SECTION 3

Conveyance Evaluation

For the initial screening of alternative alignments in the Phase 1 design, the hydraulics of the upstream 56 miles of Bayou Lafourche, from the Mississippi River to Lockport, were evaluated. The conveyance capacity, channel size, the effect of different dredge templates, and alignment alternatives were evaluated with hydraulic models. Figure 3-1 shows the primary study area for the screening conveyance options in the Phase 1 design.

This initial evaluation was conducted using Hydrologic Engineering Center-River Analysis System (HEC-RAS), a one-dimensional (1D) backwater model developed by the USACE. The model was used for the initial evaluation because there were many alternatives to screen. The HEC-RAS model was applied only for steady-state analyses for the upstream portion of the bayou. All elevations referenced in this report are based on the North American Vertical Datum 1988 (NAVD88). Conveyance capacity for water supply and dilution will be balanced against channel size, dredging, and target water levels. Additional cost features, such as hydraulic structures, bridge rehabilitation or replacement, utility relocation or crossings, land easements, property purchases, pump station rehabilitation or new construction, and dredge disposal were included in cost estimates for the initial evaluation. These results were used to reduce the number of alternatives to only a few cost-effective recommendations.

The capacity evaluation of the subset of alternatives carried forward to the 30 percent design will be evaluated with a 2D hydrodynamic/water quality model called TABS-MD (RMA2 and RMA4). During the Phase 1 design, the TABS-MD model was specifically modified for this project by FTN Associates, Ltd., and their subconsultant, Dr. Ian King, to enhance the geometric description of the channels by incorporating an irregular cross-sectional shape in the 1D elements (see Appendix A). The hydrodynamic model (RMA2) will be used to examine the conveyance capacity, velocities, and channel size over the approximate 109-mile length of Bayou Lafourche, including the interconnections to more than 3,900 square miles of surrounding marsh areas for the 30 percent design.

During the 30 percent design, the 2D model (RMA4) will be used to evaluate the flushing and dilution (reduction of salinity concentrations) of the marsh areas. Initial decisions will be based on the available geometry of the 2D model and categorized by salinity concentrations. Additional surveying and model grid development might be conducted later to improve the ability to estimate the benefits of each alternative studied in Phase 2 modeling.

This section describes the hydraulic modeling that was conducted to support the Phase 1 design. This section provides an overview of the models, the source of the data used for model calibration, details on how the alternatives were implemented in the analysis, screening-level modeling results, and a brief discussion of results. These initial alternatives were screened down to a smaller number of alternatives using both qualitative and quantitative criteria (see Section 7).

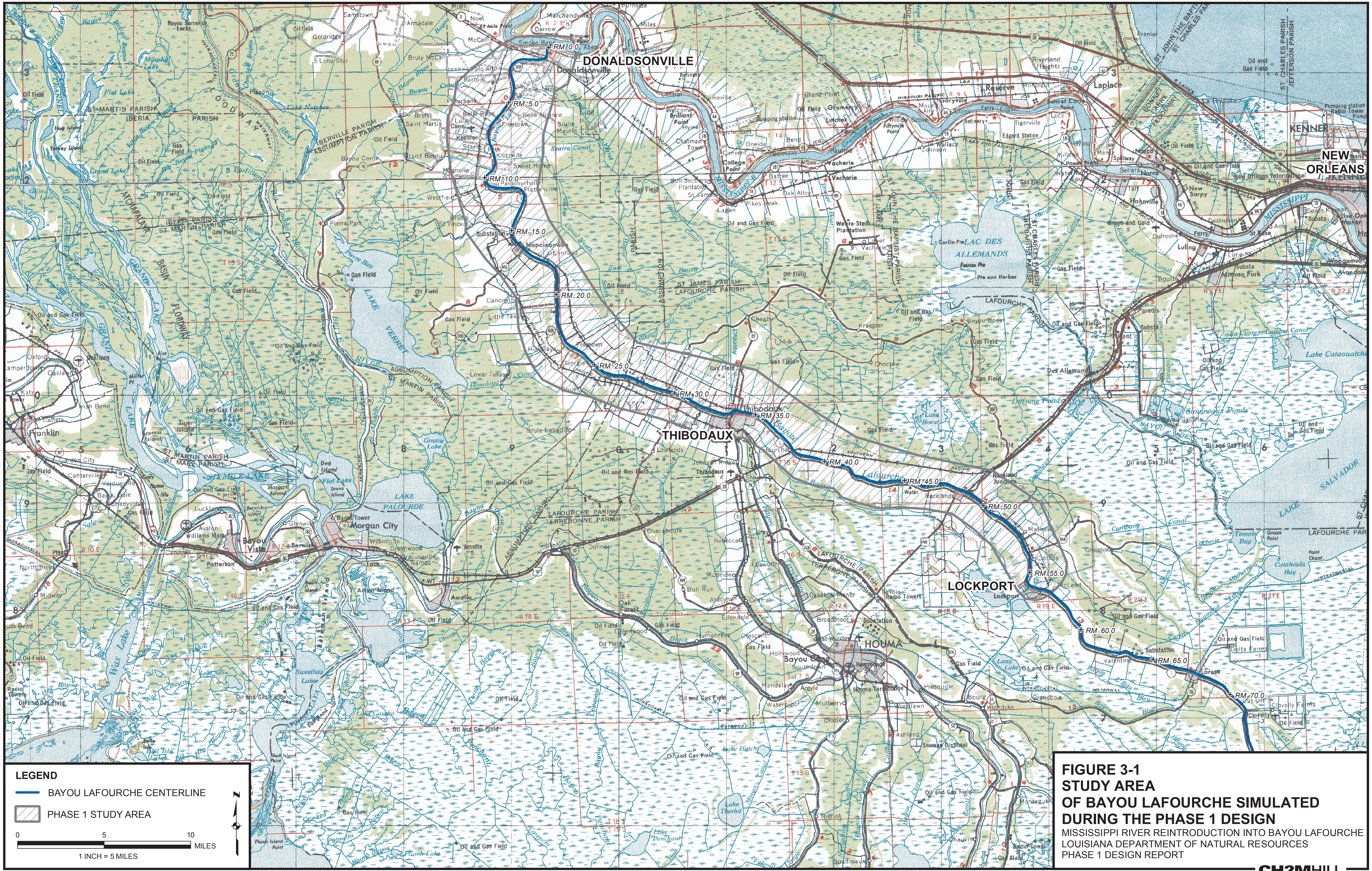

FIGURE 3-1
STUDY AREA
OF BAYOU LAFOURCHE SIMULATED
DURING THE PHASE 1 DESIGN
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
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3.1 Modeling Software

Using Bayou Lafourche as a conveyance channel for the reintroduction of Mississippi River water to the marshlands requires computer modeling tools to study both hydraulics and water quality. The overall project approach uses both a 1D, steady-state hydraulic (backwater) model called HEC-RAS for the initial alternative screening process at the Phase 1 design level, and a more sophisticated 2D (vertically averaged) model called TABS-MD for evaluating flushing in the marsh areas for the 30 percent design. Each of these models is described in this section.

3.1.1 HEC-RAS

For the Phase 1 design, the initial screening of alternatives was completed using HEC-RAS. This model, originally called HEC-2, was developed by the USACE in the 1970s. Since then, the model has been revised several times by the Hydrologic Engineering Center, and is now called HEC-RAS. In general, the HEC-RAS modeling effort was similar to earlier efforts conducted for the CWPPRA project definition (EPA, 1998), except that updated data and alternatives were studied.

For application in the Phase 1 alternative screening process, the Bayou Lafourche study reach was truncated at Lockport and was limited to the reach from the Mississippi River (RM 0.0) to Lockport (RM 56.0). Beyond Lockport, the ability of HEC-RAS to provide reasonable hydraulic information becomes uncertain because of the connecting waterways, significant interflows with the marsh areas, Gulf tidal influences, and the overall dynamic nature of the system.

A significant benefit of using HEC-RAS in the upper segment of Bayou Lafourche for the Phase 1 screening of alternatives is the added capability of the model to develop quantities from dredge templates, provide fast simulation times, and perform scour analysis at bridges deemed critically affected.

3.1.2 TABS-MD

The TABS-MD system is a collection of finite-element models that is sponsored by the USACE Waterways Experiment Station (USACE-WES) in Vicksburg, Mississippi. The main channels will be modeled using 1D elements in the modified TABS-MD program. The model that will be used to evaluate the flow in Bayou Lafourche and adjacent channels and marshes, RMA2, was initially developed by private consultants in the early 1970s, and has been enhanced over the past 3 decades through the efforts of Dr. Ian King, often in coordination with the USACE-WES. Figure 3-2 illustrates the area where the 2D model will be used for the interconnected waterways and marsh areas along Bayou Lafourche.

The 2D model, a vertically averaged hydrodynamic model, provides detailed velocity patterns and water surface elevations throughout the marshlands and channels in the study area. The 2D water quality component of the model (RMA4) will predict the salinity concentrations and changes over time from the additional diversion flows in Bayou Lafourche

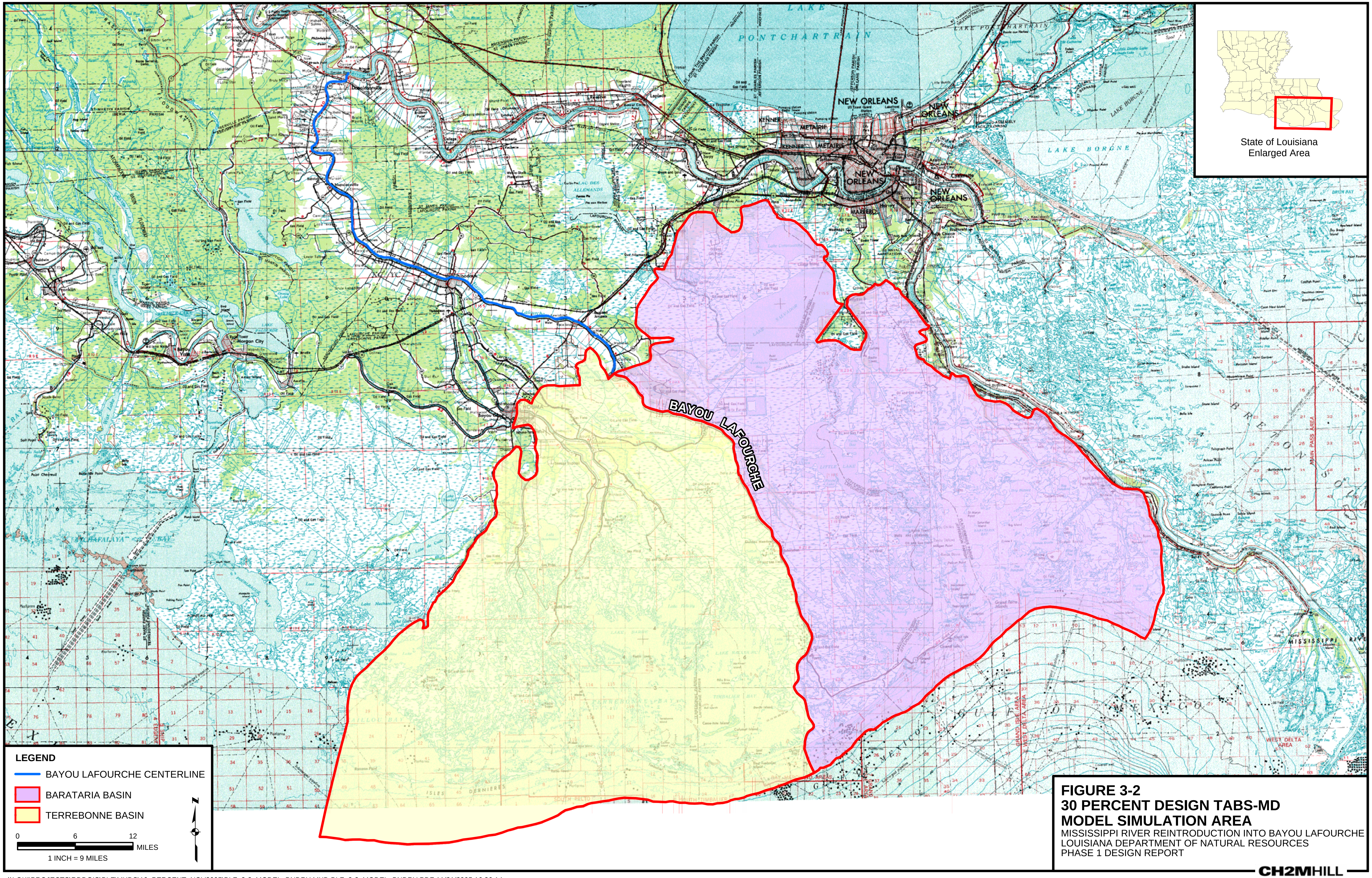

FIGURE 3-2
30 PERCENT DESIGN TABS-MD
MODEL SIMULATION AREA
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for each alternative. Because the models are computationally intensive and require significant solution time, the number of conveyance alternatives carried into the 30 percent design must be limited.

The screening process used for the Phase 1 design reduced the alternatives options to a more workable number for detailed flushing evaluations and benefited area analysis later in the design process. The physical characteristics of the alternatives carried into the 30 percent design, such as channel size, diversion location, and flows, will be incorporated into the TABS-MD model.

3.2 HEC-RAS Model Calibration

The HEC-RAS model was calibrated using historical flow and elevation data from the period March 12 through April 6, 2004. This section describes how the model data were obtained and presents the results of the calibration.

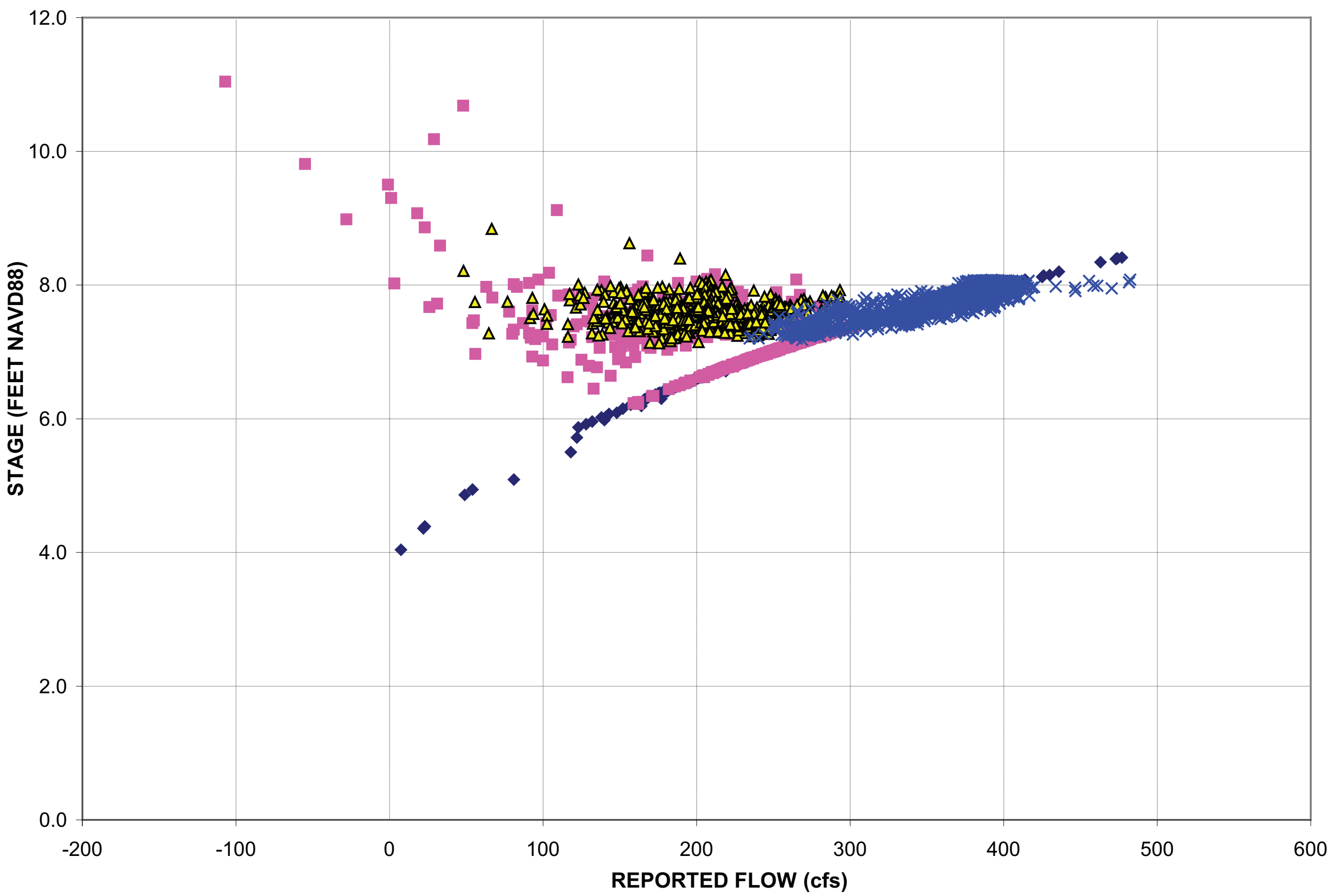
3.2.1 Data Sources for HEC-RAS Model

The UNET model that the USACE developed previously for Bayou Lafourche was used as a starting point to define the model geometry. Additional surveying was conducted to improve the accuracy of the model. Channel cross section and bridge surveys were completed between January and May 2004 by T. Baker-Smith & Son, Inc. More than 100 additional surveyed cross sections and 27 bridges were included in the initial TABS-MD 1D model. These cross sections were extracted from the TABS-MD model and used for the HEC-RAS model in the Phase 1 design. The final HEC-RAS model comprised 205 sections between the Mississippi River and Lockport, including bridges.

The HEC-RAS model used a labeling system that was consistent with the USACE UNET model. The outlet of the Donaldsonville pump station was labeled as RM 226.0, which is actually located about 0.3 mile downstream of the Mississippi River. For the Phase 1 design, RM 226.0 in the original model was used as the beginning of the HEC-RAS model (i.e., 0 miles from the river), and all references of distance downstream originate from this location. For example, Lockport is 56.3 miles downstream of the outlet of the pump station in Bayou Lafourche.

Existing Flow Rates

The USGS has a gage in Bayou Lafourche near the center of Donaldsonville. However, data from this gage are reported by the USGS and previous researchers (USACE, 1999) to be erratic. The USGS gage was established July 20, 1995, by M.L. Ross and C.L. Jones as a miscellaneous measurement site only. On December 17, 1996, it was converted to a stage/discharge site by E. Meche, B.E. McCallum, and J.C. Resweber. On December 22, 1999, after it was found that stage could not be related to discharge, a magnetic flowmeter was installed to record velocity. On April 4, 2002, a SonTek Argonaut SL Doppler current meter was installed to eventually replace the magnetic flowmeter. The March 2004 data are labeled separately on Figure 3-3 to illustrate that the replacement meter still has scatter in the stage/discharge results.



LEGEND

- 1996 STAGE/DISCHARGE
- 1999 MAGNETIC FLOWMETER
- 2000 ARGONAUT
- MARCH 2004

FIGURE 3-3
REPORTED FLOW VERSUS STAGE
FOR THE USGS DONALDSONVILLE GAGE
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Because there is only a small amount of non-pumped flow in the bayou, the Donaldsonville pump station flow data and USGS elevation (stage) data were used to calibrate the project model. According to the pump station data during the calibration period, the average daily diversion was 248 cfs.

A field data collection program began in mid-March 2004, and continues to compile velocities and depths for the project at several sites. Figure 3-4 shows the locations and data types (stage and/or velocity) for the hydraulic monitoring sites. The 15-minute data being collected downstream of Donaldsonville were used for those stations.

Lockport Rating Curve

The field data site labeled Station 1 on Figure 3-4 is at Lockport and was used to establish a stage-flow rating curve for the model calibration and alternative analysis. Measured water surface elevation data were correlated to field velocity data collected by a SonTek Argonaut SL current meter. The side-looking Argonaut meter was checked and calibrated for accuracy using a down-looking SonTek profiler on two separate occasions, May 17 and June 11, 2004. Eight individual velocity trials were taken between the 2 days using the profiler.

The data from the profiler were compared to the same period data from the side-looking meter and a velocity correction factor established. Over the range of flows measured during the calibration period, the correction factor varied from 0.99 to 1.13, with an average of 1.06.

Measured velocities from the Lockport instrument were then corrected during the calibration period and regressed against the stage record. The regression curve has an R^2 equal to 0.56, which indicates a marginal correlation with substantial variability. Figure 3-5 shows the high-tide rating curve for Station 1 that was used to fix the downstream stage boundary condition in HEC-RAS.

The marginal correlation between stage and flow at Lockport substantiates the limits of using HEC-RAS beyond this point. Downstream of Lockport, the tidal effects dominate the backwater elevations. The model's sensitivity to the downstream starting water surface was examined, and differences in stage (for the same flow) do not affect the upstream reaches much beyond Thibodaux because of the size of the channel and slopes.

Water Withdrawals

Flows were incrementally lower within the downstream study reach because of withdrawals from the system. According to the records for the 3-week calibration period, the average withdrawal was about 65 cfs. Although this level of extraction is greater than the long-term average of 39 cfs (see Appendix B), the 65-cfs withdrawal was used in the model calibration.

3.2.2 Calibration Results

Table 3-1 summarizes the field data for flows and elevations and the model results during the calibration period. Differences between the model elevations and the field data at each of the two sites of primary interest (Donaldsonville and Thibodaux) are less than 0.2 foot. Channel velocities ranged from about 0.4 to 1.4 feet per second (fps), and depths varied from 4 to 10 feet deep. Although previous hydraulic studies of Bayou Lafourche by the

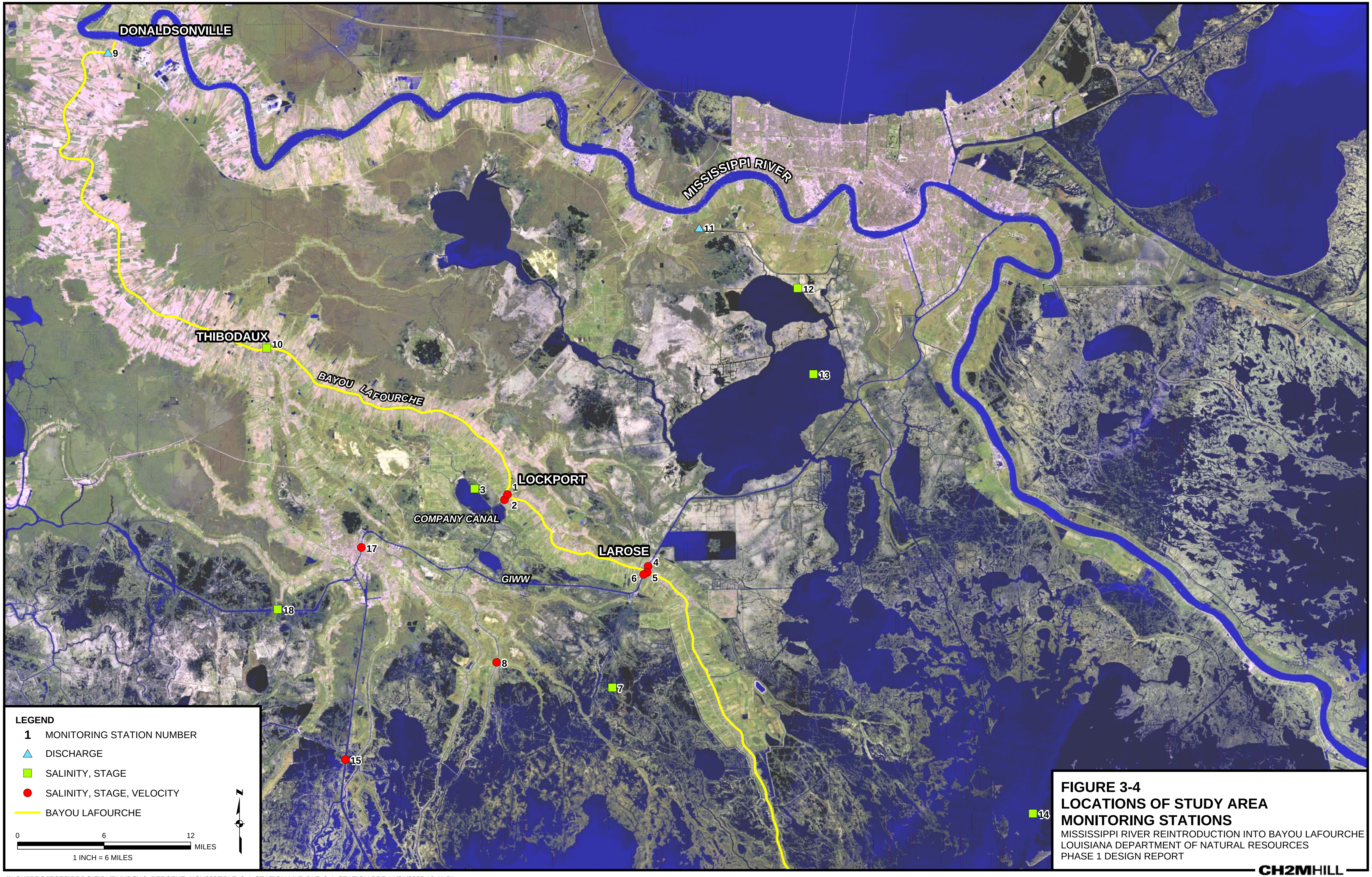

FIGURE 3-4
LOCATIONS OF STUDY AREA MONITORING STATIONS
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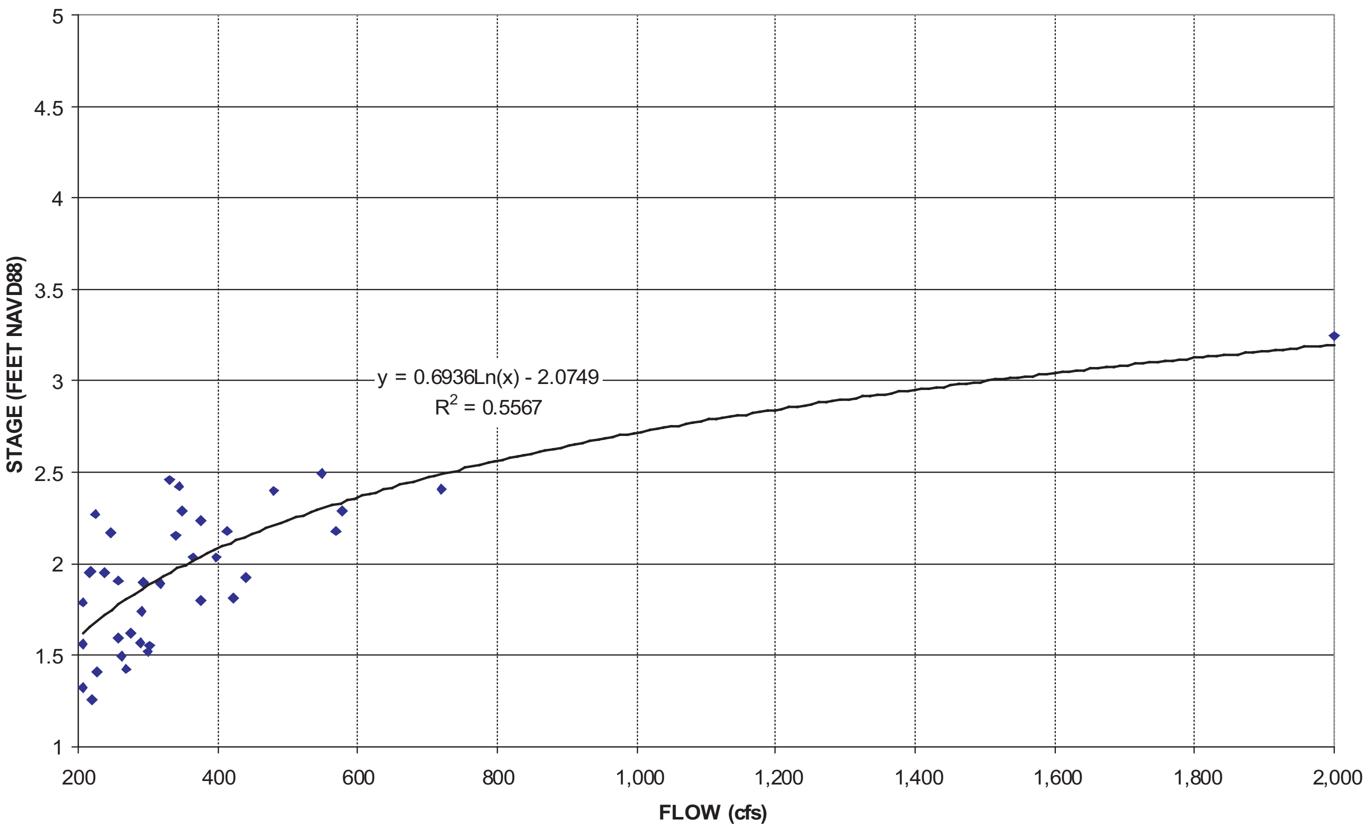

FIGURE 3-5
RATING CURVE AT LOCKPORT
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USACE and Louisiana State University have determined Manning's roughness to be between 0.020 and 0.025 (USACE, 1999), this model calibration used a roughness factor of 0.021 throughout the study reach.

TABLE 3-1
Summary of Calibration Results, HEC-RAS Model
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Site	Flow (cfs)	Stage (feet NAVD88)	Model Result (feet NAVD88)
Donaldsonville	248 (from pump data)	7.73 (from gage data)	7.92
Thibodaux (upstream)	232	4.09 (from gage data)	4.07
Thibodaux (downstream)	232	1.65 (from gage data)	1.57
Lockport	183	1.26 (from gage data)	1.26

The results in Table 3-1 indicate that the HEC-RAS model is a reasonable predictor of elevation in the reach of Bayou Lafourche from Donaldsonville to Lockport and can be used for the initial screening and comparison of conveyance alternatives.

An additional check of the HEC-RAS water surface elevations will be conducted as part of the 30 percent design phase. The TABS-MD predictions will be compared to the HEC-RAS predictions under similar flow and channel geometry configurations to provide final verification that the HEC-RAS assumptions were appropriate.

3.3 Model Implementation of Alternatives

Section 2 provided an overview of the project approach and the alternatives. This section describes how main features of the alternatives were implemented within the HEC-RAS model framework in greater detail. This section is organized as follows:

- Channel Route Alternatives
- Withdrawals for Alternative Evaluations
- Target Water Levels
- Channel Hydraulic Controls and Structures
- Channel Configuration and Dredge Templates

Results of the HEC-RAS modeling are presented in Section 3.4.

3.3.1 Channel Route Alternatives

Three channel alignments have been proposed near Donaldsonville for Phase 1, plus another possible diversion point downstream, as follows:

- Donaldsonville, with Bayou Lafourche as the sole conveyance channel
- Smoke Bend diversion, joining Bayou Lafourche near the Palo Alto Bridge (west side of Donaldsonville)

- Dugas Plantation diversion, joining Bayou Lafourche near the Palo Alto Bridge (east side of Donaldsonville)
- Terrebonne Diversion, near Thibodaux

Each Donaldsonville bypass route would require a piped conveyance segment across the Mississippi River levee, and under Highway 3089 and the railroad line to the open-channel segment that crosses the fields to Bayou Lafourche (see Section 4 for more information on diversion structures). Only the open-channel portions of the main conveyance are included in the HEC-RAS model.

Donaldsonville

The Donaldsonville alignment uses the existing bayou along the entire study area from the Mississippi River to the Gulf of Mexico (see Figure 3-1). The HEC-RAS portion of the model (upstream 56 miles) consists of the bayou channel, bridges, and the Thibodaux weir (when applicable). Water withdrawals were simulated as point losses (negative flow), and no other channel reaches were included.

Enlarging the bayou through the Donaldsonville area focused on deepening the channel and not widening the channel (EPA, 1998), which is a project assumption. The changes to available flow capacity were evaluated in the Phase 1 design using existing and increased water levels and channel size (dredge template).

The existing 50-year-old pump station at Donaldsonville would require rehabilitation and retrofitting of some of the pumps and motors to deliver the increased capacity. Replacing the entire pump station is also an option, based on required civil works, capacity, and cost. Alterations to the existing pump station are discussed in Section 4. For modeling purposes, the capacity of the channel was based solely on meeting the target water level for a given geometry (dredge template).

Smoke Bend – Westside Bypass

The Smoke Bend alignment includes a new pump station near Smoke Bend, about 1 mile west of Donaldsonville, and a bypass channel connecting with Bayou Lafourche just upstream of Palo Alto Bridge. Two alternative routes for the bypass channel are shown on Figure 3-6. The shorter route (Alternative 1) follows an existing drainage channel and cuts across agricultural fields to the south side of Palo Alto Plantation, then turns east to Bayou Lafourche (approximately 9,500 feet). The longer route (Alternative 2) follows a railroad spur line on the west boundary of the same fields until reaching just north of the road from Palo Alto Bridge, then turns east to Bayou Lafourche (approximately 13,500 feet).

The shorter route bisects more agricultural fields and parallels the historic Palo Alto Plantation property closely, which might create easement challenges. As a result, only the longer route shown on Figure 3-6 was included in the initial sizing and cost analysis. The shorter alignment for the Smoke Bend bypass is still considered a viable refinement if this alignment alternative is carried further into the design process.

In addition to the two alignment options (only one studied), there is an option to build this new channel either shallowly or deeply. There are cost ramifications for both the excavation and the pump station. A shallow channel would require less excavation, and the cut

FIGURE 3-6
SMOKE BEND BYPASS
ALIGNMENT ALTERNATIVES
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material could be balanced by being used as fill for levees along the channel to reduce the volume of material that would need to be hauled offsite. However, a shallow channel would require more pumping energy to lift water from the Mississippi River to an elevation roughly equivalent to the field elevation. Conversely, a deeper channel would require less energy, but more excavation. This is discussed further in Sections 4, 5, and 7. The bypass channel will be sized using engineering software, so this alternative (deep versus shallow channel) will not need to be explicitly included in the HEC-RAS model.

Dugas Plantation – Eastside Bypass

The eastside diversion alignment near the Dugas Plantation was not evaluated in detail because of its longer route from the Mississippi River to the junction with Bayou Lafourche at the Palo Alto Bridge (see Figure 3-7). The longer canal length needed to circumvent the developed area of Donaldsonville (approximately 23,000 feet) eliminated the eastside route from more detailed hydraulic evaluation. The Dugas bypass channel would be approximately 9,500 feet longer than the Smoke Bend bypass channel. This alternative route was proposed only as an alternative to the Smoke Bend Bypass and could still be a viable option if the Smoke Bend site is not available. The general effects on flow and downstream elevations computed for the westside bypass will still be valid for the eastside bypass alignment. Therefore, except for the cost and real estate differences, the hydraulic capacity of the Dugas Plantation bypass will be very similar to the Smoke Bend bypass. The Dugas diversion site and bypass, although discussed in this report, were not included as a viable alternative for the Phase 1 design, because of the expectation that land will be available for the more efficient Smoke Bend bypass alternative.

Bayou Terrebonne Diversion

A diversion from Bayou Lafourche into Bayou Terrebonne near Thibodaux has been proposed. Bayou Terrebonne is connected to Bayou Lafourche via a stormwater culvert under Canal Boulevard. This culvert has an existing capacity of approximately 25 cfs (preliminary estimate). The open-channel section of Bayou Terrebonne continues to increase in size in the downstream direction and appears to be of sufficient size to convey more than 25 cfs.

An evaluation of a diversion to Bayou Terrebonne would essentially require the same investigative steps and analyses performed for the Bayou Lafourche diversion. Extensive analyses would be required, including surveying, utility location or relocation, hydraulic capacity modeling, water level and property impacts, and wetlands benefits analysis.

3.3.2 Withdrawals for Alternative Evaluations

Withdrawal data from the bayou for public water supply were examined for the past several years to determine the extractions within the HEC-RAS study reach. In the 56-mile reach from Donaldsonville to Lockport, the average withdrawal was about 39 cfs. The table of water users in Appendix B shows the monthly average withdrawal data from 1998 through 2004. During the 3-month period from October through December, there are additional withdrawals for private industry, largely sugarcane refineries. The typical average use was 39 cfs along the Phase 1 design study reach.

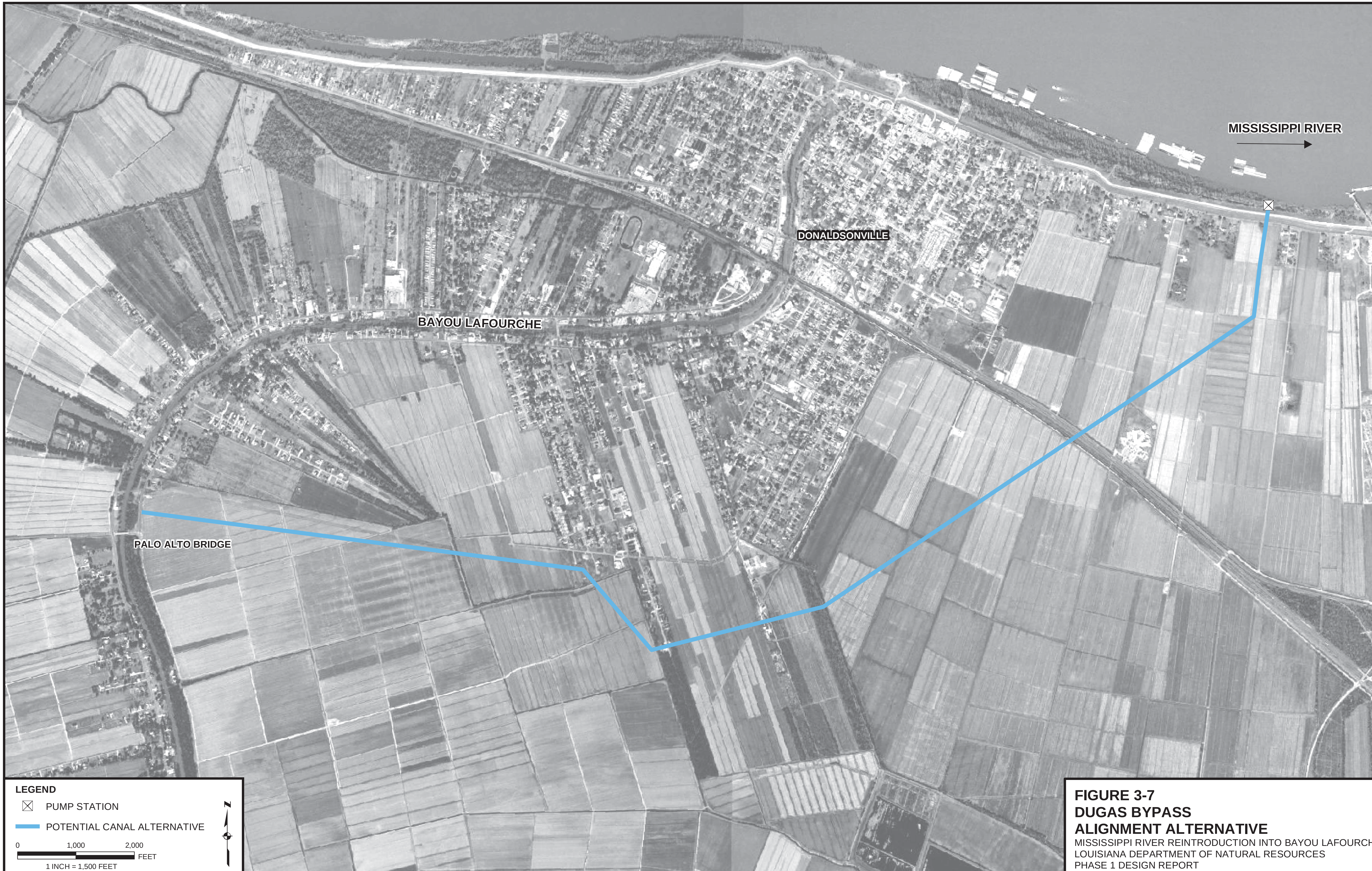

FIGURE 3-7
DUGAS BYPASS
ALIGNMENT ALTERNATIVE
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3.3.3 Target Water Levels

The Phase 1 hydraulic evaluation was completed using the concept of target water levels within Bayou Lafourche (or profiles, which are the levels along the length of the bayou). The purpose of establishing the different reference water levels was to evaluate the conveyance benefits (increased capacity) for different assumptions about the channel geometry (i.e., dredge templates) or higher water levels.

The following three target water levels were used in the Phase 1 conveyance analysis (see Section 2):

- Existing, based on the 215-cfs pumped flow at Donaldsonville, and including the Thibodaux weir
- MLW, based on historical Mississippi River levels
- MW, based on historical Mississippi River levels

The MLW, MW (average), and mean high water (MHW) target levels in the Mississippi River were determined at Donaldsonville, then extrapolated linearly to Elevation 0.0 over the 109 miles to the Gulf (see Appendix C). Therefore, the target water levels would be higher upstream and linearly reduce to the Gulf. For the Phase 1 design, only the existing, MLW, and MW levels were used as target levels for defining available flow. The three target water level profiles used for this evaluation are shown on Figure 3-8, from the Mississippi River to Lockport. A summary of the water level analysis is provided below.

Existing Water Level Profile

The complete target profile for the existing condition flow rate is shown on Figure 3-8. Existing water levels were determined using HEC-RAS simulation results for the existing channel geometry, including the Thibodaux weir, at a flow rate of 215 cfs. The existing profile flow rate of 215 cfs was developed from 26 months (April 2002 through June 2004) of Donaldsonville pump station data using daily average flows. The 50th percentile (median) flow was taken as a reliable description of the existing flow condition over a long period. Within any given day, the flows ranged between 180 and 345 cfs.

The calibrated HEC-RAS model was used to develop the existing profile, including the withdrawals and the Thibodaux weir. The model elevation at the USGS gage southwest of Donaldsonville (No. 07380401) was approximately 7.7 feet, with a flow of 215 cfs. Recorded gage elevation data vary widely with flow, but the statistical best-fit curve indicated that an elevation of 7.5 feet could be expected at the gage site for that flow rate (see Figure 3-3).

Mean Low Water and Mean Water Level Profiles

To set target water levels above the existing water level, historical MLW, MW, and MHW levels were investigated for this project. Recent property determinations in the Donaldsonville area were based on the historical MLW levels within the Mississippi River. This assumed that the pre-levee water levels would be linear along Bayou Lafourche between the Mississippi River and the Gulf.

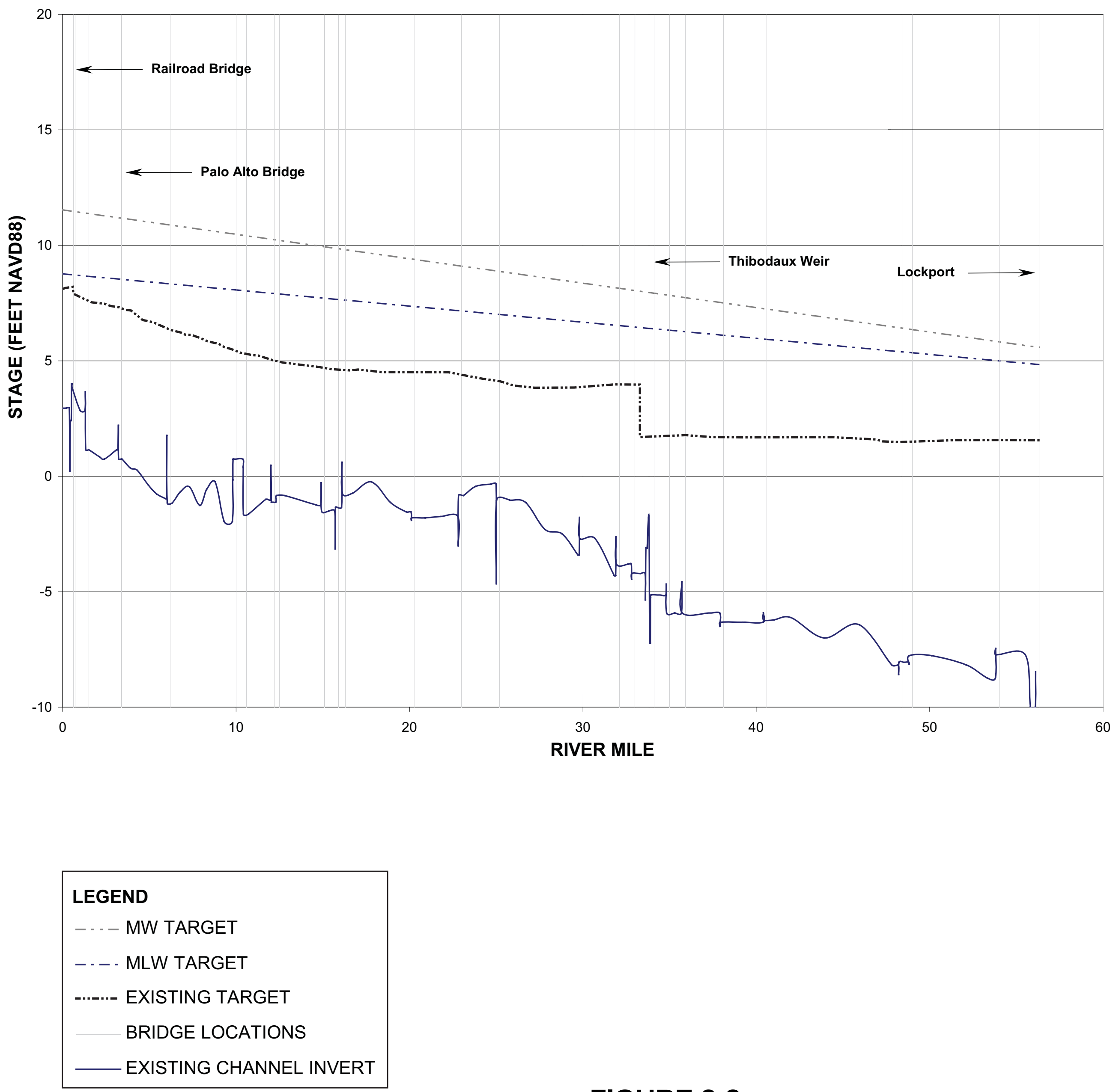

FIGURE 3-8
TARGET WATER LEVELS
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The MLW and MW profiles were developed from a statistical evaluation of the past 120 years of Mississippi River water level data (see Appendix C). These historical water levels provide a physical basis for setting higher target water levels and might have legal significance relative to existing state easements. The MLW elevation at Donaldsonville is approximately 8.8 feet, according to the historical data, and the MW elevation at Donaldsonville is approximately 11.5 feet.

Using the profiles shown on Figure 3-8, the change in the water levels will vary along the bayou depending on the station (i.e., RM). The existing water levels are generally flat upstream and downstream of the weir at Thibodaux. As the channel invert in Bayou Lafourche rises (moving from Thibodaux to Donaldsonville), the existing water levels rise while maintaining the water depths in the bayou at approximately 6 feet. The target water levels (MLW and MW) uniformly change from upstream to downstream. Within Donaldsonville (upper 3.4 miles), the MLW is only approximately 0.8 foot higher than the existing surface in the downtown area, and the MW is approximately 3.6 feet higher. This increases as it moves downstream. The MLW will rise by about 1.2 feet near the Palo Alto Bridge, then by approximately 2.9 feet more between Donaldsonville and Thibodaux (near Plattenville and Napoleonville). Figure 3-9 illustrates how the target water levels change, moving downstream. The greatest change in target levels is in Thibodaux, immediately downstream of the weir. However, Figure 3-9 illustrates only the potential maximum change in the water levels, not the actual flow simulations, which are discussed below. This figure only illustrates the potential allowable rise in water levels possible by selecting these target levels. Each computed profile only approaches the target water level in certain locations.

3.3.4 Channel Hydraulics Controls and Structures

The calibrated HEC-RAS model includes every existing bridge structure that crosses Bayou Lafourche to Lockport in the geometry file. This subsection discusses how several specific structural features were addressed in the Phase 1 design.

Existing Thibodaux Weir Removal

The Thibodaux weir will be removed to improve the capacity of Bayou Lafourche in the upstream reach from Donaldsonville to Thibodaux. This is consistent with previously proposed CWPPRA alternatives (EPA, 1998). The water surface over the weir is about 2.5 feet deep during normal operations. By eliminating the weir, the upstream conveyance capacity will have an immediate 2.5-foot equivalent increase without elevating the water surface above what is normally experienced. However, as the water levels are tracked upstream, the effect of the weir becomes less noticeable, until there is really no backwater effect from the weir in the Donaldsonville area. This is a function of the existing channel’s shape and slope.

Past proposals have noted that because removing the weir will decrease the water surface elevation upstream of Thibodaux, one or more hydraulic structures might be required for proper operation of water intakes. However, by increasing the diversion flows from the

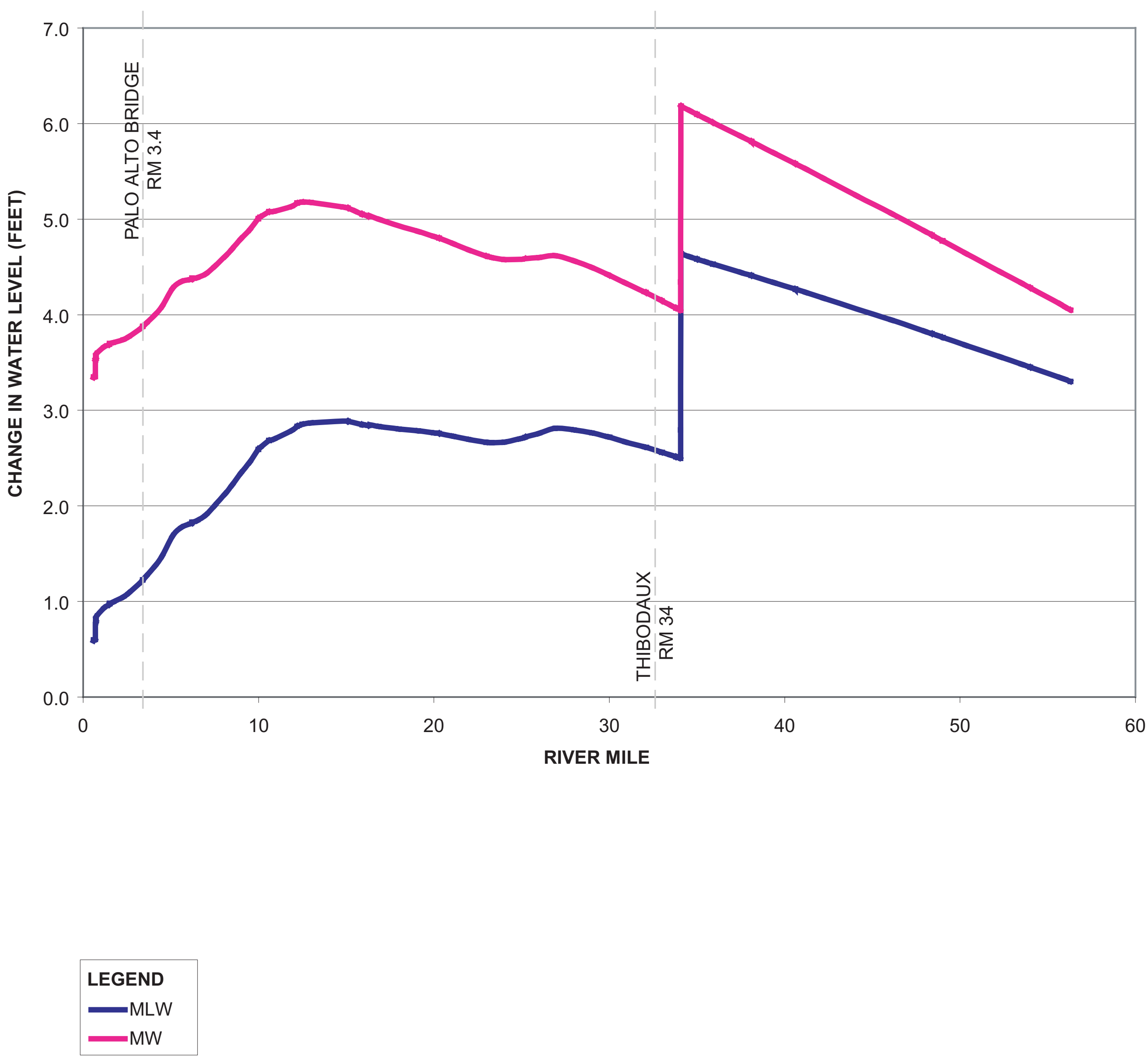

FIGURE 3-9
DIFFERENCE BETWEEN ESTIMATED EXISTING WATER LEVEL AND THE HISTORICAL MEAN LOW AND MEAN WATER LEVELS
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Mississippi River, the water levels will also tend to increase, which will offset this need. Some alternatives evaluated in the Phase 1 design also allow increases to water levels in the upstream reaches. Until the number of alternatives is reduced, these impacts will not be evaluated.

New Control Weirs

Past proposals have also suggested that additional water control structures be considered to help regulate water levels in Bayou Lafourche and provide isolation capability during spill events in the Mississippi River or the bayou (EPA, 1998). The optimized project included two control structures, one in Donaldsonville and one at Thibodaux. These gated structures would pass the high project flows, but during emergency spill operations, the main pump station would be shut down and the upstream segments of the bayou could be closed off to prevent conveying contaminated water down the system. The structures could also be used to regulate water levels and protect against rapid water level reductions (bank stability) after a high-runoff event, when the pumps would be cut back or shut down, and before they could be restarted.

The type of structures currently considered applicable are inflatable bladders (weirs) that can be raised and lowered depending on conditions. The crest elevation would likely be controlled through a telemetry system that measures water levels and connects to the main pump station at the Mississippi River.

The Phase 1 design hydraulic analysis of Bayou Lafourche does not include new control weirs because the new structures would be designed to pass the entire project flow with minimal elevation effects.

New Check Structure

A check structure located just upstream of the Palo Alto Bridge will be used for some of the alternatives that include a bypass channel around Donaldsonville. The purpose of the check structure is to maintain a stable water surface through Donaldsonville while allowing the levels downstream to rise to the target levels. This allows higher inflow from the Smoke Bend pump station, which enters Bayou Lafourche upstream of the bridge.

The Donaldsonville segment of Bayou Lafourche between the Mississippi River and the check structure would be maintained fresh with about 100 cfs from the existing Donaldsonville pump station. According to surveyed channel sections, the travel time and exchange rate in this reach would be significantly less than 24 hours. The check structure would act as a small dam, and upstream flows would have to be pumped past the structure into the downstream channel. Additional pumping capacity for stormwater runoff, redundancy, and emergency spill capability would be provided to protect the upstream reach during high-rainfall-runoff events (Section 4). For modeling purposes, on Smoke Bend alternatives with a check structure, the 100 cfs was added as a point source from Donaldsonville at the location of the confluence of the bypass channel.

Existing Union Pacific Railroad Crossing

An existing railroad crossing over Bayou Lafourche lies approximately 2,700 feet from the outlet of the existing Donaldsonville pump station and 600 feet north of Highway 3089. The crossing has three openings that convey water downstream. The openings consist of two

8.33-foot-diameter circular culverts and one 5-foot by 6-foot box culvert. These openings are insufficient to pass large flows; therefore, this crossing is a significant obstacle to using the bayou as the sole conveyance.

Past studies have noted that this railroad crossing would be modified, but the cost and implications have not always been clearly indicated. The railroad crossing's hydraulic capacity is restricted without causing significant headloss to the system and, thus, significantly raising the upstream water surface when flow is increased. According to the Phase 1 hydraulic analysis, dredging can only increase the capacity of the system by approximately 160 cfs (i.e., from 215 to 385 cfs total) while maintaining the existing water levels, without increasing the capacity of the railroad crossing. This conveyance limitation was evaluated in the HEC-RAS model to determine the need to improve capacity for cost estimating purposes.

New Drop Structure

Depending on the proposed design of the bypass channel (i.e., invert elevation), a hydraulic drop structure might be needed to compensate for the difference in elevation between the bypass channel and the bayou. This would be required for the shallow bypass channel alternative. A new shallow channel would terminate at a drop structure located in the cane field adjacent to Highway 1.

The drop structure will be a concrete inlet with a vertical drop to the elevation of the bayou channel. For the various options, the drop will be approximately 10 to 15 feet. The drop structure will have a discharge box culvert angled toward the bayou to minimize turbulence at the junction area. Riprap will be used to prevent erosion. Construction of the drop structure will be accomplished by either tunneling under the roadway or by open cut with a temporary detour. For the Phase 1 design, it was assumed that the shallow bypass channel alternatives would have a drop structure and the deep-channel alternative would not.

3.3.5 Channel Configuration and Dredge Templates

The surveyed cross sections and invert profile within the study reach from Donaldsonville to Lockport were examined for trends and consistency to aid in subdividing the 56 miles into shorter subreaches. The purpose of the examination was to find logical breakpoints in bottom slope or channel geometry to simplify implementation of the two dredge templates within the model framework. Two dredging depths, 2 and 8 feet (plus a no dredging option), were selected to evaluate the influence of dredging on project flows.

Design Reaches

After reviewing the existing bottom invert profile, there appeared to be four reasonably uniform slope segments and additional subreaches within these segments with similar bottom widths and geometry along the bayou. The study area in the model was divided into subreaches, called design reaches, for the alternative analysis, for purposes of modifying the channel cross sections by dredging. Figures 3-10 and 3-11 present schematics of the lengths of the design reaches for the 2- and 8-foot dredge templates, respectively, within each HEC-RAS model. Each HEC-RAS dredge alternative had these different reaches within the model geometry framework.

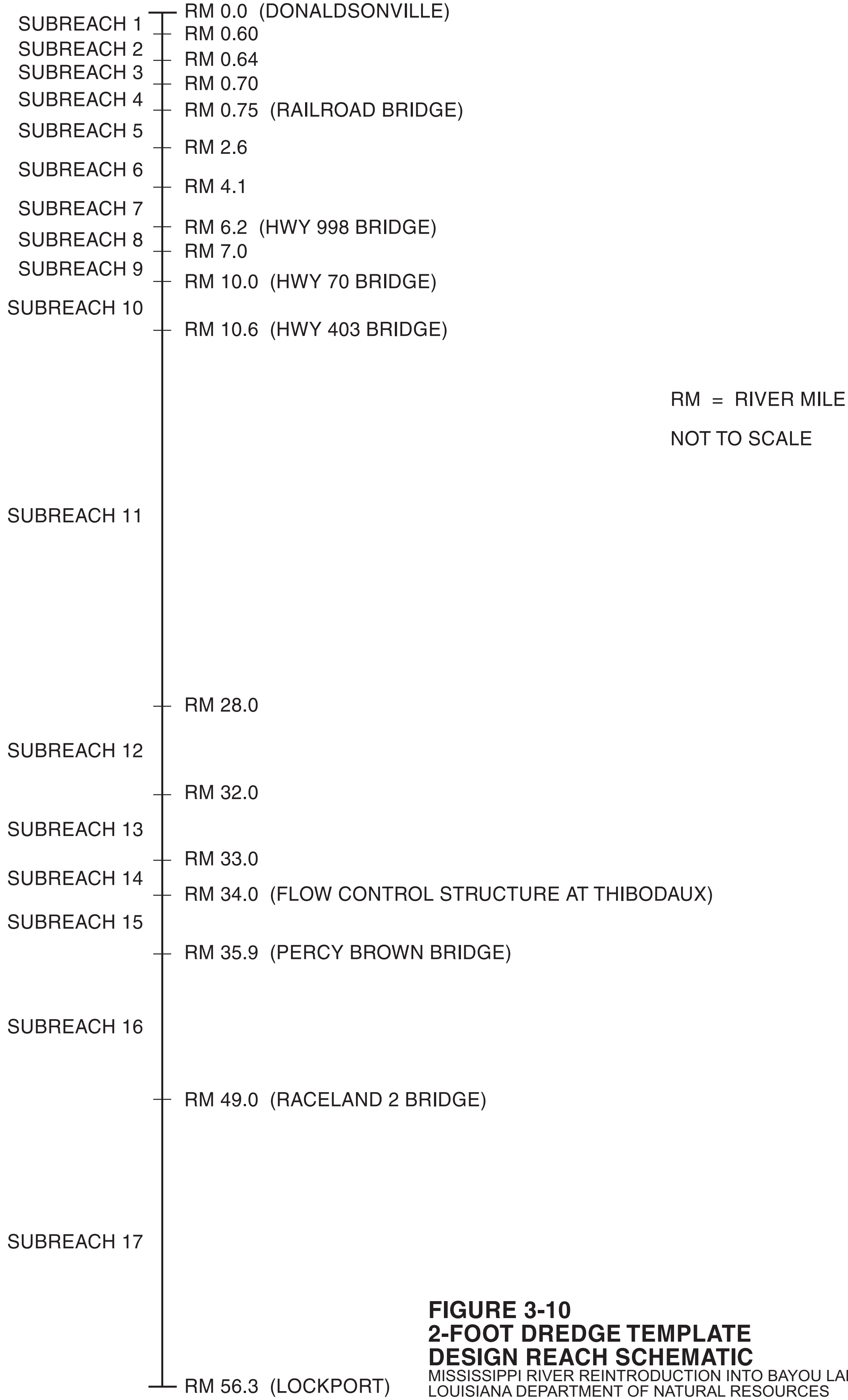

FIGURE 3-10
2-FOOT DREDGE TEMPLATE
DESIGN REACH SCHEMATIC

MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
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W082005005RDD_20 (11/01/04)

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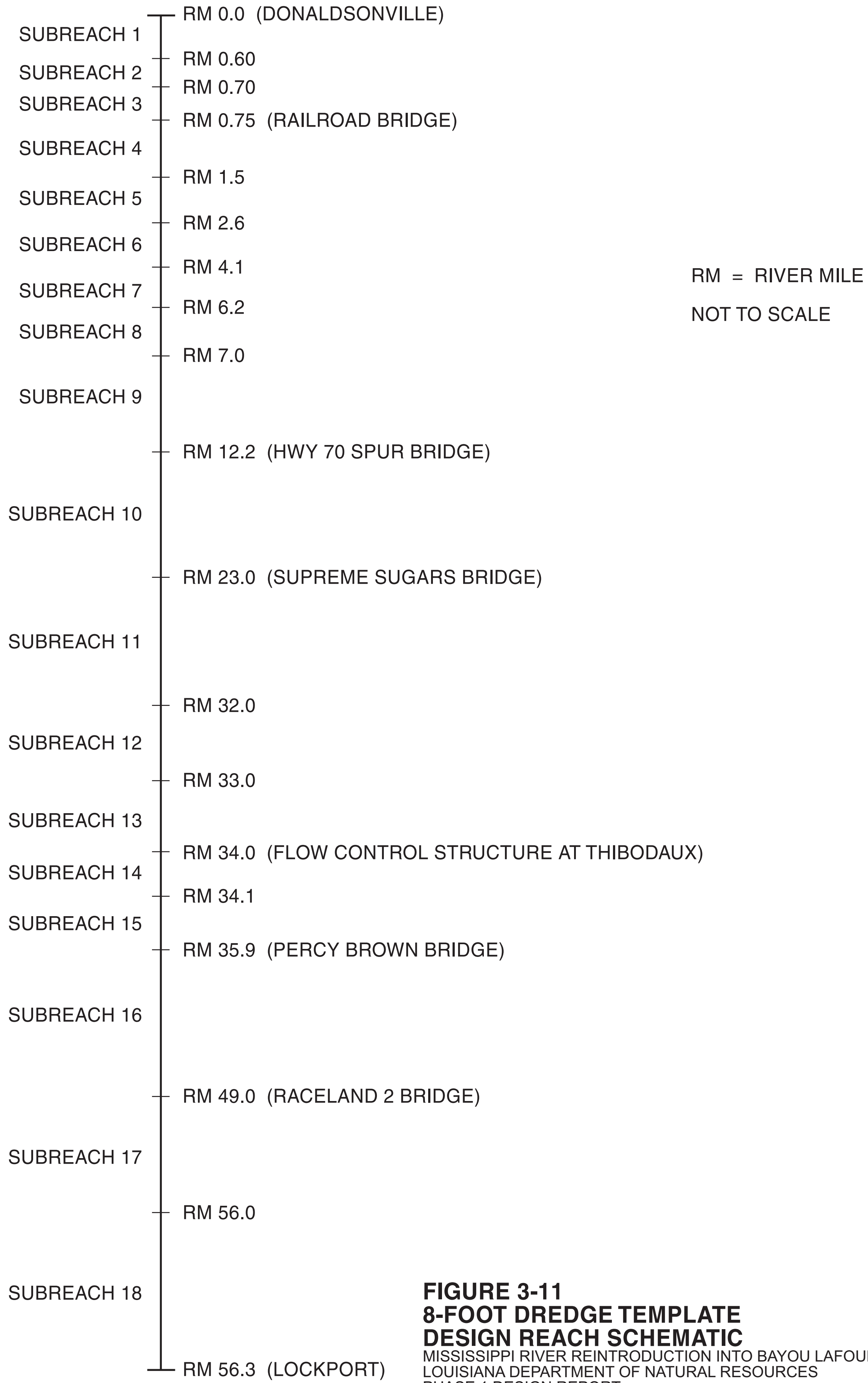

FIGURE 3-11
8-FOOT DREDGE TEMPLATE
DESIGN REACH SCHEMATIC
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
PHASE 1 DESIGN REPORT

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Dredge Templates

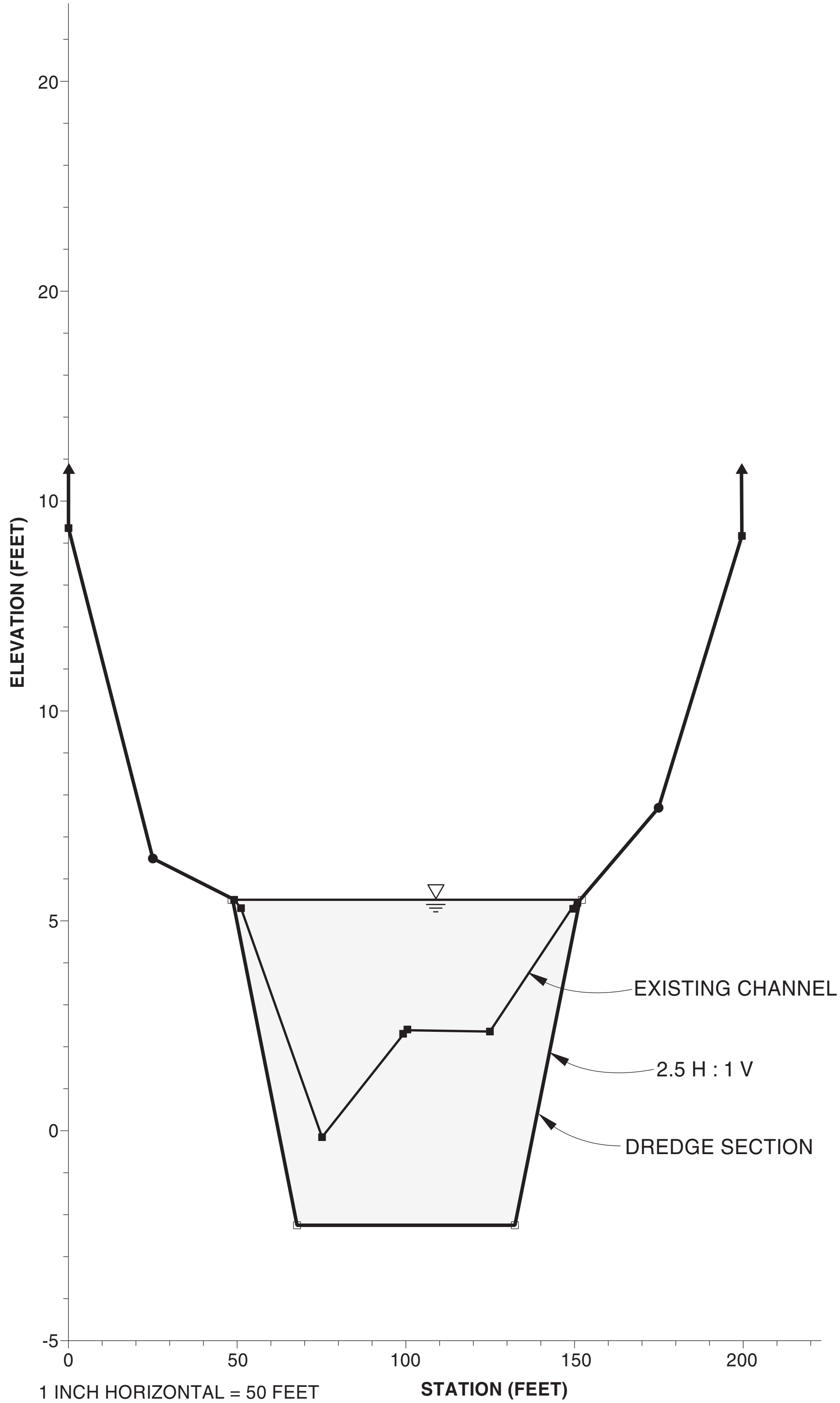
Figures 3-12 and 3-13 provide examples of how the two dredge templates would modify a typical cross section geometry. The dredge template modified each existing cross section; therefore, the resulting dredged channel was nearly uniform within the design reach. The dredge templates consist of a trapezoidal channel section with 2.5:1 (horizontal:vertical [H:V]) side slopes, an average bottom width for each subreach, and an approximate dredging depth. Table 3-2 lists the design reach bottom width, approximate bottom elevation, and invert slope for each template, by subreach.

TABLE 3-2
Description of Dredge Templates by Design Reach
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

	2-foot Dredge			8-foot Dredge		
Subreach No.	**Bottom Width (feet)**	**Average Invert Elevation**	**Invert Slope**	**Bottom Width (feet)**	**Average Invert Elevation**	**Invert Slope**
1	60	0.49	1.06E-04	30	-5.51	1.06E-04
2	5	0.21	1.06E-04	5	-5.67	1.06E-04
3	25	0.33	1.06E-04	75	-5.71	1.06E-04
4	100	0.30	1.06E-04	15	-5.94	1.06E-04
5	35	-0.13	1.06E-04	5	-6.24	1.06E-04
6	65	-0.97	1.06E-04	35	-6.97	1.06E-04
7	65	-2.06	1.25E-04	35	-7.72	1.25E-04
8	60	-2.63	1.25E-04	25	-8.23	1.25E-04
9	60	-2.96	2.44E-05	25	-8.79	2.44E-05
10	40	-3.16	2.44E-05	35	-9.61	2.44E-05
11	70	-4.12	2.44E-05	55	-10.92	2.44E-05
12	80	-5.51	2.44E-05	30	-11.51	2.44E-05
13	65	-5.71	2.44E-05	50	-11.67	2.44E-05
14	85	-5.87	2.44E-05	50	-11.74	2.80E-05
15	85	-6.23	2.80E-05	65	-11.90	2.80E-05
16	80	-7.33	2.80E-05	50	-12.30	2.80E-05
17	95	-9.04	2.80E-05	75	-14.65	2.80E-05
18	-	-	-	60	-14.98	2.80E-05

Notes:
Subreach lengths are not the same between 2- and 8-foot dredge templates (see Figures 3-8 and 3-9).
A minimum 5-foot bottom width was used when the natural channel was narrow.

The length of the dredging over the study area varied as an option for the alternatives to investigate benefits of reducing the extent of dredging, or using different dredging depths along the bayou. Table 3-3 shows the various dredging identification codes and descriptions used to identify alternatives. The identification code indicates the depth and extent of dredging captured by the numbering scheme and RM designation. As an example, the identification code 8–2@RM29 means an average of 8 feet of dredging upstream of RM 29.0, and an average of 2 feet of dredging downstream to RM 56.0. The identification code of 2 simply means 2 feet of dredging over the entire study reach (56 miles).



1 INCH HORIZONTAL = 50 FEET
1 INCH VERTICAL = 4 FEET

FIGURE 3-12
2-FOOT DREDGE TEMPLATE
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
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W082005005RDD_21 (11/01/04)

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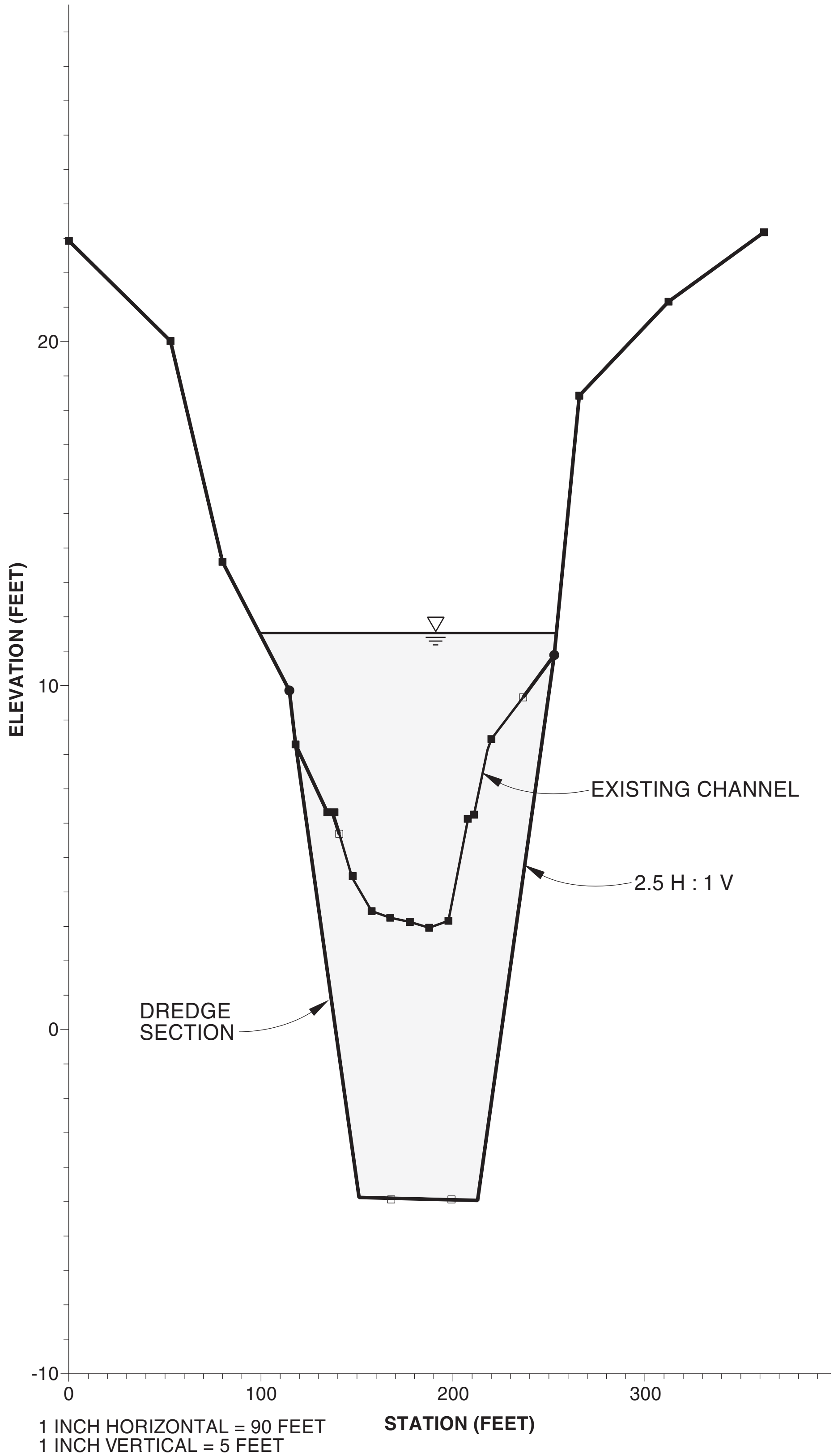

FIGURE 3-13
8-FOOT DREDGE TEMPLATE
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
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TABLE 3-3
Identification Scheme of Dredge Templates in HEC-RAS Model
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Code	Description
ND	No dredging
2-ALL	2-foot dredge, complete
8-ALL	8-foot dredge, complete
2-0@RM3.4	2-foot dredge upstream of RM 3.4, none downstream
2-0@RM29	2-foot dredge upstream of RM 29.0, none downstream
8-2@RM3.4	8-foot dredge upstream of RM 3.4, 2-foot dredge downstream
8-2@RM29	8-foot dredge upstream of RM 29.0, 2-foot dredge downstream
8-0@RM29	8-foot dredge upstream of RM 29.0, none downstream

Notes:

RM 3.4 is approximately the Palo Alto Bridge.
RM 29.0 is approximately 5 miles upstream of Thibodaux.
For Smoke Bend alternatives, dredging begins at RM 3.4.

Bank Stability

The dredging of the bayou and shape of the cross section have been assumed for the Phase 1 evaluation to be stable at 2.5:1 (H:V) side slopes based on the USACE analysis (USACE, 1999). Silt and sediment deposition have made the original designed channel irregular in shape, and made it difficult to establish the slope using native materials. According to the literature and geotechnical reconnaissance, this cross section is sufficient. During the 30 percent design, there will be additional geotechnical investigations to determine a final slope for the dredging cut.

Should additional bank stabilization be necessary in and around sensitive structures because of potential scour, localized slope protection methods will be used to stabilize the structure. Initial simulations indicate that velocities will be relatively low. Scour computations would be completed as part of the 30 percent design for the reduced number of alternatives.

3.3.6 Smoke Bend Bypass Channel Configuration

The alternatives that include the Smoke Bend bypass to Bayou Lafourche would require new channel excavation sufficient to convey the estimated flow at a velocity of less than 2 fps. The total length of the longest bypass route is about 13,500 feet. For the Phase 1 design, the bypass channel was engineered to convey the total downstream flow minus the 100 cfs to be sent through Donaldsonville, with 18 inches of freeboard. To match the target elevations, each alternative had a different flow, which subsequently required a different channel size to meet the velocity and flow requirements.

For the Phase 1 design, two types of channel excavation, shallow cut and deep cut, were proposed using the Smoke Bend pump station design and energy requirements, and facilities at the confluence for certain alternatives (check structure and confluence pump station). In the shallow-cut bypass option, 1.5 feet of freeboard were assumed to estimate excavation quantities for the shallow-cut channel. In the deep-cut channel, the freeboard was included in the depth of the channel excavation.

Appendix D provides hydraulic parameters and excavation tables with and without freeboard, showing the different combinations of bottom width and depth needed to convey flows from 400 to 3,000 cfs in the bypass canal.

3.4 Results of Conveyance Analysis

3.4.1 Methodology

The HEC-RAS model was used to evaluate a combination of 69 alternative alignments (corresponding to the number remaining after Screening Criterion 3), target water surfaces, dredging, and improvements (check structures and railroad bridge modifications) to determine the approximate allowable flows that would meet the target water levels. Table 3-4 contains descriptions of the 69 modeled alternative combinations.

Each alternative incorporated the 39-cfs withdrawal representing the public utility diversions and an elevation at Lockport based on the approximated rating curve. Reduction of flows in the most downstream segment of the study reach, between Thibodaux and Lockport for the Bayou Terrebonne diversion, was not included in the Phase 1 design.

The alternatives and options were subdivided into two groups: Bayou Lafourche alignment or Smoke Bend bypass alignment. These two groups were then partitioned into alternatives and options for the three target water levels, improvements to the railroad crossing, and several types of dredge templates. The total flow was increased until the target water surface was achieved within the study reach for any given section between Donaldsonville and Thibodaux.

The results of the allowable flow determination are listed in Table 3-5. The flow listed for the bypass alternative was the total project flow downstream of the Palo Alto Bridge. This total flow included the 100 cfs from the existing Donaldsonville pump station; therefore, the Smoke Bend pump station would be sized to handle the total project flow, less 100 cfs. For the Phase 1 design, only round numbers were used to select the pump station size and cost (e.g., total flow = 980 cfs; therefore, a 1,000-cfs pump station cost would be used).

Often, there was a common controlling section (i.e., a location where proposed water levels met the reference target level) in the upstream portion of the bayou that determined the capacity of the alternative. This section varied depending on whether the bypass channel was included. For the Bayou Lafourche alignment, the elevation control section was usually upstream of the railroad crossing. For the Smoke Bend alignment, the control section was typically at the confluence of the bypass channel and Bayou Lafourche. For some combinations of dredge templates, the control sections were farther downstream, but always upstream of Thibodaux.

TABLE 3-4
Combinations of Alignments, Dredge Templates, and Target Water Levels that Form the Phase 1 Design Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative Nos.	Short Title	Geometry Description	Water Surface Control Location	Flow Description
NA	Calibration	Existing geometry with weir from Donaldsonville to Lockport.	Donaldsonville gage location	248 cfs (average November 2003 flow rate) – flow change locations based on average daily with-drawals for water supply and irrigation.
1-3	Existing Condition with Weir-BL	Existing geometry with weir from Donaldsonville to Lockport.	Not applicable	Existing flow rate based on flow duration analysis of 3 years of data. 215 cfs is the 50th percentile.
4-6	2 Dredging-NM RR-BL	2-foot dredged geometry from Donaldsonville to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
7-9	8 Dredging-NM RR-BL	8-foot dredged geometry from Donaldsonville to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
10-12	8-2 (RM 29.0) Dredging-NM RR-BL	8-foot dredged geometry from Donaldsonville to RM 29.0 and 2-foot dredged geometry from RM 29.0 to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
13-15	2-0 (RM 29.0) Dredging-NM RR-BL	2-foot dredged geometry from Donaldsonville to RM 29.0 and no dredging from RM 29.0 to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
16-18	No Dredging-M RR-BL	No dredging from Donaldsonville to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
19-21	2 Dredging-M RR-BL	2-foot dredged geometry from Donaldsonville to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
22-24	8 Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
25-27	8-2 (RM 3.4) Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to RM 3.4 and 2-foot dredged geometry from RM 3.4 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
28-30	2-0 (RM 3.4) Dredging-M RR-BL	2-foot dredged geometry from Donaldsonville to RM 3.4 and no dredging from RM 3.4 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
31-33	8-2 (RM 29.0) Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to RM 29.0 and 2-foot dredged geometry from RM 29.0 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.

TABLE 3-4
Combinations of Alignments, Dredge Templates, and Target Water Levels that Form the Phase 1 Design Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative Nos.	Short Title	Geometry Description	Water Surface Control Location	Flow Description
34-36	8-0 (RM 29.0) Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to RM 29.0 and no dredging from RM 29.0 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
37-39	2-0 (RM 29.0) Dredging-M RR-BL	2-foot dredged geometry from Donaldsonville to RM 29.0 and no dredging from RM 29.0 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
40-42	BL & SB No Dredge No Control	Includes Smoke Bend Canal and existing Bayou Lafourche canal. No check structure or modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.
43-45	BL & SB 2' Dredge No Control	Includes Smoke Bend Canal and 2-foot dredged Bayou Lafourche. Dredging extends upstream of confluence of Bayou Lafourche and Smoke Bend. No check structure or modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface.
46-48	BL & SB 8' Dredge No Control	Includes Smoke Bend Canal and 8-foot dredged Bayou Lafourche. Dredging extends upstream of confluence of Bayou Lafourche and Smoke Bend. No check structure or modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.
49-51	BL & SB 8' - 2' Dredge No Control (RM 29.0)	Includes Smoke Bend Canal and 8- to 2-foot combination dredging. Dredging (8-foot) begins downstream of check structure (upstream of confluence). Dredging changes to 2 feet at RM 29.0.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.
52-54	BL & SB 2'-0' Dredge No Control (RM 29.0)	Includes Smoke Bend Canal and 2- to 0-foot combination dredging. Dredging (2-foot) begins downstream of check structure (upstream of confluence). Dredging changes to 0 feet at RM 29.0.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.

TABLE 3-4
Combinations of Alignments, Dredge Templates, and Target Water Levels that Form the Phase 1 Design Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative Nos.	Short Title	Geometry Description	Water Surface Control Location	Flow Description
55-57	BL & SB No Dredge with Control	Includes Smoke Bend Canal and existing Bayou Lafourche Canal. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
58-60	BL & SB 2' Dredge with Control	Includes Smoke Bend Canal and 2-foot dredge of Bayou Lafourche Canal. Dredging extends to downstream face of Palo Alto Bridge. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
61-63	BL & SB 8' Dredge with Control	Includes Smoke Bend Canal and 8-foot dredge of Bayou Lafourche Canal. Dredging extends to downstream face of Palo Alto Bridge. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
64-66	BL & SB 8'-2' Dredge with Control	Includes Smoke Bend Canal and 8- to 2-foot combination dredging. Dredging (8-foot) extends from check structure (upstream confluence). Dredging changes to 2 feet at RM 29.0. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
67-69	BL & SB 2'-0' Dredge with Control	Includes Smoke Bend Canal and 2- to 0-foot combination dredging. Dredging (2-foot) extends from check structure (upstream of confluence to RM 29.0), where dredging changes to 0 feet. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.

Notes:

The water surface control location is the typical point where the target is met. The whole profile upstream of Lockport will be checked.

BL = Bayou Lafourche

B = Smoke Bend

TABLE 3-5
Summary of Estimated Allowable Flow for Each Alternative and Target Water Level
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Donaldsonville Pump Station Flow (cfs) RS 226	Smoke Bend Pump Station Flow (cfs) RS 226	Palo Alto Bridge Combined Flow (cfs) RS 211
1	BL	NM	NA	ND	E	215	--	--
2	BL	NM	NA	ND	MLW	289	--	--
3	BL	NM	NA	ND	MW	688	--	--
4	BL	NM	NA	2-ALL	E	373	--	--
5	BL	NM	NA	2-ALL	MLW	480	--	--
6	BL	NM	NA	2-ALL	MW	1,030	--	--
7	BL	NM	NA	8-ALL	E	379	--	--
8	BL	NM	NA	8-ALL	MLW	487	--	--
9	BL	NM	NA	8-ALL	MW	1,040	--	--
10	BL	NM	NA	8-2@RM29	E	385	--	--
11	BL	NM	NA	8-2@RM29	MLW	485	--	--
12	BL	NM	NA	8-2@RM29	MW	1,040	--	--
13	BL	NM	NA	2-0@RM29	E	375	--	--
14	BL	NM	NA	2-0@RM29	MLW	480	--	--
15	BL	NM	NA	2-0@RM29	MW	1,025	--	--
16	BL	M	NA	ND	E	234	--	--
17	BL	M	NA	ND	MLW	315	--	--
18	BL	M	NA	ND	MW	833	--	--
19	BL	M	NA	2-ALL	E	850	--	--
20	BL	M	NA	2-ALL	MLW	1,020	--	--
21	BL	M	NA	2-ALL	MW	1,800	--	--
22	BL	M	NA	8-ALL	E	1,300	--	--
23	BL	M	NA	8-ALL	MLW	1,600	--	--
24	BL	M	NA	8-ALL	MW	2,470	--	--
25	BL	M	NA	8-2@RM3.4	E	850	--	--
26	BL	M	NA	8-2@RM3.4	MLW	1,250	--	--
27	BL	M	NA	8-2@RM3.4	MW	2,000	--	--
28	BL	M	NA	2-0@RM3.4	E	220	--	--
29	BL	M	NA	2-0@RM3.4	MLW	420	--	--
30	BL	M	NA	2-0@RM3.4	MW	970	--	--
31	BL	M	NA	8-2@RM29	E	1,100	--	--
32	BL	M	NA	8-2@RM29	MLW	1,530	--	--
33	BL	M	NA	8-2@RM29	MW	2,340	--	--
34	BL	M	NA	8-0@RM29	E	580	--	--
35	BL	M	NA	8-0@RM29	MLW	1,300	--	--
36	BL	M	NA	8-0@RM29	MW	2,100	--	--
37	BL	M	NA	2-0@RM29	E	580	--	--
38	BL	M	NA	2-0@RM29	MLW	970	--	--
39	BL	M	NA	2-0@RM29	MW	1,650	--	--
40	SB	NM	N	ND	E	100	115	215
41	SB	NM	N	ND	MLW	100	338	438
42	SB	NM	N	ND	MW	100	951	1,051
43	SB	NM	N	2-ALL	E	100	730	830
44	SB	NM	N	2-ALL	MLW	100	1,300	1,400
45	SB	NM	N	2-ALL	MW	100	2,200	2,300
46	SB	NM	N	8-ALL	E	100	1,220	1,320
47	SB	NM	N	8-ALL	MLW	100	1,900	2,000
48	SB	NM	N	8-ALL	MW	100	3,000	3,100
49	SB	NM	N	8-2@RM29	E	100	880	980
50	SB	NM	N	8-2@RM29	MLW	100	1,710	1,810
51	SB	NM	N	8-2@RM29	MW	100	2,680	2,780
52	SB	NM	N	2-0@RM29	E	100	460	560
53	SB	NM	N	2-0@RM29	MLW	100	1,130	1,230
54	SB	NM	N	2-0@RM29	MW	100	1,950	2,050
55	SB	NM	Y	ND	E	100	115	215
56	SB	NM	Y	ND	MLW	100	315	415
57	SB	NM	Y	ND	MW	100	1,020	1,120
58	SB	NM	Y	2-ALL	E	100	730	830

TABLE 3-5
Summary of Estimated Allowable Flow for Each Alternative and Target Water Level
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Donaldsonville Pump Station Flow (cfs) RS 226	Smoke Bend Pump Station Flow (cfs) RS 226	Palo Alto Bridge Combined Flow (cfs) RS 211
59	SB	NM	Y	2-ALL	MLW	100	1,290	1,390
60	SB	NM	Y	2-ALL	MW	100	2,190	2,290
61	SB	NM	Y	8-ALL	E	100	1,220	1,320
62	SB	NM	Y	8-ALL	MLW	100	1,900	2,000
63	SB	NM	Y	8-ALL	MW	100	2,980	3,080
64	SB	NM	Y	8-2@RM29	E	100	880	980
65	SB	NM	Y	8-2@RM29	MLW	100	1,710	1,810
66	SB	NM	Y	8-2@RM29	MW	100	2,680	2,780
67	SB	NM	Y	2-0@RM29	E	100	460	560
68	SB	NM	Y	2-0@RM29	MLW	100	1,130	1,230
69	SB	NM	Y	2-0@RM29	MW	100	1,950	2,050

Notes:

[a]BL = Bayou Lafourche only
SB = Smoke Bend bypass and Bayou Lafourche

[b]NM = No modification to existing railroad bridge culverts
M = Modification to existing railroad bridge culverts

[c]Y = Check structure in place
N = No check structure
NA = Not applicable for Bayou Lafourche alignment
Check structure assumptions:
Location = Immediately upstream of confluence
Flow input upstream of check structure = 100 cfs

[d]ND = No dredging
2 = Dredge template characteristics:
Depth = 2 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 17 subreaches
8 = Dredge template characteristics:
Depth = 8 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 18 subreaches
8-2@RM3.4 = Combined dredging template characteristics:
8-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 2-foot dredge downstream
2-0@+RM3.4 = Combined dredging template characteristics:
2-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 0-foot dredge downstream
8-2@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 2-foot dredge downstream
2-0@RM29 = Combined dredging template characteristics:
2-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream
8-0@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream

[e]E = Existing water level

The material-handling quantities were a major cost component for any alternative that includes dredging or the bypass channel. By using a fixed number of dredge templates for the bayou, the dredged sediment quantities from the main channel could be computed for a fixed number of combinations. For the bypass channel, the excavation quantities varied among alternatives depending on the computed flow. A uniform trapezoidal channel was computed for various flows and depths (deep or shallow) for each alternative. Regression equations were developed between depth and cross-sectional area. For each allowable flow in the bypass canal, the depth and resulting cross-sectional area were determined from Flowmaster® and the regression equations, respectively. Therefore, the estimated excavation quantities for the bypass alternatives (40 through 69) varied more than the others. Table 3-6 provides a list of the estimated dredge and excavation quantities for each alternative. The Smoke Bend bypass excavation subdivided alternatives 40 through 69 into a deep-cut and shallow-cut set of options. The shallow-cut option was eliminated during the initial stages of the screening process.

The complete set of alternative descriptions and resulting project flows is provided in Appendix E. This appendix also includes plots of the water profile results. Table 3-7 shows the resulting flows that meet the target water levels for a representative selection of dredge templates, improvement options, and alignments.

According to the Phase 1 design HEC-RAS modeling results, significant benefits (increased flow) are associated with dredging and/or allowing a rise in the target water level. The project flows ranged from approximately 300 cfs (allowing a water level rise to MLW, but no dredging) to more than 3,000 cfs (allowing a water level rise to MW and 8 feet of dredging). The maximum flows determined for the seven dredge templates and combinations of options were as follows:

- Existing Water Level: 1,320 cfs using 8-foot dredging for entire 56 miles
- MLW Level: 2,000 cfs using 8-foot dredging for entire 56 miles
- MW Level: 3,100 cfs using 8-foot dredging for entire 56 miles

3.4.2 Preliminary Results Discussion

In reviewing results, and as illustrated in Table 3-7 and Appendix E, several interesting preliminary observations are worth noting and are discussed in the following subsections.

Dredging Effects

There appears to be no significant advantage to dredging downstream of RM 29.0. The project flows are similar for dredging the full 56 miles and dredging only to RM 29.0, both for 2- and 8-foot dredging. The increase in flow is only about 200 cfs, but the dredging quantities are nearly double.

There is a substantial flow benefit for dredging downstream of Palo Alto Bridge (RM 3.4) to approximately RM 29.0. For the same set of conditions (i.e., target elevation, alignment, and railroad crossing improvement), the additional dredging provides an increased capacity of 200 to 500 cfs when only Bayou Lafourche is used, and 700 to 800 cfs with the Smoke Bend bypass canal. There is still a considerable amount of dredge material, but much less than what would result from dredging the full length. Additional dredging from 2 to 8 feet for any distance increases the allowable flow by 600 to 700 cfs.

TABLE 3-6
Summary of Estimated Dredging and Excavation Quantities for Each Alternative
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

							Smoke Bend Bypass	
Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Bayou Lafourche Dredging (cy)	Deep Channel Excavation Quantity	Shallow Channel Excavation Quantity (cy)
1	BL	NM	NA	ND	E	0	--	--
2	BL	NM	NA	ND	MLW	0	--	--
3	BL	NM	NA	ND	MW	0	--	--
4	BL	NM	NA	2-ALL	E	4,770,000	--	--
5	BL	NM	NA	2-ALL	MLW	4,770,000	--	--
6	BL	NM	NA	2-ALL	MW	4,770,000	--	--
7	BL	NM	NA	8-ALL	E	8,620,000	--	--
8	BL	NM	NA	8-ALL	MLW	8,620,000	--	--
9	BL	NM	NA	8-ALL	MW	8,620,000	--	--
10	BL	NM	NA	8-2@RM29	E	6,732,000	--	--
11	BL	NM	NA	8-2@RM29	MLW	6,732,000	--	--
12	BL	NM	NA	8-2@RM29	MW	6,732,000	--	--
13	BL	NM	NA	2-0@RM29	E	2,850,000	--	--
14	BL	NM	NA	2-0@RM29	MLW	2,850,000	--	--
15	BL	NM	NA	2-0@RM29	MW	2,850,000	--	--
16	BL	M	NA	ND	E	0	--	--
17	BL	M	NA	ND	MLW	0	--	--
18	BL	M	NA	ND	MW	0	--	--
19	BL	M	NA	2-ALL	E	4,770,000	--	--
20	BL	M	NA	2-ALL	MLW	4,770,000	--	--
21	BL	M	NA	2-ALL	MW	4,770,000	--	--
22	BL	M	NA	8-ALL	E	8,620,000	--	--
23	BL	M	NA	8-ALL	MLW	8,620,000	--	
24	BL	M	NA	8-ALL	MW	8,620,000	--	--
25	BL	M	NA	8-2@RM3.4	E	4,926,000	--	--
26	BL	M	NA	8-2@RM3.4	MLW	4,926,000	--	--
27	BL	M	NA	8-2@RM3.4	MW	4,926,000	--	--
28	BL	M	NA	2-0@RM3.4	E	225,800	--	--
29	BL	M	NA	2-0@RM3.4	MLW	225,800	--	--
30	BL	M	NA	2-0@RM3.4	MW	225,800	--	--
31	BL	M	NA	8-2@RM29	E	6,732,000	--	--
32	BL	M	NA	8-2@RM29	MLW	6,732,000	--	--
33	BL	M	NA	8-2@RM29	MW	6,732,000	--	--
34	BL	M	NA	8-0@RM29	E	4,341,000	--	--
35	BL	M	NA	8-0@RM29	MLW	4,341,000	--	--
36	BL	M	NA	8-0@RM29	MW	4,341,000	--	--
37	BL	M	NA	2-0@RM29	E	2,850,000	--	--
38	BL	M	NA	2-0@RM29	MLW	2,850,000	--	--
39	BL	M	NA	2-0@RM29	MW	2,850,000	--	--
40	SB	NM	N	ND	E	0	241,855	51,365
41	SB	NM	N	ND	MLW	0	398,396	118,943
42	SB	NM	N	ND	MW	0	592,119	292,338
43	SB	NM	N	2-ALL	E	4,545,000	765,916	230,649
44	SB	NM	N	2-ALL	MLW	4,545,000	901,505	388,926
45	SB	NM	N	2-ALL	MW	4,545,000	1,075,935	635,951
46	SB	NM	N	8-ALL	E	8,237,000	1,017,226	366,849
47	SB	NM	N	8-ALL	MLW	8,237,000	1,160,484	553,798
48	SB	NM	N	8-ALL	MW	8,237,000	1,355,812	852,193
49	SB	NM	N	8-2@RM29	E	6,351,000	896,802	272,578
50	SB	NM	N	8-2@RM29	MLW	6,351,000	1,077,743	501,691
51	SB	NM	N	8-2@RM29	MW	6,351,000	1,260,713	771,945
52	SB	NM	N	2-0@RM29	E	2,625,000	647,043	154,208
53	SB	NM	N	2-0@RM29	MLW	2,625,000	825,211	341,972
54	SB	NM	N	2-0@RM29	MW	2,625,000	983,960	567,499
55	SB	NM	Y	ND	E	0	239,423	51,365
56	SB	NM	Y	ND	MLW	0	383,886	112,228
57	SB	NM	Y	ND	MW	0	618,140	311,429
58	SB	NM	Y	2-ALL	E	4,545,000	765,916	230,649

TABLE 3-6
Summary of Estimated Dredging and Excavation Quantities for Each Alternative
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Bayou Lafourche Dredging (cy)	Smoke Bend Bypass: Deep Channel Excavation Quantity	Smoke Bend Bypass: Shallow Channel Excavation Quantity (cy)
59	SB	NM	Y	2-ALL	MLW	4,545,000	897,048	386,168
60	SB	NM	Y	2-ALL	MW	4,545,000	1,072,259	633,215
61	SB	NM	Y	8-ALL	E	8,237,000	1,017,226	366,849
62	SB	NM	Y	8-ALL	MLW	8,237,000	1,160,484	553,798
63	SB	NM	Y	8-ALL	MW	8,237,000	1,352,949	846,724
64	SB	NM	Y	8-2@RM29	E	6,351,000	898,143	272,578
65	SB	NM	Y	8-2@RM29	MLW	6,351,000	1,077,743	501,691
66	SB	NM	Y	8-2@RM29	MW	6,351,000	1,260,713	771,945
67	SB	NM	Y	2-0@RM29	E	2,625,000	647,043	154,208
68	SB	NM	Y	2-0@RM29	MLW	2,625,000	825,211	341,972
69	SB	NM	Y	2-0@RM29	MW	2,625,000	983,960	567,499

Notes:

[a]BL = Bayou Lafourche only
SB = Smoke Bend bypass and Bayou Lafourche

[b]NM = No modification to existing railroad bridge culverts

M = Modification to existing railroad bridge culverts

[c]Y = Check structure in place
N = No check structure
NA = Not applicable for Bayou Lafourche alignment
Check structure assumptions:
Location = Immediately upstream of confluence
Flow input upstream of check structure = 100 cfs

[d]ND = No dredging

2 = Dredge template characteristics:
Depth = 2 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 17 subreaches
8 = Dredge template characteristics:
Depth = 8 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 18 subreaches
8-2@RM3.4 = Combined dredging template characteristics:
8-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 2-foot dredge downstream
2-0@+RM3.4 = Combined dredging template characteristics:
2-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 0-foot dredge downstream
8-2@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 2-foot dredge downstream
2-0@RM29 = Combined dredging template characteristics:
2-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream
8-0@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream
[e]E = Existing water level

TABLE 3-7
Allowable Flow Rates and Dredge Quantities for Selected Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

		Bayou Lafourche Only[b]				Smoke Bend and Bayou Lafourche[c]			Smoke Bend and Bayou Lafourche[d]		
	Dredging Quantity[a]	Flow (cfs)			Dredging Quantity	Flow (cfs)			Flow (cfs)		
Target Water Level:	**(cy)**	**Existing**	**MLW**	**MW**	**(cy)**	**Existing**	**MLW**	**MW**	**Existing**	**MLW**	**MW**
Dredging Option											
No Dredging	--	215	315	833	--	215	438	1,051	215	415	1,120
2-0@RM3.4	225,800	220	420	970	--	--	--	--	--	--	--
2-0@RM29	2,850,000	580	970	1,650	2,625,000	560	1,230	2,050	560	1,230	2,050
2-ALL	4,770,000	850	1,020	1,800	4,545,000	830	1,400	2,300	830	1,390	2,290
8-2@RM3.4	4,926,000	850	1,250	2,000	--	--	--	--	--	--	--
8-0@RM29	4,341,000	580	1,300	2,100	--	--	--	--	--	--	--
8-2@RM29	6,732,000	1,100	1,530	2,340	6,351,000	980	1,810	2,780	980	1,810	2,780
8-ALL	8,620,000	1,300	1,600	2,470	8,237,000	1,320	2,000	3,100	1,320	2,000	3,080

[a]Assumes the dredging quantity in the Bayou Lafourche channel. Does not include excavation quantity for the Smoke Bend bypass.
[b]Assumes that the railroad bridge in Donaldsonville is replaced with minimal-headloss structure.
[c]Assumes that the railroad bridge in Donaldsonville is not replaced, no check structure or confluence pump station.
[d]Assumes that the railroad bridge in Donaldsonville is not replaced, with check structure and confluence pump station.
Note:
cy = cubic yard

Allowing Higher Water Levels

Allowing a rise to the MLW level in Donaldsonville using only Bayou Lafourche as the main conveyance allows an increase of approximately 150 to 350 cfs in flow, depending on the amount of dredging and modification of the railroad bridges.

Allowing a rise to the MLW level for the Smoke Bend bypass alternative allows an increase of approximately 350 cfs in flow, depending on the amount of dredging.

Allowing a rise to the MW level using only Bayou Lafourche as the main conveyance allows an increase of approximately 600 to 1,500 cfs in flow, depending on the amount of dredging and modifications of the railroad bridge.

A rise to the MW level from the existing water level provides a similar flow benefit to 8-foot dredging of a segment of Bayou Lafourche (all 56 miles, to RM 29.0, or to RM 3.4).

Bypass Effects

Using the Smoke Bend alignment option instead of Bayou Lafourche alone appears to provide a limited increase in flow (less than 150 cfs), unless a concurrent rise in water surface is also considered. There is almost no flow benefit to including a check structure and pump station at the Smoke Bend confluence because the controlling water surface is located at or downstream of the confluence, not within Donaldsonville. The major benefit of a check structure and pump station near the confluence is to maintain stable water elevations upstream of Palo Alto Bridge in Bayou Lafourche.

The HEC-RAS results demonstrate the importance of dredging and the limits to capacity resulting from the existing channel size and railroad crossing. Improvements in cross section size and/or allowable increases in water levels over existing conditions will translate into several hundreds of cfs increase to the project total flow.

Donaldsonville Water Level, Dredging, and Flow Relationships

The relationship between dredging, target water levels, and diversion flows was critical to the Phase 1 design screening process and selection of alternatives to carry forward for the 30 percent design. During the hydraulic analysis for the Phase 1 design, three target water levels were used as boundary conditions – existing, MLW, and MW. The MLW target level represented a maximum rise of 1.2 feet, and the MW represented a maximum rise of about 42 inches (3.5 feet) in the Donaldsonville reach.

Target water levels were coupled with dredging depths to maximize flows in the bayou without exceeding the target water levels.

Each of the alternatives included an estimated dredging quantity (in millions of cubic yards [mcy]) defined by the dredge template applied. A series of regression methods, using the HEC-RAS model results, was developed to show continuous relationships between target water level, diversion flow, and dredge quantity. The HEC-RAS model dredge quantities were plotted along with the forecasting curves to provide information concerning intermediate water levels, dredge quantities, and diversion flows. This evaluation focused on diversion flows from 1,000 and 2,000 cfs for the suite of 69 alternatives in Table 3-5.

The result of the investigation was to show the relationship of dredge quantity with target water levels in Donaldsonville for five flows from 1,000 and 2,000 cfs (1,000 cfs, 1,250 cfs, 1,500 cfs, 1,750 cfs, and 2,000 cfs). This relationship showed how a change in water level would affect the dredging requirements for any flow from 1,000 to 2,000 cfs.

Table 3-8 shows the results of the regression analysis, and provides a matrix to compare the relationships between dredging, water level, and diversion flow. A TM is provided in Appendix K that explains the detailed steps and processes of using the HEC-RAS model to produce this result.

TABLE 3-8
Bayou Lafourche Evaluation Matrix – Dredging Quantity Projections
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

	Water Levels in Donaldsonville (feet, NAVD88)			
Flow (cfs)	**Existing**	**MLW**	**Existing + 24 inches**	**MW**
1,000	6.01	3.42	1.32	0.42
1,250	8.11	5.17	2.76	1.25
1,500	10.35	6.93	4.02	2.23
1,750	12.72	8.67	5.65	3.47
2,000	15.21	10.43	5.80	4.87

Note:

Only for alternatives that include railroad bridge modification.