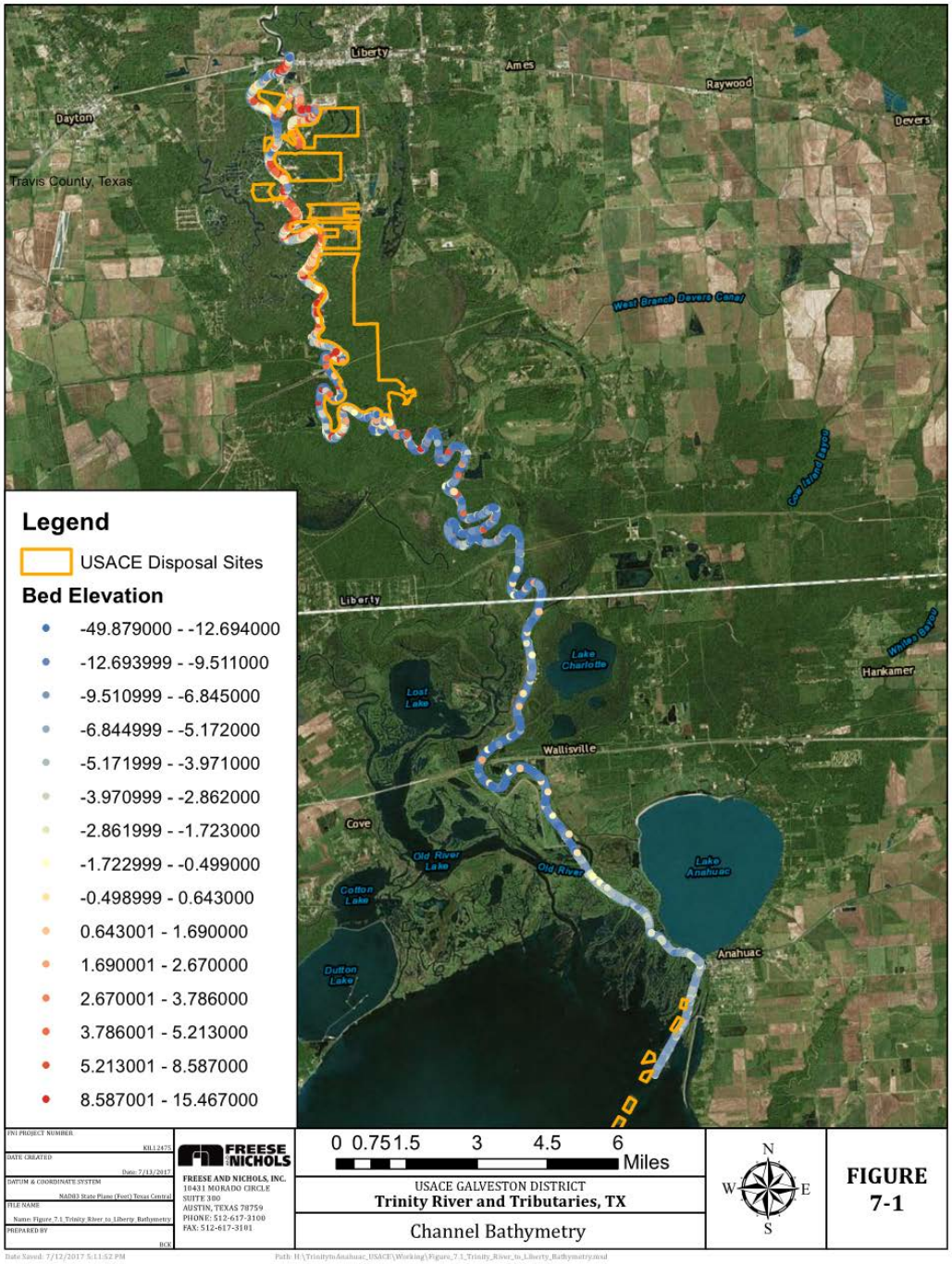

Figure 7-1: Channel to Liberty and Anahuac Channel Bathymetry

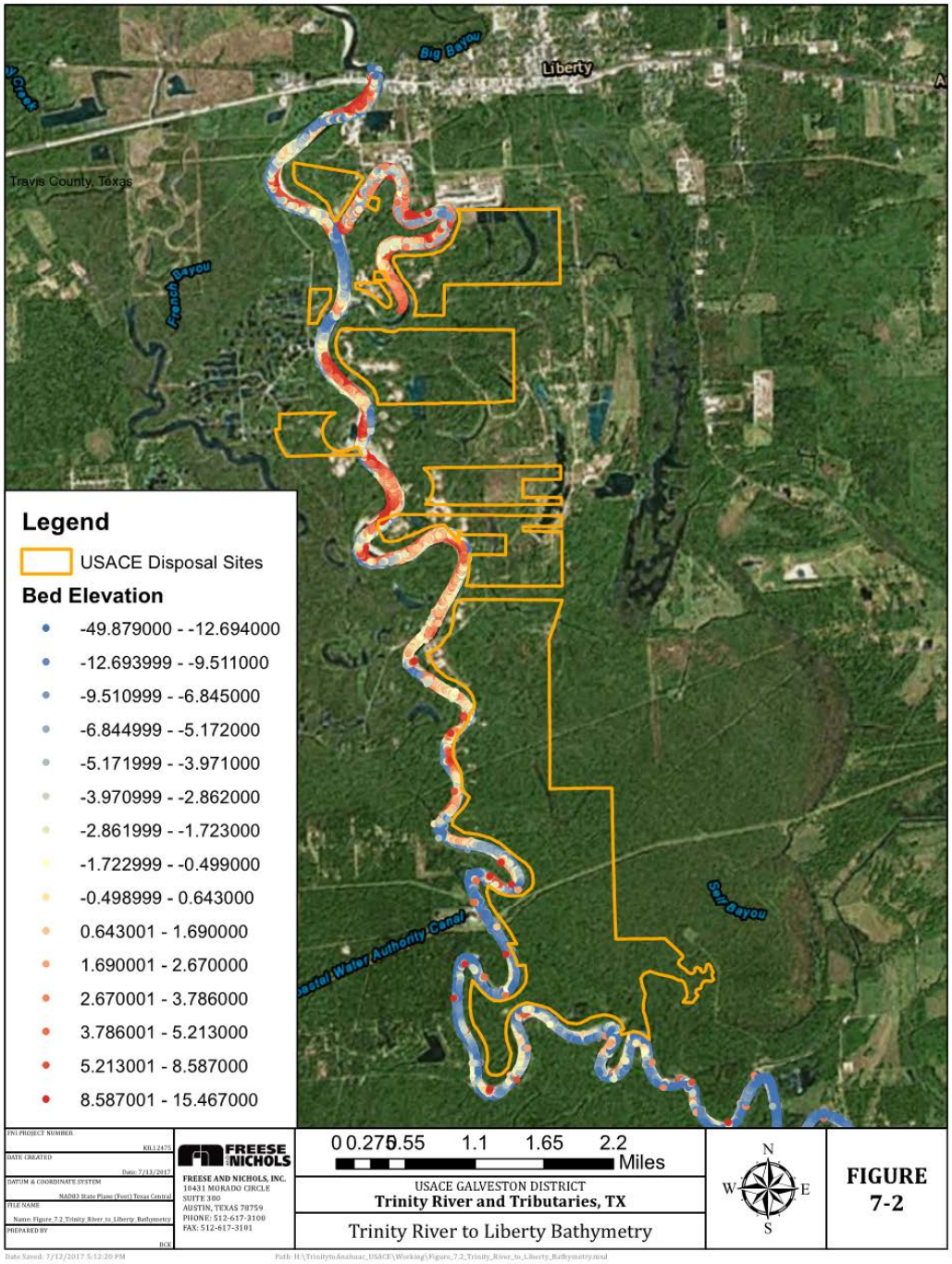

Figure 7-2: Channel to Liberty Bathymetry

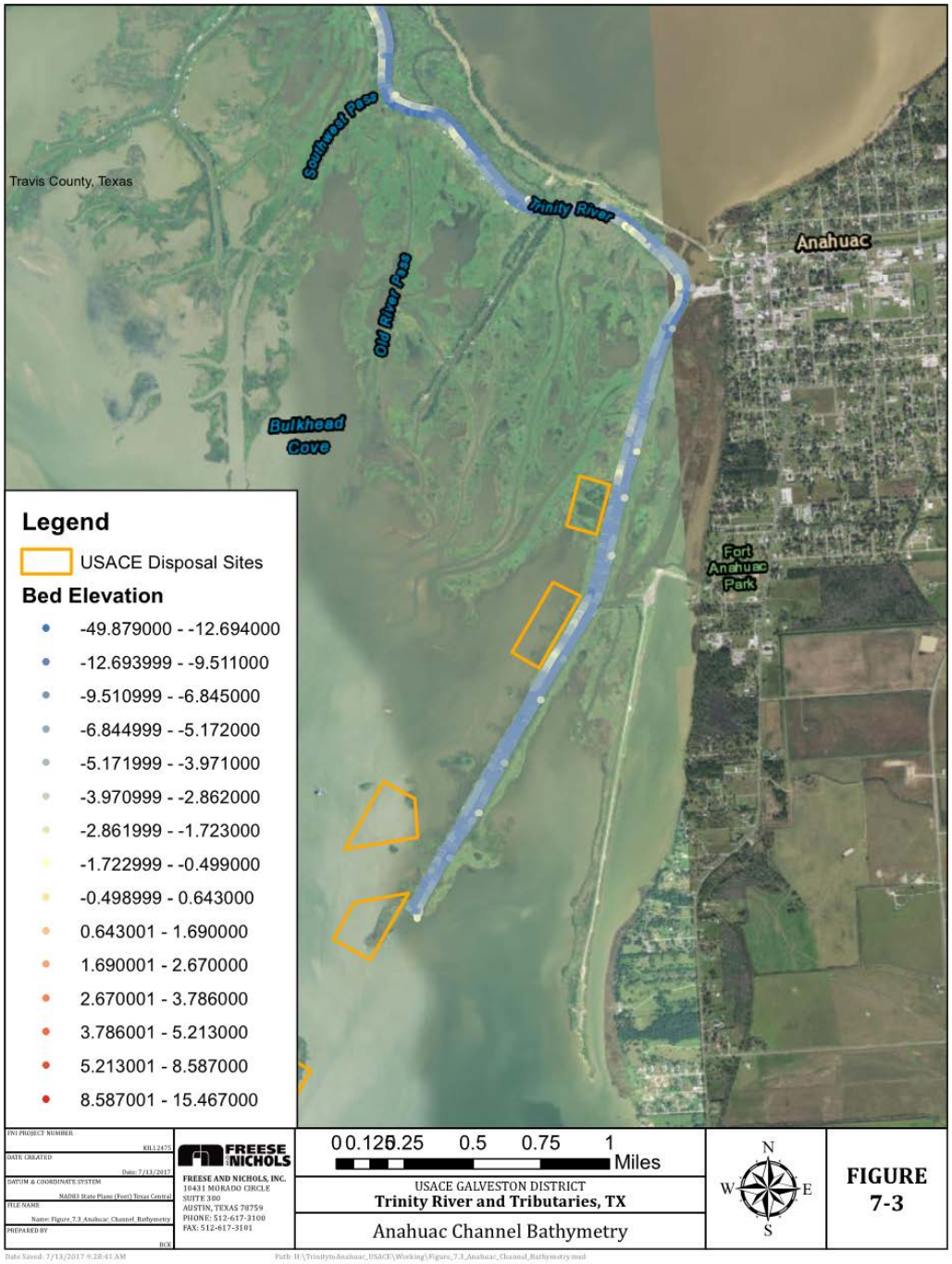

Figure 7-3: Anahuac Channel Bathymetry

8.0 SEDIMENTATION RATE ANALYSIS

Sedimentation rate analyses for the Channel to Liberty and Anahuac navigation channels will be provided by the USACE Galveston District in a separate report as one of its technical contributions to the Long-Term Port of Liberty Navigation Development Plan PAS study.

9.0 SUMMARY REVIEW OF PORT OF LIBERTY MARKET ANALYSIS

Manufacturing activity in the Lower Trinity River Basin (Basin) is concentrated in a few large industries, including fabricated metal products, chemicals, non-metallic mineral products, and wood products. These industries, with the exception of wood, serve to support and/or supply the oil and gas sector. Additionally, the presence of underground salt domes offers the potential for oil and natural gas storage (Moffatt & Nichol (M&N), 2015).

The Trinity River and Tributaries navigation system could potentially serve as a gateway for barge traffic at Liberty, Texas, by offering substantially lower transportation costs on a per-ton-basis, as compared to movement of cargo by rail or truck. A preliminary comparative cost analysis performed by M&N (2015) compared the cost of shipping a ton of agricultural product from Liberty via barge versus truck to some of the major Gulf Coast ports. Based on this analysis, the cost of shipping a ton of agricultural product to New Orleans via a 1-barge tow or 3-barge tow in-lieu of goods carried on trucks would offer an estimated per ton-savings of $8.25/ton or $19.09/ton, respectively.

Furthermore, deeper and wider channels for the Trinity River and Tributaries navigation system would improve estimated transportation cost savings by reducing light loading and other operational inefficiencies, and attract future waterborne transport of products to support the oil and gas industry and demands for coastal construction material.

9.1 FUTURE WATERBORNE COMMERCE PROSPECTS

Communications with the City Manager of Liberty, Texas (FNI, 2017) and representatives of the Trinity River Authority have resulted in identifying a number of prospective users of commercial barge transportation on the Trinity River. Among the identified potential users are: (1) Boomerang Tube (successor to National Pipe and Tube facility) at Liberty, Texas; (2) Domino Sand Services; and, (3) Baze Chemical. Descriptions of these entities are summarized below:

- Boomerang Tube, headquartered in St. Louis, makes Oil Country Tubular Goods (OCTG) and Line Pipe (LP). The firm has capacity for 360,000 tons of Electric Resistance Weld (ERW) OCTG and LP annually. Inbound steel receipts are primarily from domestic mills consisting of hot rolled steel coils. Inbound and outbound receiving and shipping capabilities are by truck and rail either direct or through a transload location near Liberty. Local estimates are that Boomerang could provide upwards of 400,000 tons of outbound cargo, steel casing and tubing, annually.

- Domino Sand Services has a silica sand operation near Liberty with production capability of 600,000 tons annually. Currently sand is trucked but the firm declares that it can coordinate logistics to ship hydraulic fracturing sand by rail to Permian Basin and other fracturing mining locations. There is a long -term development plan that includes transporting sand by truck, rail

and barge. The fracturing sand processing facility is stated to be capable of 90,000 tons per month at full capacity.

- Baze Chemical is a multi-plant producer of chemicals with locations at Odessa, TX, Palestine, TX, Liberty, TX and New Iberia, LA. Potential barge volumes are unknown at this time.

The area contiguous to Port of Liberty is renowned for sand and rock extraction. Trinity Materials has multiple quarries in Texas including a facility in Cleveland, Texas that is about 32 highway miles from Liberty. The relatively short highway distance would enable barge shipments to be economically feasible in contrast to most of the other Trinity Materials quarries that are located between 200 and 300 miles from Liberty. The Cleveland facility produces concrete sand, masonry sand, pea gravel and oversize rock. Trinity River Authority representatives believe that rock from adjacent quarries such as Cleveland could be used as "waterway improvement materials" for the maintenance and protection of the Gulf Intracoastal Waterway (GIWW). Other potential commodities include the barge transport of drilling and production chemicals and agricultural products, such as rice.

Table 9-1 provides a list of additional potential shippers and/or users and products of the Trinity River & Tributaries navigation system, if the channels were to be restored and improved for barge traffic.

Table 9-1
List of Potential Shippers and/or Users (TRA, 2017b)

Company	City	State	In/Out Bound	Product
Trinity Materials	Dallas	Texas	Out	Sand
Hannas Bend Aggregate	Liberty	Texas	Out	Sand
Liberty Ranch Sand Mine	The Woodlands	Texas	Out	Sand
David Parker	Dayton	Texas	Out	Sand
Insteel Wire Production	Dayton	Texas	In/Out	Steel
Sumiden Wire Production Corp	Dayton	Texas	In/Out	Steel
Global Tubing	Dayton	Texas	In/Out	Steel
Hiller Carbon	Tampa	Florida	In/Out	Carbon
Huntsman Corporation	Dayton	Texas	In/Out	Chemical
CMC Railroad Inc	Dayton	Texas	In/Out	Trans Load
Boomerang Tube	Liberty	Texas	In/Out	Steel
Quickrete	Liberty	Texas	In	Sand
Liberty Forge	Liberty	Texas	In/Out	Steel
ARG	Raywood	Texas	Out	Agricultural
Baze Chemical	Liberty	Texas	In/Out	Chemical
Moss Bluff Gas Storage	Liberty	Texas	Out	Liquid Natural Gas

Collectively, transportation of these products and tonnage by barge should provide for substantial national economic benefits. Direct interviews of the potential shippers and/or users, as listed in Table 9-1, will be necessary to develop a more complete analysis of potential cargo movement forecasts. These

interviews would also a provide a better refined estimate of the potential transportation cost saving should commodities movement shift to barge from trucks and rail transport.

9.2 CONSIDERATIONS FOR TRANSPORATION COST SAVINGS

Barge freight movements, to and from the Port of Liberty, Texas, will have to transit the navigable portion of the Trinity River, a distance of 41.4 miles for the Channel to Liberty channel, and 5.6 miles for the Anahuac Channel. Barge movements beyond the Trinity River will move in efficient size tows on the Gulf Intracoastal Waterway (GIWW) and Mississippi River System. Although, barge tow sizes and equipment utilization for the Trinity River and Tributaries navigation system are unknown at this time, the following narrative provides a general overview of the most salient factors that could affect barge freight costs for the navigation system.

Barge freight cost savings compared to alternative transportation modes, typically truck and rail, will be a function of the efficiency of barge tows. Tow costs are predominantly a function of tow size with respect to number and sizes of barges. The greater the number of barges per tow the lower the average total cost per barge. Conversely, the smaller the number of barges per tow the greater the average total cost per barge.

Another important tow cost factor is tow speed. The slower the tow speed because of navigation constraints, such as curves and waterway speed restrictions, the higher the relative tow cost. Equipment utilization is another major potential cost factor. The potential cost savings is constrained by the availability of available cargo and suitable barges. In order to achieve the best cost savings there must be sufficient quantities and types of cargo for particular barges such that the barges are loaded inbound for receipts and outbound for shipments at the point of discharge. In some instances, reloading of barges at or near the point of discharge is not practical, e.g. specialty tank barges for particular chemicals. However, most dry cargo river hopper type barges can handle an array of complimentary dry bulk cargoes such as inbound receipts of scrap steel and outbound movements of rock. The ability to reload barges at, or close to, the point of discharge is an important factor in the determination of equipment utilization and corresponding freight rates.

These factors, tow size (barges), tow speed, and frequency of loaded inbound and outbound barges using different cargoes, have a significant impact on tow costs per barge and consequently barge freight rates. Another important factor is the amount of cargo per barge. Standard river barges load to depths of 9-ft feet. The 9-foot depth will allow between 1,500 to 1,600 tons of dry bulk cargo per barge, depending on the configuration of the barge with respect to box or rake. However, other inland waterways such as the GIWW can accommodate barge depths upwards of 12-ft. The 12-foot depth will allow maximum dry cargo tonnages per barge, about 2,000 tons.

The current authorized depth of the Channel to Liberty and Anahuac navigation channels is 6-ft MLT. Although the river is reported to be predominantly naturally deeper in most stretches of the lower portion of the Trinity River, the lowest maintained depth will constitute the constraint on the maximum depth of

loaded barges. At a 6-foot depth channel with no allowance for under keel clearance, the typical 1,500 ton capacity hopper barge would load to about 1,000 tons. If there is over dredging for advanced maintenance beyond the authorized channel depth, such that greater barge depths would be able to transit the channel after maintenance dredging, cargo volumes could increase. For example, a 7-foot channel would allow for about 1,100 cargo tons per barge. An 8-foot depth channel would allow for about 1,300 cargo tons per barge.

The effect of light loading barges is that barge transportation costs per ton increase in direct proportion to the extent of the difference between a fully loaded barge and a light loaded barge. For example, a light loaded barge carrying 1,000 cargo tons would cost approximately 33 percent more per ton than a fully loaded barge with 1,500 cargo tons, other things equal.

These factors, tow size, tow speeds, loaded inboard empty outbound cycle of barges versus loaded and loaded cycles of barges and cargo tons carried per barge as a function of channel depth, can alter barge freight costs ranging from as much as $20 per ton cheaper than competitive rail or higher than competitive rail. Further development of potential Channel to Liberty and Anahuac navigation channel barge cargo will be required to better refine these factors in order to determine barge freight rates and corresponding freight cost savings compared to other modes of transportation.

9.3 ADDITIONAL BENEFITS

Channel improvements to the Trinity River and Tributaries navigation system, beyond the currently authorized channel geometry, would result in additional benefits by improving navigation safety through wider channels allowing for better barge tow maneuverability; lowering carbon emissions within the Basin by reducing truck and rail traffic; and, providing for ecosystem restoration through the beneficial use of dredged material though channel maintenance. An alternatives array of channel geometries should be formulated to perform an optimization analysis of net benefits using a preferred barge tow design configuration.

10.0 NAVIGATION CHANNEL GEOMETRY

10.1 WALLISVILLE LOCK AND DAM COMPLEX

10.1.1 Introduction

Near the mouth of the Trinity River at Wallisville, Texas, lies the Wallisville Lake and Dam Complex, which is an approximate 23,000-acre multiple purpose complex designed to prevent saltwater intrusion up the Trinity River in order to conserve fresh water and to protect fresh water intakes for local municipalities, including the City of Houston and Chambers County. Protected freshwater included irrigation intake structures for rice production. Federal authorization of the Wallisville Lake complex was provided by the Rivers and Harbors Act of 1956, 1946, and 1962, and the Supplemental Appropriations Act of 1983 (USACE, 2012d). As shown on Figure 10-1, the complex consists of a set of levees along the east and west banks of the Trinity River in conjunction with a dam across the river, a navigation lock and engineered navigation channel, a gated control structure on the main stem of the river, Structure A flow control weir in the Cut-off near Pickett's Bayou, Structure B at the head of Lost River, and parks and recreation areas. It is owned by the United States Government and operated by the USACE to provide for five purposes: navigation, salinity control, water supply, fish and wildlife enhancement, and recreation.

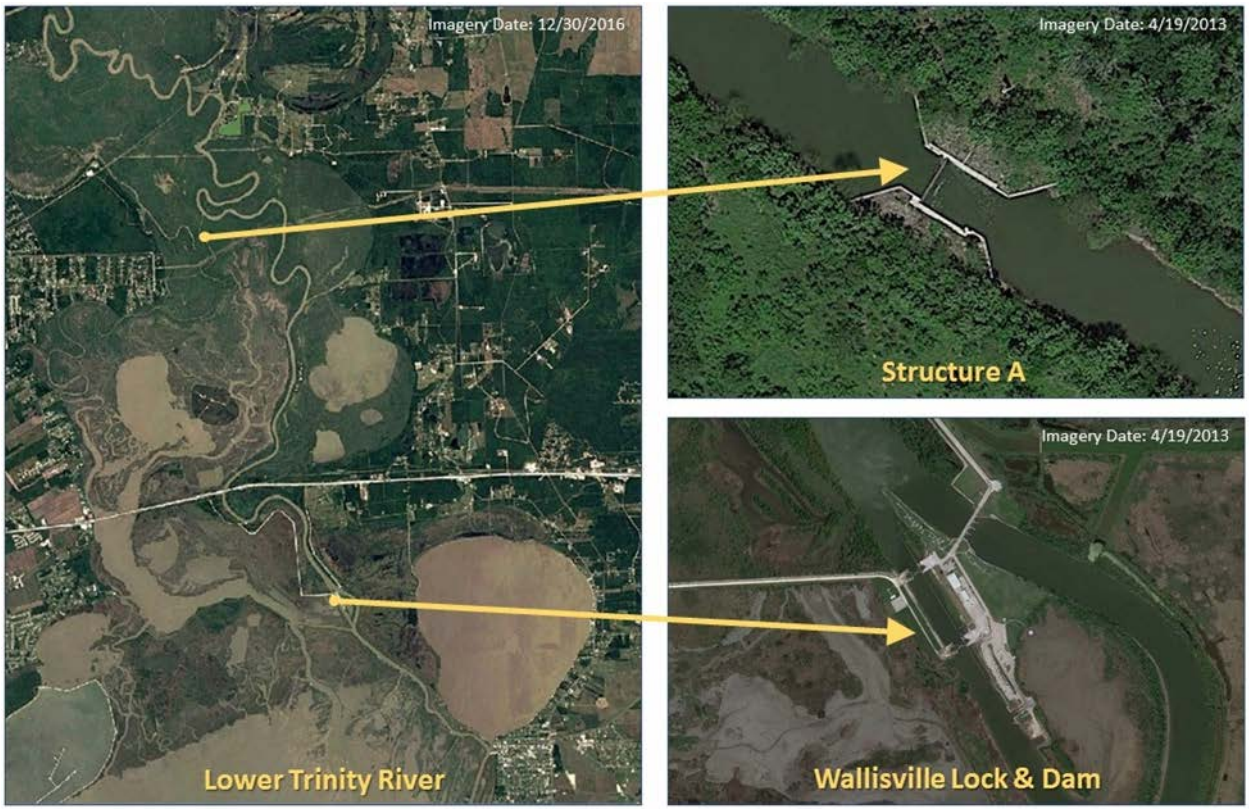

Figure 10-1: Wallisville Lock & Dam Complex and Structure A (Source: Google Earth)

10.1.2 Navigation Lock and Salinity Barrier Structure

The navigation lock and control structure is a four-gate concrete saltwater control structure made up of two sets of paired wood and steel gates.

The navigation lock chamber between the two sets of gates is approximately 600 ft long and 84 ft wide with a sill depth of 16 ft for commerce and small boating use (USACE, 2016c). The entire concrete dam structure, including the bridge, is 224 ft wide in the river and stretches 324 ft long.

10.1.3 Lock Operations

The navigation lock and salinity control structures are normally open during flood events to allow flow to pass through the structures. During the dry season, the structures are normally closed to control salt water intrusion. The structures are operated periodically in the dry season to maintain desirable water levels in the cypress wetlands and to flush salt water away from the structures. The lock gates are operated daily to prevent sediment accumulation in the lock gate structure that would prevent the locks from closing and as needed for navigation purposes (Engineer Research and Development Center (ERDC), 2015).

A flow-control weir, Structure A, is located on the Old River Cut Off channel near Moss Bluff and diverts flow from the Trinity River into the Old River. The structure can operate as a weir at low flows. Additionally, it can be opened for free flow during flood events and at extreme flood levels when the flows come out of banks and completely overtop the structure (ERDC, 2015).

10.2 BARGE TOW DESIGN CONFIGURATION

Barge tow configurations consisting of a tow boat pushing one or more barges and are typical for transporting commodities along inland waterways. Table 10-1 displays the variation of characteristics and dimensions of the predominant barge and tow types.

Table 10-1
Predominant Barge and Tow Types, Characteristics, and Dimensions (USACE, 1980)

Equipment Type	Length (ft)	Breadth (ft)	Draft (ft)	Capacity (tons)
Open Hopper Barges				
Standard	175	26	9	1,000
Jumbo	195	35	9	1,500
Super Jumbo	250-290	40-52	9	2,500-3,000
Covered Hopper Barges				
Standard	175	26	9	1,000
Jumbo	195	35	9	1,500

Equipment Type	Length (ft)	Breadth (ft)	Draft (ft)	Capacity (tons)
Chemical & Petroleum Barges	150-300	50-54	9	1,900-3,000
Towboats	65-160	24-50	5-9	

*Fully Loaded Draft

Barge and tow design configurations are controlled by the dimensions of the Wallisville Navigation Lock Chamber and the alignment of the river. Historically, commodities were transported on the Trinity River and Tributaries Navigation System using tows consisting of one to two barges, similar to first three example configurations as shown on Figure 10-2.

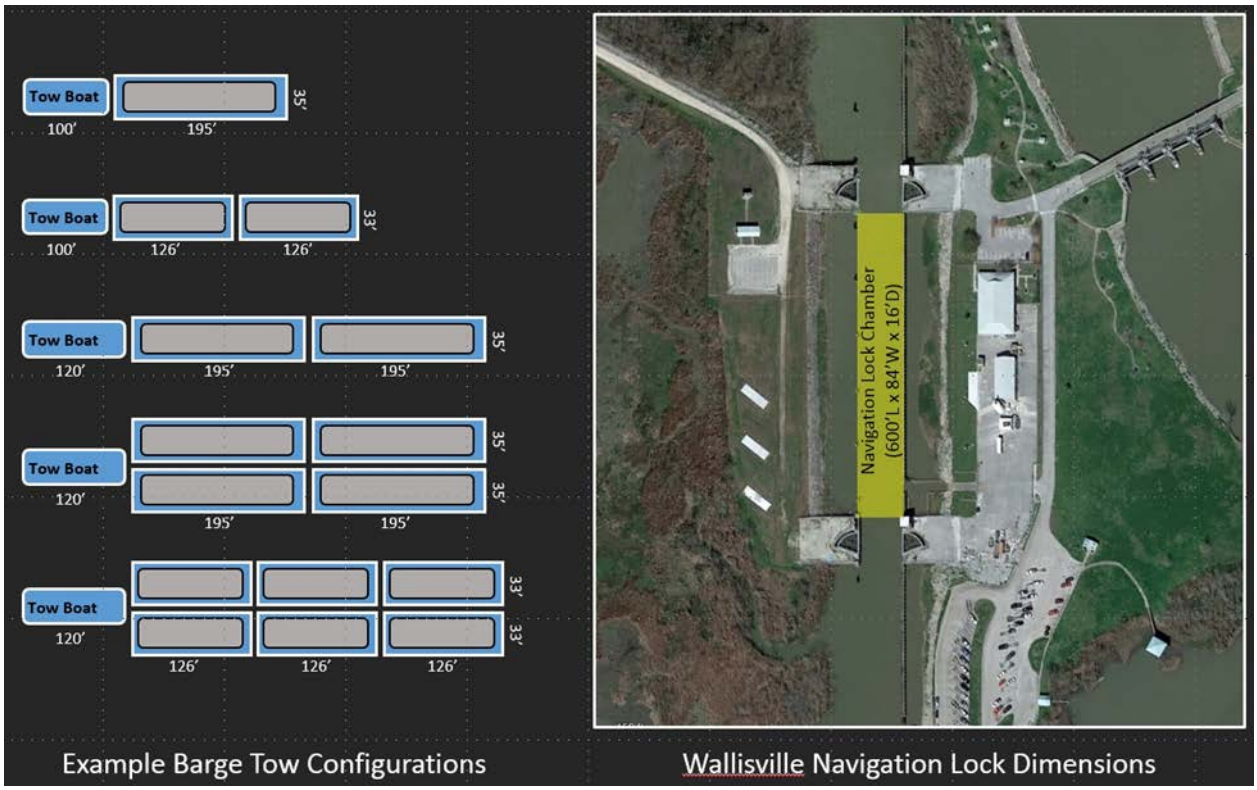

Figure 10-2: Example Barge Tow Configurations

10.3 NAVIGATION CHANNEL GEOMETRY & ALIGNMENT

The general dimensions of the Channel to Liberty and the Anahuac Channel existing navigation channels is 6 ft deep MLT by 100 ft wide (USACE, 2012b). Figures 10-3 and 10-4 depict the channel alignments maintained by USACE Galveston through the last recorded maintenance dredging episodes: 1994 for the Channel to Liberty navigation channel (from Stations 0+00 to 847+77.40), and 2011 for the Anahuac navigation channel (from Station 0+00 to the -6-ft daylight contour, approximately at Station 330+00).

Channel to Liberty downstream of Station 847+77.40 to the mouth of Trinity River is typically naturally deeper than -6-ft MLT; therefore, maintenance dredging requirements for this reach have been minimal.

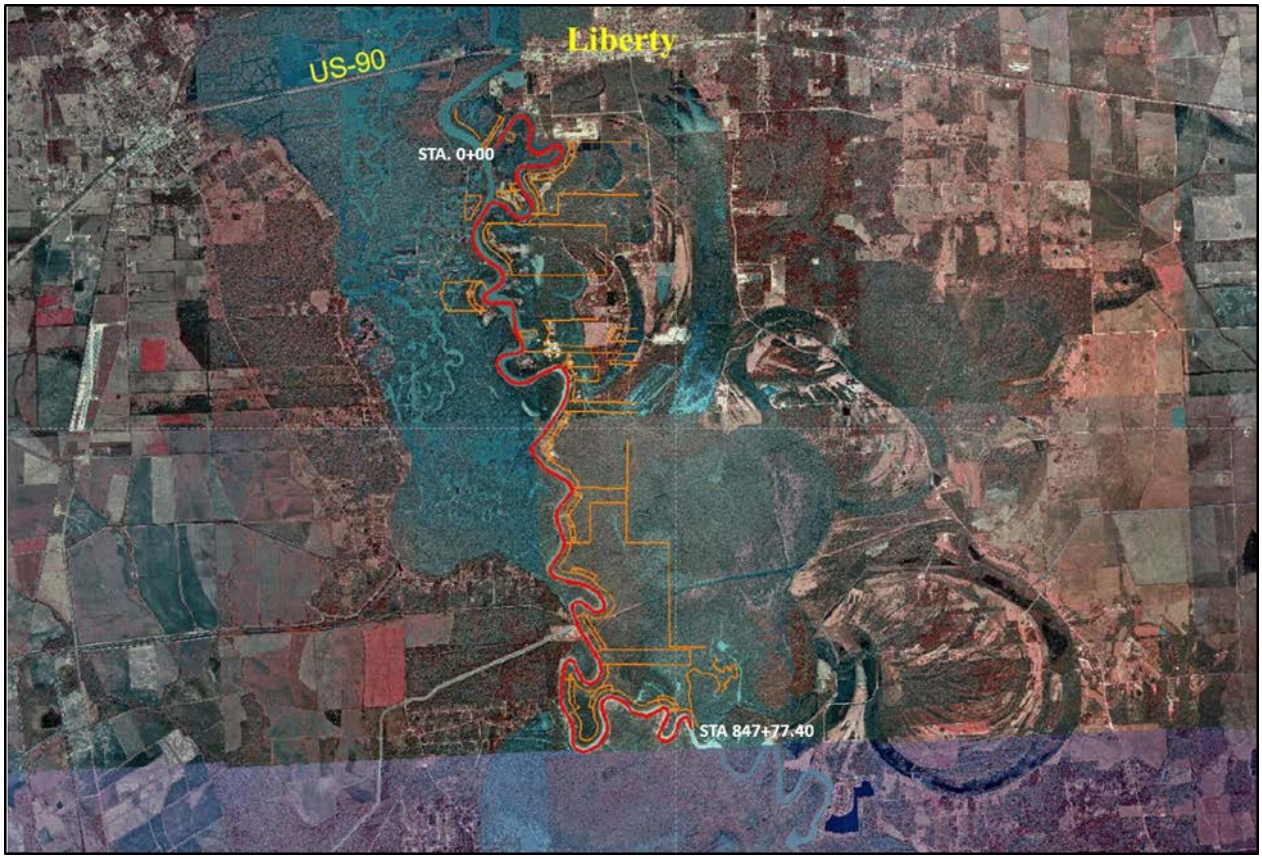

Figure 10-3: Channel to Liberty Existing Navigation Channel Maintenance Alignment (USACE, 2017)

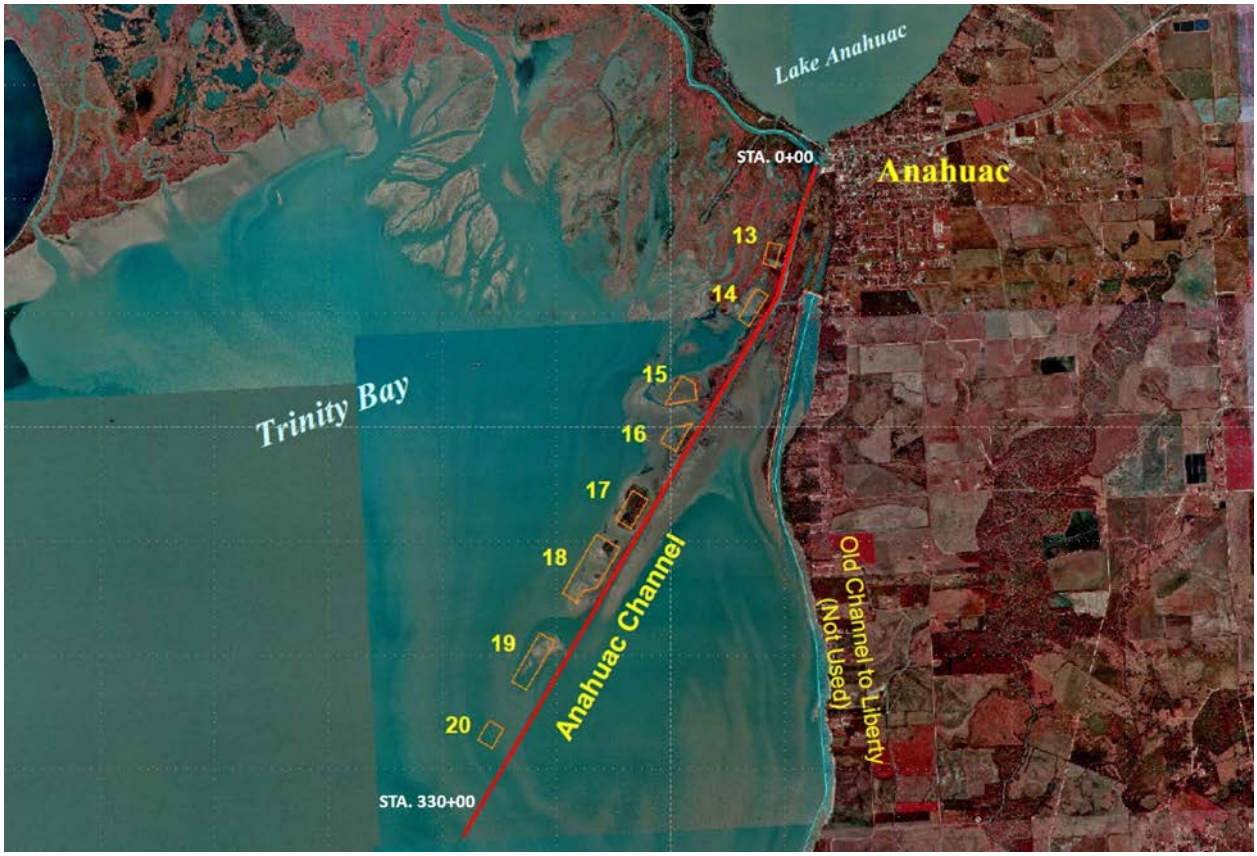

Figure 10-4: Anahuac Channel Existing Navigation Channel Maintenance Alignment (USACE, 2017)

Since the last maintenance dredging episode of the Channel to Liberty navigation channel, the Lower Trinity River has experienced meandering in some areas resulting in the need to reposition the channel centerline for future maintenance. For comparison purposes, Figure 10-5 displays an overlay of the new channel centerline to the historically maintained channel centerline.

The Anahuac Channel alignment and channel centerline is expected to remain the same as the historic channel alignment and channel maintenance centerline.

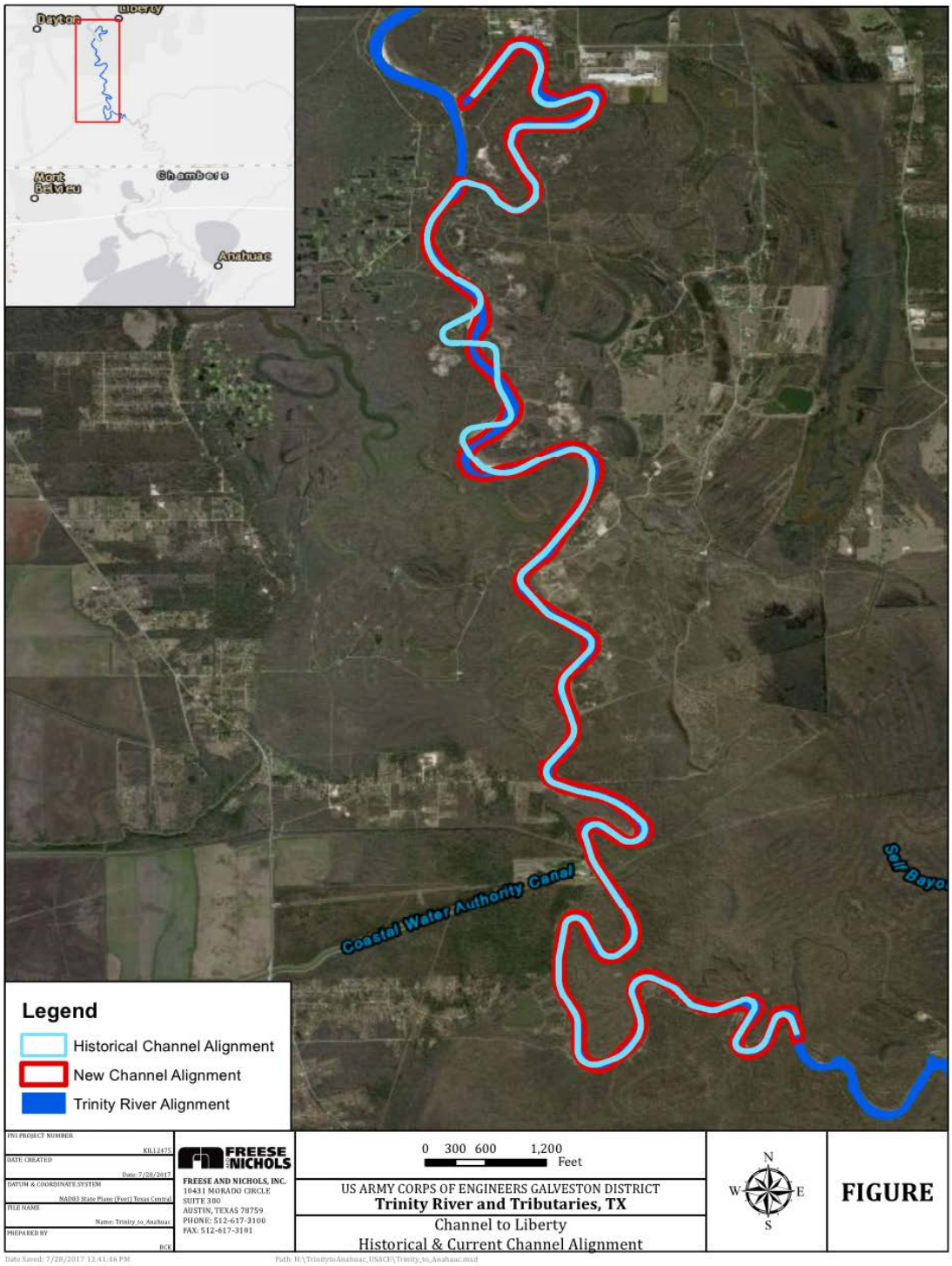

Figure 10-5: Channel to Liberty Overly Historic and New Channel Maintenance Centerlines

Both the Channel to Liberty and the Anahuac Channel have historically been maintained to a depth of 6-ft MLT and a bottom width of 100-ft. Typically, an additional 1-ft overdepth dredging is allowed to account for dredging equipment inaccuracies. Figure 10-6 demonstrates a typical channel geometry cross-section, with an overdepth allowance and side slopes of 3:1.

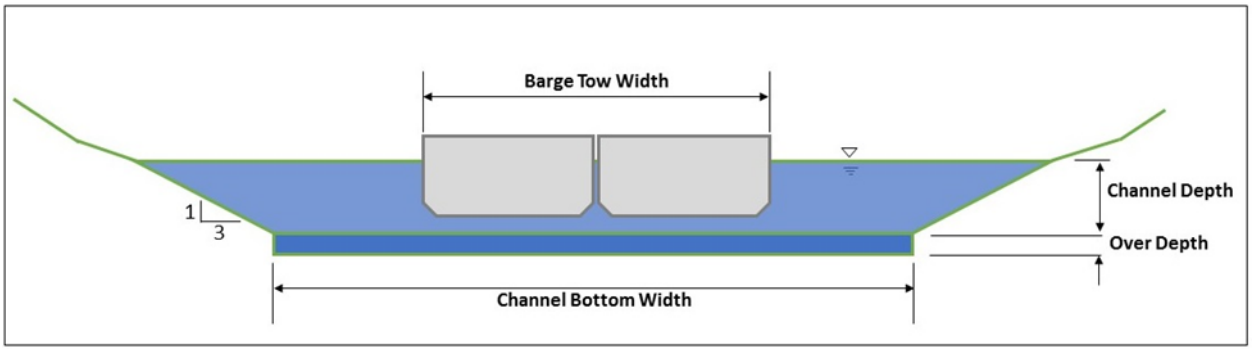

Figure 10-6: Typical Navigation Channel Geometry Cross-Section

As noted in Table 10-1, shallow draft barges typically draft 9 ft. The existing Channel to Liberty and Anahuac Channel navigation channels are authorized to be maintained at -6-ft MLT, which will require barges to light-load to transit through the two waterways.

Additionally, the two navigation channels have generally been maintained to a width of 100 ft. In accordance with the USACE (1980), minimum channel width for a tow width of 50 ft for one-way traffic should be not less than 130 ft. Assessments of future improvements to channel geometries to achieve transportation cost savings should consider the guidance provided by USACE (1980) for minimum channels widths required for tows of various sizes as shown in Table 10-2, and in conjunction with the constraining width of the Wallisville navigation lock chamber.

Table 10-2
Recorded Minimum Channel Widths for Tow Sizes (USACE, 1980)

Channel Width (ft)		
Tow Width (ft)	**Two Way Traffic**	**One Way Traffic**
105	300	185
70	230	150
50	190	130*

*Channel widths of 130 feet are not recommended for commercial traffic

Channel geometries with of 6-ft depth by 100-ft width ("6 X 100") and 9-ft depth by 130-ft width ("9 X 130") were evaluated for initial and maintenance dredged material quantities and costs and reported in Section 11.0 and Appendix B (RPS Group, 2017) of this report. The "6 X 100" channel alternative was selected because existing authorization allows for maintenance of this channel geometry. The "9 X 130" channel alternative was selected to correspond to the typical shallow-draft barge

dimensions and to adhere to the minimum shallow-draft navigation channel width as recommended by the USACE (1980). For the Channel to Liberty navigation channel, calculated dredged material volumes were corrected and tied to the MLLW datum. For the Anahuac navigation channel, calculated dredged material volumes were tied directly to the water level measured during the TRA 2017a bathymetric survey.

11.0 FUTURE DREDGED MATERIAL VOLUME ESTIMATES

Based on the review of existing authorities for the Trinity River and Tributaries Navigation Channel System, it is concluded that the navigation channel dimensions as shown in Table 1-1 for Channel to Liberty, Anahuac Channel, and Channel to Smith Point are authorized for continued maintenance, if future USACE O&M project appropriations become available. However, the objective of this evaluation is to determine the potential viability for reestablishing waterborne commerce to Liberty, therefore, it was further concluded that of the three channels that make up the navigation system, only the Channel to Liberty and Anahuac navigation channels are in need to be maintained to allow for barge tow traffic to Liberty, Texas.

Alternative channel sizes of “6 X 100” and “9 X 130” for the Channel to Liberty and Anahuac navigation channels were considered to estimate dredged material quantities and project costs for initial dredging and for future maintenance dredging. Channel alignment follows the current centerline of the Trinity River and Anahuac Channel as surveyed under the TRA Report (2017a).

11.1 INITIAL DREDGED MATERIAL QUANTITIES

Based on the bathymetric survey of the Channel to Liberty and the Anahuac navigation channels performed by TRA and TWDB in January 2017 (Appendix A), coarse estimations of dredged material quantities were determined for alternative channel geometries of “6 X 100” and “9 X 130”.

The bathymetric surveys were conducted at a coarse-scale, and consisted of three-longitudinal survey transects (center, 1/3 left, and 1/3 right); minimum of four cross-section survey transects per river mile; with a vertical accuracy ranging from 0.2 to 0.3 ft (TRA, 2017a). Corrections for tidal elevations were not noted in the TRA Report (TRA, 2017a).

Estimates of initial dredged material quantities for each channel geometry alternative, to include allowance for 1 ft of overdepth, are reported in Table 11-1. For the Channel to Liberty navigation channel, dredged material volumetric calculations were segmented into eight areas along the channel as shown on Figure 11-1.

Table 11-1
Initial Dredged Material Quantities by Channel Geometry Alternative (Combined Channel to Liberty and Anahuac Navigation Channels)

Initial Dredging Estimated Dredged Material Volumes (cy)		
Channel to Liberty[1]	**Channel Geometry Alternative**	
	"6 X 100"	**"9 X 130"**
Area 1	678,142	1,296,102
Area 2	622,116	1,236,384
Area 3	102,841	349,289
Area 4	17,734	128,371
Area 5	3,769	78,918
Area 6	363	40,896
Area 7	16,453	56,796
Area 8	41,822	391,222
Sub-Total	**1,483,240**	**3,577,978**
Anahuac Channel[2]	**Channel Geometry Alternative**	
	"6 X 100"	**"9 X 130"**
Anahuac	4,237	152,922
Sub-Total	**4,237**	**152,922**
TOTAL	**1,487,477**	**3,730,900**

[1]At MLLW Datum

[2]At Measured Water Level

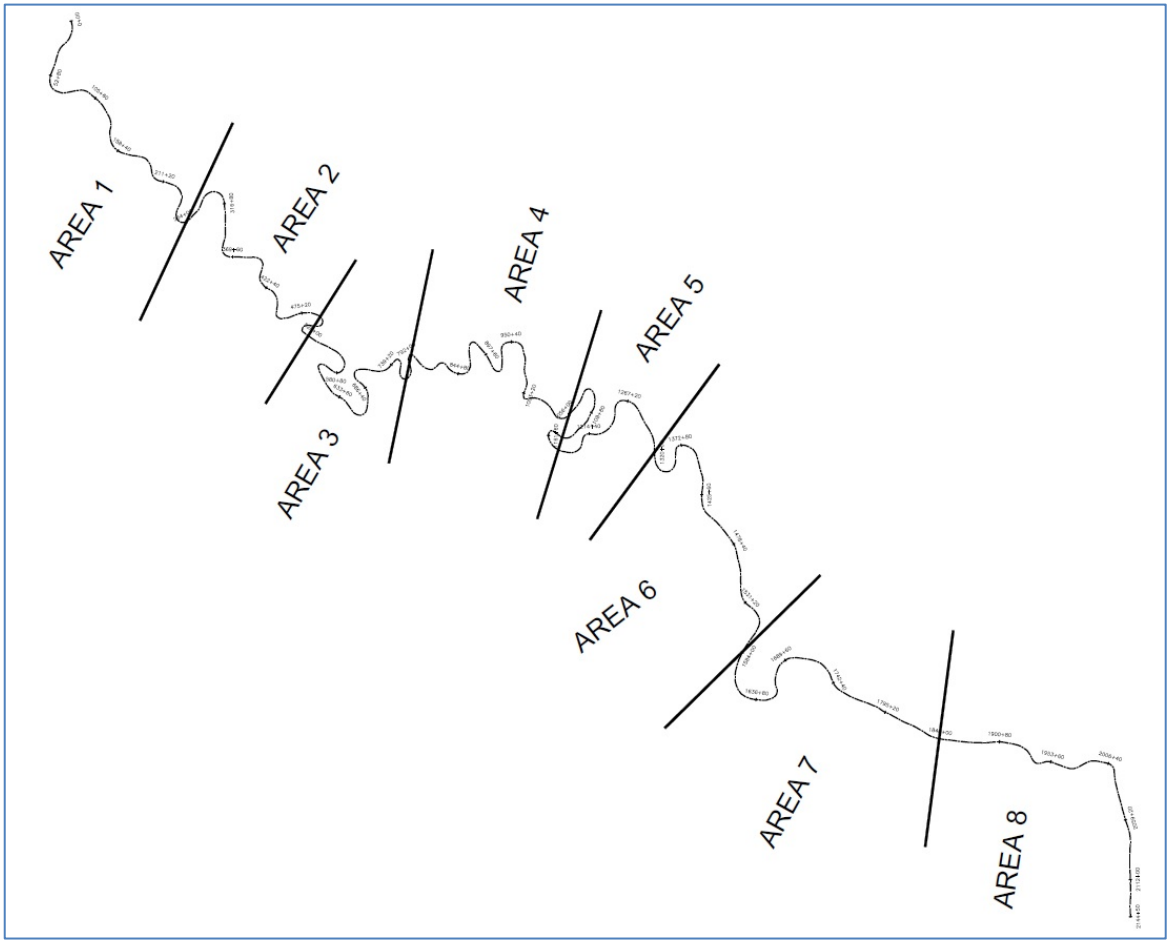

Figure 11-1: Channel to Liberty Segmented Areas for Dredged Material Volume Calculations

11.2 FUTURE MAINTENANCE DREDGING REQUIREMENT

Estimations of future maintenance dredging requirements was based primarily on annual maintenance dredging volumes as derived from historic dredging records and as reported in Table 4-1. The requirements include a 3-year maintenance dredging cycle assumption. Per cycle forecast of future maintenance dredged material quantities for each channel geometry alternative, to include allowance for 1 ft of overdepth, are reported in Table 11-2. Total future maintenance dredging quantities for each channel geometry alternative for periods of 20-years (7-cycles) and 50-years (17-cycles) are reported in Table 11-3.

Table 11-2
Future Maintenance Dredged Material Quantities by Channel Geometry Alternative Per Dredging Cycle (Combined Channel to Liberty and Anahuac Navigation Channels)

Per Cycle Future Maintenance Dredging Estimated Dredged Material Volumes (cy) (Combined Channels)		
Dredging Period	**Channel Geometry Alternative**	
	"6 X 100"	**"9 X 130"**
Per 3-Year Cycle	1,000,000	2,100,000

Table 11-3
Total Future Maintenance Dredged Material Quantities by Channel Geometry Alternative (Combined Channel to Liberty and Anahuac Navigation Channels)

Total Future Maintenance Dredging Estimated Dredged Material Volumes (cy) (Combined Channels)		
Dredging Period	**Channel Geometry Alternative**	
	"6 X 100"	**"9 X 130"**
20-Year Maintenance	7,000,000	14,700,000
50-Year Maintenance	17,000,000	35,700,000

12.0 DREDGED MATERIAL PLACEMENT AREAS

12.1 FUTURE PLACEMENT AREAS – CHANNEL TO LIBERTY

The historically used placement areas for the Channel to Liberty navigation channel were previously coordinated as designated dredged material placement areas by USACE, 1975. However, these placement areas have not been used in over 20 years. This lack of use has resulted in conversion to wetland vegetation and ponds within most of the sites. Future use of these placement areas for dredged material disposal would require reevaluation for environmental impacts, and may require re-coordination with State and Federal agencies. Additionally, the majority of the real estate for the placement areas are privately owned, and therefore, would require a coordinated effort by the non-Federal sponsor (CLCND) to reacquire the easements. The exception is PA 12, which the USACE (2012b) reports as a site no longer available for use.

12.2 FUTURE PLACEMENT AREAS – ANAHUAC CHANNEL

For the Anahuac Channel, open-water PAs 14 through 20 were previously coordinated as designated dredged material placement areas by the USACE (1975). To comply with the USACE's regional sediment management objectives and environmental impacts associated with open-water placement, reevaluation of these open-water sites as dredged material placement areas may be required to comply with the National Environmental Policy Act (NEPA). PA 13 is an unconfined upland dredged material disposal site, and has been fully coordinated for use by the USACE (1975). Therefore, it is anticipated that no environmental or cultural resources constraints will be introduced for future use for dredged material placement.

12.3 ADDITIONAL NEW PLACEMENT AREAS

Any additional or new dredged material placement areas needed for undertaking dredge operations on the Channel to Liberty or the Anahuac navigation channels most likely will require future environmental coordination and documentation to ensure compliance with NEPA and other environmental protection acts, executive orders, and regulations.

13.0 ENVIRONMENTAL CONSIDERATIONS

Environmental considerations for the dredging of the Channel to Liberty and Anahuac navigation channels will be provided by the USACE Galveston District as a separate report as one of its technical contribution to the Long-Term Port of Liberty Navigation Development Plan PAS study.

14.0 PROJECT COSTS

From the dredged material quantities estimations presented in Section 11.0, preliminary construction cost estimates for initial dredging and subsequent maintenance dredging were developed for each channel geometry alternative. It was assumed the navigation channels would be dredged using a cutterhead hydraulic pipeline dredge and with the dredged material pumped unconfined to the placement areas. The preliminary construction costs estimates were based on the assumption of a per cycle mobilization/demobilization (mob/demob) cost of $1.0 million; per cycle unit cost of $5.00/cy; a per cycle Supervision & Administration (S&A) and Engineering During Construction (EDC) rate of 7.0 percent; and a per cycle contingency factor of 20 percent. It was further assumed that there will be no costs associated with Land, Easements, Rights-of-Way, Relocation, and Disposal (LERRD) areas, since historically acquisition of placement areas easements for the Channel to Liberty and Anahuac navigation channels were either at no cost to the local sponsor (CLCND) or associated with navigation servitude. These cost assumptions apply to both the initial dredging and future maintenance dredging cost estimates.

Based upon review of previous authorization and deauthorization languages, it should be noted that the "6 X 100" channel geometry alternative is assumed to be authorized for the USACE to continue channel maintenance. If this assumption is confirmed, then future costs to construct the "9 X 130" alternative should be the cost increment between the cost to maintain the "6 X 100" channel geometry and the cost to deepen and widen to the "9 X 130" geometry. Project costs for future maintenance of the "9 X 130" channel geometry will also be governed by the incremental cost difference between the two channel geometries.

14.1 INITIAL CONSTRUCTION COSTS

Based on the initial dredging quantities for each channel geometry alternative as reported in Section 11.0, the initial construction cost for each alternative is presented in Table 14-1 and includes the incremental cost differences between the two channel geometries.

Table 14-1
Initial Dredging Cost Estimates by Channel Geometry Alternative

Initial Dredging Costs* (Combined Channels)		
Construction Cost Type	**Channel Geometry Alternative**	
	"6 X 100"	**"9 X 130"**
Full Construction Cost	$10,900,000	$25,300,000
Incremental Construction Cost	$0	$14,400,000

*Includes Costs for Mob/Demob, S&A/EDC, and 20% Contingency

In accordance with the USACE (2000), the non-Federal cost share for construction of General Navigation Features (GNF) for commercial navigation with shallow-draft navigation channel depths up to 20 ft is 10 percent, with an additional 10 percent of the GNF construction costs to be paid over a period not to exceed 30-years.

14.2 FUTURE MAINTENANCE DREDGING COSTS

Per cycle construction cost estimates, for future maintenance dredged material quantities for each channel geometry alternative as reported in Table 11-2, are presented in Table 14-2 and include the incremental cost differences between the two channel geometries. Additionally, total cost estimates for future maintenance dredging quantities for each channel geometry alternative for periods of 20 years (7 cycles) and 50 years (17-cycles) are reported in Tables 14-3 and 14-4, respectively, and includes the incremental cost differences between the two channel geometries. Annual inflation rates were not factored into to the 20- and 50-year future maintenance dredging costs.

Table 14-2
Per Cycle Maintenance Dredging Cost Estimates by Channel Geometry Alternative

Per Cycle Maintenance Dredging Costs* (Combined Channels)		
	Channel Geometry Alternative	
Maintenance Cost Type	**"6 X 100"**	**"9 X 130"**
Full Maintenance Cost	$7,700,000	$14,800,000
Incremental Maintenance Cost	$0	$7,100,000

*Includes Costs for Mob/Demob, S&A/EDC, and 20% Contingency

Table 14-3
Total Maintenance Dredging Cost Estimates by Channel Geometry Alternative (20 years)

Total Maintenance Dredging Costs (20 Years)* (Combined Channels)		
	Channel Geometry Alternative	
Maintenance Cost Type	**"6 X 100"**	**"9 X 130"**
Full Maintenance Cost	$53,900,000	$103,400,000
Incremental Maintenance Cost	$0	$49,500,000

*Includes Costs for Mob/Demob, S&A/EDC, and 20% Contingency

Table 14-4
Total Maintenance Dredging Cost Estimates by Channel Geometry Alternative (50 years)

Total Maintenance Dredging Costs (50 Years)* (Combined Channels)		
	Channel Geometry Alternative	
Maintenance Cost Type	"6 X 100"	"9 X 130"
Full Maintenance Cost	$131,000,000	$251,000,000
Incremental Maintenance Cost	$0	$120,000,000

*Includes Costs for Mob/Demob, S&A/EDC, and 20% Contingency

In accordance with the USACE (2000), the O&M of GNF for shallow-draft navigation channels is performed at 100 percent Federal cost.

15.0 RECOMMENDATIONS

Section 2.0 (Authorization and De-Authorization) of this report concludes the 6-ft MLT deep by 100-ft-wide Channel to Liberty and Anahuac navigation channels remain authorized for the USACE to continue maintenance dredging of these channels. However, it is recognized that the USACE dredges Federal navigation channels using formulas that consider cargo-tonnage moving through the navigation channels. Since actual cargo movement through the two channels has been limited from the mid-1990s to 2015, as reported in the USACE IWR's U.S. Waterborne Commerce statistics publications, the probability of the channels to be budgeted and receive appropriations for maintenance dredging in the immediate future is very unlikely.

Yet, Section 9.0 (Summary Review of Port of Liberty Market Analysis) identifies and reports opportunities for renewed waterborne commodity movements that have the potential of introducing significant transportation cost savings, transportation safety, environmental, and other benefits by converting existing and future cargo modes of transport from using rail or trucks to barges.

Therefore, it is recommended a detailed review and analysis of the current economic conditions and development of forecast of future commercial use and commodity throughput be performed to ascertain if sufficient economic justification exists to request future USACE Civil Works budgeting and seek Energy and Water appropriations to undertake maintenance dredging of the Channel to Liberty and Anahuac navigation channels to the existing authorized depth of -6-ft MLT.

It is further recommended that the proposed economic assessment be structured to consider incremental transportation cost savings and benefits associated with potential improvements to the existing authorized channel geometry. Results of the economic assessment could possibly serve as the basis of analysis for future feasibility studies that may consider and evaluate navigation improvements to the Trinity River and Tributaries navigation system.

16.0 REFERENCES

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Appendix A

Port of Liberty Bathymetric Survey, Phase 1 (2017)

Port of Liberty Bathymetric Survey, Phase I
Longitudinal Lines and Cross-sections

Project Information and Metadata

17 February 2017

Prepared for:
Galveston District, United States Army Corps of Engineers

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Summary

The following survey data sheet explains the activities related to Phase I of the coarse-scale, bathymetric survey completed for the Port of Liberty Planning Assistance to States Feasibility Study by the Trinity River Authority of Texas (TRA). At the Kickoff Meeting held at TRA's Lake Livingston Office on 25 August 2016, a need for bathymetric data between the Port of Liberty facility (RM 40.5) and the mouth of the Trinity River (RM 0) was identified. TRA agreed to complete a coarse-scale bathymetric survey for this area based on the following criteria:

Type	**Description**	**Phase**
Vertical Accuracy	0.2-0.3 survey ft.	Phase I - Complete
Cross-sections	As many as possible within budget constraints	Phase I - Complete
Longitudinal Lines	Minimum of 3 (L 1/3, Center, & R 1/3)	Phase I - Complete
Composite Sediment Samples	5-6 at shoals or shallow areas	Phase II
Increased Resolution in shallow/shoal areas	Additional Shallow/Shoal Cross-sections	Phase II

This datasheet and associated electronic data deliverable complete Phase I of this project. The electronic deliverable consists of bathymetric data stored in a file geodatabase containing two point feature classes, 1) TR_bathymetry_4203 and 2) TR_bathymetry_4204. Additional metadata are available within the file geodatabase. Based on data collection parameters, equipment specifications, and field conditions, the average error estimation is shown in the table below and further detailed in the *Data Collection* section.

Direction	**Error**
Horizontal	0.2 feet (+/- 0.10 feet)
Vertical	0.3 feet (+/- 0.15 feet)

Summary of Field Activities

Field Reconnaissance – 23 and 24 December, 2016

Field Work – 23 through 27 January 2016

Field Staff – 3 TRA and 2 Texas Water Development Board (TWDB)

Study Area – US 90 near Liberty, TX (RM 40.5) to the mouth of the Trinity River (RM 0) (Figure 1)

Weather –

Mean Temperature: 54°F

Mean Wind Speed: 5 mph

Mean Wind Gust: 18 mph

Average Flow at USGS Gage 08067000, Trinity River at Liberty – Approximately 20,700 cfs (Provisional)

Figure 1. Map of the Trinity River between Liberty, TX (RM 40.5) and the mouth of the Trinity River (RM 0).

Equipment and Specifications

No.	Type	Specifications
3	Jon Boats (16-19 ft.)	-
1	SonTek RiverSurveyor ® M9 Acoustic Doppler Profiler (ADP)	1% depth
3	Trimble R8 GPS Antennas	Kinematic - Vert. +/- 20 mm + 1ppm Kinematic – Hor. +/- 10 mm +1 ppm
3	SonarMite HydroLite™ Echosounder	1 cm or 0.1% depth

Data Collection

At the beginning of each day, a SONARMITE Hydrolite ™ echosounder with a Trimble R8 GPS antenna was installed on each boat (Figure 2). The transducer depth and the antenna height above the water surface was programmed into a Trimble TSC3 data controller. To collect real-time kinematic (RTK) correction data, each TSC3 was connected to the virtual reference station (VRS) in Anahuac, TX using an internal modem. The VRS option was used because the local base method deployed during the reconnaissance required that the base be moved every 1-3 river miles.

Figure 2. Photograph showing three boats collecting longitudinal bathymetric data with echosounder and GPS equipment attached.

The GPS and echo sounders were each connected via Bluetooth to a TSC3, enabling each GPS point to record XYZ position data *at the water surface*, then assigning an echosounder depth measurement to each point. Continuous topographic data points were collected at 1 meter intervals. The default Trimble R8 horizontal and vertical tolerances for continuous topographic data of 0.164 feet and 0.262 feet, respectively, were used. Data were collected in grid coordinates using the appropriate Texas State Plane Zone (TX-Central 4203 or TX-South Central 4204) in survey feet.

At the beginning of each day, a bar check was completed and each instrument was tested to ensure that all three boats were measuring the bed elevations within 0.05 feet. Additionally, a survey rod was used to measure the depth at the bar check to verify the transducer accuracy.

Once the instrumentation was verified, each boat was assigned a reach and task consisting of longitudinal lines or cross-sections (**Error! Reference source not found.**). Because of the scope of this study, a minimum of four cross-sections were collected per river mile. To reduce turbulence near the transducers, data were collected from upstream to downstream at a speed of approximately 5 mph, depending on water velocity.

Figure 3. Map showing a representative section of the survey with cross-sections locations and longitudinal lines in blue with river miles.

Due to equipment problems on 24 and 25 January 2016, one SonarMite was replaced with a SonTek RiverSurveyor®. This instrument was used to collect cross-sections between river miles 34 and 6.5.

Post Processing and Quality Assurance

Each data file was downloaded and converted to apply depths to water surface elevations, then quality assured in Trimble Business Center (TBC) and Excel. Data meeting the following criteria were removed from the dataset:

Number of Satellites	< 10
Horizontal Precision	> 0.3 ft
Vertical Precision	> 0.3 ft
PDOP	> 4
Transducer Quality	< 60

To locate and remove errant data (i.e. submerged large woody debris, echosounder return from large fish, excessive boat movement, etcetera), each data point satisfying the following criterion was visually inspected for reasonableness: +/- 1 meter difference in elevation between adjacent points. Errant data points were removed.

To provide additional detail, no overlapping or repetitive data were removed and cross-sections were not straightened. TRA assumes that the bathymetry will be smoothed by the modeling staff when appropriate.

Phase II

Phase II will consist of sediment sampling and additional, more detailed bathymetry collected at up to six locations within the study area. Upon review of this document and the electronic data deliverable, U.S. Army Corps of Engineers staff should contact TRA staff to schedule a project planning meeting for Phase II prior to 1 March 2017.

Appendix B

Estimated Dredged Material Volume Calculations

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Report to Freese and Nichols
Estimated Dredging Volumes Report
For
Channel to Liberty

July 2017

Table of Contents

List of Sections

Abbreviations iii

Section 1 Introduction 2
1.1 Site Location and Basic Design Parameters 2
1.2 Port of Liberty Background 2

Section 2 Methodology 3
2.1 Bathometric Acquisition Methods 3

2.1.1 Bathymetric Collection Design 4

2.1.2 Estimation of Edge of Water 5
2.2 Local Geodetic Datums 5

2.2.1 Navigable Depth Needs 5

2.2.1 Datum Conversions 6

2.2.2 Low Water Reference Plane Datum 7

2.2.3 Local MLLW Datum 8
2.2 Existing Bathometry and Design Dredged Surfaces 9

Section 3 Results 9
3.1 Hydraulic Reference Plane 9
3.1 Dredge Volume Quantities 10

3.11 Volumes to Restore Historic Channel Dimensions 11

3.12 Volumes with Creation of a 9'X130' Channel 11

Section 4 References 12

List of Figures

Figure 1 Flow Trinity River at Liberty, TX. USGS Station 08067000.
Figure 2 NOAA CO-OPS at Round Point. CO-OPS Station 8770559.
Figure 3 Gage depth Trinity River at Liberty, TX. USGS Station 08067000.
Figure 4 Triangulated irregular network (TIN) surface using Delaunay triangulation of the points in AutoCAD Civil 3D.
Figure 5 Water Surface Elevation NAVD88.
Figure 6 Channel to Liberty 5 mile segments for dredge volumes.

List of Tables

Table 1 Estimated Dredge Volumes for a 6+1'X100' channel using a Median Flow Hydraulic Reference Plane Datum and a MLLW Datum.
Table 2 Estimated Dredge Volumes for a 9+1'X130' channel and a 6+1'X100' channel using the MLLW Datum.

List of Appendices

Appendix 1 Gage Trinity River at Liberty, TX. (U.S. Geological Survey (USGS) station 08067000.

Abbreviations

Abbreviation	Description
CO-OPS	Center for Operational and Oceanographic Products and Services
GNSS	Global Navigation Satellite System
LWRP	Low Water Reference Plane
MLLW	Mean Lower Low Water
NAD	North American Datum
NGS	National Geodetic Survey
NHD	National Hydrography Dataset
RTK	Real-Time Kinematic
TRA	Trinity River Authority of Texas
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
VRS	Virtual Reference Station

Executive Summary

The channel to Liberty Planning Assistance to the States project was initiated by the Trinity River Authority (TRA) to explore the feasibility of redeveloping a port facility located in Liberty Texas. The need for a project in this area are driven by both navigational and safety concerns with the further development of the Port of Houston, as larger vessel traffic is expected increase with current industrial trends.

The proposed Liberty navigation channel in the Trinity River was split into a series of five mile radiuses along the reach for presentation of dredge volume by reach, as this was the estimated practical limit of hydraulic dredge placement of new work materials considering previous dredging project experiences and cost effectiveness from similar projects. Placement Areas (PA) would be needed to be established within a radius to accommodate quantities expected within these areas. Two channel designs and two local datums were used in estimations of dredge volumes.

The 6'X100' channel design using a hydraulic median flow reference frame indicates that there is very little dredging that needs to occur in the upper reach of the navigation channel, as much of the navigation depth is due to the median river flow. The entire dredge volume at median flow is only approximately 26,000 cubic yards, and 99% of this cut occurs in area 8 near the bay. However, if the channel uses the local tidal datum of Mean Lower Low Water (MLLW) to provide navigational clearances, then the total dredge volume is 1.4 million cubic yards, and the upper 3 reaches account for 96% of the dredging required. A 95% exceedance LWRP is usually used as a datum for riverine navigation reaches, and would lie between these two estimates, but would minimize dredge volumes required to maintain navigability.

The estimated dredge volumes for a 9'X130' channel were estimated using a MLLW datum. The 9'X130' design using the tidal datum of mean lower low water results in almost 3.6 million cubic yards of dredge material, with 70% of the volume being within the upper two areas of the reach. The differences between the 6' and 9' channel are a little over 2 million cubic yards

Section 1
Introduction

1.1 Site Location and Basic Design Parameters

The channel to Liberty Planning Assistance to the States (PAS) project was initiated by the Trinity River Authority (TRA) to explore the feasibility of redeveloping a port facility located in Liberty Texas. The need for a project in this area are driven by both navigational and safety concerns with the further development of the Port of Houston, as larger vessel traffic is expected increase with current industrial trends. There are also expected continued and growing demands for cargo handling capacity at the Port of Liberty facilities leading to possible local economic development of the surrounding and regional communities.

The channel to the Port of Liberty is a navigation project located on the central Texas coast. The historic and proposed channel designs use the natural Trinity River channel as a centerline, and are connected to the Houston Ship Channel by the Anahuac Channel. Historically, the Trinity Navigation Channel was also connected by the Smith Point portion of the Trinity River Channel, which has now been isolated from the upper reach. Both lower channels are not currently maintained. This feasibility-level planning study uses the TRA Phase I coarse-scale bathymetric survey for the Port of Liberty under the PAS process. This data is to be used to roughly or preliminarily gage the waterway improvements that would be needed to reestablish a multipurpose channel between the Port of Liberty facility (approximately RM 40.5) and the mouth of the Trinity River (RM 0).

The historically United States Army Corps of Engineers (USACE) maintained design was a 6’X100’ channel which appears to have been last maintained in 1987. For this feasibly study, two channel designs were considered; a 6+1 foot channel with a 100-foot bottom width that closely matches the last maintained design, and a 9+1 foot channel with a 130-foot bottom width. Both of these preliminary designs follow the existing centerline of the river as did the historically maintained design, and have a +1 component for allowable dredging overdepth.

1.2 Port of Liberty Background

The navigation channel reach extends from Trinity Bay to the edge of or just above tidal influence and much of the reach have elevations very near Mean Sea Level. Preparatory work

for the Port of Liberty, was started In August 1968 when work started on the “Fisher-Davis” cut to shorten the Trinity River approximately located at river mile 40.5. The oxbow cut off from the river became the Port of Liberty with the southern exit to the oxbow maintained to provide access to the Port. The historic channel followed the existing river, and was a 6+1 configuration. The USACE authorized and maintained the route as a federal navigation channel to Liberty until 1987. The channel maintenance was ultimately postponed because of budget considerations, and resulted in restricting vessel usage of the Channel. The port remained active until approximately 1992, but due to the lack of regular maintenance dredging that was needed to maintain a commercially navigable depth, the Port became inactive.

Section 2
Methodology

The bathometry survey field work was done between January 23rd and January 27th 2016. River flow as estimated provisionally at the United States Geological Survey (USGS) Gage 08067000 Trinity River at Liberty was approximately 20,700 cubic feet per second during that period, which is near median flow (Figure 1). The National Oceanic and Atmospheric Administration also had a tide prediction station 8770559 at Round Point in Trinity Bay that was active during the survey (Figure 2).

2.1 Bathometric Acquisition Methods

The bathometry was estimated using a SONARMITE Hydrolite ™ echosounders to estimate water depth, and Trimble R8 GPS with Virtual Reference Station (VRS) capability supplementing the Global Navigation Satellite System (GNSS) to estimate horizontal and vertical positions. The units were installed on small boats. The transducer depth and the antenna height above the water surface were recorded and used to allow estimation of bed elevation in the datum NAD_1983_2011. To collect Real-Time Kinematic (RTK) corrected data, each R8 was connected to the VRS location in Anahuac, TX using an internal modem. At the beginning of each day, quality control check was completed for each boat to ensure that estimation of the bed elevations within 0.05 feet. The survey extended across multiple days and no level monitors were deployed. Thus separating of the tidal and flow signals was not possible.

Topographic data points were collected by setting the receiver was set to take instantaneous solutions at 1 meter intervals moving from upstream to downstream, and a speed averaging approximately 5 mph was reported. Although not specified, it would appear that this was estimate was speed through the water, not speed over ground. However, this movement would result in the receiver taking a single shot while actually moving, which would be excess movement for most survey tasks, but can result in estimates in the horizontal that meet this preliminary task. The pitch and roll of small boats can also add another significant source of error since the R8 and the echosounder do not adjust for changes from vertical orientation. The horizontal and vertical tolerances for RTK continuous topographic data set in the R8 unit were 0.164 feet and 0.262 feet, respectively. The average error based on equipment specifications for the R8 are shown in the table below, but most likely underestimates the actual error since they do not account the field conditions due to usage, or environmental conditions imposed by the floodplain of river and associated vegetation.

Direction	**Error**
Horizontal	0.2 feet (+/- 0.10 feet)
Vertical	0.3 feet (+/- 0.15 feet)

Data were collected by the R8 and reported in the North American Datum NAD_1983_2011. The NAD was then transformed to grid coordinates of Texas State Plane expressed in US survey feet to allow easy estimation of volumes and areas. The survey crossed a state plane zone boundary, and thus two files were provided. These two geodatabases contained point feature classes were named; TR_bathymetry_4203 and TR_bathymetry_4204, respectively.

2.1.1 Bathymetric Collection Design

Bathymetric point data are most effective when the data points fall on in uniform unbiased grid pattern. However, the design forced by convenience was longitudinal profile data consisting of three lines, with the addition of a series of 178 partial cross sections. This design may produce artifacts due several factors including biased sampling, but should serve the purpose of a preliminary project. Eventually the project may need a more unbiased point database with complete cross sections on which to use spatial interpolation to build contoured bathymetric chart of the project reach for accurate dredge volume estimates.

2.1.2 Estimation of Edge of Water

Within the proposed navigation channel reach within the Trinity River many of the GIS data points mapped outside of limits of the Trinity shown on every readily available digitized map, including the latest National Hydrography Dataset (NHD), which was last updated in 2015. Thus due to the apparent dynamic nature of this reach, it necessitated that the reach be manually digitized using the survey to obtain a barrier adequate for an analysis. This departure also suggests that the river morphology actively changes within relatively short time periods, which may be prove to be a secondary issue in maintaining channel locations, updating navigation charts, or maintaining a local datum. The edge of the river for dredge volume analysis was set based on both historical aerial photographs, and the partial cross sections done during the survey along the reach. A personal conversation (2017) with the field staff that did the partial cross sections estimated that the partial cross sections extended to an average distance of approximately 10 feet from either bank since they were taken from exclusively from a boat and did not extend to the edge of water. It is also important to note that the edge of water point estimations were for the flow in the Trinity River when the cross sections were taken in the survey.

2.2 Local Geodetic Datums

The bathometric data was intended to be used for estimation of dredging for safe navigation, and the reach starts in a tidal area at the upper end of Trinity Bay and extends to near the town of Liberty, which may be supratidal. The bathometric data obtained from the sonar units were simple depths. Due to the lack of controlling structures on this reach, either a local datum based on a traditional tidal datum such as Mean Lower Low Water (MLLW), or a hydraulic Low Water Reference Plane (LWRP) are viable local datums.

2.2.1 Navigable Depth Needs

The designs preliminarily explored were for barge traffic following the existing centerline of the river. Most riverine navigation projects utilize navigation structures such as dams and locks to make inland waterways depth stable for use as transportation corridors. The Wallisville Lock, located near the mouth of Trinity Bay, and was originally intended to provide a stable pool structure for navigation. The lock chamber is a limiting point for navigation and is 600 feet long, 84 feet wide, with a 16 foot sill. The Wallisville Lock project, authorized in 1962 and started in 1966, was originally to impound a reservoir with surface elevation of four feet above mean sea

level. However, subsequent changes cumulated in a ruling against the full reservoir (Sierra Club vs Secretary of the Army, 1973), and a reduced reservoir size in a 1981 plan also ultimately never came to realization resulting in Wallisville having no impounded reservoir, and the lock structure being only used for salinity control during low flows in the Trinity to protect freshwater intakes. For navigation to Liberty, this means the natural changes in surface water elevation along the river's course will not be controlled by an engineered elevation of impounded water created by a dam and lock system. Thus navigable depth will be dependent on relative bottom elevations, which will change with respect to both the tide and the flow in the Trinity.

The inland endpoint of the proposed navigation channel is at the town of Liberty which has an elevation of approximately 30 feet above mean sea level (USGS, 1984). While the river surface elevation at Liberty is lower, the area is possibly supratidal although this needs to be confirmed. Thus safe navigable depth progressing from the bay to the upper part of the navigable reach will become increasingly decoupled from tidal height and more strongly dependent on flow in the Trinity River. The location of the transition between a tidally dominated controlling depth and a flow dominated depth is unknown, but the variance of gage depth at Liberty can be quite large, and does not show an obvious tidal signature (Figure 2). Thus the lowest dredge volumes achievable would incorporate a hydraulic based vertical datum, but this datum will need to be rigorously established, and a profile of a LWRP will be needed to produce navigation charts that properly reflect navigation hazards.

In the lower half of the reach there are waterbodies that have been documented to be tidally influenced, and thus the controlling depth in this reach, or the lower limits of safe navigation, will be more strongly controlled by local sea level (Figure 3). In the tidal portion of the reach at higher river stages there will be no periodic tide, but depths over the tidal depths will be increased during these periods, and thus safe navigation depths will be maintained. In these portions of the reach it may be more appropriate to estimate navigability relying on a tidal datum such as MLLW, which is typically used in tidally influenced waterways.

2.2.1 Datum Conversions

The survey data was collected in in the datum NAD_1983_2011. To convert the survey dataset to local datums such as local MLLW requires long term data on local mean sea levels,

specifically a station has to have a 19-year period over which sea level observations are taken, and this reduced to obtain values of the harmonic constants for datum definition. The datums NAVD 29 and NAVD 88 can be roughly related to regional MLLW by using the NGS estimations of othometric heights in conjunction with the Center for Operational and Oceanographic Products and Services' (CO-OPS) local sea level data (Figure 4). The Morgan Point station (8770613) NGS estimates are shown in Figure 4, which relates local MLLW to NAVD 29 or NAVD 88, as well as local Mean Sea Level (MSL) and other local datums. The local MSL differs from NAVD 29 and NAVD 88 throughout the Galveston Basin, and this introduces a possible small error in navigational depth.

The NAD83 datum is set by a single datum origin point, otherwise known as a primary bench mark. NAD_1983 and by extension NAVD 88, uses the tide gage at Father Point, Quebec, Canada as the primary bench mark. The datum uses an estimated geoid model, which is a specific gravitational equipotential surface which best fits global sea level. GEOID99, the latest geoid model, specifically relates NAD_1983 ellipsoid heights to NAVD 88 orthometric heights by calibrating GPS ellipsoid heights on leveled benchmarks throughout the conterminous United States using a fitted least squares model. Because of this method, local othometric heights, as well as local tidal heights such as local MLLW, may differ slightly in elevation from NAD_1983, and a basin average of NAVD 88 is 0.286 feet above MLLW.

The USGS uses NAVD29 on many of their gages as it has operational significance, and it was originally called the Sea Level Datum of 1929. This datum was formulated from mean sea level as measured at 26 tide gauges on both the east and west coasts, and the elevations of local bench marks were set relative to these using leveling adjustments. Because of the leveling processes, local sea level datums may displaced slightly in NAVD29. The National Geodetic Survey (NGS) estimates indicate local MSL relative to NAVD29 vary over a small range within the Galveston bay system but averages about 0.642 feet above NAVD29, and the MLLW in the Galveston system has an average of approximately 0.241 feet below NAVD29.

2.2.2 Low Water Reference Plane Datum

Development of a LWRP datum is viable, and would allow for much reduced dredging volume requirements in comparison to a MLLW datum especially within the upper reach of the channel. To define a LWRP for the upper reach would traditionally require a series of rating curves, and

these are not available in the bathometric work that has been done. However, for the flow during the survey, the depths in the existing channel are accurately known. A presentation of the estimates of dredge volumes for this one hydraulic reference plane will be presented, which was near median flow at the USGS Liberty gage.

The LWRP is not an equipotential surface as it represents depth of water along a slope of a flowing river at a chosen statistical flow, and because of this a LWRP cannot be readily converted to match the height estimations of NAVD29, or the ellipsoid estimations NAVD88. Also, the differences in dredge volumes of the LWRP and MMLW datums will gradually taper to zero as an equipotential surface at a point in the river starts to closely approximate the local sea level. This is achieved when the flow no longer makes a significant contribution to actual navigable depth. It should be noted that the USACE New Orleans District has developed methods that would speed the development of a LWRP considerably by utilizing Sonar and Lidar to obtain NAVD88 data, and this data can be used in 2D or 3D hydraulics models to create an interpolated adjustment grid so that survey data from geoid based datums can be converted to the local LWRP datum.

2.2.3 Local MLLW Datum

The use of MLLW as a local datum requires conversion of the data collected in in the datum NAD_1983_2011 to local MLLW datum. NAVD 88 can be roughly related to regional MLLW by using the NGS estimations of othometric heights in conjunction with the Center for Operational and Oceanographic Products and Services' (CO-OPS) local sea level data. The local MLLW differs from NAVD 88 throughout the Galveston Basin, but a mean of this value is that NAVD 88 values are 0.286 feet above MLLW. Several other sources of uncontrolled error enter into the conversion to a MLLW datum including errors in GPS vertical estimation on single fast shots, field operational issues such as pitch and roll, the lack of location and orthometric height estimates of the water’s edge, and finally tidal long waves may increase or decrease in amplitude along the reach due to the basin constraints of the river. Tides are likely dampened considerably due to propagating up the Trinity River and through the Wallisville structure. However, no level data was collected at landward locations within the reach during the survey thus the spectral redistribution and attenuation of tidal energy is not known and will have to be ignored if this datum is used with the data available. These uncontrolled error sources may contribute to errors that are of moderate magnitude, and while unmeasured they may if additive be in the range of around a foot. Despite the constraints, this datum most likely has the

smallest potential error range due to the remaining uncontrolled variables in the existing dataset.

2.2 Existing Bathometry and Design Dredged Surfaces

Existing bathymetry point values were utilized to create a triangulated irregular network (TIN) surface using Delaunay triangulation of the points in AutoCAD Civil 3D (Figure 4). The proposed channel designs of 6+1 by 100 foot bottom and 9+1 by 130 foot bottom were created along the centerline of the river that had been estimated and defined above. No attempts to widen, ease, or flare turn radiuses were undertaken. All preliminary proposed designs had channel side slopes set at a 3:1 ratio. These designs produced a second TIN surface, and the difference between the existing bathometric TIN and the design TIN surfaces can be used to produce a volume that would need to be cut from the existing bathometric surface to create the design criteria of the proposed channel bathometry surfaces, and represents the volume that would be needed to be dredged.

Section 3 Results

3.1 Hydraulic Reference Plane

The gage Trinity River at Liberty, TX, (U.S. Geological Survey (USGS) station 08067000) has gage height measured in a local datum which was estimated by the USGS to be 2.22 feet below National Geodetic Vertical Datum (NGVD) of 1929 (Appendix 1). The USGS uses NAVD29 on many of their gages as it has operational significance, and it was originally called the Sea Level Datum of 1929.

The Trinity River at the USGS Liberty gage has over the period of record to 2015 a mean flow of 24508.4 cubic feet per second (cfs), median flow of 23307.7 cfs (Letter et al, 2015). The survey was performed at an average flow of 20,700 cfs at the Liberty gage, which is just below median flow for the gage and corresponds to a NAVD29 height of approximately 22 feet at the gage. Inland channels that use LWRP's as navigable depths typically use a low flow value such as a 95% exceedance rate so that the channel can be assured to be navigable at most times. The Liberty gage has a 95% exceedance of approximately 8122 cfs (Letter et al, 2015), which corresponds to an elevation of approximately 7.62 feet (NAVD 29).

It is also important to note that should a hydraulic datum not be developed; dredging to MLLW necessitates that large amounts of material be removed from the upper reaches of the channel to make the channel reliably navigable at MLLW without regard to flow. A rough adjustment of

datum elevations near the Liberty gage would estimate that using the LWRP of the 95% flow exceedance level, approximately 7.86 additional feet of material would need to be removed in this local area make it navigable at MLLW alone (7.62ft NAVD 29+0.221ft adjustment to MLLW).

A plot of water surface elevation NAD88_2011 by Cartesian distance from the river mouth during the survey indicates that the river has a significant rise in estimated orthometric height above the geoid across the reach (Figure 5). The estimated water surface elevations from the survey data range from approximately -0.25 feet near Trinity Bay to 20.86 feet at Liberty. The data represents height during the survey period at near median flow, and no rating curves are available for the navigable reach to estimate the shape of the reference plane at other flows. The figure is also somewhat distorted by changing flow and tidal cycles during the survey (Figures 2, 3). Importantly, there is also distortion of the data is because it is plotted not by river mile, but by Cartesian distance from the river delta. The river miles of the navigation reach are approximately 40.5 miles, while the Cartesian distance is only approximately 21 miles, which compresses and slightly distorts the line and is due to the sinuosity of the river. However, the preliminary data suggests that a LWRP, if formally developed, could take advantage of flow supported depth to markedly minimize dredge volumes needed for a navigation channel. Additionally, at median flows the preliminary data suggests that there are significant increases in navigable depth due to flow that begin fairly proximal to Trinity Bay, and they continue to the top of the reach near Liberty. A 95% exceedance LWRP is estimated to provide 7.86 feet near the Liberty gage compared to the 20.86 feet at the median flow during the survey, but due to the potential large reductions in dredge volumes, development of an LWRP adjustment grid may be an economically viable way to provide safe navigation.

3.1 Dredge Volume Quantities

The proposed navigation channel was split into a series of segments five river miles long along the reach for presentation of dredge volume by reach, as this was the estimated practical distance limit of hydraulic dredge placement of new work materials, considering previous dredging project experiences and cost effectiveness from similar projects (Figure 6). Placement Areas (PA) would be needed to be established within a segment to accommodate quantities expected within these areas. Two designs and two local datums were used in estimates of dredge volumes.

3.11 Volumes to Restore Historic Channel Dimensions

The channel has historically been maintained to a 6'X100' dimension with 1 foot of advance maintenance and allowable overdepth. Restoration of this design criteria were run; one utilizing a hydraulic datum, and one utilizing a MLLW datum. The additional overdepth of one foot outside the required template was included to allow for inaccuracies in the dredging process. Utilizing a design similar to the historical design would also allow estimation of future maintenance dredging activities, as they should be of comparable volumes to past events. The estimated dredge volumes with the two datums are presented in Table 1.

The hydraulic median flow reference frame indicates that there is very little dredging that needs to occur in the upper reach of the navigation channel, as much of the navigation depth is due to the median river flow. The entire dredge volume at median flow for this channel design is approximately only 26,000 cubic yards, and 99% of this dredging cut occurs in area 8 near the bay. However, if the channel uses the tidal datum of MLLW to provide navigational clearances, then the total dredge volume is 1.4 million cubic yards, and the upper 3 reaches account for 96% of the dredging required. A 95% exceedance LWRP would lie between these two estimates, but should minimize dredge volumes required to maintain navigability.

3.12 Volumes with Creation of a 9'X130' Channel

Estimates of dredge volume for a 9'X130' channel were run only for the MLLW datum. The 9'X130' channel is of a different dimension, and while it will provide for navigation flexibility, it most likely will not have comparable maintenance dredging volumes. The estimated dredge volumes as compared to the 6'X100' MLLW channel design are presented in Table 2.

The 9'X130' design using the tidal datum of mean lower low water to provide navigational clearances results in almost 3.6 million cubic yards of dredge material, with 70% of the volume being within the upper two areas of the reach. The differences between the 6' and 9' channel are a little over 2 million cubic yards

Section 4
References

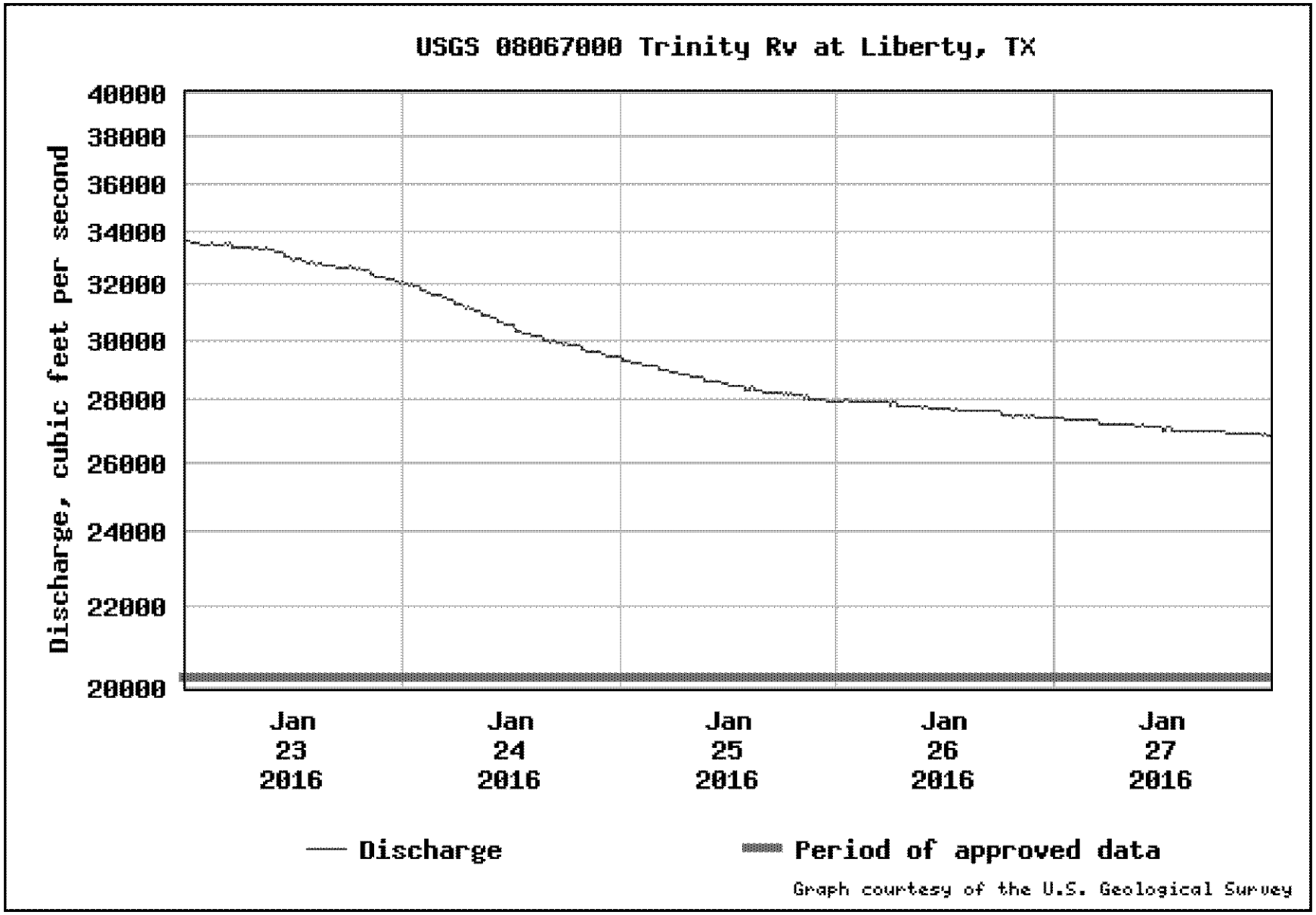
Letter, J.V. Jr., G.L. Brown, R. McAdory, and T.C. Pratt (2015). Numerical Modeling of Trinity River Shoaling below Wallisville, Texas. USACE Coastal and Hydraulics Laboratory.

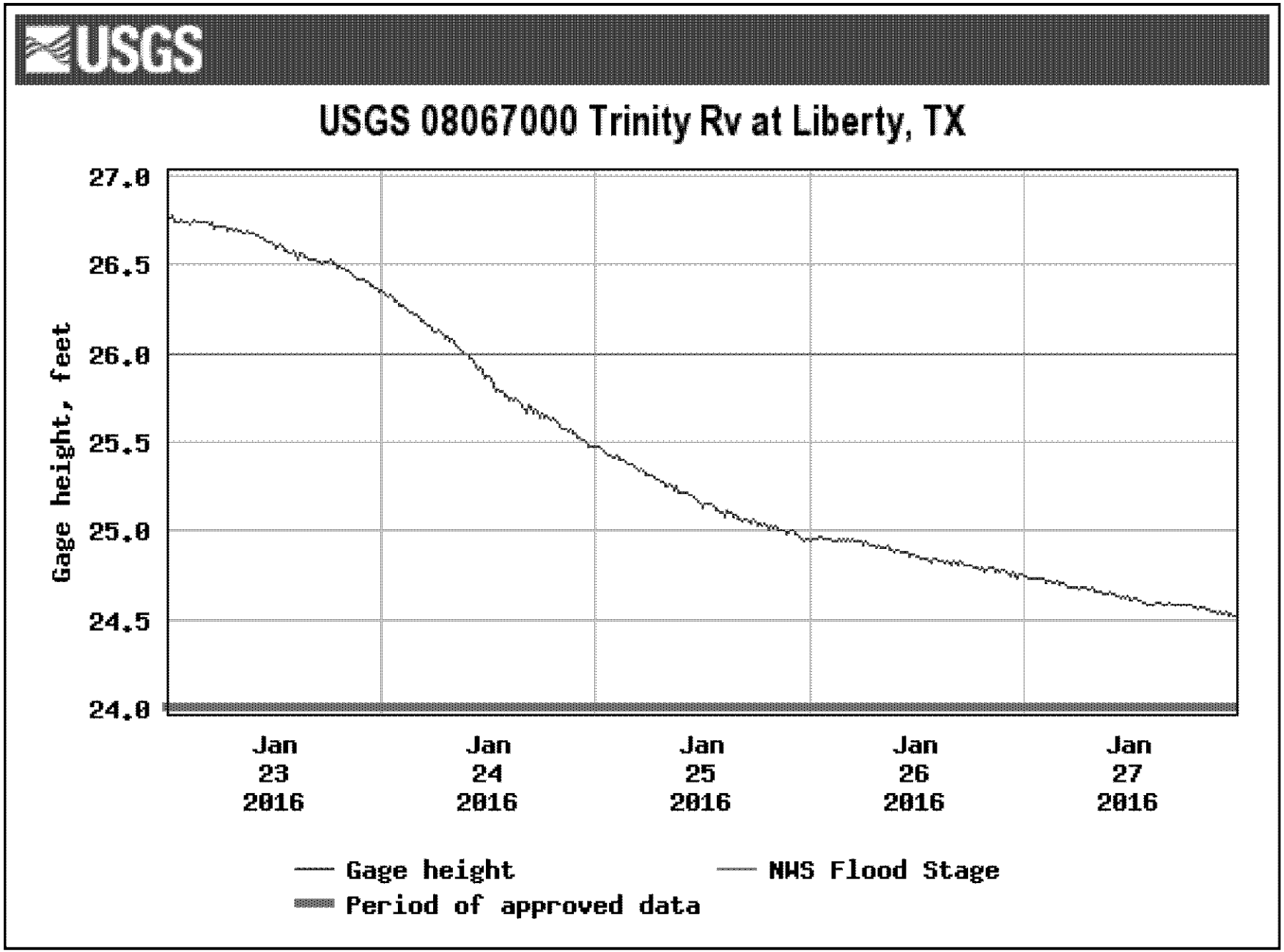
Richardson T.W. (1984). Agitation dredging: lessons and guidelines from past projects. Waterways Experiment Station Technical Report HL-84-6.

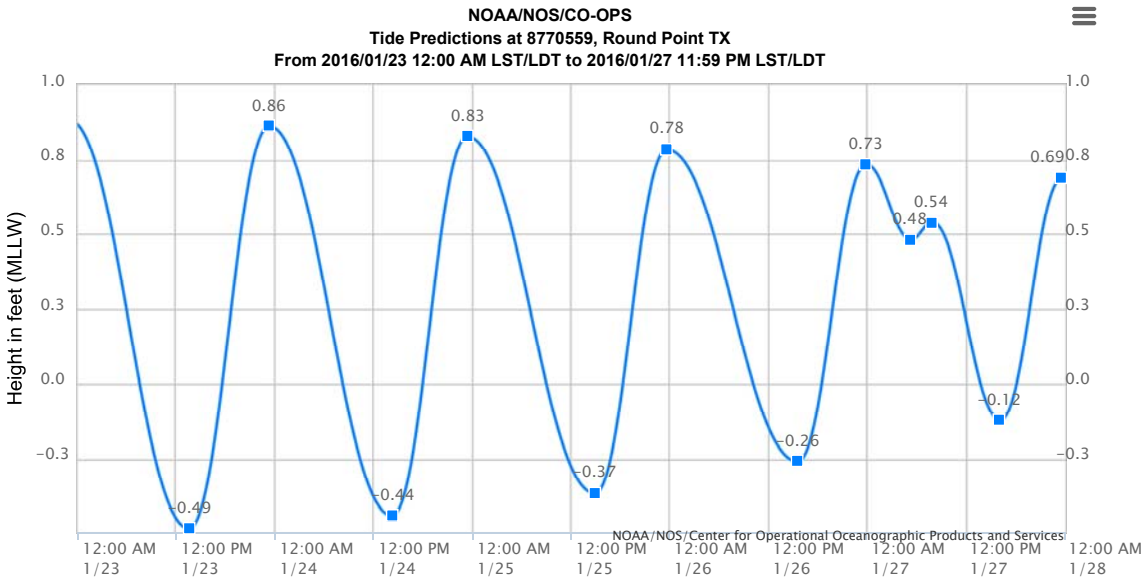
Sierra Club v. Robert F. Froehlke, Secretary of the Army. United States District Court, S. D. Texas, Houston Division. February 16, 1973. Civ. A. No. 71-H-983.

USGS (1984). Liberty Texas Quadrangle. 30094-A7-TF-024.

Figures


USGS 08067000 Trinity Rv at Liberty, TX
Discharge, cubic feet per second
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
Jan 23 2016
Jan 24 2016
Jan 25 2016
Jan 26 2016
Jan 27 2016
Discharge
Period of approved data
Graph courtesy of the U.S. Geological Survey


USGS
USGS 08067000 Trinity Rv at Liberty, TX
Gage height, feet
27.0
26.5
26.0
25.5
25.0
24.5
24.0
Jan 23 2016
Jan 24 2016
Jan 25 2016
Jan 26 2016
Jan 27 2016
Gage height
NWS Flood Stage
Period of approved data


NOAA/NOS/CO-OPS
Tide Predictions at 8770559, Round Point TX
From 2016/01/23 12:00 AM LST/LDT to 2016/01/27 11:59 PM LST/LDT
Height in feet (MLLW)
1.0
0.8
0.5
0.3
0.0
−0.3
0.86
0.83
0.78
0.73
0.69
0.54
0.48
−0.12
−0.26
−0.37
−0.44
−0.49
NOAA/NOS/Center for Operational Oceanographic Products and Services
12:00 AM 1/23
12:00 PM 1/23
12:00 AM 1/24
12:00 PM 1/24
12:00 AM 1/25
12:00 PM 1/25
12:00 AM 1/26
12:00 PM 1/26
12:00 AM 1/27
12:00 PM 1/27
12:00 AM 1/28

ELEVATION INFORMATION

PID: AW1554
VM: 11214
STATION ID: 8770613
EPOCH: 1983-2001
DATE: Thursday, July 20, 2017 3:22:38 AM EST

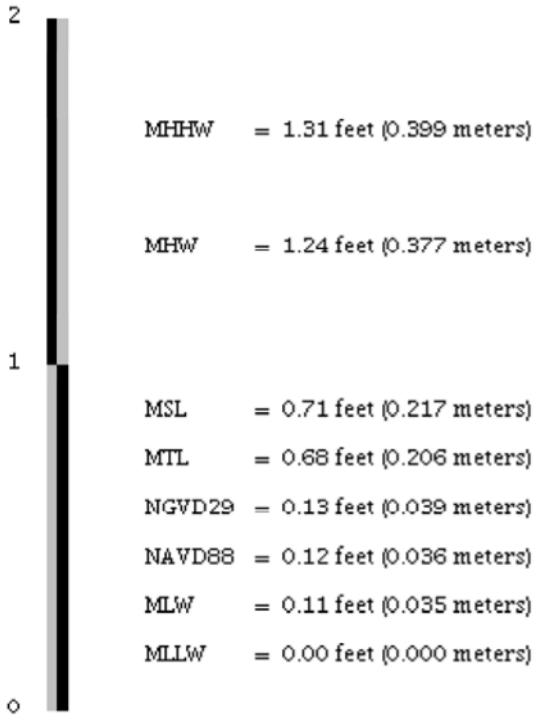


Figure 4. National Geodetic Survey Datum Conversion Heights for Morgans Point CO-OPS station 8770613.

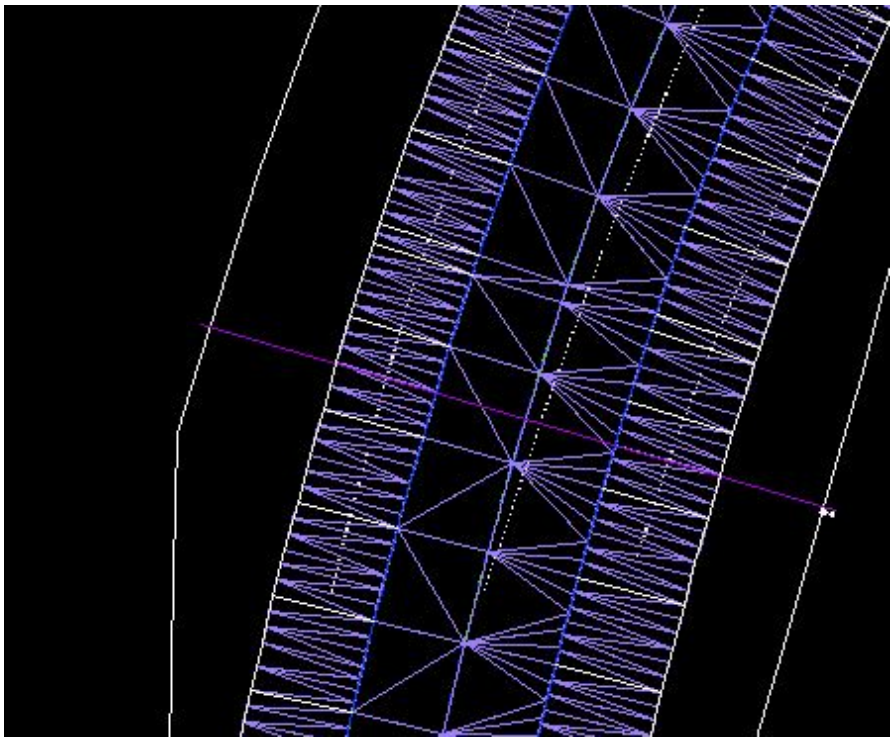
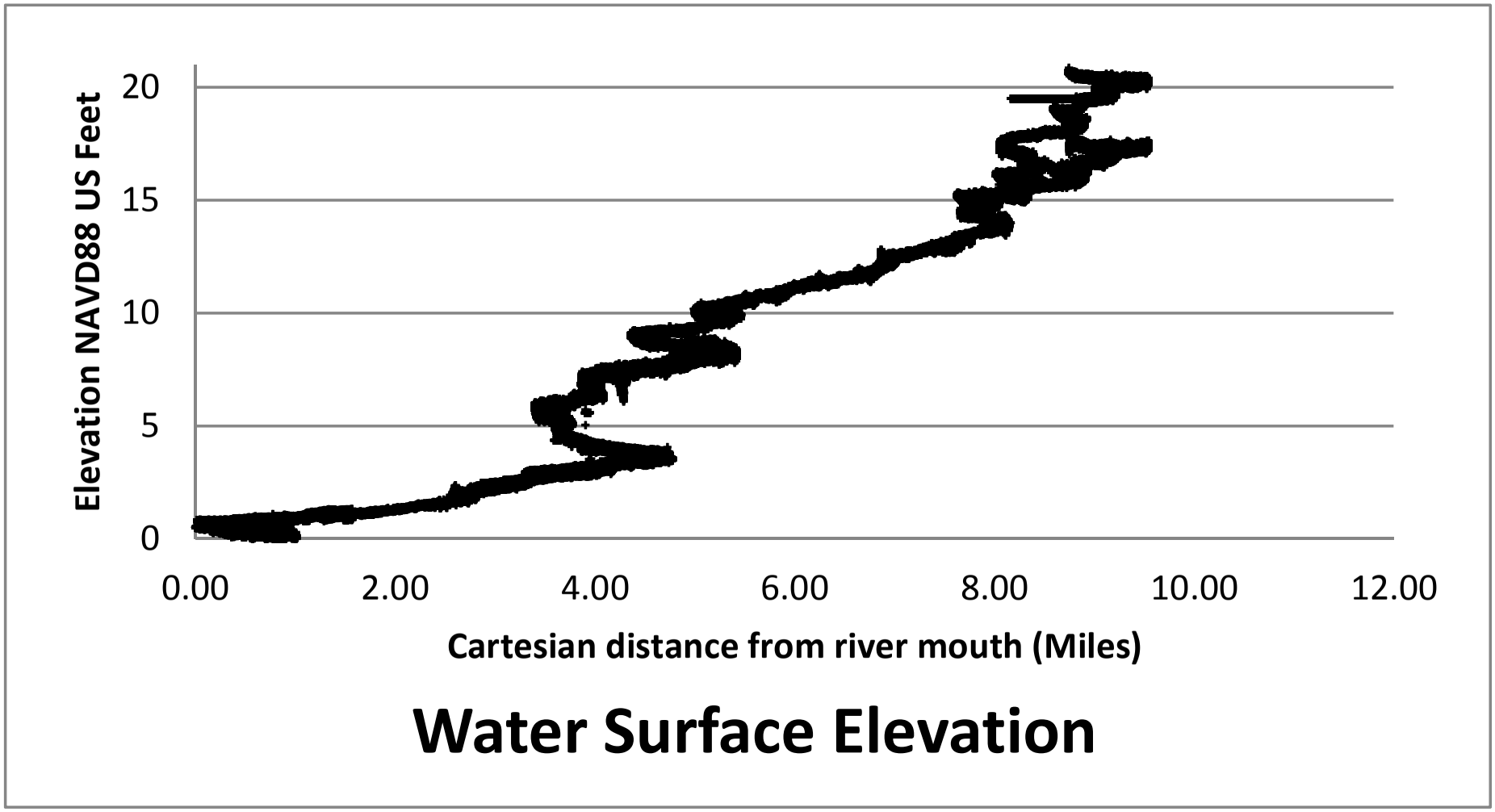
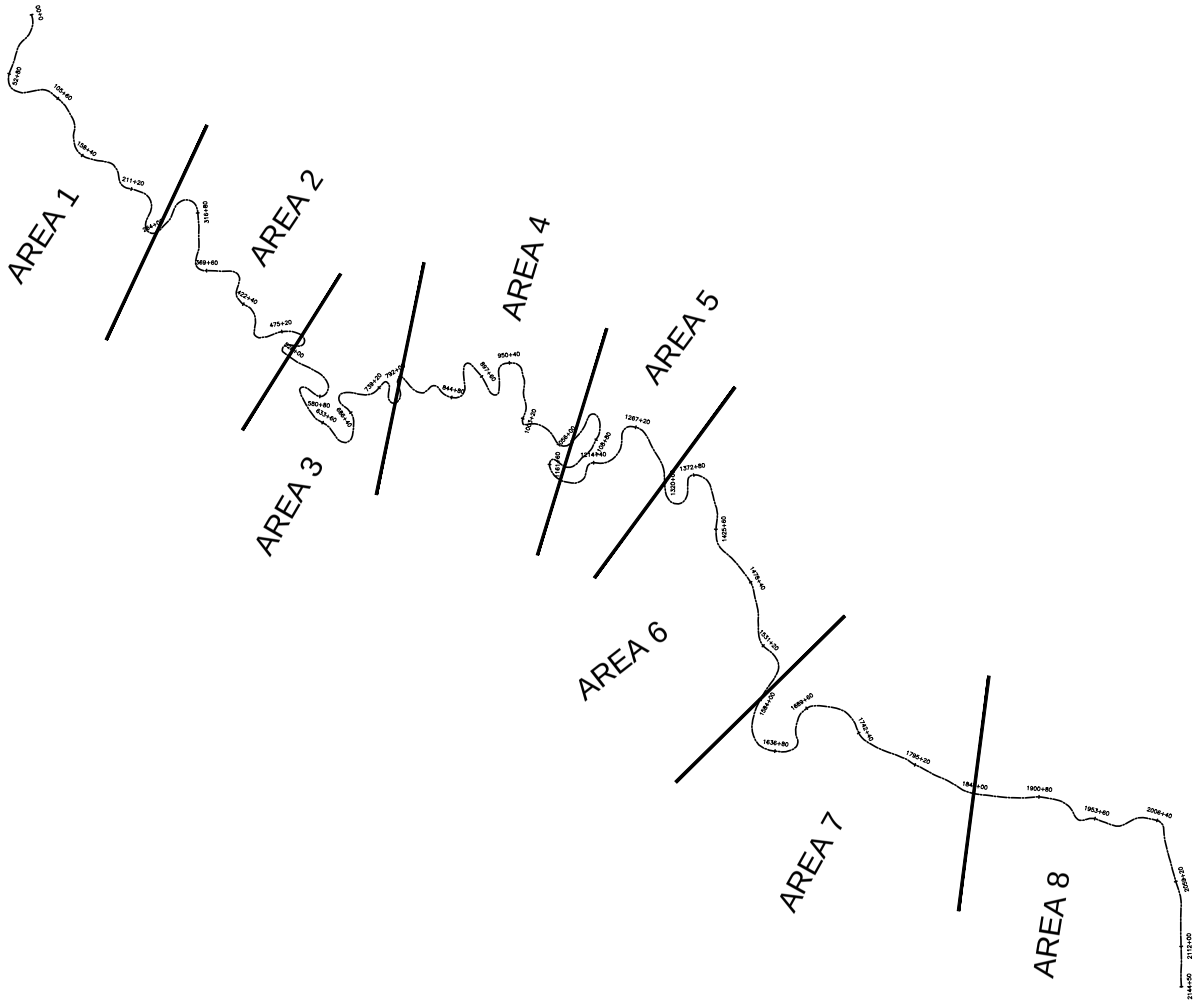


Figure 5. Triangulated irregular network (TIN) surfaces for a portion of the proposed channel in AutoCAD Civil 3D


Elevation NAVD88 US Feet
20
15
10
5
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Cartesian distance from river mouth (Miles)
Water Surface Elevation



0 5,000′ 10,000′
SCALE IN FEET

TRINITY RIVER AUTHORITY

PROJ. NO.: 021205	DATE: 8/1/2017	FILE: 4204 TRA surface

FIGURE 7

AREA LOCATION OF PORT OF LIBERTY CHANNEL

RPS
4801 Southwest Parkway,
Parkway 2, Suite 150
Austin, Texas 78735
(512) 326-5659
TBPE #F-293

SHEET
1 of 1

P:\active\7528_TRA_Port_of_Liberty\Cadd\Cut & Fill MLLW 8/1/2017 2:56 PM

Tables

Datum	Median WRP	MLLW	Difference (cyd)
Area	Channel6+1 (cyd)	Channel6+1 (cyd)	
1	2.1	678,142.4	678,140.3
2	4.4	622,115.5	622,111.1
3	4.2	102,840.7	102,836.5
4	0.0	17,733.9	17,733.9
5	0.0	3,768.6	3,768.6
6	0.0	363.4	363.4
7	26.5	16,453.3	16,426.7
8	25,881.1	41,822.4	15,941.4
Total	**25,918.2**	**1,483,240.2**	**1,457,322.0**

Table 1
Estimated Dredge Volumes for a 6+1'X100' channel using a Median Flow Hydraulic Reference Plane Datum and a MLLW Datum.

Datum	MLLW		Difference (cyd)
Area	Channel6+1 (cyd)	Channel9+1 (cyd)	
1	678,142.4	1,296,101.8	617,959.4
2	622,115.5	1,236,384.3	614,268.8
3	102,840.7	349,289.3	246,448.6
4	17,733.9	128,370.6	110,636.7
5	3,768.6	78,918.0	75,149.3
6	363.4	40,895.7	40,532.3
7	16,453.3	56,796.3	40,343.1
8	41,822.4	391,221.9	349,399.5
Total	**1,483,240.2**	**3,577,977.9**	**2,094,737.6**

Table 2
Estimated Dredge Volumes for a 9+1'X130' channel and a 6+1'X100' channel using the MLLW Datum.

Appendix 1

Gage Trinity River at Liberty, TX. (U.S. Geological Survey (USGS) station 08067000.

USGS Water-Year Summary 2016

08067000 Trinity River at Liberty, TX

LOCATION - Lat 30°03'27", long 94°49'05" referenced to North American Datum of 1927, Liberty County, TX, Hydrologic Unit 12030203, at downstream side of downstream bridge on U.S. Highway 90 in Liberty, 450 ft downstream from Texas and New Orleans Railroad Co. bridge, and at mile 40.3.

DRAINAGE AREA - 17,468 mi^2.

SURFACE-WATER RECORDS

PERIOD OF RECORD - Oct. 1938 to Sept. 1940 (gage heights, discharge measurements, and some records of daily discharge), Oct. 1940 to current year (daily mean discharges above 10,000 ft^3/s). Gage-height records collected in this vicinity since 1903 are contained in reports of the National Weather Service. PERIOD OF RECORD, Water-Quality.-- CHEMICAL DATA: Oct. 1970 to Aug. 1972. BIOCHEMICAL DATA: Oct. 1970 to Aug. 1972. PESTICIDE DATA: May 1971 to Aug. 1972.

REVISED RECORDS - WSP 1922: Drainage area.

GAGE - Water-stage recorder. Datum of gage is 2.22 ft below NGVD of 1929; unadjusted for land-surface subsidence. Prior to Mar. 13, 1973, nonrecording gage at site at same datum. Satellite telemeter at station.

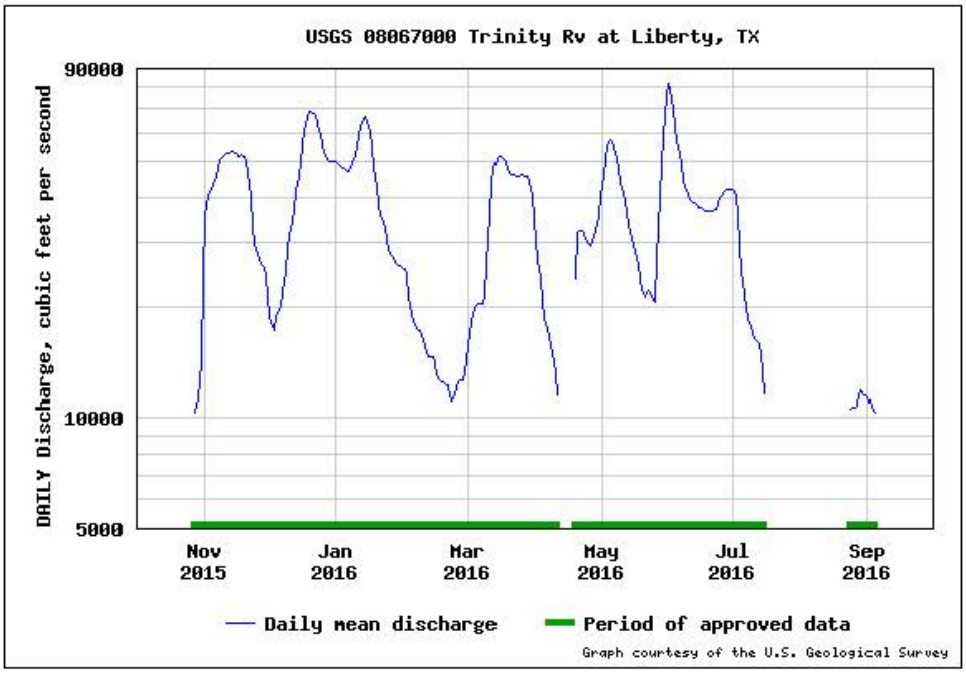
REMARKS - Since installation of gage in water year 1941, at least 10% of contributing drainage area has been regulated. Many diversions above station for municipal supplies, industrial uses, and irrigation. Some records listed in the "Period of Record" for surface water and water quality may not be available electronically.

EXTREMES OUTSIDE PERIOD OF RECORD - Flood of May 8-11, 1922, reached a stage of 28.6 ft, present datum, from observations by the National Weather Service at nonrecording gage on railroad bridge upstream.

EXTREMES FOR PERIOD OF RECORD - Maximum discharge, 135,000 ft^3/s, Oct. 21, 1994, gage height, 31.00 ft; minimum not determined (affected by tides); minimum gage height observed, 2.32 ft, Nov. 24, 1970. Maximum gage height since at least 1903, 31.00 ft, Oct. 21, 1994 (at 0500 hours).

U.S. Department of the Interior
U.S. Geological Survey

Suggested citation: U.S. Geological Survey, 2017, National Water Information System data available on the World Wide Web
(USGS Water Data for the Nation), accessed [July 25, 2017],
at URL //nwis.waterdata.usgs.gov/nwis/wys_rpt?dv_ts_ids=&133986&adr_begin_date=2015-10-01&adr_end_date=2016-09-30&site_no=08067000&agency_cd=USGS


USGS 08067000 Trinity Rv at Liberty, TX
DAILY Discharge, cubic feet per second
90000
10000
5000
Nov 2015
Jan 2016
Mar 2016
May 2016
Jul 2016
Sep 2016
Daily mean discharge
Period of approved data
Graph courtesy of the U.S. Geological Survey

Other Non-Federal Sponsors Letter(s) of Support

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City of Liberty.pdf

August 2, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen,

I am writing to express my support for The Trinity River Authority of Texas (TRA) WRRDA 7001 Proposal, "Trinity River & Tributaries Channel to Liberty Navigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project.

A recent market analysis of the Lower Trinity River Basin (Basin) reported robust agriculture, energy and manufacturing activities in a six-county region that could benefit from a reliable and improved TR&T navigation system, as global demand for movement of goods and resources drive the growth of future production within the Basin.

I sincerely hope that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Sincerely,

Dennis Beasley
President
Liberty Community Development Board

1829 Sam Houston Street Liberty, Texas 77575 936-336-3684 Fax: 936 336 9846 www.cityofliberty.org

JAY KNIGHT
COUNTY JUDGE

1923 SAM HOUSTON
LIBERTY, TEXAS 77575

THE COUNTY OF LIBERTY

Est. 1836

August 2, 2017

Colonel Paul E. Owen
Commander, Southwestern Division
US Army Corps of Engineers
1100 Commerce Street, Suite 831
Dallas, Texas 75242-1317

Dear Colonel Owen,

Please accept this letter as an indication of my support for The Trinity River Authority of Texas (TRA) WRRDA 7001 Proposal, "Trinity River & Tributaries Channel to Liberty Navigation Improvements Study." The Study would consist of a feasibility study to re-establish and improve to Liberty, Texas the navigation features of the Trinity River & Tributaries (TR&T) project.

A recently completed market analysis of the Lower Trinity River Basin reported robust activity in agriculture, energy and manufacturing in a six-county region, which includes Liberty County, that could benefit from a reliable and improved TR&T navigation system, as global demand for movement of goods and resources drive the growth of future production within the Basin.

My sincere wish is that the Army Corps of Engineers will give serious consideration to including this proposal in the 2018 Report to Congress on Water Resources Development.

Sincerely,

Jay H. Knight
County Judge
Liberty County Texas

936/336-4665 jay.knight@co.liberty.tx.us FAX: 936/336-4518

Map Document

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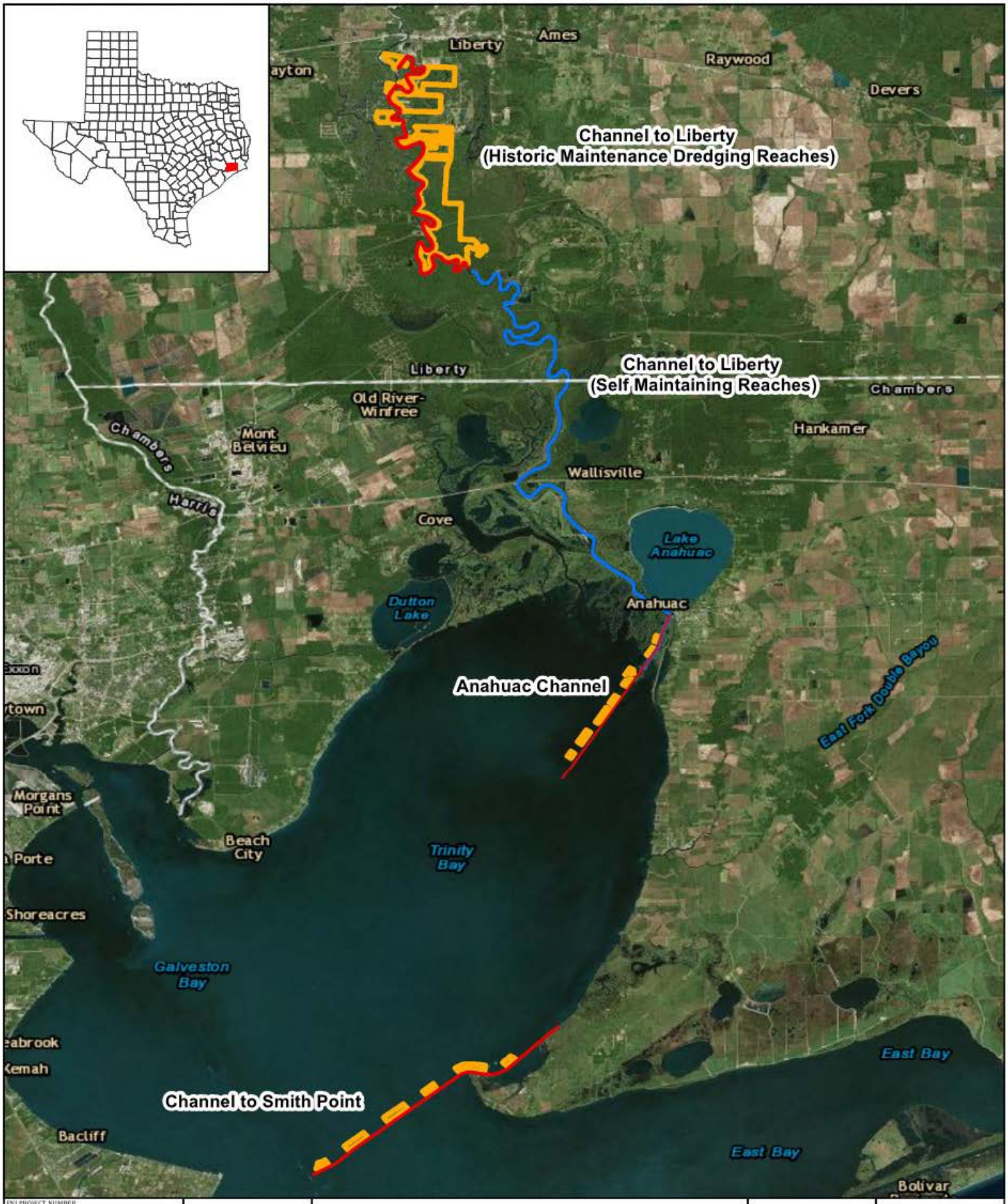
Project Map.pdf



FNI PROJECT NUMBER KIL12475 DATE CREATED Date: 7/31/2017 DATUM & COORDINATE SYSTEM NAD83 State Plane (Feet) Texas Central FILE NAME Name: Figure1_TrinityRiver_Tributaries PREPARED BY BCE	FREESE AND NICHOLS FREESE AND NICHOLS, INC. 10431 MORADO CIRCLE SUITE 300 AUSTIN, TEXAS 78759 PHONE: 512-617-3100 FAX: 512-617-3101	0 300 600 1,200 Feet US ARMY CORPS OF ENGINEERS GALVESTON DISTRICT **Trinity River and Tributaries, TX** Channel to Liberty (Trinity River), Anahuac Channel, & Channel to Smith Point	N W E S	**FIGURE**

Date Saved: 7/7/2017 8:53:06 AM

Path: H:\Trinity\Anahuac_USACE\Working\Figure1_TrinityRiver_Tributaries.mxd