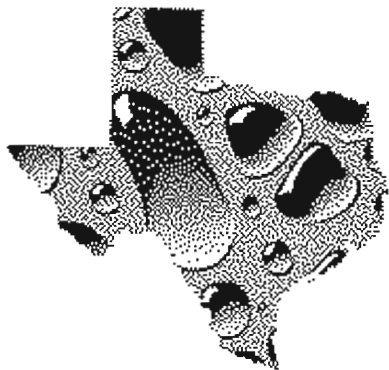




TRANS-TEXAS WATER PROGRAM

SOUTHEAST AREA

Draft Screening Report

Environmental Analysis of Potential Transfer Routes

February 1998

**Sabine River Authority of Texas
Lower Neches Valley Authority
San Jacinto River Authority
City of Houston
Brazos River Authority
Texas Water Development Board**

This document is a product of the Trans-Texas Water Program: Southeast Area. The program's mission is to propose the best economically and environmentally beneficial methods to meet water needs in Texas for the long term. The program's four planning areas are the Southeast Area, which includes the Houston-Galveston metropolitan area, the South-Central Area (including Corpus Christi), the North-Central Area (including Austin) and the West-Central Area (including San Antonio).

The Southeast Area of the Trans-Texas Water Program draws perspectives from many organizations and citizens. The Policy Management Committee and its Southeast Area subcommittee guide the program; the Southeast Area Technical Advisory Committee serves as program advisor. Local sponsors are the Sabine River Authority of Texas, the Lower Neches Valley Authority, the San Jacinto River Authority, the City of Houston and the Brazos River Authority.

The Texas Water Development Board is the lead Texas agency for the Trans-Texas Water Program. The Board, along with the Texas Natural Resource Conservation Commission, the Texas Parks & Wildlife Department and the Texas General Land Office, set goals and policies for the program pertaining to water resources management and are members of the Policy Management Committee.

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Executive Summary

The goal of the Trans-Texas Water Program (TTWP) is to identify the most cost-effective and environmentally sensitive strategies for meeting the current and future water needs of Texas. Phase II of the TTWP for the Southeast area of Texas is an in-depth feasibility analysis of water resource management strategies recommended in Phase I of the TTWP. The interbasin transfer of water under three potential water demand scenarios is one management strategy in consideration by the program. The three scenarios include 1) the transfer of 600,000 acre-feet/year to areas west of the Southeast Study Area; 2) the transfer of 300,000 acre-feet/year to areas west of the Southeast Study Areas; and 3) no increase in the transfer of water out of the Southeast Study Area.

The environmental issues for water transfer between the five river basins in the TTWP Southeast Study Area are considered for 16 basin-to-basin transfer routes (or segments). The preferred alternative alignment for transfer of water between the Sabine, Neches, San Jacinto, Trinity, and Brazos rivers is determined in this report through analysis of environmental issues along each potential transfer segment.

Interbasin Transfer Routes

The interbasin transfer segments are numbered consistently with the Phase I TTWP report. Of the 16 segments analyzed in this report, three segments transfer water from the Sabine River

to the Neches River (SN-1, SN-4a, and SN-4b). Three segments transfer water from the Neches River to the Trinity River (NT-1a, NT-3a, and NT-3b). Five segments run from the Trinity River to the San Jacinto River (TS-2a, TS-3a, TS-3b, TS-4a, and TS-4b). Four segments run from the San Jacinto River to the Brazos River (SB-1a, SB-1b, SB-1c, and SB-3). One segment (TB-1) runs directly from the Trinity River to the Brazos River without crossing the San Jacinto River.

Existing Environment for Segments

The existing environment along each of the 16 segments is described in terms of segment length, compatible land use, threatened and endangered species, river and stream crossings, wetlands, water quality, prime farmland soils, geology, public lands, and traffic. Sensitive natural communities, vegetational areas, fisheries, and cultural resources are discussed for the general vicinity surrounding the segments.

For portions of each segment requiring new construction, the area in consideration is a 200 foot right-of-way. For segments or portions of segments which run within an existing canal or drainageway, a smaller 100 foot right-of-way is considered. These right-of-ways are referred to as corridors in the remainder of the report. Generally the shorter segments have less environmental impact, as they disturb less area. However, portions of segments which run



1.0 Introduction

The Trans-Texas Water Program (TTWP) is a comprehensive water resources planning program created to evaluate a full range of water management strategies. The overall goal of the TTWP is to identify the most cost-effective and environmentally sensitive strategies for meeting the current and future water needs of some areas in Texas. The TTWP focuses on the Southeast, South-Central, North-Central, and West-Central Study Areas in Texas (Texas Water Development Board, (1995). This report focuses on the Southeast Study Area, which is shown in Figure 1.1.

Phase I of the TTWP was intended as an initial coarse screening of a broad range of water management strategies for each study area. Evaluations of each alternative were conducted in terms of technical feasibility, cost, legal and institutional issues, and other factors. The product of Phase I was a conceptual water management plan for each study area consisting of alternatives for further investigation in Phase II. A report summarizing the results of the Phase I investigation for the Southeast Study Area was published in March 1994. The report included recommendations regarding the water management strategies to be evaluated in Phase

II. The recommendations for potential strategies to be evaluated are:

- implementation of aggressive water conservation programs in the Houston metropolitan area;
- wastewater reclamation and reuse, particularly by industries in the Houston area;
- systems operation of existing surface-water reservoirs to increase their effective yield;
- contractual water transfers;
- new surface-water supply projects (*i.e.*, a permanent saltwater barrier on the lower Neches River and the new Allens Creek Reservoir); and
- transfer of water from the Sabine River Basin to the Houston area.

These strategies will be considered in the context of three water demand scenarios also described in the Phase I report. Scenario 1 represents the TWDB's proposed plan for new water supply development in the San Antonio area. Under this plan, transfer of additional water from the southeast would need to begin by 2010 and would increase to 600,000 acre-feet per year by 2050. Scenario 3 includes the TWDB's proposed plan, but also adds additional local projects and wastewater reuse to the proposed supply, resulting in a delay of the need for southeast water transfers until the year 2020. This plan also results in a reduction of the amount needed west of the Brazos in 2050 to 300,000 acre-feet per year. Scenario 3 assumes extensive development of local water resources west of the Brazos River basin and does not include any Southeast area water supplying the San Antonio area.



2.0 Interbasin Transfer Routes

2.1 Route Selection

The feasibility of interbasin transfers is an important issue for the Trans-Texas Water Program. The Phase I investigation provided a preliminary study and screening of the available transfer route alternatives. This Phase II report includes a more detailed study of the interbasin transfer routes that were recommended in the Phase I report for further analysis (Figure 2.1).

2.2 Sabine River Basin to Neches River Basin

The Phase I study analyzed six separate transfer corridors between the Sabine and Neches rivers. After preliminary analysis, Segments SN-1, SN-4a, and SN-4b were chosen for further study (Figure 2.1).

Segment SN-1 begins at Toledo Bend Reservoir and traverses the watershed divide to Sam Rayburn Reservoir. From there, the natural flow path carries the water down the Angelina River to B.A. Steinhagen Lake on the Neches River. This segment makes use of existing reservoirs and stream channels and is the only segment which diverts water directly from Toledo Bend Reservoir. This segment has a high static lift.

Segment SN-4a uses the existing Sabine River Authority (SRA) canal for a short distance beginning at the SRA's pump station facilities in Orange County. The segment leaves the SRA canal approximately five miles west of the

SRA's pump station facilities and runs due west to the Neches River at Lakeview. From this point the water will flow south in the Lakeview Canal through the Jack Gore Baygall unit of the Big Thicket National Preserve (BTNP) to the Lower Neches Valley Authority's (LNVA) Neches First Lift Pump Station. This segment requires a short distance of new conveyance facilities and utilizes existing facilities that are owned by the SRA and LNVA. Segment SN-4a has a very low static lift.

Segment SN-4b begins at the existing SRA pump station facilities in Orange County and uses the SRA Main Canal to Cow Bayou. From this point, the alignment proceeds to the west and ends at the LNVA's First Lift pump station at the Neches River in Jefferson County. This alignment completely avoids the BTNP and has a very low static lift.

2.3 Neches River Basin to Trinity River Basin

The Phase I study analyzed eight separate transfer corridors between the Neches and Trinity rivers. After preliminary analysis, Segments NT-1a, NT-3a, and NT-3b were chosen for further study (Figure 2.1).

Segment NT-1a begins at B.A. Steinhagen Lake and runs westward and southward, avoiding of the BTNP. The western terminus of the route is a transfer station just east of the Trinity River near Romayor. The topography is rough and would involve a substantial static lift. The entire length of Segment NT-1a would require the construction of new facilities.

2.5 San Jacinto River Basin to Brazos River Basin

The Phase I study analyzed five segments between the San Jacinto and Brazos rivers. After preliminary analysis, Segments SB-1a, SB-1b, SB-1c, and SB-3 were chosen for further study (Figure 2.1).

Segment SB-1a begins at a transfer station on the east side of the West Fork San Jacinto River south of Conroe in Montgomery County. This segment travels westward to the Grimes County line, whereupon it turns north. After traveling approximately 10 miles northward, the alignment turns to the west again and heads due west toward Navasota in Grimes County. This segment ends at a transfer station on the east side of the Brazos River near Navasota. The static lift for this segment is very high.

Segment SB-1b begins at the same point as SB-1a in Montgomery County but branches southwest to a point where it crosses the watershed divide between the San Jacinto and Brazos rivers just east of Hempstead in Waller County. Once the water is in the Brazos River Basin, it would be released into a natural channel and, from there, would flow downstream to points where it would be picked up for transfer farther west. It is not known at the time of this report if transferred water will be blended with that of the Brazos River before being transferred westward. This segment has a very high static lift.

Segment SB-1c begins at the same point as SB-1a and SB-1b but heads in a southerly direction towards Wallis in Waller County in the Brazos

River Basin. The terminus for this segment is the proposed Allens Creek Reservoir. This segment also has very high static lift.

Segment SB-3 is the only segment that transfers water to Lake Somerville. This segment begins at a transfer station on the east side of the Brazos River near Navasota and follows the valley of Yegua Creek to Lake Somerville. The static lift of this segment is high.

2.6 Trinity River Basin to Brazos River Basin

Only one segment, Segment TB-1, moves water directly from the Trinity River to the Brazos River. Segment TB-1 begins at the west side of Lake Livingston, near the U.S. Highway 190 bridge in San Jacinto County, and goes westward, running north of Huntsville, to discharge into the headwaters of Gibbons Creek in the Brazos River Basin. The water would then flow downstream, to be recovered for transfer to the West-Central Area. This segment bypasses the San Jacinto River Basin to transfer water directly from Lake Livingston into the Brazos River Basin. The topography along this segment is generally hilly and much of the alignment would not be suitable for canals. This segment has the highest static lift of any single segment in the study.



3.0 Existing Environment for Alternative Segments

This section discusses the various environmental conditions in the areas crossed by the 16 segments selected for further analysis in Phase II. Conditions related to land use, threatened and endangered species, hydrology, water quality, wetlands, soils and geology, public lands, and traffic descriptions are discussed in this section and summarized at the end of the section in Table 3.9.

3.1 Compatible Land Use

This section describes the types and area of land use along the 16 transfer route segments. Land use types were determined by comparing the proposed transfer routes to 1:24,000 and 1:20,000 scale aerial photos and 1:24,000 scale topographic maps of the affected areas. A 200-foot corridor was assumed for those portions of each segment which would involve a new channel. When possible, a 100-foot corridor (50 feet on each side) was assumed for those portions of each segment which would use an existing drainageway. Table 3.1 lists the segments, the total length for each, and the amount of each segment which would utilize existing drainageways, e.g., canals, streams, rivers. Table 3.2 provides the area of the three dominant land use types along the proposed transfer route segments. Table 3.2 presents the area within the segment corridor as well as the area within the corridor of the downstream flow path. Woodlands were characterized as natural areas covered by trees. On the aerial photos, woodland areas appeared as dark patches.

Agriculture was composed of areas that were cleared for cultivation purposes, rangeland, or pastureland. The main indicators of agriculture on aerial photos were cleared land, plowed contours, and irrigation ditches within the fields. Common irrigation patterns in the project area were contours plowed to match the topography of the field. The few urban areas within the project area were characterized by streets, parking lots, and closely spaced residential and commercial areas. It appears that some of the urban areas could be avoided during the actual final placement of the proposed routes.

Some of the routes followed existing canals or streams. The impact to the existing land uses would be much less along the existing channels than along the areas where a new channel would cut across the landscape.

Segment SN-1

The majority of Segment SN-1 crosses through woodlands (454 acres). The aerial photos for Jasper County show that the woods are thick, mature forests with occasional clearings due to pipelines or roads. Much of the area in this segment which is considered agricultural land is cleared rangeland or pastureland and is not active cropland. In Jasper County, the downstream flow path of Segment SN-1 runs within the existing channel of the Angelina River. The total length of Segment SN-1 is approximately 19 miles.

Table 3.2
Land Use along the Proposed Transfer Segments

Segment	Woodlands (acres)	Urban (acres)	Agricultural (acres)
SN-1	454	0	0
SN-4a	513	0	105
SN-4b	548	158	68
NT-1a	1,123	85	191
NT-3a	535	0	287
NT-3b	325	58	834
TS-2a	824	0	107
TS-3a	844	0	78
TS-3b	211	0	0
TS-4a	151	0	243
TS-4b	51	5	191
SB-1a	844	0	417
SB-1b	696	0	106
SB-1c	524	0	1,001
SB-3	150	0	445
TB-1	603	0	483

Segment SN-4a

Segment SN-4a crosses through 513 acres of woodlands and 105 acres of agricultural lands. The segment would run within the existing channel of the LNVA canal for approximately one-third the length that it crosses woodlands. The remaining two-thirds would require construction of a new channel through woodlands. The total length of the prospective alignment for Segment SN-4a is approximately 29 miles.

Segment SN-4b.

Segment SN-4b runs mainly through woodlands. Segment SN-4b crosses through more urban areas than any of the other prospective routes. The urban areas that the route crossed were Forest Heights and Vidor, Texas. Forest Heights is a small residential community that can be avoided by moving the final alignment. The route also runs through the outskirts of the town of Vidor. Approximately two-thirds of Segment SN-4b runs adjacent to Indian Bayou. The total length

approximately 21 miles of Luce Bayou, to Lake Houston.

Segment TS-4a

Segment TS-4a crosses through 243 acres of agricultural lands and 151 acres of woodlands. The wooded areas are interspersed along the route with concentrations near the beginning of the segment at the Trinity River and after the segment leaves the LNVA canal. The total length of the prospective alignment for Segment TS-4a is approximately 19 miles.

Segment TS-4b.

Segment TS-4b crosses through woodlands which are primarily interspersed among agricultural lands. The largest wooded area is near the beginning of the segment at the Trinity River. The entire route uses the existing LNVA Canal. For purposes of this study, it was assumed that the area of previous impact for the LNVA Canal was 100 feet wide. However, it is anticipated that the LNVA Canal may need widening, new parallel roads, or other ancillary facilities to accommodate the proposed project. Therefore, the area of impact for Segment TS-4b was limited to the outer 50-foot wide bands contained within a 200-foot right-of-way. Based on these measurements, Segment TS-4b would cross through 51 acres of woodlands, five acres of urban area, and 191 acres of agricultural lands. The total length of the prospective alignment for Segment TS-4b is approximately 20 miles.

Segment SB-1a.

Segment SB-1a crosses through both woodlands

and agricultural lands. Woodlands account for approximately two-thirds the length of Segment SB-1a (844 acres), while agriculture accounts for the remaining one-third (417 acres). The woodlands vary from dense, mature woodlands to thin patches of younger trees. Segment SB-1a does not follow any existing channel, so an entirely new channel would have to be constructed through the woodlands. The total length of the prospective alignment for Segment SB-1a is approximately 41 miles.

Segment SB-1b.

Segment SB-1b crosses approximately 696 acres of woodlands and 106 acres of agricultural lands. The total length of the prospective alignment for Segment SB-1b is approximately 35 miles. The downstream flow path extends approximately 47 miles into the Clear Creek channel.

Segment SB-1c.

Segment SB-1c crosses approximately 524 acres of woodlands and 1,001 acres of agricultural lands. The first half of Segment SB-1c consists of the same alignment as the first half of Segment SB-1b. Segment SB-1c does not follow any existing channel, so an entirely new channel would have to be constructed. The total length of the prospective alignment for Segment SB-1c is approximately 63 miles.

Segment SB-3

Segment SB-3 crosses through 445 acres of agricultural lands and 150 acres of woodlands. The woodland areas are fairly evenly distributed among the mostly agricultural or rangeland

Table 3.3
Natural Communities on the Texas Organization of Endangered Species Lists
Located within the Trans-Texas Water Program Southeast Area

Community Type	Status ¹
American Beech-Southern Magnolia Series (<i>Fagus grandifolia</i> - <i>Magnolia grandiflora</i>)	G3, S2
American Beech-White Oak Series (<i>Fagus grandifolia</i> - <i>Quercus alba</i>)	G3, S2
Bald Cypress-Water Tupelo Series (<i>Taxodium distichum</i> - <i>Nyssa aquatica</i>)	G4, S3
Bluejack Oak-Pine Series (<i>Quercus incana</i> - <i>Pinus</i> spp.)	G4, S3
Coastal Live Oak-Pecan Series (<i>Quercus virginiana</i> - <i>Carya illinoensis</i>)	G3, S3
Little Bluestem-Nuttall's Rayless Golden-Rod Series (<i>Schizachyrium scoparium</i> - <i>Bigelovia nuttallii</i>)	G3, S3
Longleaf Pine-Beakrush Series (<i>Pinus palustris</i> - <i>Rhynchospora</i> spp.)	G3, S2
Longleaf Pine-Little Bluestem Series (<i>Pinus palustris</i> - <i>Schizachyrium scoparium</i>)	G3, S2
Sphagnum-Beakrush Series (<i>Sphagnum</i> spp.- <i>Rhynchospora</i> spp.)	G4, S2
Swamp Chestnut Oak-Willow Oak Series (<i>Quercus prinus</i> - <i>Quercus phellos</i>)	G3, S3
Water Oak-Coastal Live Oak Series (<i>Quercus nigra</i> - <i>Quercus virginiana</i>)	G3, S3
Water Oak-Willow Oak Series (<i>Quercus nigra</i> - <i>Quercus phellos</i>)	G4, S3

Source: Hayes, 1992

¹ Status according to the Texas Biological and Conservation Data System. G3 - Very rare with 21 to 100 occurrences; G4 - Apparently secure globally; S2 - Imperiled in Texas, very rare with 6 to 20 occurrences in Texas; S3 - Rare in Texas with 21 to 100 occurrences (Hayes, 1992).

Segment SN-4b.

Segment SN-4b extends from the Sabine River basin in Orange County to the LNVA's First Lift pump station at the Neches River. This transfer route crosses the Pineywoods Vegetational Area.

Segment NT-1a.

Segment NT-1a extends from B.A. Steinhagen Lake on the Neches River to the Trinity River basin near Romayor. This transfer route crosses through the Pineywoods Vegetational Area.

Segment NT-3a.

Segment NT-3a extends from the LNVA First Lift north of Beaumont to the Trinity River basin between Moss Hill and Hardin. This transfer route crosses the Pineywoods and Gulf Prairies and Marshes vegetational areas.

Segment NT-3b.

Segment NT-3b extends from the LNVA's First Lift pump station to the Trinity River basin south of Liberty in Liberty County. This transfer route crosses through the Pineywoods and Gulf Prairies and Marshes vegetational areas of Texas.

Segment TS-2a.

Segment TS-2a extends from the Trinity River basin near Romayor to the San Jacinto River basin southeast of Conroe. This segment crosses the Pineywoods Vegetational Area.

Segment TS-3a.

Segment TS-3a extends from the Trinity River basin between Moss Hill and Hardin to the San Jacinto River basin south of Conroe. This transfer route crosses the Pineywoods Vegetational Area.

Segment TS-3b.

Segment TS-3b extends from the Trinity River basin westward to Luce Bayou, where water is then allowed to flow freely to Lake Houston. This transfer route passes along the boundary of the Pineywoods and Gulf Prairies and Marshes vegetational areas.

Segment TS-4a.

Segment TS-4a extends from the Trinity River basin south of Liberty westward to Lake Houston. This transfer route crosses the Pineywoods and Gulf Prairies and Marshes vegetational areas.

Segment TS-4b.

Segment TS-4b extends from the Trinity River basin and south of Liberty westward to Lynchburg Reservoir. This transfer route crosses the Gulf Prairies and Marshes Vegetational Area.

Segment SB-1a.

Segment SB-1a extends from the San Jacinto River basin westward to the Brazos River basin south of Navasota. This route crosses the Pineywoods and Blackland Prairies vegetational areas.

Pimephales promelas, *Cycleptus elongatus*, *Fundulus zebrinus* and *Etheostoma spectabile*.

The Brazos River system is the largest basin in the study area and is one of the most distinctive with respect to fish species. Twelve species reach their southwestern range limits in the Brazos system. These include: *Esox americanus*, *Hybopsis streriana*, *Notropis atrocaudalis*, *Erimyzon oblongus*, *Cyprinodon rubrofluvialis*, *Fundulus blairae*, *F. Olivaceus*, *Centrarchus macropterus*, *Elassoma zonatum*, *Lepomis marginatus*, *Pomoxis nigromaculatus* and *Etheostoma parvipinne*. The Brazos River system also contains two endemic riverine shiners, *Notropis buccula* and *N. oxyrhynchus*.

3.2.3 Threatened and Endangered Species

The following discussion describes the federally listed and state-listed threatened and endangered species whose ranges overlap the Southeast Area of the Trans-Texas Water Program. Appendix B contains species descriptions for each of these species and a matrix depicting which species possibly occur within each segment according to the U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD) records.

The red-cockaded woodpecker (*Picoides borealis*) and bald eagle (*Haliaeetus leucocephalus*) are listed for all segments. The Arctic peregrine falcon (*Falco peregrinus tundrius*), white-faced ibis (*Plegadis chihi*), American swallow-tailed kite (*Elanoides forficatus*), wood stork (*Mycteria americana*), Texas horned lizard (*Phrynosoma cornutum*), and timber rattlesnake (*Crotalus horridus*

autriculaudatus) are listed as possibly occurring within segments between the Sabine and San Jacinto rivers, as well as Segments SB-1b, SB-1c, SB-3, and TB-1. The remaining species that possibly occur in the Southeast Area include the interior least tern (*Sterna antillarum*), Attwater's greater prairie chicken (*Tympanuchus cupido attwateri*), brown pelican (*Pelecanus occidentalis*), whooping crane (*Grus americana*), piping plover (*Charadrius melodus*), Bachman's sparrow (*Aimophila aestivalis*), reddish egret (*Egretta rufescens*), white-tailed hawk (*Buteo albicaudatus*), mountain plover (*Charadrius montanus*), black bear (*Ursus americana*), Rafinesque's big-eared bat (*Plecotus rafinesquii*), Houston toad (*Bufo houstonensis*), western smooth green snake (*Liophorophis vernalis*), alligator snapping turtle (*Macrochelys temminckii*), northern scarlet snake (*Cemophora coccinea copei*), paddlefish (*Polyodon spathula*), blue sucker (*Cycleptus elongatus*), creek chubsucker (*Erimyzon oblongus*), blackside darter (*Percina maculata*), prairie dawn (*Hymenoxys texana*), Texas trailing phlox (*Phlox nivalis ssp. texensis*), and Navasota ladies'-tresses (*Spiranthes parksii*).

3.3 Cultural Resources

No information is readily available regarding the presence of cultural resources within the proposed project area. The Texas Historical Commission will require a survey of the proposed alignment, and at that time adequate information should become available concerning cultural resources of the area.

faster moving streams with slightly higher gradients. The south and east portions of the study area are characterized by slower moving streams contained in meandering channels which cut through rich, deep soils. Rivers and larger perennial streams are classified water bodies and are subject to designated water quality standards by TNRCC.

Lakes in the study area are comprised of tributary and main stem reservoirs and exhibit a wide variety of hydrological regimes. Larger lakes are utilized for drinking water, irrigation, and recreation. These impoundments are generally classified water bodies and are subject to designated water quality standards by TNRCC. Smaller impoundments which occur on small, unclassified stream segments may not be subject to designated water quality standards.

Transfer segments will utilize existing stream channels, canals, lakes, and drainageways whenever possible in order to minimize construction and environmental impacts to surrounding areas. Conversely, construction of new transfer facilities may be preferable if the use of existing drainageways results in adverse water quality or environmental consequences. A detailed study of existing flow characteristics will be necessary to quantify hydrologic requirements and capacity of each proposed receiving stream or drainageway, as this report provides only a qualitative analysis.

Interbasin transfer segments designed to move water across basins are necessarily constructed perpendicular to the overall stream patterns of the study area. This results in a number of stream channels which may be crossed by each proposed segment. Discussion of stream

crossings are included in the hydrology and water quality section of this report because the potential environmental consequences of construction or expansion of these facilities most directly affects hydrologic and water quality characteristics. Construction activities at these crossing sites can contribute suspended solids and other pollutants to the stream as well as disrupt or change the hydrologic characteristics of the channel. Stream crossing data were collected using USGS 7.5" quads which include the segment corridors within the study area. Table 3.4 contains the number of intermittent and perennial stream crossings and the number of major river crossings contained in the proposed path of each segment. Because the engineering and construction considerations are greater for major river crossings than for smaller stream crossings, they are presented separately in the table.

The most appropriate sites and methods of transferring water across stream and river channels will be chosen depending on site specific environmental and engineering constraints. A discussion of the number and types of stream crossings required by each segment is located in the segment-by-segment discussion below.

The quality of the state's water resources is protected and regulated by the Texas Natural Resource Conservation Commission (TNRCC). On even numbered years the TNRCC prepares The State of Texas Water Quality Inventory which is submitted to the United States Environmental Protection Agency (EPA) in accordance with Section 305(b) of the Clean Water Act. This report includes descriptions of surface water quality within each classified segment in each river and coastal basin in the

Table 3.4
Number of Stream and River Crossings for Each Segment

Segment	Number of River Crossings	Number of Perennial Stream Crossings	Number of Intermittent Stream Crossings
SN-1	0	4	25
SN-4a	1	2	17
SN-4b	1	3	7
NT-1a	0	6	45
NT-3a	0	3	13
NT-3b	0	4	30
TS-2a	1	7	20
TS-3a	1	11	10
TS-3b	0	5	1
TS-4a	0	2	4
TS-4b	0	1	0
SB-1a	0	5	80
SB-1b	0	5	52
SB-1c	0	6	58
SB-3	0	8	24
TB-1	0	10	69

All twelve river segments are designated by TNRCC as having a Contact Recreation use. Eight of these twelve are classified as supporting their Contact Recreation use. Fecal coliform contamination is the major cause of non-attainment in the remaining four river segments (Sabine 503, Neches 610, Trinity 802, and Brazos 1202).

Eleven of the twelve river segments are designated by TNRCC as Public Water Supply waters. All eleven of these river segments are classified as fully supporting their Public Water Supply use. All twelve of the river segments are also designated by TNRCC as having a High Aquatic Life use. Five of the twelve are supporting their High Aquatic Life use, while the remaining seven are classified as partially supporting. Major causes of non-attainment in

Contributing River Segment	Transfer Segments and Receiving River Segment(s)	Classification of River Segment	Designated Uses of River Segment	Support of Designated Uses	Water Quality Concerns
Trinity 0803 Lake Livingston	TB-1 to Gibbons Crk which flows to Brazos 1209 which flows to Brazos 1202	Water Quality Limited (wq standards violation)	Contact Recreation High Aquatic Life Public Water Supply	Supporting Partially Supporting Supporting	temperature; dissolved oxygen; ions; nutrients; chlorophyll-a; manganese in sediment, PCBs in fish tissue
Trinity 0802 below Lake Livingston	TS-2a,3a to San Jacinto 1004; TS-3b to San Jacinto 1002	Water Quality Limited (wq standards violation)	Contact Recreation High Aquatic Life Public Water Supply	Not Supporting Partially Supporting Supporting	TDS; fecal coliform; nutrients; dissolved cadmium causing partial support of aq life use
Trinity 0801 Trinity River Tidal	TS-4a San Jacinto 1002 TS-4b Lynchburg Reservoir	Effluent Limited	Contact Recreation High Aquatic Life	Supporting Supporting	fecal coliform; nutrients
San Jacinto 1004 West Fork San Jacinto River	SB-1a,b Brazos 1202 SB-1C Allens Creek Reservoir	Water Quality Limited (advanced waste treatment required)	Contact Recreation High Aquatic Life Public Water Supply	Supporting Supporting Supporting	fecal coliform; nutrients; chlorophyll-a;
San Jacinto 1002 Lake Houston	hydraulic terminus (does not flow to bay)	Water Quality Limited (public water supply; wq standards violations; advanced waste treatment required)	Contact Recreation High Aquatic Life Public Water Supply	Supporting Partially Supporting Supporting	TDS; ions; pH; fecal coliform; DO; nutrients, diazinon; dissolved lead and cadmium in water

these river segments are suppressed dissolved oxygen concentrations and fish tissue contamination by metals and toxic substances.

Four of the river segments are fully supporting all of their designated uses. These include Sabine 504, Neches 0603, Trinity 801, and San Jacinto 1004. Even though these water bodies are supporting their designated uses, occasionally elevated concentrations of fecal coliform bacteria, chlorides, TDS, metals and nutrients continue to be a concern.

Water transferred westward to the Brazos River basin will be picked up for transfer before its entry into the Brazos River or will be stored in Somerville Lake or the proposed Allen's Creek Reservoir. Blending transferred water with that of the Brazos before use by the public is not a desired option because of the relatively high dissolved solids concentrations of the Brazos River. A discussion of the quality of water potentially carried or affected by each transfer segment is also located in the segment-by-segment discussion below.

Segment SN-1.

Segment SN-1 carries water from Toledo Bend Reservoir (Sabine River segment 504), crosses four perennial and 25 intermittent streams before ending at an eastern arm of Sam Rayburn Reservoir (Neches River segment 610). The flow path continues through the reservoir, into the Angelina River (Neches River segment 609), and then to B.A. Steinhagen Lake (Neches River segment 603).

Toledo Bend Reservoir is fully supporting its designated uses of Contact Recreation, High Aquatic Life and Public Water Supply. Water quality concerns of the reservoir include metals, nutrients and sulfate. A restrictive fish consumption advisory was established in November 1995 due to elevated metals concentrations in fish tissue.

Water from Toledo Bend Reservoir will be transferred via a new canal to Sam Rayburn Reservoir. Water quality concerns at Sam Rayburn Reservoir include depressed dissolved oxygen, nutrients, and metals. A restrictive fish consumption advisory was also established for Sam Rayburn Reservoir in November 1995 due to elevated metals in fish tissue. Sam Rayburn Reservoir is supporting its designated use as a Public Water Supply but is not supporting its uses as Contact Recreation or High Aquatic Life.

Although the constructed segment ends at Sam Rayburn Reservoir, the flow pathway continues through the reservoir, to the Angelina River and into B.A. Steinhagen Lake. The Angelina River (Neches River segment 609) is fully supporting its designated uses of Contact Recreation, High Aquatic Life and Public Water Supply. Although water quality is good, concerns include low dissolved oxygen concentrations in the upper portion of the segment. B.A. Steinhagen Lake (Neches River segment 603) is also fully supporting its designated uses of Contact Recreation, High Aquatic Life and Public Water Supply. Water quality concerns include metals in fish tissue and elevated nutrient concentrations.

dissolved metals concentrations.

Segment NT-3a.

Segment NT-3a begins at the LNVA First Lift pump station and utilizes both the existing LNVA Canal and a new canal. The segment crosses 4 perennial and thirteen intermittent streams before arriving at a transfer point located just east of the Trinity River segment 802.

The quality of water entering segment NT-3a may be affected by water quality of the Neches River segment 602 and potential connecting transfer segments. At the time of this report it is not known if the transferred water will be blended with that of the Trinity River segment 802 near the end of the transfer segment. Water quality concerns for Neches River segment 602 and Trinity River segment 802 are presented above.

Segment NT-3b.

Segment NT-3b also begins at the LNVA First Lift pump station and utilizes the LNVA Canal before diverging from NT-3a. Segment NT-3b continues in the LNVA canal until it enters a new canal which terminates at a transfer point south of Liberty and east of the Trinity River segment 801. The new canal crosses four perennial streams, approximately 30 intermittent streams, and numerous drainage ditches.

The quality of water carried by this transfer segment is potentially affected by the water

quality of Neches River segment 602 and potential contributing transfer segments located upstream. A discussion of the water quality concerns of Neches River segment 602 is presented above. At the time of this report it is not known if the transferred water will be blended with that of the Trinity River segment 801 near the end of the transfer segment. Trinity River segment 801 is fully supporting its Contact Recreation and High Aquatic Life uses. This river segment is tidally influenced and is not designated as a public water supply. Water quality concerns of the river segment include elevated fecal coliform and nutrient concentrations.

Segment TS-2a.

Segment TS-2a begins at the transfer station just east of the Trinity River segment 802 near Romayor. The segment crosses the Trinity River via a new transfer facility and continues to a transfer point located on the east side of the West Fork San Jacinto River segment 1004 southeast of Conroe. The segment crosses seven perennial streams and approximately 20 intermittent streams.

It is unknown at the time of this report whether transferred water will be blended with that of the Trinity River segment 802, at the beginning of the transfer segment, or with that of the San Jacinto River segment 1004 near the end of the segment. Water quality concerns of Trinity River segment 802 are presented above. San Jacinto River segment 1004 is fully supporting its designated uses of Contact Recreation, High Aquatic Life and Public Water Supply. Water

Segments SB-1a, SB-1b, and SB-1c.

All three proposed segments for transferring water from the San Jacinto River basin to the Brazos River basin begin south of Conroe on the east side of the San Jacinto River segment 1004. These three transfer segments flow along the same route for approximately eight miles and utilize new conveyance facilities for their entire length. The segments cross three intermittent streams before Segment SB-1a splits to the north.

Segment SB-1a continues northwest, crossing 77 intermittent and five perennial streams on its way to a transfer station on the east side of the Brazos River segment 1202 near the confluence with the Navasota River (Brazos River segment 1209). It is unknown at the time of this report whether transferred water will be blended with that of the San Jacinto River segment 1004, near the beginning of the transfer segment, or with that of the Brazos River segments 1202 or 1209 near the end of the transfer segment. Water quality concerns of the San Jacinto River segment 1004 are presented above. The Navasota River (Brazos River 1209) is partially supporting its Contact Recreation use and fully supporting its High Aquatic Life and Public Water Supply uses. Water quality concerns of the Navasota River include elevated concentrations of fecal coliform bacteria, nutrients, and chlorophyll-a. The Brazos River segment 1202 is not supporting its Contact Recreation use and is fully supporting its High Aquatic Life and Public Water Supply uses. Water quality concerns of this segment of the

Brazos River include elevated fecal coliform bacteria, nutrient, and chlorophyll-a concentrations.

From the split with Segment SB-1a, transfer segments SB-1b and SB-1c continue south and west, crossing approximately 27 intermittent and two perennial streams.

Segment SB-1b then splits from SB-1c and continues southwest, crossing fourteen intermittent and one perennial stream before entering the stream channel of Clear Creek. Clear Creek enters the Brazos River segment 1202 below its confluence with the Navasota River. It is unknown at the time of this report whether transferred water will be blended with that of the San Jacinto River segment 1004, near the beginning of the transfer segment, or with that of the Brazos River segment 1202 near the end of the transfer segment. Water quality concerns of each of these river segments are presented above.

Segment SB-1c continues southward from the split with SB-1b, crossing the Brazos River segment 1202, Mound Creek, Bessies Creek, and approximately 28 intermittent streams. Segment SB-1c ends at the proposed Allens Creek Reservoir. The proposed reservoir will release water to the Brazos River segment 1202.

Segment SB-3.

Segment SB-3 begins at a transfer point east of the Brazos River near the confluence with the Navasota River. The transfer segment crosses

soil conditions (33CFR328.3, 1984)." According to current regulations, construction in wetlands should follow a sequence of events which includes avoidance, where possible; minimization of impacts if avoidance is not possible; and, finally, mitigation.

Data about wetlands along each alignment was gathered from National Wetland Inventory (NWI) maps produced by the USFWS (Table 3.6). Wetlands were grouped into five wetland categories, including forested, emergent, open water, scrub shrub, and other. Wetlands delineated on NWI maps were categorized according to the USFWS definition of wetlands (Cowardin, et al., 1992). It is not sufficient to rely on these maps for an exact accounting of wetland acreage or type, but they are useful to provide a comparative index between alignments. These wetlands may or may not be considered jurisdictional according to Section 404 of the Clean Water Act.

An average right-of-way width of 200 feet was assumed for calculating the area potentially affected by each segment. A 100-foot right-of-way was assumed for those segment portions which utilized an existing drainageway or canal, and for the downstream flow path of Segments SN-1, TS-3b, TB-1, and SB-1b. If necessary, the final alignment may be moved to affect less wetland area.

Forested wetlands are characterized by woody vegetation that is approximately 20 feet tall or taller. These wetlands include broad-leaved deciduous trees, needle-leaved deciduous trees,

broad-leaved evergreen trees, needle-leaved evergreen trees, and dead trees. Emergent wetlands are characterized by erect, rooted, herbaceous vegetation (excluding mosses and lichens). These wetlands can be persistent or nonpersistent (leaves fall at the end of the growing season). Open water areas are characterized by lack of vegetation in water less than 6.6 feet deep. Scrub shrub wetlands are dominated by woody vegetation less than 20 feet tall. Other wetlands along the segments include unconsolidated shore, unconsolidated bottom, and aquatic bed. Unconsolidated shore wetlands are characterized by (1) unconsolidated substrates with less than 75 percent areal cover of stones, boulders, or bedrock; (2) less than 30 percent areal cover of vegetation other than pioneering plants; and (3) various exposed or flooded areas. Unconsolidated bottom wetlands have less than 25 percent cover of particles smaller than stones and less than 30 percent vegetative cover. Aquatic beds include areas dominated by vegetation at the water surface or below it for most of the growing season (Cowardin, et al., 1992).

Segment SN-1.

Segment SN-1 traverses an area that contains approximately five acres of wetlands according to the NWI maps. Approximately three acres of wetlands would also be crossed by additional flow downstream of Segment SN-1, in the Neches River basin. All of the wetlands affected by Segment SN-1 are forested.

Table 3.6
Estimated Wetland Acreage within Each
Segment Corridor and Downstream Flow Paths

Segment	Forested (Acres)	Emergent (Acres)	Open Water (Acres)	Scrub Shrub (Acres)	Other (Acres)	Total Acres	Total Downstream Flow Path
SN-1	5	0	0	0	0	5	3
SN-4a	72	1	0	0	9	82	0
SN-4b	56	0	2	9	9 ¹	79	0
NT-1a	44	6	0	6	1	57	0
NT-3a	63	37	0	0	3	103	0
NT-3b	18	30	5	7	0	60	0
TS-2a	29	16	3	2	7 ²	57	0
TS-3a	30	7	0	1	12	50	0
TS-3b	17	9	0	1	0	27	71
TS-4a	0	0	0	0	0	0	0
TS-4b	0	0	0	0	0	0	0
SB-1a	10	11	31	0	4 ³	56	0
SB-1b	8	9	8	0	0	25	58
SB-1c	10	27	23	0	4 ³	64	0
SB-3	12	0	4	0	0	16	0
TB-1	1	5	5	0	1	12	26

¹ Unconsolidated Bottom

² Unconsolidated Bottom (6) and Aquatic Bed (1)

³ Unconsolidated Shore

Segment SB-1b.

Segment SB-1b traverses an area that contains approximately 25 acres of wetlands, of which eight acres are considered open water. The remaining acreage is divided between forested wetlands (eight acres) and emergent (nine acres). Approximately 58 acres of wetlands would also be crossed by additional flow in the Clear Creek/Brazos River area downstream of Segment SB-1b. This area is divided between forested, emergent and open water wetlands.

Segment SB-1c.

Segment SB-1c traverses an area that contains approximately 64 acres of wetlands according to the NWI maps. Twenty-seven acres are composed of emergent wetlands, and 23 acres are composed of open water. The remaining wetlands are divided between forested wetlands (10 acres) and unconsolidated shore (four acres).

Segment SB-3.

Segment SB-3 crosses an area that contains approximately 16 acres of wetlands. Forested wetlands comprise 12 acres of this total. The remaining four are open water.

Segment TB-1.

Segment TB-1 traverses an area that contains approximately 12 acres of wetlands. This area is classified as forested (one acre), emergent (five acres), open water (five acres), and other (one acre). Approximately 26 wetland acres situated in the Gibbons Creek area, downstream

of Segment TB-1 will also be crossed by the additional flow.

3.5 Soils and Geological Resources

3.5.1 Soils

The Farmland Protection Policy Act (FPPA) protects prime farmlands (7 U.S.C. 4201 et seq.). The formal definition of prime farmlands in the FPPA indicates that land not currently in crops can still be protected under the act if the land is used for timber or livestock. Much of the land along the segments is clearly being farmed, but other portions are undisturbed forest or livestock range.

For the purpose of this study, the area of prime farmland soils along a transfer route was determined by comparing the soil types along the route to the Natural Resources Conservation Service's (NRCS) list of prime farmland soil types in Texas (Soil Conservation Service; SCS, 1982). An average width of 200 feet of right-of-way was used to calculate the areas along the transfer routes. Areas where data was not available are noted in the text. If necessary, the final alignment may be moved to affect less of the prime farmlands. Table 3.7 summarizes the acreage of prime farmland soil along the various segments.

Segment SN-1

Segment SN-1 is contained within Sabine County. The soil survey for Sabine County is not available, therefore prime farmland soil information from the county is not available.

Segment SN-4a and SN-4b.

Segment SN-4a crosses Newton, Orange, and Jefferson counties. The transfer route does not cross any prime farmland soils in Newton County (Neitsch, 1982). The soil survey for Orange County is available only as an unpublished draft, and the information from the county is preliminary and subject to corrections. The preliminary soil survey does not contain information on 9 of 16 soil types crossed by this segment. So the total length of prime farmland soils is unknown for Segment SN-4b in Orange County (SCS, 1995a). In Jefferson County, the segment crosses 60 acres of prime farmland soils (Crout, 1965a)

Segment NT-1a

Segment NT-1a crosses Tyler, Polk, Hardin, and Liberty counties. A total of 419 acres of the segment corridor crosses prime farmland out of 1,399 acres total area. However the soils surveys for Tyler and Hardin counties are not available, so information for 950 acres along the segment is only available at the association level.

Segment NT-3a

Segment NT-3a crosses Jefferson, Liberty, and Hardin counties. A total of 160 acres of the segment crosses prime farmland out of 819 acres total area in the segment corridor. In Jefferson County, the segment crosses no prime farmland soils (Crout, 1965a). In Liberty County, the segment crosses prime farmland in Ae, Aldine silt loam (AdA), LaA, Ba, Bm, Ka, SrB soils for a total of 160 acres (Griffith,

1996). The soils survey for Hardin County is not available, so information for 194 acres along the segment is unavailable.

Segment NT-3b.

Segment NT-3b crosses Jefferson and Liberty counties. A total of 377 acres of the segment corridor crosses prime farmland out of 984 acres total area. Segment NT-3b does not cross any prime farmland soils in Jefferson County (SCS, 1995b). In Liberty County, the route crosses prime farmland in soil types Bernard-Morey Complex (Bm); Beaumont clay (Ba); Anahuac-Aris complex (An); Vamont clay, 0 to 1 percent slopes (VaA); Aldine-Aris Complex (Ae); Lake Charles clay, 0 to 1 percent slopes (LaA); Vamont silty clay, depressional (Vd); Spurger-Waller Complex, 0 to 2 percent slopes (SwB); Mocarey-Yeaton Complex (My); and Kaman clay, occasionally flooded (Ka) for a total of 371 acres of prime farmland (Griffith, 1996).

Segment TS-2a.

Segment TS-2a crosses Liberty and Montgomery counties. A total of 553 acres of the segment crosses prime farmland out of 1,065 acres total area in the segment corridor. In Liberty County, the segment crosses prime farmland in soil types VaA; Segno fine sandy loam (Sa); SwB; Otanya fine sandy loam, 1 to 3 percent slopes (OyB); Sorter loam (Sb); Splendor fine sandy loam (Sp); Waller loam (Wa); Kirbyville fine sandy loam, 0 to 1 percent slopes (Kr); Waller-Kirbyville Complex, 0 to 1 percent slopes (Wk); and Spurger fine

loamy fine sand, 1 to 5 percent slopes (ChC); Rader fine sandy loam, 0 to 1 percent slopes (RaA); and Norwood silty clay loam, 0 to 1 percent slopes (NrA) (Greenwade, 1996).

Segment SB-1b.

Segment SB-1b crosses Montgomery, Harris, and Waller counties. A total of 201 acres of the segment crosses prime farmland out of the 600 acres contained in the segment corridor. In Montgomery County, the segment crosses prime farmland in Sp, Se, Bu, and Hockley fine sandy loam (Ho). (McClintock, 1972). In Waller County, the segment crosses prime farmland in Sp; Se; Hockley fine sandy loam, 1 to 3 percent slopes (HoA); Katy fine sandy loam, 1 to 3 percent slopes (KaB); Hockley fine sandy loam, 3 to 5 percent slopes (HoC); Hockley gravelly fine sandy loam, 1 to 5 percent slopes (HpC); Wockley fine sandy loam, 1 to 3 percent slopes (WoB); Aris fine sandy loam, 0 to 1 percent slopes (ArA); Wockley fine sandy loam, 0 to 1 percent slopes (WoA); and Chazos loamy fine sand, 5 to 8 percent slopes (ChD). (Greenwade, 1984). The segment also crosses prime farmland at the northern tip of Harris County (Wheeler, 1976) consisting of Kenny loam fine clay, (Ka), Hockley fine sandy loam (HoB) 1-4% slopes, and Wackley fine sandy loam (Wo).

Segment SB-1c.

Segment SB-1c crosses Montgomery, Harris, and Waller counties. A total of 885 acres of the segment corridor crosses prime farmland out of 1,598 acres total area. In Montgomery County, the segment crosses prime farmland in soil types Ho, Sp, Se, and Bu for a total of 114

acres (McClintock, 1972). In Harris County, the segment crosses prime farmland in soil types Hockley fine sandy loam, 1 to 3 percent slopes (HoB) and Wockley fine sandy loam (Wo) for a total of 64 acres (Wheeler, 1976). In Waller County, the segment crosses prime farmland in soil types Splendora fine sandy loam, 0 to 3 percent slopes (SpB); Se; WoA; HpC; HoC; HoB; ArA; Katy fine sandy loam, 0 to 1 percent slopes (KaA); Brazoria clay, 0 to 1 percent slopes (BrA); and NrA for a total of 707 acres (Greenwade, 1984).

Segment SB-3

Segment SB-3 crosses Washington County. A total of 109 acres of the segment corridor crosses prime farmland out of 595 acres total area. In Washington County, the segment crosses prime farmland in Frelsburg clay (32), Chazos loamy fine sand (21), Bleiberville clay (7), Carbangle clay loam (19), Latium Clay (43), Bleiberville clay (6), Clemville silt loam (24), Carbangle clay loam (18), Frelsburg clay (31), Trinity clay (68), Silawa loamy fine sand (61), Greenvine Clay (36) soils for a total of 109 acres (Chervenka, 1981).

Segment TB-1

Segment TB-1 crosses San Jacinto, Walker, and Grimes counties. A total of 32 acres of the segment corridor crosses prime farmland out of 1,148 acres total area. In San Jacinto County, the segment crosses prime farmland in SrB soils for a total of 23 acres (McKewen, 1988). In Walker County, the segment crosses prime farmland in Leson clay (33) soils for a total of

Segment NT-1a

Within Tyler, Polk and Hardin counties, Segment NT-1a crosses the Bentley and Willis formations. The segment briefly crosses the Beaumont and Deweyville formations before crossing the alluvium of the Trinity River.

Segment NT-3a

Segment NT-3a begins in the alluvium of the Neches River, and continues through the Beaumont Formation within Jefferson, Hardin, and Liberty counties. The formation in Jefferson County is marshy due to the high clay content. The formation is better drained in Liberty and Hardin counties, and is not as marshy. The segment briefly crosses the Deweyville Formation before it ends in the alluvium of the Trinity River.

Segment NT-3b.

Segment NT-3b begins in the alluvium of the Neches River, and continues through the Beaumont Formation within Jefferson County. The segment ends in the alluvium of the Trinity River.

Segment TS-2a.

Segment TS-2a begins in the alluvium of the Trinity River. Within Liberty County, the segment crosses the Bentley and Montgomery formations. The Bentley Formation is comprised of clay, silt, sand, and very minor siliceous gravel of granule and small pebble size. It is calcareous with occasional

concretions of calcium carbonate, iron oxide, and iron-manganese oxides common in the zone of weathering. The topography of the Bentley Formation is fairly flat and featureless except for numerous rounded shallow depressions and pimple mounds. Rivers and streams are the major agents of erosion in the formation. Segment TS-2a runs mostly over the Bentley Formation but briefly crosses the Montgomery Formation on each side of the San Jacinto River. The Montgomery Formation has fewer iron oxide concretions and finer gravel than the Bentley Formation but otherwise is similar. The segment ends in the alluvium of the San Jacinto River.

Segment TS-3a

Segment TS-3a begins in the alluvium of the Trinity River. Within Liberty and Montgomery counties, the segment continues through the Beaumont Formation. The segment ends in the alluvium of Lake Houston (Flawn, 1968b).

Segment TS-3b.

Segment TS-3b begins in the alluvium of the Trinity River. Within Liberty and Montgomery counties, the segment runs within Luce Bayou to end in Lake Houston. Luce Bayou is entirely bounded by the Beaumont Formation but probably has alluvial deposits along the stream channel (Flawn, 1968b).

Segment TS-4a

Segment TS-4a begins in the alluvium of the Trinity River, where Segment NT-3b ends.

mudstone and sand. The Whitsett Formation is composed of quartz sand and contains abundant fossilized wood. These three formations were formed in the Tertiary Period. Within Grimes County, the segment continues within the Catahoula and Manning formations. The Manning Formation is composed of quartz sand, clay and lignite and contains abundant fossilized wood. The segment then crosses a series of fault lines which occur in the Whitsett Formation before it enters the alluvium formed around Gibbons Creek, the Navasota River, and the Brazos River.

3.6 Public Lands

This section describes the public lands and recreation areas within a one-half mile corridor of the proposed transfer routes. Each of the segments has at least one public land or recreational area within the one-half mile corridor. Realignment of preferred segments to reduce potential impacts to public lands and recreation areas will be considered where possible.

Public lands such as State Parks, National Park Service facilities, National Forests and Grasslands, and National Wildlife refuges within the corridors surrounding the 16 alternate routes selected for study were identified from public land maps (Texas Department of Transportation, 1993) and USGS 7.5-minute topographic quadrangles. In addition, the Texas Outdoor Recreation Plan (TPWD, 1985) and the Texas Outdoor Recreation Database (TPWD, 1995c) identified other recreation areas near the routes.

Appendix E lists the public lands and recreation areas which occur within one-half mile of each of the segments.

Segment SN-1.

Segment SN-1 begins at Toledo Bend Reservoir and crosses the Sabine and Angelina National Forests. Recreational waterways used by this segment include the Angelina River and B.A. Steinhagen Lake.

Segment SN-4a.

Segment SN-4a begins in the alluvium of the Sabine River. This segment crosses the Sabine Island Wildlife Game Management Area and the Beaumont Unit of the Big Thicket National Preserve (BTNP) (while in the LNVA Canal).

Segment SN-4b.

Segment SN-4b is within one-half mile of the Sabine River, the Sabine Island Wildlife Game Management Area (WGMA), the Beaumont Unit of the BTNP, and the Neches River. The Sabine River is permanently floatable and considered a recreation area. The proposed route runs within Indian Bayou near the Sabine River. The WGMA is located on the Louisiana side of the Sabine River. The segment would not enter the WGMA, but changes to the flow of the Sabine River could have an impact on the area. The segment runs within one-half mile of the southern boundary of the Beaumont Unit of the BTNP where the segment crosses the Neches River. The BTNP is owned by the National Park Service. The segment, as

recreation areas.

Segment SB-1a.

Segment SB-1a is located within one-half mile of the W.G. Jones State Park, the West Fork San Jacinto River and the Brazos River but does not enter the W.G. Jones State Park. The rivers are permanently floatable and considered recreation areas.

Segment SB-1b and SB-1c.

Segments SB-1b and SB-1c are located within one-half mile of the Stephen F. Austin State Historical Park near San Felipe, Texas; W.G. Jones State Park, Spring Creek; and the Brazos River. The Stephen F. Austin State Park is bordered on the east by the Brazos River. Neither of the routes enter the W.G. Jones State Park. Spring Creek and the Brazos River are permanently floatable and considered recreation areas.

Segment SB-3.

Segment SB-3 would begin near the Brazos River and end at Somerville Lake, which is a U.S. Army Corps of Engineers facility. This is an area of high recreational value. The Brazos River is also a recreation area.

Segment TB-1.

Segment TB-1 would begin at Lake Livingston. This segment would cross Harmon Creek and enter Gibbons Creek Reservoir. The water would then flow downstream into the Brazos

River. Lake Livingston and Gibbons Creek Reservoir are areas of high recreational value. The Brazos River is also considered a recreation area.

3.7 Traffic

Improvements will be required at each point where a segment crosses an existing road, highway, or railroad. For the purpose of this study highway crossings are counted separately from smaller road crossings because construction of highway crossings generally will be more expensive and have greater impacts to traffic than smaller road crossings. Only new crossings are counted in Table 3.8 because it is assumed that no new construction will be required at existing crossings.

The source for this information is the preliminary alignments marked on 1:24,000 scale topographic maps. Any roads, highways, or railroads that have been built since the maps were produced have not been counted. Field confirmation will be required to get a more accurate count.

Segment SN-1.

Segment SN-1 would require 10 new road crossings and two new railroad crossings. No highways would require additional construction.

Segment SN-4a.

Segment SN-4a would require 11 new road crossings and one new railroad crossing. No additional construction for highways would be

Segment TS-4a.

Segment TS-4a would require six new road crossings and one highway crossing. One railroad crossing would be required with this segment.

Segment SB-1b.

Segment SB-1b crosses IH-75 (State Highway 45), FM 1774, and IH-290. It also crosses 28 small streets and three railroads, including the Missouri Pacific Railroad, the former Chicago Rock Island and Pacific Railroad, and the Southern Pacific Railroad rail lines. While running within the Brazos River, Segment SB-1b crosses IH-90. Segment SB-1b would require construction of 28 road crossings, three highway crossings, and three railroad crossings.

Segment SB-1c.

Segment SB-1c crosses IH-75 (State Highway 45), FM 1774, IH-290, State Highway 529, IH-90, State Highways 10, and 359. It also crosses 39 small streets and three railroads, including the Missouri Pacific Railroad, the former Chicago Rock Island and Pacific Railroad, and the Texas and New Orleans Railroad rail lines. Segment SB-1c will require construction of 39 road crossings, seven highway crossings, and three railroad crossings.

Segment SB-3

Segment SB-3 does not cross any highways. Segment SB-3 would require construction of six road crossings and one railroad crossing.

Segment TB-1

Segment TB-1 crosses four highways. The segment would require construction of 28 road crossings and two railroad crossings.

3.8 Summary of Existing Environment

Table 3.9 contains a summary of the existing environmental conditions for each segment discussed in this report. Segments are grouped with respect to their basin locations and are presented in an east to west order. The relative impacts by each segment are discussed in Chapter 4.



4.0 Environmental Impacts of Alternatives

This section discusses the potential environmental impacts of construction, operation and maintenance of the proposed segments which would be used to convey water across the Southeast Area of the Trans-Texas Water Program. The individual segments range from approximately 20 to 100 miles in length, using existing canals, stream channels and new canals. Two hundred foot right-of-ways for new facilities and 100 foot right-of-ways for existing canals and natural stream channels were used to calculate the potential area of impact for each segment and downstream flow path. In many cases, final alignment of a particular segment may decrease environmental impacts. Generally, shorter segments and those using existing canals have less environmental impacts, as they disturb less area. Those segments utilizing existing stream channels for conveyance may disturb less area but are at a higher risk of impacting aquatic communities and instream water uses. The existing environmental conditions potentially affected by each segment were discussed in Section 3.0.

4.1 Land Use Impacts

Of the three proposed Sabine-Neches River basin transfer options, segment SN-4b would impact the most woodland area and segment SN-1 would impact the least. The entire segment length of SN-1 would involve construction of new conveyance facilities, mostly through thick, mature forests contained in the Sabine National Forest. Woodland impacted by segment SN-4a includes an existing canal which passes through

portions of the Big Thicket National Preserve. Approximately two-thirds of the remaining woodland affected by SN-4a would be in the area of new canal construction.

Segment SN-4a impacts more agricultural land than either SN-1 or SN-4b. The agricultural area impacted by segment SN-1 consists mostly of cleared rangeland or pastureland. Segment SN-4b would impact the least amount of agricultural land.

Urban areas would be impacted by SN-4b but not by the remaining Sabine-Neches River transfer segments. Segment SN-4b utilizes existing canals in the area nearest the city of Orange, but would require new construction of canals in the area of Vidor and Beaumont.

Three segments are proposed for the transfer of water from the Neches to the Trinity River basins. Of these, segment NT-1a impacts two to three times the number of woodland acres as the remaining two segments and would require new conveyance facilities for its entire length. Segment NT-3b impacts the least amount of woodland area and would utilize an existing canal for much of its length. The most agricultural area is impacted by segment NT-3b and the least by NT-1a.

Urban areas would be impacted by NT-1a and NT-3b. Although the area of impact to urban areas is greater for NT-1a, realignment of this segment may decrease or eliminate the use of urban right-of-way.

into the southeastern edge of the Blackland Prairies area.

4.2.2 Fisheries

Interbasin water transfer has the potential to impact freshwater and coastal fisheries in several ways. Transfer of water between basins may result in changes in water chemistry, temperature, nutrients, organic particulates, and sediment, as well as changes in instream flows and inflows to bays and estuaries. Physical habitat conditions such as velocity, depth, and substrate or cover are directly related to stream flow and may affect fish production. Potential changes in water quality also could impact fisheries in the affected basins. Instream flows in the reach of the Sabine River below Deweyville and freshwater inflows to Sabine Lake will be reduced by additional diversion of water from the Sabine River to the Neches River or basins farther west; whereas, flows in portions of the Neches, Trinity, San Jacinto and Brazos Rivers will increase slightly. Detailed investigations will be necessary to quantify impacts of changes in stream flow on fisheries.

In addition, interbasin transfer of water could impact native fisheries resources by introducing exotic or nuisance species of plants and animals. Kaskey and Rasmussen (Undated) listed the following native species that could expand their range westward with the water transfers: chestnut lamprey (*Ichthyomyzon castaneus*), smallmouth bass (*Ictiobus bubalus*), black buffalo (*Ictiobus niger*), chain pickerel (*Esox niger*), emerald shiner (*Notropis atherinoides*), and mud darter (*Etheostoma asprigene*). Two introduced species which could be harmful, the grass carp (*Ctenopharyngodon idella*) and the blue tilapia (*Tilapia aurea*), occur in the eastern

basins and could be transferred to systems further west.

Kaskey and Rasmussen (Undated) also identified a number of means and types of other aquatic organisms that could spread via interbasin water transfer routes. Recipient basins could be affected by transfers of microbes, algae, mollusks, and fish. Algal blooms during the summer and fall could be spread between lake systems via that transfer route. Species such as giant duckweed (*Spirodela oligorhiza*), salvinia (*Salvinia spp.*), water hyacinth (*Eichornia crassipes*), egeria (*Egeria densa*), hydrilla (*Hydrilla verticillata*), alligatorweed (*Alternanthera philoxeroides*), and water fern (*Azolla sp.*) could be transferred to other water systems within the Southeast Area and west to other basins. These species could cause odor and taste problems in water supplies as well as detrimental economic and environmental impacts due to clogged waterways, limiting recreation, disruption of wildlife habitat, and providing microhabitats for various human disease vectors. Native mollusk populations could be affected by the spread of the introduced species.

4.2.3 Endangered and Threatened Species

The Texas Biological and Conservation Data System documents known locations of endangered and threatened species as listed by the Texas Organization for Endangered Species (TOES). The majority of the listed species would not be impacted by construction of a transfer facility. A few, such as the bald eagle and red-cockaded woodpecker, will nest in the region. When necessary, the alignment could be moved to avoid any nest sites. Mammalian, reptilian, amphibian, and vegetative species impacts due to construction of a transfer facility

4.5 Wetlands

The U.S. Army Corps of Engineers (Corps) regulates activities in jurisdictional waters of the United States (U.S.). Jurisdictional waters include all waterways (i.e., streams, rivers, bayous, etc.), reservoirs, ponds constructed along jurisdictional waterways, and wetlands. A permit under Section 404 of the Clean Water Act (33 USC 1344) would be required for construction activities in non-navigable waters and wetlands. A permit under Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) would be required for construction activities in navigable waters. Portions of the Big Cypress Bayou, Sabine, Neches, and Trinity rivers are considered navigable waters. Construction activities within the navigable portions of these rivers would require Corps notification for purposes of Section 10.

Impacts to wetlands and other jurisdictional waters of the U.S. would require mitigation. Forested wetlands typically require the greater amount of mitigation. These mitigation ratios can range from 1:1 up to 10:1 depending on the vegetation community and its value. The remaining wetlands also would require mitigation, and these ratios could range from 1:1 up to 5:1.

Additional mitigation acreage may be required to establish buffer zones around wetlands and for impacts at streams and rivers. These mitigation requirements would vary depending on the severity of impacts, but these ratios could range from 1:1 to 2:1.

Of the Sabine-Neches transfer segments, SN-1 impacts the fewest acres of wetlands, while SN-4a impacts the most. All or most of these

wetland areas are forested. The downstream flow path of segment SN-1, however, includes natural systems such as Sam Rayburn Reservoir, the Angelina River and the Neches River. The first potential downstream transfer station which will move the additional flow from the Neches River is at B.A. Steinhagen Lake. If the lake transfer station is not included in the TTWP, the additional flow could potentially impact the Neches River as far downstream as the next transfer station, located north of Beaumont. The portion of the Neches below B.A. Steinhagen Lake flows through the Big Thicket National Preserve which encompasses numerous wetland areas.

Three segments are proposed for transferring water from the Neches to the Trinity River basin. Of these, segment NT-3a would impact the most wetland area. Although it is the longest of the three segments, NT-1a would impact the least number of wetland areas. The majority of wetlands impacted by all three segments are dominated by forest or emergent vegetation.

Of the five Trinity-San Jacinto transfer segments, TS-2a impacts the most wetland area. Although Segment TS-3b will require one of the shortest lengths of new construction, the downstream flow path utilizes the natural channel of Luce Bayou and Lake Houston. It is unknown at the time of this report if improvements will be required to the natural channel of Luce Bayou to accommodate the increased flow. If no improvements are required, then the potential impact to wetlands along the stream corridor will be minimal.

Of the three segments which transfer water from the San Jacinto River basin to the Brazos River

the downstream flow path of SN-1 extends into the BTNP below B.A. Steinhagen Lake. Impacts to recreation activities due to increased water levels in this reach of the Neches river are not expected to be significant.

Construction and operation of segments SN-4a and SN-4b would impact the Sabine River, the Sabine Island Wildlife Game Management Area (WGMA) and the Neches River Corridor and Beaumont Units of the BTNP. The downstream flow path of Segment SN-4a, located in the BTNP (existing LNVA canal), would experience increased flow but it is not known at the time of this report whether improvements would be required to accommodate the increased water level. Segment SN-4b does not pass through the BTNP but both it and SN-4a would require new channel construction near the Beaumont Unit boundary. The Sabine Island WGMA is located on the Louisiana side of the Sabine River but could potentially be impacted by reduced flows to the area.

The three segments included in the Neches-Trinity River water transfer options are located within one-half mile of B.A. Steinhagen Lake, the Menard Creek, Big Sandy Creek Corridor and Beaumont Units of the BTNP, the China City Park, and the Trinity River. All three segments would potentially impact the BTNP. For segments NT-3a and NT-3b, only the common channel which follow the existing LNVA canal from the southern edge of the Beaumont Unit would potentially impact the BTNP. It is unknown at the time of this report if improvements will be made to the existing canal or transfer station to accommodate the additional flow. If no improvements are required, the segments potential impact to the BTNP as a public or recreational area will be

minimal. Segment NT-1a would impact the Menard Creek and Big Sandy Creek Corridor Units of the BTNP near the Trinity River end of the segment. This portion of the segment is roughly parallel to Menard Creek and passes within a few hundred feet of the BTNP boundary. New facilities would also be required in the crossing of the Big Sandy Creek Corridor Unit of the BTNP. This segment would require construction of new conveyance facilities for its entire length.

In the Trinity-San Jacinto transfer area, public lands potentially impacted by the transfer segments include the Trinity and San Jacinto Rivers, Luce Bayou, Lake Houston State Park, Cedar Bayou, the Mussel Shoals/Big Tupelo Breaks, San Jacinto Battleground State Historical Complex. The Trinity and San Jacinto rivers would be impacted by potential construction activities in the vicinity of transfer stations at the beginning and end of the segments, as well as by slight water level changes downstream of transfer points. Water level changes in the major rivers are not expected to impact recreational use.

Luce Bayou will be directly impacted as a downstream conveyance for segment TS-3b. As discussed earlier, it is unknown at the time of this report if improvements will be made to the existing channel to accommodate the additional flow. If no improvements are required, the segments' potential impact to Luce Bayou as a recreational area may be minimal. Localized water quality impacts to the bayou and downstream Lake Houston may occur as a result of additional flow and erosional activity in the natural stream channel.

Of the three Neches-Trinity transfer segments, NT-1a would impact traffic at the most railroad crossings and the most small road crossings. Segment NT-3a requires no new highway crossings and NT-3b requires three. No new railroad crossings would be required by NT-3b.

Five segments are included in the Trinity-San Jacinto transfer options. Segment TS-2a will impact traffic at the most small road and highway crossings. Both TS-2a and TS-4a will impact traffic at only one railroad crossing. The remaining segments will not impact railroad traffic. Because segment TS-4b is contained in an existing canal, it will require no new crossings.

Three segments are included in the San Jacinto-Brazos transfer options. Segments SB-1a and SB-1c will impact traffic at the most small road, highway and railroad crossings of any segments in the TTWP Southeast Study Area. Segment SB-1b will impact traffic at fewer small road and highway crossings than the other two but ties with SB-1c with the number of new railroad crossings.

Segment SB-3 would require no new highway crossings and only one new railroad crossing. Segment TB-1, which delivers water directly to the Brazos from the Trinity River basin, would impact traffic at two new railroad crossings and four new highway crossings. It ties with SB-1b for impacts to traffic at small road crossings.

4.9 Summary of Impacts

Previous discussions have addressed the condition of and potential impacts to various environmental parameters by construction,

operation and maintenance of interbasin transfer segments of the TTWP. Table 4.9 visually summarizes the relative environmental impacts of each segment and its downstream flow path. Individual segments are compared only to other segments in the same segment group, e.g. Sabine-Neches River basins (SN). This analysis will allow the reader to assess the feasibility of moving water between adjacent basins to meet water demands in a variety of geographic areas. The areas of concern discussed in this document are the Houston/northern Harris County area and the heavily urbanized areas west of the Brazos River basin, including the city of San Antonio. The Phase I report describes three water demand scenarios for meeting the needs of these areas.

Based on the environmental analyses included in this report, three segments are recommended as the preferred alternatives for transfer of water from the Sabine River to the Brazos River basins. Recommendations made in this report are based solely on the analysis of potential environmental impacts by each proposed segment.

To transfer water out of the Sabine River basin, Segment SN-4b is the environmentally preferred alternative. This segment utilizes the greatest extent of existing facilities of the Sabine-Neches group. This segment also bypasses the Big Thicket and impacts a moderate amount of other natural wetland areas.

For transfer of water from the Neches River basin to the Trinity River basin, Segment NT-3b is the environmentally preferred alternative. Segments NT-3a and NT-3b are very similar in nature and have the potential to impact similar environments. Segment NT-3a, however, has the potential to impact slightly more threatened

Table 4.1 Summary of Environmental Impacts of Transfer Segments

	Group SN			Group NT			Group TS				Group SB				Group TB*	
	SN-1	SN-4a	SN-4b	NT-1a	NT-3a	NT	TS-2a	TS-3a	TS-3b	TS-4a	TS-4b	SB-1a	SB-1b	SB-1c	SB-3	TB-1
Environmental																
Total Length	○	○	●	●	○	○	●	●	○	○	○	○	○	●	○	○
New Construction	○	●	○	●	○	○	●	●	○	○	○	○	○	●	○	○
Existing Canals	●	○	○	●	○	○	●	●	○	○	○	●	●	○	●	●
Downstream Flow Path	●	○	○	○	○	○	○	○	●	○	○	●	○	○	○	●
Woodlands	○	○	●	●	○	○	○	●	○	○	○	●	○	●	○	○
Agricultural	○	●	○	○	○	●	○	○	○	●	○	○	○	●	○	○
Urban	○	○	●	●	○	○	○	○	○	○	●	○	○	○	○	○
Threatened & Endangered Species	●	○	○	○	●	○	○	○	○	○	●	○	○	●	○	○
Intermittent Streams	●	○	○	●	○	○	●	○	○	○	○	●	○	○	○	○
Perennial Stream	●	○	○	●	○	○	○	●	○	○	○	○	○	○	●	●
River Crossings	○	●	●	○	○	○	●	●	○	○	○	○	○	○	○	○
Wetlands in Segment	○	●	○	○	●	○	●	○	○	○	○	○	○	●	○	○
Wetlands in Downstream Flow Path	●	--	--	--	--	--	--	--	●	--	--	●	--	--	--	●
Prime Farmland Soils	N/A	N/A	N/A	N/A	○	●	●	○	○	○	○	○	○	●	○	○
New Road Crossings	○	●	○	●	○	○	●	○	○	○	○	●	○	●	○	○
New Highway Crossings	○	○	●	○	○	●	●	○	○	○	○	●	○	○	○	○
New Railroad Crossings	●	○	○	●	○	○	●	○	○	●	○	●	○	○	○	○
Public Lands	●	○	○	○	○	●	○	○	○	●	●	○	●	●	○	●
Other Parameters																
Static Lift	●	○	○	●	○	○	○	●	○	○	○	●	○	○	○	●
○ most desirable of group ○ moderately desirable of group ● least desirable of group * Compared to Groups TS and SB N/A data not available -- parameter does not apply to segment																

○ most desirable of group
 ○ moderately desirable of group
 ● least desirable of group

* Compared to Groups TS and SB
 N/A data not available
 — parameter does not apply to segment



Appendix A

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Appendix B

List of Threatened, Endangered, and Candidate Species Occurring in the Southeast Area

The following species are known to occur, either as residents or migrants, within the Southeast Area of the Trans-Texas Water Program. Table B.1 provides a listing of each segment analyzed in this report and indicates whether or not a threatened, endangered, or candidate species' range overlaps a particular segment corridor.

The interior least tern (*Sterna antillarum athalassos*) is a federally listed and state-listed endangered species. It is still fairly common along the eastern and Gulf coasts. However, populations are declining inland and along the west coast (Scott, 1987) due to habitat destruction and riverine alterations (TOES, 1988).

The Attwater's greater prairie chicken (*Tympanuchus cupido attwateri*) is listed by the TPWD and USFWS as endangered. This species prefers coastal prairies with a mixture of agricultural lands. Prairie chickens use low growth areas during the breeding period in spring. Afterwards they need the regrowth from the herbaceous layer for concealment and nesting cover. The largest known wild population of the prairie chicken is located at the Attwater's Prairie Chicken National Wildlife Refuge near the town of Eagle Lake. Habitat destruction and flooding of nests have been the primary factors for this species' decline (Arroyo, 1992).

The red-cockaded woodpecker (*Picoides borealis*) is a federally listed and state-listed endangered species. This woodpecker species prefers mature to over-mature (75 to 126 years old) southern pines with heart rot for roosting and nesting. (Arroyo, 1992). Foraging can occur in a variety of habitat types based on food availability and proximity to cavity-tree sites. Reasons for the red-cockaded woodpecker's decline include timber harvesting practices, wildfire suppression agricultural practices, roadways, and urban expansion (Burnside and James, 1993).

The brown pelican (*Pelecanus occidentalis*) is a federally listed and state-listed endangered species that occurs primarily along the coast. Brown pelicans rarely travel far inland or seaward, preferring to live along the bays and estuaries. Historic use of pesticides, which resulted in lower reproductive rates, and disturbance human have been primary reasons for the brown pelican's decline (TOES, 1988).

TABLE B.1
Endangered and Threatened Species Potentially Occurring
Within the Trans-Texas Water Program's Southeast Area

	STATUS ¹		SEGMENT															
REPTILES/AMPHIBIAN:	USFW	TPWD	SN-1	SN-4a	SN-4b	NT-1a	NT-3a	NT-3b	TS-2a	TS-3a	TS-3b	TS-4a	TS-4b	SB-1a	SB-1b	SB-1c	SB-3	TB-1
Houston Toad	E	E				X	X		X	X	X	X	X		X	X		
Louisiana Pine Snake	--	E	X	X	X	X	X	X	X	X	X	X	X					X
Western Smooth Green Snake	--	E				X	X	X	X	X	X	X	X		X	X		
Texas Horned Lizard	--	T	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Alligator Snapping Turtle	--	T	X	X	X	X	X	X	X	X	X	X	X		X	X		X
Northern Scarlet Snake	--	T	X	X	X	X	X	X	X	X	X	X	X					
Timber Rattlesnake	--	T	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
FISH:																		
Paddlefish	--	E	X	X	X	X	X	X	X	X	X	X	X					X
Blue Sucker	--	T	X	X	X	X	X	X							X	X	X	X
Creek Chubsucker	--	T	X			X	X		X	X	X	X	X		X	X		X
Blackside Darter	--	T	X															
VEGETATION:																		
Prairie Dawn	E	E							X		X	X	X					
Texas Trailing Phlox	E	E	X			X	X											
Navasota Ladies'-Tresses	E	E															X	X

¹ Status according to 50 Code of Federal Regulations 17.11 - 17.12 (1996) and the Texas Parks and Wildlife Department (1993a). E - Endangered, T - Threatened, E [or T] (S/A) - Similarity of Appearance to listed species.

The American swallow-tailed kite (*Elanoides forficatus*) is listed as threatened by the TPWD. Individuals of this species are regularly observed along the Texas coast during migration and have been sporadically recorded throughout the southwestern United States. Swallow-tailed kites prefer to breed in areas near water, such as wetlands, rivers, and lakes. Habitats necessary for year-long needs generally consist of bottomland hardwood forests with adjacent semiprairie, freshwater marshes, and bald cypress swamps (Oberholser, 1974). Prey items include flying insects, frogs, lizards, snakes, and bird nestlings (Clark and Wheeler, 1987).

The wood stork (*Mycteria americana*) is listed as threatened by the TPWD. This species prefers to feed in wet areas such as swamps, ponds, wet meadows, and coastal shallows (Scott, 1987). Postbreeding dispersals have resulted in storks scattering as far as the United States-Canada border (Oberholser, 1974). Loss of habitat is the primary reason for the wood stork's decline (TOES, 1988).

The white-tailed hawk (*Buteo albicaudatus*) is listed by the TPWD as threatened. This hawk species is found in open coastal grasslands and semiarid inland brush country (Clark and Wheeler, 1987). Unlawful shooting and habitat destruction are the primary reasons for the decline of the white-tailed hawk (TOES, 1988).

The mountain plover (*Charadrius montanus*) is listed as a Candidate species by the USFWS. This species occurs in upland areas characterized as dry short-grass prairie or plains away from water. Prey items consist of insects, and feeding occurs within small flocks. Cultivation of the prairie belt is the prime factor in the mountain plover's decline (Udvardy, 1977).

The black bear (*Ursus americana*) is listed as endangered by the TPWD and threatened by the USFWS. The basis for the threatened listing by the USFWS is due to similarity of appearance with the Louisiana black bear. The black bear prefers bottomland hardwood and floodplain forests, with lesser preference for upland hardwood forest, mixed pine/hardwood forest, wetlands, and agricultural fields. Denning often occurs in larger bald cypress and tupelo-gum trees with visible cavities in or along rivers, lakes, streams, and other water bodies (USFWS, 1994). The black bear has been restricted by civilization to remote mountainous areas or to impenetrable thickets along water courses (Davis and Schmidly, 1994). The black bear is occasionally sighted in East Texas. These bears are considered wanderers from Louisiana although some native bears may exist in Texas (TPWD, 1995).

The Rafinesque's big-eared bat (*Plecotus rafinesquii*) is listed as threatened by the TPWD. This species prefers forested areas and will roost in hollow trees, crevices behind bark, and under dry leaves, as well as partially lit buildings and other man-made structures such as wells and cisterns. Winter aggregations of both sexes are common, but solitary individuals are frequently found. Little is known of its diet, but it probably prefers night-flying insects (Davis and Schmidly, 1994; and Schmidly, 1983). Habitat destruction in combination with the species' naturally low numbers are responsible for the big-eared bat's decline (TOES, 1988).

The paddlefish (*Polyodon spathula*) is listed as an endangered species by the TPWD. A planktivore, the paddlefish is one of the largest freshwater fish and is native only to North America. Its range historically extended from the Great Lakes throughout the large streams of the Mississippi Valley and adjacent Gulf slope drainages as well as through the easternmost portions of Texas. The fish were documented in the Neches and Angelina rivers as early as 1897 and were abundant in the natural oxbow lakes and ponds throughout the floodplain of the Neches River from 1920 to 1940. However, populations have subsequently declined, and in 1977 the fish was placed on the Texas State Endangered Species List. Its decline has been attributed to commercial and recreational harvest as well as decreased habitat availability and water quality resulting from dam construction, channelization, logging, pollution, urbanization, and industrialization (Boschung, et al., 1983).

In 1989, the TPWD initiated the Paddlefish Recovery Plan in an effort to restore populations within their native Texas range. The Neches River was selected as the initial recovery area, with target recovery areas including the Neches River basin and two major tributaries, Pine Island Bayou and Village Creek; B.A. Steinhagen Reservoir; the Angelina River basin beginning at the headwaters of Steinhagen Reservoir; and Sam Rayburn Reservoir. The TPWD has begun a stocking program in these areas in 1989, and it will continue over the next three years (Pitman, 1992).

Table B.2 depicts the numbers of paddlefish stocked to date in the rivers within the TTWP Southeast Study Area. Stocking was begun in 1989 and involved initially only the Neches River. In 1990 both the Neches and Trinity rivers were stocked with a total of 137,504 paddlefish. The Sabine and Angelina rivers were added to the stocking program in 1991. Big Cypress Bayou and Sulphur River were added to the stocking program in 1992, and a total 221,422 paddlefish were stocked. Each of these waterways was stocked from 1992 to 1995. As of August 28, 1996, 70,206 paddlefish have been stocked in the Neches, Angelina, Sabine, and Trinity rivers (TPWD, unpublished data).

Life history information for the fish gathered from historic records and from hatcheries in other states indicated that during summer, the paddlefish use bayous, oxbow lakes, backwaters, and reservoirs with abundant zooplankton for feeding. In the winter, the fish inhabit deeper (greater than three meters) still-water areas which provide refuge from river currents. When water temperatures rise from 50 to 63 degrees in the spring, sexually mature paddlefish migrate to spawning areas in deep pools at the mouths of tributaries. Spawning migrations of over 240 miles have been documented. In addition to changes in temperature and photoperiod, the actual spawning run is triggered by a sudden, 10- to 20-foot rise in water elevation. Spawning occurs in well-oxygenated water over clean gravel substrate (U.S. Army Corps of Engineers, 1994).

The Texas trailing phlox (*Phlox nivalis ssp. texensis*) is listed as endangered by the USFWS and TPWD. This species prefers open, longleaf pine savannahs, fire-maintained pinelands, and the edges of young pine plantations on deep, sandy soil (Poole and Riskind, 1987).

The Navasota ladies'-tresses (*Spiranthes parksii*) is listed as endangered by the USFWS and TPWD. This species prefers open wooded margins of slightly eroded, intermittent, minor tributaries of the Brazos and Navasota rivers. This orchid is typically found growing with post oak, blackjack oak, yaupon, American beautyberry, and little bluestem (Poole and Riskind, 1987).

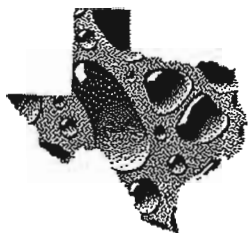


Appendix C

List of Prime Farmland Soils Within the Southeast Area

Table C.1
List of Prime Farmland Soils within Southeast Area

Abbreviation	Soil Description
Ad	Addicks Loam
AdA	Aldine Silt Loam, 0 to 2 percent slopes
Ae	Aldine-Aris complex
An	Anahuac-Aris Complex
Ar	Aris Silt Loam
ArA	Aris Fine Sandy Loam, 0 to 1 percent slopes
Ba	Beaumont Clay
Bd	Bernard Clay Loam
Be	Bernard Clay Loam
BeB	Besner-Mollville Complex, gently undulating
BeC	Bernaldo Fine Sandy Loam, 3 to 8 percent slopes
Bm	Bernard-Morey Complex
BoB	Brazoria Clay, 1 to 3 percent slopes
BrA	Brazoria Clay, 0 to 1 percent slopes
Bu	Burleson Clay, 0 to 1 percent slopes
Cd	Clodine Loam
ChC	Chazos Loamy Fine Sands, 1 to 5 percent slopes
ChD	Chazos Loamy Fine Sands, 5 to 8 percent slopes
CuC	Cuero Clay Loam, 1 to 5 percent slopes
DaA	Dallardsville Loamy Very Fine Sand, 0 to 2 percent slopes
DaB	Dallardsville Loamy Very Fine Sand, 1 to 3 percent slopes
FrC	Frelsburg Clay, 1 to 5 percent slopes
Ho	Hockley Fine Sandy Loam
HoA	Hockley Fine Sandy Loam, 1 to 3 percent slopes
HoB	Hockley Fine Sandy Loam, 1 to 4 percent slopes
HoC	Hockley Fine Sandy Loam, 3 to 5 percent slopes
HpC	Hockley Gravelly Fine Sandy Loam, 1 to 5 percent slopes
Hs	Houston Black Clay
Ka	Kaman Clay, occasionally flooded
KaA	Katy Fine Sandy Loam, 0 to 1 percent slopes
KaB	Katy Fine Sandy Loam, 1 to 3 percent slopes
Kr	Kirbyville Fine Sandy Loam (Liberty)
Kr	Kirbyville Fine Sandy Loam, 0 to 1 percent slopes
KuA	Kirbyville Fine Sandy Loam, 0 to 2 percent slopes
LaA (LcA)	Lake Charles Clay, 0 to 1 percent slopes
My	Mocarey-Yeaton Complex
NoA	Norwood Silt Loam, 0 to 1 percent slopes



Appendix D

Recreation Areas Near Proposed Segment Transfer Routes

Table D.1
Recreation Areas near Proposed Segment Transfer Routes

Route	Recreation Areas
SN-1	Toledo Bend Reservoir Sabine National Forest Angelina National Forest Angelina River B.A. Steinhagen Lake
SN-4a	Sabine Island Wildlife Game Management Area Big Thicket National Preserve
SN-4b	Sabine River Sabine Island Wildlife Game Management Area Big Thicket National Preserve Neches River
NT-1a	B.A. Steinhagen Lake Trinity River
NT-3a	Cotton Creek Willow Creek
NT-3b	Big Thicket National Preserve China City Park Trinity River
TS-2a	San Jacinto River
TS-3a	Greens Bayou San Jacinto River
TS-3b	Lake Houston State Park San Jacinto River
TS-4a	Trinity River Cedar Bayou Lake Houston
TS-4b	Mussel Shoals/Big Tupelo Breaks San Jacinto River San Jacinto Battleground State Historical Complex
SB-1a	W.G. Jones State Park Brazos River
SB-1b	W.G. Jones State Park Spring Creek Brazos River
SB-1c	W.G. Jones State Park Spring Creek Brazos River
SB-3	Somerville Lake
TB-1	Lake Livingston Harmon Creek Gibbons Creek Reservoir Brazos River