SECTION 2

# Overview of Alternatives Development

## 2.1 General Approach

This section provides an overview of how project alternatives were developed and evaluated. A methodology was developed to characterize, group, define, and evaluate a large range of possible alternatives to meet project objectives. A goal of this evaluation was to review a combination of previously and newly proposed potential alternatives. The alternatives were then logically screened to narrow the range of potential alternatives to a short list that reflected the overall objectives of the project. The short-listed alternatives will be more closely analyzed and screened in the 30 percent evaluation so that a preferred alternative can be recommended.

The initial list of potential alternatives is large because of the possible combinations of the following physical variables:

- Diversion location and flow rates
- Dredged channel cross section
- Allowable water elevation

Although numerous components will need to be individually analyzed in detail during the 30 percent and final design efforts, this initial Phase 1 effort focused on refining the general conveyance route and hydraulic capacity of the system. During the Phase 1 evaluation, the following prominent issues became apparent early in the process:

1. The number of possible alternatives associated solely with channel geometry is great, and requires a systematic evaluation to efficiently reduce the number of potential options.

2. Costs attributed to dredging the bayou dominate the overall costs of the alternatives.

3. Demonstrating the relationship between raised water levels in Bayou Lafourche, property impacts, and project alternative conveyance capacity and costs is vital to environmental and policy-level decisionmakers for subsequent phases of the project.

In light of the broad range of project alternatives, it was necessary to formulate an approach to characterize a potential channel system (depth and cross section along the channel profile, plus other key hydraulic features) and identify the diversion capacity of that system. Using characterization of the alternatives, planning-level cost estimates were developed to allow comparisons among project alternatives. To define the alternatives to evaluate, components of the alternatives were characterized. The following four main categories of project features were combined to create the alternatives for evaluation:

- **Conveyance System –** The conveyance system is composed of Bayou Lafourche and other major new channels constructed as part of the overall system. Existing major channels that already intersect Bayou Lafourche, such as the Gulf Intracoastal Waterway or Company Canal, are not assumed to be part of the primary conveyance system for

this evaluation. Conveyance system project components that are part of the Phase 1 design effort include the bayou's cross section (including potential dredging) and water-depth profile along each reach; alternative bypass channel routes around Donaldsonville; major hydraulic structures that influence capacity and water levels of the system; and additional project features constructed, modified, or demolished along the conveyance route that are not included in the other categories.

- **Diversion Structures –** The diversion structures include the facilities necessary to convey fresh water from the Mississippi River into Bayou Lafourche or a bypass channel. These include pump stations located along the river, intake piping, discharge piping, and sediment control facilities. Past projects only considered upgrading the existing pump station at Donaldsonville. Depending on the selected alternative, these facilities could be either upstream or adjacent to the existing pump station in Donaldsonville.

- **System Control and Monitoring –** Control and monitoring systems include all systems deployed to control or stabilize water levels during times of pump shutdown, hazardous spill containment, or storm events. These systems generally include deployable weirs, monitoring stations, and monitoring/control linkages to the pump station. These components were only briefly reviewed for the Phase 1 design, but will be developed in further detail as the conveyance and diversion component alternatives are refined in the 30 percent effort.

- **Infrastructure, Utility, and Site Modifications –** Increasing the discharge down Bayou Lafourche for the selected alternative will require some level of modification to the various constructed features depending on the alternative. Some alternatives require land to be acquired for a new bypass channel and associated improvements. Other impacts to existing infrastructure, such as roads, bridges, and utilities, vary depending on the particular features of the alternatives.

These overall categories of project components and how the project components were defined to apply to individual project alternatives are discussed below. More detail on development and evaluation of these components and the alternatives themselves can be found in Sections 3 through 8.

## 2.2 Conveyance Systems

The conveyance system features used to define alternatives revolve around the following factors: route or alignment, hydraulic structures, bayou water levels, and dredging requirements.

A diagram presenting the methodology of combining the various project features and components to formulate the various conveyance alternatives is presented on Figure 2-1. By combining the basic features (route, target water level, and dredge template) with the other alternative features (variations in bypass channel excavation criteria, modifications to the Union Pacific Railroad (UPRR) crossing, inclusion of a bayou check structure immediately upstream of Palo Alto Bridge), 144 alternatives were initially characterized for evaluation. The project features that were combined to develop these alternatives are briefly described in the following subsections.

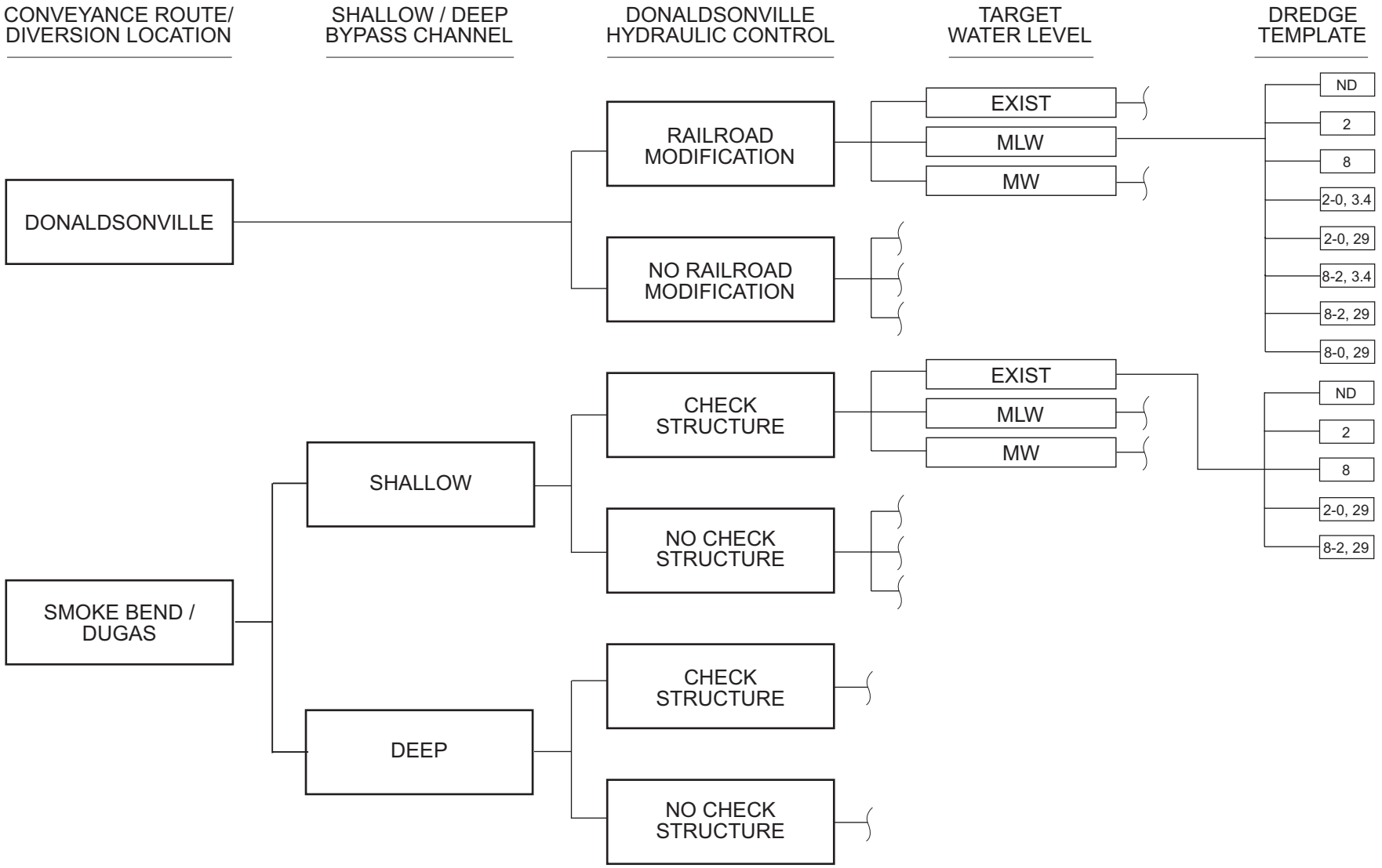


**FIGURE 2-1**
**CONVEYANCE ALTERNATIVES CHARACTERIZATION DIAGRAM**
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
PHASE 1 DESIGN REPORT

### 2.2.1 Route

Two basic conveyance system routes are in the upper reach of the bayou in or near Donaldsonville, each named after the approximate location of the Mississippi River diversion site (Smoke Bend and Donaldsonville). The Donaldsonville route uses the existing bayou as the main conveyance route, which is similar to past proposals (EPA, 1998).

The Smoke Bend alternative consists of a bypass channel around the upper reach of Bayou Lafourche, starting with a diversion upstream of Donaldsonville at Smoke Bend and ending just upstream of the Palo Alto Bridge. This alternative will route flow around the more densely populated reach of Bayou Lafourche. The advantages of using a bypass channel are the ability to minimize water level impacts in Donaldsonville and to eliminate the need for dredging in the upper reach of Bayou Lafourche (with associated construction impacts).

### 2.2.2 Hydraulic Structures

The Donaldsonville and Smoke Bend bypass alternatives each possess important hydraulic features in the Bayou Lafourche reach upstream of the Palo Alto Bridge. For the Donaldsonville route alternatives, the existing railroad bridge near the levee will significantly restrict increasing flow, because of the limited hydraulic capacity of the existing culverts under the bridge. For those alternatives, the following two conveyance features were included: either the existing railroad bridge and culverts were replaced with a new open-span railroad bridge to reduce the hydraulic restriction, or the bridge and its culverts were left unmodified.

A small dam located just upstream of the confluence of the bypass channels and Bayou Lafourche was included as an alternative feature for some of the conveyance alternatives. The purpose of the dam (referred to as a check structure) is to eliminate backwater effects into Donaldsonville from higher downstream water levels. Details of this structure are discussed in later sections of this report.

### 2.2.3 Target Water Levels

To evaluate hydraulic capacity of the bayou, assumptions were made about the project's effect on water surface levels throughout the bayou. As part of the alternative formulation process, the design team considered a wide range of potential flows for the project. Flows of up to 10,000 cfs were initially considered for the project. However, when viewed in the context of property development adjacent to the bayou and evaluations of the impacts of higher flows in previous studies, it was determined that lower flow limits were more appropriate. These lower flow limits were achieved by developing alternatives that varied by target water level. Three not-to-exceed water level profiles were developed and termed target water levels. The allowable diversions were developed by increasing flow until the modeled water surface met the average existing water surface elevations in Bayou Lafourche (termed existing target water level), and historical mean low and mean Mississippi River elevations at Donaldsonville (extrapolated linearly down to sea level at the Gulf of Mexico) as the two higher target water levels (termed mean low water [MLW] target level and mean water [MW] target level). Further discussion about the basis for these target levels is provided in Section 3 and a detailed description of how the target water level profiles were developed is presented in Appendix C. As described in Section 3, the

establishment of target water levels allowed project alternatives to be formulated by "degree of impact" on properties adjacent to the bayou.

### 2.2.4 Dredge Template

Increasing the capacity of the bayou depends on two factors within the bayou channel: raising the water level and dredging. Past studies set a target capacity (e.g., 1,000 cfs) and then varied the dredging to match a given target water level (near the existing level). This approach requires effort and several iterations to alter the cross section geometry, by dredging, to meet the capacity (flow) targets.

For this Phase 1 design analysis, three different channel geometries were proposed: no dredge, 2-foot dredge, and 8-foot dredge (as measured by the depth from the bottom of the existing channel invert). The three geometries were applied in various combinations, resulting in several different dredge template scenarios. Dredging was limited to upstream of Lockport, based on previous study conclusions. For each defined cross-sectional geometry, flow was varied to meet the target water levels. This approach resulted in a more efficient computational methodology for formulating alternatives and a better way of drawing comparisons among the alternatives.

### 2.2.5 Bypass Channel Depth

Two options were considered for the geometry criteria of the bypass channels: a deep channel or a shallow channel. A deep channel could be excavated that would allow water surfaces to better match the water surface at the confluence with Bayou Lafourche. Alternately, a shallower channel could be constructed that would require less excavation. Alternatives were formulated to enhance the tradeoffs of channel excavation.

## 2.3 Diversion Structures

The diversion structures are the facilities used to divert water from the Mississippi River into Bayou Lafourche or the bypass channels. These facilities include the pipes, intake and discharge structures, and pumps that deliver the water into the bayou. These facilities require a site along the river that provides necessary access for the diversion works and has suitable geotechnical properties for foundation support. The diversion structure might also include sediment removal facilities to provide for better sediment control.

More detailed discussions with permitting agencies for levee penetrations and site-specific field investigations are needed to select a final diversion structure configuration. Therefore, a conservative approach has been taken at this stage of the project, where a diversion facility configuration based on existing conditions has been assumed. Opportunities will exist during the 30 percent design evaluations to optimize the diversion facilities for the recommended alternatives.

Following are the basic components of the diversion system that required characterization for the Phase 1 design:

- Diversion site location
- Pump station configuration

- Pump intake
- Pump discharge
- Sedimentation facilities

### 2.3.1 Diversion Site Locations

Two potential locations for reintroduction structures were identified through site reconnaissance, review of U.S. Geological Survey (USGS) topographic maps and aerial photographs, and discussions with the U.S. Army Corps of Engineers (USACE) and the LFWD. The site locations included in this Phase 1 evaluation are the existing Donaldsonville site and the Smoke Bend site (located at River Mile [RM] 177.5, on the outside of a large curve in the Mississippi River). A detailed discussion on the diversion site alternatives is presented in Section 4.

### 2.3.2 Pump Station Configuration

A pump station located on the river side of the levee is the most common configuration along the river because of the concern for maintaining the integrity of the levee. Previous studies have typically located a pumping facility on the river side. A pump station located on the land side of the levee would require that a series of intake pipes be installed under the levee by microtunneling to avoid removing and replacing the levee during construction. Intake pipes would be located sufficiently deep that they would be submerged for all river water elevations. It is not clear whether the USACE would allow such a facility because of concerns of reduced levee integrity. For the Phase 1 design, it was assumed that a pump station would be located on the river side using a configuration that is typical for the area.

### 2.3.3 Pump Intake

A piped intake for a pump station located on the river side of the levee would be similar to the existing Donaldsonville pump station. This type of inlet would include a piling-type structure in the river to protect the submerged inlet from river traffic and large debris damage. A forebay-channel intake was also evaluated. For the Phase 1 design, a piped intake was assumed for the diversion facilities.

### 2.3.4 Pump Discharge

Discharge piping from a pump station located on the river side of the levee could have two discharge pipe arrangements. To maintain the integrity of the levee and minimize the potential for flooding, the USACE might require that the discharge pipe invert be above a given high water elevation. Alternatively, through discussion and coordination with the agencies, the discharge pipes might be allowed to pass through the levee at a lower elevation. Lower discharge pipes would reduce the difficulty in creating a siphon over the levee. A siphon would reduce the operating costs when the water levels are favorable. For the Phase 1 design, it was assumed that discharge piping would not penetrate the levee below the 100-year flood elevation.

### 2.3.5 Sedimentation Facilities

Previous studies have investigated the possibility of constructing a sediment basin in the bayou immediately downstream of the railroad bridge in Donaldsonville. Heavier

sediments that would settle out into the channel need to be removed as soon as possible after being pumped into the bayou to minimize downstream maintenance dredging. To create the basin, the existing channel could be widened to create a small pool with low velocities for coarse sand and silt particles to settle out. Access to the settling basin would be required to allow for frequent routine maintenance. Sediment would be removed by clamshell, dragline, or excavator. For the Phase 1 design, it was assumed that a sedimentation basin would be constructed downstream of the pump station for both Donaldsonville and any alternative that uses a bypass channel.

### 2.3.6 Existing Pump Station

Previous studies often included rehabilitating the existing pump station to 340 cfs (closer to its actual rating) and providing additional capacity by means of new and separate pumping facilities. For the Phase 1 design, it was assumed that a completely new pump station would be built for any alternatives using Donaldsonville as the primary reintroduction site. For any bypass alternative, it was assumed that the existing pump station would be maintained to run one pump at approximately 100 cfs for water supply and water quality requirements in Donaldsonville, upstream of the bypass channel confluence.

## 2.4 System Control and Monitoring

Control of water levels must be responsive enough to minimize water level fluctuations during severe storm events and during times when the diversion facilities are shut down. This section provides an overview of how weir systems, a check structure, and monitoring stations were addressed in the Phase 1 design. Cost allowances are included in later sections for some of these items. Control and monitoring systems generally include specialized structures and controls to ensure that water levels are maintained and flooding is controlled. Assumptions made for these systems are described in the following subsections.

### 2.4.1 Weir Systems

Currently, one primary weir exists along the main channel of Bayou Lafourche at Thibodaux. It has been proposed to remove this weir to provide adequate channel capacity for the increased flow rates being contemplated. Removing the weir will require more sophisticated control systems to maintain water levels within an acceptable range. For all project alternatives, it was assumed that the Thibodaux weir would be removed. This removal will allow maximum flow through the bayou and minimize water level rise upstream of Thibodaux. This assumption is consistent with past recommendations (EPA, 1998).

The previously proposed optimized project calls for the installation of two weirs, one at Thibodaux and another below Donaldsonville. For the Phase 1 design, it was assumed that two inflatable weirs would be installed for water level control. The Thibodaux weir would stabilize upstream water levels and help maintain bank stability during diversion facility shutdown. If the diversion facility were shut down in response to a chemical spill on the Mississippi River, the Donaldsonville weir would be deployed to prevent or minimize contaminants moving to downstream water supply intakes on the bayou. The need for these

or additional water control structures will be studied in greater detail later in the design process.

### 2.4.2 Check Structure

A component of some of the alternatives that involve routing flows from the Mississippi River around Donaldsonville is a check structure (i.e., a small dam). This check structure would be located immediately upstream of the convergence of a proposed bypass channel with the existing bayou. This structure would isolate water levels in the upstream reaches of the bayou in Donaldsonville so the level in the most upstream reach of the bayou could be strictly managed. However, the main purpose of this check structure will be to allow higher reintroduction flow via the bypass channel and higher water levels downstream of Donaldsonville without affecting the water levels upstream in the bayou, within the main downtown portion of the city. A small amount of flow (100 cfs) would be conveyed from the Donaldsonville pump site into the newly isolated reach for small water supply and water quality purposes.

A pumping facility will also be needed at the check structure to convey flow (including excess stormwater runoff) from the newly formed Donaldsonville reach over the dam and into the downstream portion of the bayou. When isolated, Bayou Lafourche could drain across the check structure only by pumping. For the Phase 1 design, a 500-cfs pump station was assumed to handle both the 100-cfs dry flow plus some stormwater runoff.

### 2.4.3 Monitoring Stations

Five data collection platforms (DCP) were proposed by EPA (1998) at several locations between Donaldsonville and Larose. These DCPs would be equipped with instruments capable of providing real-time stage, rainfall, and flow data. In addition to monitoring flows and levels, it is possible to automate the pump discharge through a supervisory control and data acquisition (SCADA) system. SCADA information might be desired at the potential check structure, significant water intakes, and pump stations along the project alignment. Control of equipment from a remote location might also be a desired option. For the Phase 1 design, it was assumed that all alternatives would use the previously proposed five DCPs and have a basic SCADA system for automatic control of the diversion discharge. Details of this system will be developed more fully in the 30 percent design phase.

## 2.5 Infrastructure, Utility, and Site Modifications

The main infrastructure components that have been identified for the initial screening are the railroad, road, and utility crossings; and the water intakes and discharge structures along the bayou. Costs were assigned where anticipated modifications could be reasonably defined. Sections 5 and 7 provide details on identifiable impacts and assumptions used for the Phase 1 design.

## 2.6 Comparison of Alternatives

Project alternatives were reduced from an initial 144 to a short list of 5 to be evaluated in further detail in the 30 percent design. Development, evaluation, and screening of the

alternatives are described in detail in Sections 3 through 8. As the alternative attributes were refined through further engineering and evaluation (e.g., flow capacity, water level rise and impacts, dredging quantities, and cost), several comparisons were made. Screening criteria were developed in steps using both qualitative and quantitative criteria. In all, eight basic criteria were used to screen the alternatives from the initial 144 to 5. Figure 2-2 presents a summary of these criteria. Different levels of analysis are represented by each set of criteria; Figure 2-3 presents the groups of screening criteria in the general sequence of the effort. Criteria 1 through 3 allowed a relatively quick screening from 144 to 69 alternatives by the following means:

1. Eliminating three Smoke Bend dredge templates (Screening Criterion 1): In the initial effort of the project, during the channel hydraulics analysis, it was apparent that for alternatives using the Smoke Bend route, there was no reason to dredge through Donaldsonville. This allowed elimination of two of the dredge templates (see Figure 2-1). Additionally, one dredge template was eliminated that closely matched another template in hydraulic capacity. By eliminating these three templates, the possible list of alternatives was reduced from 144 to 108.

2. Eliminating three Donaldsonville dredge templates because of railroad crossing constriction (Screening Criterion 2): A significant restriction to flow in Bayou Lafourche is the railroad crossing in Donaldsonville. The bayou conveyance capacity is restricted by the existing three culverts at this location. To pass flows exceeding 1,000 cfs under the railroad without raising water levels significantly, a new railroad bridge is required. Because diversion flows are restricted unless the UPRR bridge is replaced, three additional dredge templates for the Donaldsonville alignment were eliminated from further consideration. This reduced the number of alternatives from 108 to 99.

3. Eliminating the Smoke Bend shallow-cut option (Screening Criterion 3): The advantages and disadvantages of excavating a shallow Smoke Bend bypass channel versus a deeper bypass channel were compared. The shallow bypass channel takes advantage of reduced construction costs (less excavation), but requires a higher-head pumping system to match the hydraulic capacity requirements of the system. The opposite logic applies to a deeper bypass channel, which trades higher initial construction cost (more excavation) with lower-head pumping system requirements. A present-worth analysis of construction and pumping costs for the two options was performed over a 20-year term, and the deeper bypass channel was found to be more economical. With the shallow-cut bypass channel removed from further consideration, 30 alternatives were eliminated. This reduced the number of alternatives from 99 to 69. Of these 69 alternatives, 39 were for the Donaldsonville alignment and 30 for the Smoke Bend alignment.

A detailed description of the screening process, starting from 69 alternatives and concluding at the five short-listed alternatives, is presented in Section 7.

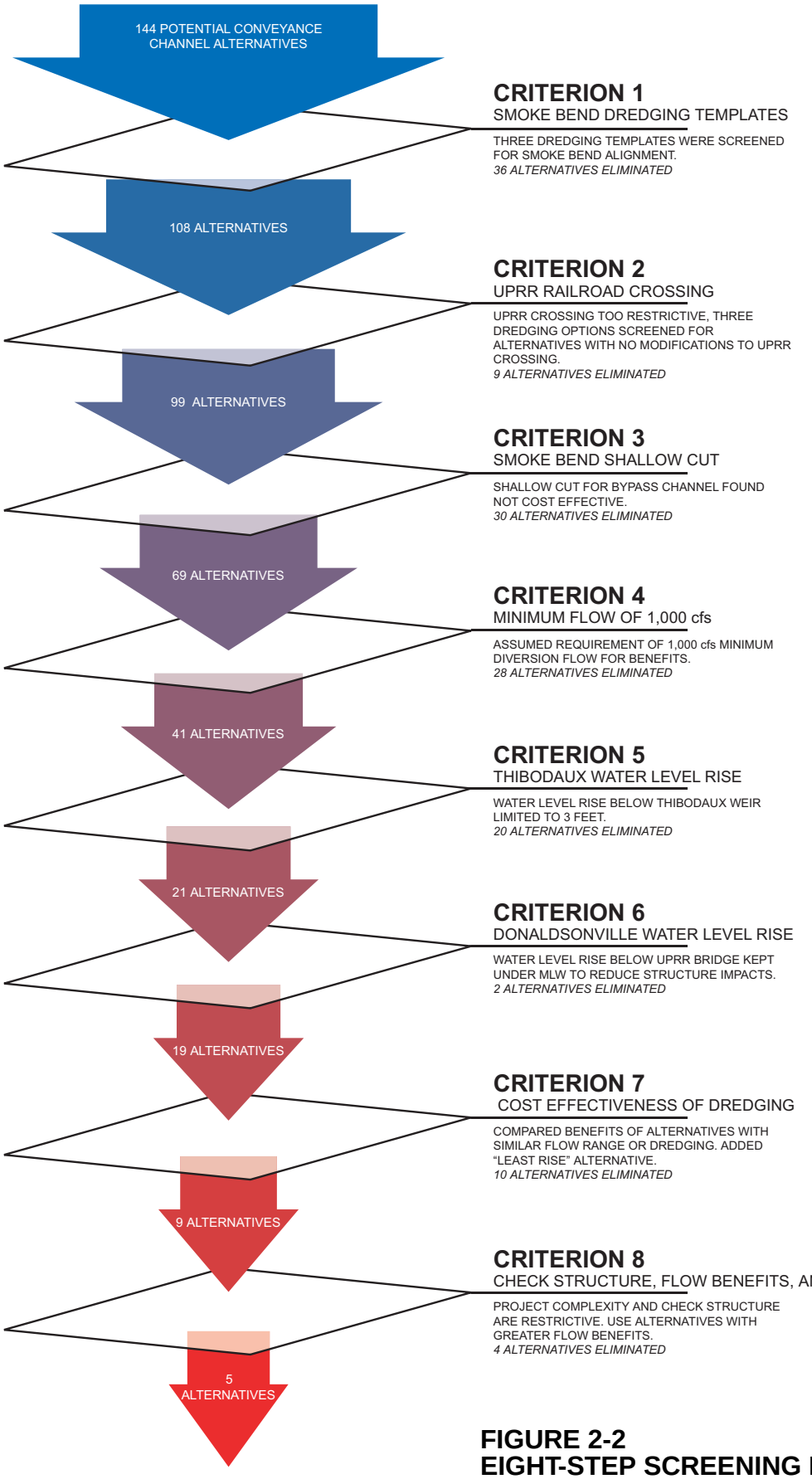


**FIGURE 2-2**
**EIGHT-STEP SCREENING PROCESS**
**CONVEYANCE CHANNEL ALTERNATIVES**
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
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**FIGURE 2-3**
**PROCESS FOR COMPARING ALTERNATIVES**
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