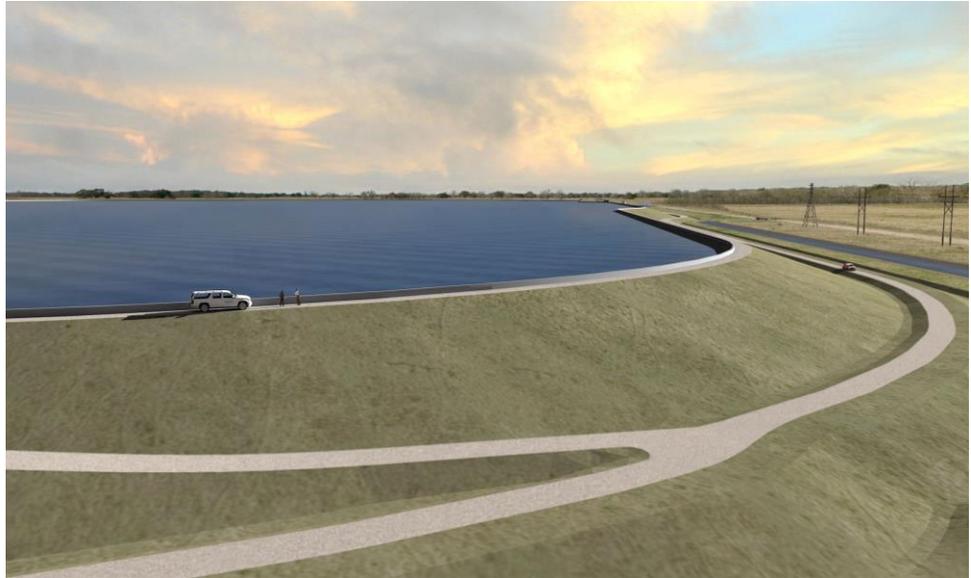


# Regulatory Considerations for Permitting an Off-Channel Reservoir



*Rendering of Lane City Reservoir*

Prepared for:  
Texas Water Development Board

Prepared by:  
Lower Colorado River Authority  
Contract Number 1400011761  
October 13, 2015



## Executive Summary

With water demands in the State of Texas expected to increase, water planners throughout Texas are exploring a variety of strategies to meet the water needs of a growing state. With precipitation that fluctuates between periods of high rainfall to those with lower rainfall, developing storage options to capture surface water when available provides opportunities to help meet future needs. Water for Texas, the State Water Plan, includes several off-channel reservoirs, or constructed water supply lakes built near rivers, as a means to store water without constructing a large dam to impound water flowing in a river. Such reservoirs provide one possible management tool to store water to meet multiple objectives such as municipal, industrial and agricultural water supply or environmental flow needs.

This report was prepared as part of a Near-Term Water Supplies Demonstration Grant awarded to the Lower Colorado River Authority (LCRA). As a demonstration project, the Lane City Reservoir provides an example of innovative approaches for reservoir permitting and design that may benefit other water managers in Texas. The purpose of this report is to provide an overview of significant federal, state and local permits that may be necessary for similar projects and to document innovative and cost-effective design approaches used for the Lane City Reservoir.

The report is organized into four sections, plus references:

- Introduction – Section 1 provides the purpose and scope of the report and an overview of the Lane City Reservoir project
- Overview of Federal, State and Local Regulations and Permit Requirements – Summary information on the applicability and key requirements of major permits that would be anticipated for most off-channel reservoirs is provided in Section 2 along with elements that may vary among projects
- Schedule and Cost Considerations – Noting a variety of factors that influence timelines and costs related to various permits, this section provides planning level considerations for estimating the schedule and costs of permitting activities
- LCRA Lane City Reservoir Case Study – This section highlights innovative design aspects and unique permitting conditions associated with the Lane City Reservoir

While the specific design approaches used for the Lane City Reservoir will not be applicable to every off-channel reservoir, they demonstrate that integrating site-specific construction considerations and a thorough understanding of safety, operational and regulatory requirements during the design process can result in innovative, cost-effective solutions.

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## **Acronyms and Abbreviations**

CFR	Code of Federal Regulations
LCRA	Lower Colorado River Authority
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TWDB	Texas Water Development Board
TXDOT	Texas Department of Transportation
U.S.C.	United States Code

# **1 Introduction**

According to the current state water plan, Water for Texas 2012, Texas needs an additional 8.3 million acre-feet per year to meet its projected water demands in 2060 (TWDB, 2012, p 176). Water planners throughout Texas are considering a variety of strategies to meet projected water demands including construction of off-channel reservoirs, or constructed water supply lakes built near rivers, as a means to store water without constructing a large dam to impound water flowing in a river. Such reservoirs provide a management tool to store water to meet multiple objectives such as municipal, industrial and agricultural water supply or environmental flow needs.

## **1.1 Purpose and Scope**

This report was prepared as part of a Near-Term Water Supplies Demonstration Grant awarded to the Lower Colorado River Authority (LCRA). As a demonstration project, the Lane City Reservoir provides an example of innovative approaches for reservoir permitting and design that may benefit other water managers in Texas. The purpose of this report is to document information that may be useful to others considering construction of an off-channel reservoir.

The scope of the report includes an overview of significant federal, state and local regulations, permits and reviews needed as information for Texas entities considering construction of an off-channel reservoir. Note that this report highlights major regulations and permits that would be anticipated for a multi-purpose water supply reservoir and should not be considered an exhaustive list of every permit or regulation that may apply. For example, off-channel reservoirs constructed for industrial or power generation purposes may be subject to additional regulations. Further, every site is different and regulations may change over time, so it is important to carefully review each proposed project and obtain appropriate legal counsel and technical support regarding applicable regulations and permit requirements.

In addition to identifying significant permitting actions that may be required, this report also includes a case study of an off-channel reservoir under development by the LCRA, the Lane City Reservoir, to provide examples, best practices and lessons learned related to permitting of the reservoir. Additionally, innovative facility components that are expected to reduce construction costs and expedite the construction schedule are addressed in this report.

## **1.2 Overview of the Lane City Reservoir**

By 2060, the population of Region K, the water planning region that includes the lower Colorado River basin, is projected to more than double to 2.8 million people. Consequently, the total water demand in the region also is projected to increase from 1.1 million acre-feet per year to approximately 1.4 million acre-feet per year by the year 2060 (TWDB, 2012, p. 95). To meet projected water demands within its region, the LCRA Board of Directors adopted a goal to add 100,000 acre-feet of firm water supply by 2017. A critical project for meeting that goal is an off-channel reservoir in Wharton County, the Lane City Reservoir.

The reservoir will hold up to approximately 40,000 acre-feet of water, but the water could be used and the reservoir refilled multiple times over the course of a year, making it capable of adding up to 90,000 acre-feet per year of firm water to the region's supply. Firm water is water that is to be made available without shortage through a repeat of the Drought of Record. The



summarized herein may apply. Every site is different and regulations may change over time, so it is important to carefully review each proposed project and obtain appropriate legal counsel and technical support regarding applicable regulations and permit requirements.

## 2.1 Federal Regulations/Permits

### 2.1.1 *Clean Water Act Section 404/ Rivers and Harbors Act Section 10*

#### **Applicability, Authority and Jurisdiction**

Activities that have the potential to discharge dredged or fill materials into waters of the U.S., including adjacent wetlands, are regulated under Section 404 of the Clean Water Act, and administered by the U.S. Army Corps of Engineers under 33 Code of Federal Regulations (CFR) 328. New rules effective in Texas in August 2015 generally define waters of the U.S.<sup>1</sup> as follows:

- Waters having historical, current or future use for interstate or foreign commerce
- Wetlands, ponds, lakes, oxbows, impoundments, and similar waters; that are tributaries to or have a significant nexus to interstate waters or those used for interstate commerce
- Prairie potholes, Carolina and Delmarva bays, pocosins, vernal pools, Texas coastal prairie wetlands, or tributaries to any of the aforementioned waters; territorial seas; and wetlands adjacent to waters
- Waters within a 100-year floodplain with significant nexus to other waters

Additionally, the U.S. Army Corps of Engineers has the responsibility to permit projects in navigable waters under Section 10 of the Rivers and Harbors Appropriation Act of 1899 which prohibits the building of “any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States” and excavation, fill or modification of the course, location or

#### COORDINATION WITH USACE IS IMPORTANT FOR SUCCESSFUL PERMITTING

One of the critical success factors for LCRA’s Lane City Reservoir was consideration of potential impacts to the Waters of the U.S. throughout the entire project planning and development process – from early siting and conceptual design through construction planning. Careful design of the project footprint and use of existing facilities reduced impacts to wetlands and other Waters of the U.S.

The project’s permitting team met with the USACE permit-writers early in the design process to fully understand regulatory implications of design decisions. The permitting team, in turn, worked side-by-side with the engineering team to incorporate permitting constraints into the design.

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<sup>1</sup> As of October 2015, the date of this report, new rules regarding waters of the U.S. have implemented in Texas. Litigation regarding the new rules is ongoing and the definition is subject to change which could affect application of the Clean Water Act to future off-channel reservoirs.

capacity of any navigable water of the U.S without a permit. Navigable waters are basically waters that have been, are currently, or could be used for interstate or foreign commerce.

As shown in Figure 2, jurisdiction for Clean Water Act Section 404 and Rivers and Harbors Act Section 10 permitting rests with the Albuquerque, Galveston, Tulsa or Fort Worth U.S. Army Corps of Engineers Districts in Texas. When applicable, these permitting processes are often conducted together.

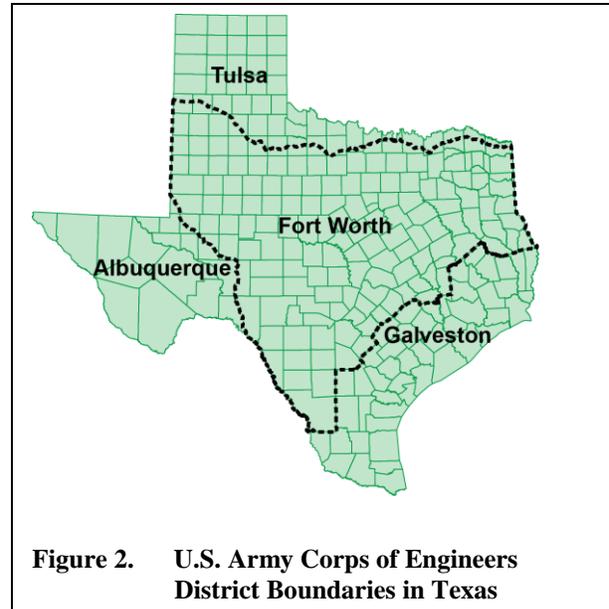
Please see Section 4.2.2 for discussion of applicability to the Lane City Reservoir.

### Key Requirements

There are two types of Clean Water Act 404 permits: 1) Standard Individual Permits and Letters of Permission and 2) Nationwide, Regional, and Programmatic General Permits. The U.S. Army Corps of Engineers considers several factors to determine which permit type applies to a given project, including the type of activity, the environmental and social impacts resulting from a proposed project, and the public interest. Regional general and nationwide permits have already completed the impact analysis, public notice and review processes required under the National Environmental Policy Act; therefore, projects that meet the conditions of these types of permits can be reviewed and approved in a much quicker timeframe than those requiring individual permits.

It is helpful to understand the requirements and constraints of the various permit options early in the planning and siting of a proposed off-channel reservoir. Careful site selection and facilities design that avoid impacts to waters of the U.S. or minimize impacts such that they can be authorized under one or more nationwide permits can considerably reduce the cost and schedule associated with obtaining necessary authorizations. The permit application and review process requires analysis of alternative projects that would meet the purpose of and need for the project, so it is important to identify alternative sites or alternative facility configurations to identify a “preferred project” that meets the water supply needs of the project sponsor and results in the least impacts. In addition to impacts to waters of the U.S., other key considerations that the U.S. Army Corps of Engineers must consider during their review include impacts to:

- Archeological/cultural resources
- Tribal resources
- Threatened and endangered species / essential fish habitat
- Floodplains
- Water quality
- Stream/river geomorphology (for projects discharging flow to waters of the U.S.)



### Best Practice

Even when impacts from a project are expected to be minimal, it is often a good idea to conduct studies – such as geomorphology assessments – to provide documentation of no significant impact.

### 2.1.2 *Endangered Species Act*

#### **Applicability, Authority and Jurisdiction**

Threatened and endangered species are protected federally under the Endangered Species Act. Section 7 of the Endangered Species Act directs all federal agencies to use their existing authorities to conserve threatened and endangered species and, in consultation with the U.S. Fish and Wildlife Service<sup>2</sup>, to ensure that their actions (for example, issuing a permit) do not jeopardize listed species or destroy or adversely modify critical habitat. Therefore, compliance with the Endangered Species Act must be ensured before any activity can be authorized by the U.S. Army Corps of Engineers under Clean Water Act Section 404 or Rivers and Harbors Act Section 10. Additionally, even in cases when a federal action is not taken and no federal permit is required, project sponsors could be subject to Section 10 of the Endangered Species Act. This could apply during construction, or potentially, during operation of an off-channel reservoir. If federally-listed terrestrial (land-based) or aquatic species may be affected while the project is in operation, the project sponsor should evaluate whether a Section 10 permit may be required. If so, the sponsor may be required to take appropriate actions to protect the listed species.

#### **Key Requirements**

Biological evaluations are used to identify potential impacts to federally-listed threatened or endangered species and designated critical habitat. During site selection and early planning phases, it is helpful to do a desktop survey to identify known habitat and species observed in the area and take measures to avoid them. Once the site is selected, a field survey is conducted by a qualified biologist to identify species habitat with a special focus on critical habitat as defined in the Endangered Species Act and federal regulations. During a Clean Water Act Section 404 permit review, the U.S. Army Corps of Engineers will consider the evaluation to determine if the proposed project would be expected to affect threatened or endangered species. If a project may have an effect on federally-listed species, then some kind of consultation with National Marine Fisheries Service and/or U.S. Fish and Wildlife Service is required. Potentially, an incidental take permit or habitat conservation plan or other mitigation may be required for construction or during operations.

#### **Best Practice**

New species may be listed by U.S. Fish and Wildlife Service as threatened or endangered from time to time. It is important to be aware of pending federal listings that may impact project construction or future operations.

### 2.1.3 *National Historic Preservation Act*

#### **Applicability, Authority and Jurisdiction**

Federal agencies must consider the effects of their actions on archeological and cultural resources as required by Section 106 of the National Historic Preservation Act (36 CFR 800).

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<sup>2</sup> The Commerce Department's National Marine Fisheries Service has responsibilities for mainly marine wildlife such as whales and fish such as salmon, sturgeon and other species that live most of their life in the sea but swim upstream to rivers to spawn.

Such actions would include issuing permits or use of federal funding sources for a project.<sup>3</sup> If the project requires a Clean Water Act Section 404 permit, the U.S. Army Corps of Engineers archeologist will provide guidance as to archeological evaluations and consultation that is required. Other federal agencies may provide similar guidance if the project requires other federal approvals. In Texas, the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission, administers required “Section 106” project reviews.

Please see Section 4.2.2 for discussion of applicability to the Lane City Reservoir.

### Key Requirements

Federal agencies are legally responsible for initiating the consultation process if required. Generally, however, project sponsors engage a qualified professional to prepare archeological and cultural resource reports based on desktop reviews and field surveys. The reports will identify properties in the project area that are, or may be eligible for, listing in the National Register of Historic Places and if such sites would be affected by the project. Potential effects from the project include direct effects (such as inundation) as well as indirect effects such as impacts to the viewshed of those structures. These are findings that a qualified archeologist or cultural resource professional evaluate as part of their investigation.

If the findings of the investigation indicate that the project will have no effect on historic properties, the federal agency may determine that consultation with the State Historic Preservation Officer is not required. If there may be an effect, then the Section 106 consultation process would be initiated. In addition to consultation with the State Historic Preservation Officer, consultation may also be required with a Tribal Historic Preservation Officer and the federal Advisory Council on Historic Preservation. In many cases, consultation can be completed relatively quickly (within a couple of months); however, the timeframe may be longer if the Tribal Historic Preservation Officer or Advisory Council on Historic Preservation are engaged in the process.

Furthermore, if sites are identified that would be adversely affected, then a mitigation plan must be developed and a memorandum of agreement between the project sponsor and one or more of the consulting agencies must be prepared and executed. This information, along with any agreement with the State Historic Preservation Officer and other parties, would either be submitted as part of the permit applications, environmental assessments or other supporting documents or developed during the permit review process.

#### Best Practice

Include sufficient time in the permitting schedule for cultural resource surveys, report preparation and consultation with the State Historic Preservation Officer, Tribal Historic Preservation Officer and federal Advisory Council on Historic Preservation, if required.

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<sup>3</sup> If a planned off-channel reservoir does not require a federal action, the National Historic Preservation Act would not apply; however, the State Antiquities Act (discussed in more detail in Section 2.2.3) would apply to projects on publicly owned or controlled lands.

### 2.1.4 Other Federal Regulations/Permits

In addition to those regulations and permits described in the preceding sections, other federal statutes and regulations may apply to an off-channel reservoir project. Table 1 summarizes many of the major federal requirements.

**Table 1. Summary of Major Federal Regulations/ Permits**

Permit, Approval, or Certification	Responsible Agency	Applicability Criteria	Required Actions
Clean Water Act (Section 404)/ Rivers and Harbors Act (Section 10) (33 United States Code (U.S.C.) 26 <i>et seq.</i> and 33 U.S.C. 403 <i>et seq.</i> ; 33 CFR Part 328)	U.S. Army Corps of Engineers	Activities (dredge and fill) in waters of the U.S.; construction in navigable waters.	Waters of the U.S. (including wetlands) delineation and jurisdictional determination, coordination with the U.S. Army Corps of Engineers, preparation of permit application. 404 permitting is contingent on Section 401 water quality certification by the Texas Commission on Environmental Quality.
Endangered Species Act (16 U.S.C. § 1531 <i>et seq.</i> ; 50 CFR Part 17)	U.S. Fish and Wildlife Service	Construction in areas where threatened and endangered species or habitat could be impacted as a result of the construction and/or operation of the proposed facility.	Perform review and survey of threatened and endangered species on or in close proximity to the subject property.
Bald and Golden Eagle Protection Act (16 U.S.C. Section 668 <i>et seq.</i> ; 50 CFR Part 17)	U.S. Fish and Wildlife Service	Prohibits the take or commerce of any part of these species.	Perform review and survey of species on or in close proximity to the subject property.
Migratory Bird Treaty Act (16 U.S.C. Section 703-711 <i>et seq.</i> ; 50 CFR Parts 20 and 21)	U.S. Fish and Wildlife Service	Protects migrant bird species from take.	Perform review and survey of species on or in close proximity to the subject property.
Magnuson-Stevens Fishery Conservation and Management Act - Essential Fish Habitat Regulations (16 U.S.C. 1802(24) <i>et seq.</i> ; 50 CFR Part 600)	National Marine Fisheries Service, Nation Oceanic and Atmospheric Administration	May apply if a habitat of concern is affected directly or indirectly.	An essential fish habitat conservation assessment and consultation could be required.
National Historic Preservation Act (Section 106) (16 U.S.C. 470 <i>et seq.</i> ; 36 CFR Part 800)	State Historic Preservation Officer, Texas Historical Commission	Construction in an area where historic or archeological resources may be affected.	Perform review and survey of properties listed or eligible to be listed in the National Register of Historic Places.
National Flood Insurance Act and the Flood Disaster Protection Act (42 U.S.C. 40011 <i>et seq.</i> ; 44 CFR Parts 59 - 80)	Federal Emergency Management Agency or qualified local authority (county or city)	Federal agencies must consider Executive Order 13690 which amends Executive Order 11988 to include the Federal Flood Risk Management	Submit application to local floodplain administrator; may require modeling to demonstrate potential changes resulting from the project.

Permit, Approval, or Certification	Responsible Agency	Applicability Criteria	Required Actions
		Standard.	
Invasive Species, Executive Order 13122 and associated acts, as amended; Nonindigenous Aquatic Nuisance Prevention and Control Act (16 U.S.C. 4701); Lacey Act (Sections 3371–3378); Federal Plant Protection Act (7 U.S.C. 7701 <i>et seq.</i> ); and Federal Noxious Weed Act (7 U.S.C. 2801 <i>et seq.</i> )	All federal agencies; considered by the U.S. Army Corps of Engineers in Section 404 permitting process	Construction or operation of project that could result in the spread of invasive species; applicable to water supply projects (particularly for projects transferring water among water bodies where zebra mussels, hydrilla or similar species could spread).	Applicants may be required to develop control plans to prevent the spread of species during construction or operation.
<i>Note: In addition to the regulations cited in this table, numerous other executive orders, related regulations and agency policies may be applicable.</i>			

## 2.2 State Regulations/Permits

In addition to federal requirements and permits, several state permits are likely to be required for off-channel reservoirs. Most of these lie within the jurisdiction of the Texas Commission on Environmental Quality; however, other state agencies administer certain applicable regulations.

### 2.2.1 Surface Water Permit

#### Applicability, Authority and Jurisdiction

Surface water in Texas is owned by the state, and its use is regulated under Chapter 11 of the Texas Water Code. The Texas Commission on Environmental Quality, the agency responsible for issuing permits to divert, use and store surface water, administers the requirements of Chapter 11 through rules in Volume 30, Texas Administrative Code (TAC), primarily chapters 295, 297 and 298. Obtaining a simple and uncontested new water right or amending an existing right to impound water in an off-channel reservoir may be a lengthy process. A more complicated or contested water right can require significantly more time. Additionally, if water will be moved in and out of reservoirs or between reservoirs via a river or water of the state during reservoir operations, a bed and banks authorization may be required. In some cases when reservoirs hold more than one source of water, the Texas Commission on Environmental Quality may require an accounting plan to track water use under different water rights.

Please see Section 4.2.1 for discussion of applicability to the Lane City Reservoir.

#### Key Requirements

A water right permit application requires general information regarding the applicant and the proposed location and rate of diversion, proposed location and type of use and technical information about the reservoir and its operations. Water conservation and drought contingency plans are also required. The type of application determines the amount of technical review, the level of public notice and opportunity for a contested case hearing. For example, computer simulations demonstrating water availability, compliance with environmental flow standards and potential impacts to other water right holders and the environment are required for a new water right. Simple amendments to an existing right that do not change the diversion point, diversion

rate and volume of water, however, may not require modeling or other complex evaluations. Simple amendments are generally issued in a much shorter timeframe than a major amendment or a new permit.

### ***2.2.2 Dam Safety Program***

#### **Applicability, Authority and Jurisdiction**

The Dam Safety Program, authorized under 30 TAC Chapter 299, monitors and regulates private and public dams in the State of Texas. Dams fall under the jurisdiction of the Texas Commission on Environmental Quality's Dam Safety Program if they meet one or more of the following four criteria: they (1) have a height greater than or equal to 25 feet and a maximum storage capacity greater than or equal to 15 acre-feet; (2) have a height greater than 6 feet and a maximum storage capacity greater than or equal to 50 acre-feet; (3) are a high- or significant-hazard dam as defined in 30 TAC 299.14 (relating to Hazard Classification Criteria), regardless of height or maximum storage capacity; or (4) are used as a pumped storage or terminal storage facility. Some water rights include special conditions regarding obtaining necessary Dam Safety Program approvals; therefore, the approval process may be required in connection with water right permitting processes.

Please see Section 4.2.4 for discussion of applicability to the Lane City Reservoir.

#### **Key Requirements**

The fundamental requirement to receive authorization to construct a dam is a set of design drawings and construction specifications that demonstrate an effective and safe design that is certified by a professional engineer registered in Texas. Other required information includes hydrologic and hydraulic analysis, design report, geotechnical report, breach analysis, quality control plan, emergency action plan and potentially other technical information that provide details about the dam's design and operations. Measures to ensure compliance with dam safety regulations, including inspections, will be required during the facility's operation.

### ***2.2.3 Texas Antiquities Code***

#### **Applicability, Authority and Jurisdiction**

The Texas Antiquities Code, enacted in 1969, requires that public agencies notify the Texas Historical Commission prior to "breaking ground" for construction or field surveys. The Commission's rules provide that notice is required for projects that disturb five or more acres or involve moving more than 5,000 cubic yards of earth; or that occur in a historic district or site or that will affect a recorded archeological site. If a project sponsor has reason to believe that an archeological site may be present, a survey may be required even if notice is not otherwise required under the rules. Additionally, memoranda of agreement with the Texas Historical Commission that define an entity's requirements would supersede general Commission rules. While the National Historic Preservation Act requires compliance by federal agencies, the Texas Antiquities Code applies to projects on any lands owned or controlled by a political subdivision of the state (publically-owned land).

## Key Requirements

Similar to the requirements of the National Historic Preservation Act, a qualified professional submits a report to the Commission describing the proposed project and sites within the potential area of effect that are listed or eligible for listing in the National Register of Historic Places, if the project will affect those sites and mitigation measures for any adverse effects.

### 2.2.4 Texas Parks and Wildlife Code - Threatened and Endangered Species

#### Applicability, Authority and Jurisdiction

Under Chapters 67, 68 and 88 of the Texas Parks and Wildlife Code, the Texas Parks and Wildlife Department has the authority to designate plants and animals to the state threatened and endangered species list. The regulations also prohibit take or other adverse impacts to state-listed species. Project sponsors have the responsibility to comply with the regulations. While the Texas Parks and Wildlife Department does not issue project development permits directly, the agency does issue some permits (listed in Table 2) and provides reviews on water right applications submitted to the Texas Commission on Environmental Quality.

#### Key Requirements

Similar to the habitat and species evaluations discussed in Section 2.1.2, survey of the proposed project area should be conducted to assess the presence or likely presence of the state-listed threatened or endangered species. If observed, steps should be taken to avoid or minimize impact and mitigate unavoidable impacts. In some cases, a species relocation plan must be approved by the Texas Parks and Wildlife Department and implemented prior to the start of construction.

Best Practice
Freshwater mussels have been added to the state's threatened and endangered species list in many river basins in Texas. Consult with the Texas Parks and Wildlife Department to determine if a mussel survey is needed for your project.

### 2.2.5 Other State Regulations/ Permits

In addition to those regulations and permits described in the preceding sections, other state statutes and regulations may apply to an off-channel reservoir project. Table 2 summarizes major state requirements, although it is not an exhaustive list and project sponsors should thoroughly investigate other permits and regulations that might apply to their project.

**Table 2. Summary of Major State of Texas Regulations/ Permits**

Permit, Approval, or Certification	Responsible Agency	Applicability Criteria	Required Actions
Surface water rights (TEX. WATER CODE ch. 11; 30 TEX. ADMIN. CODE chs. 295, 297, & 298)	Texas Commission on Environmental Quality	Applies to authorization to divert, use and store surface water sources; bed and banks authorization may be needed; other conditions may apply.	Obtain appropriate amendment or new water right authorizing diversion, use and impoundment needed for the proposed reservoir.
Dam Safety (30 TEX. ADMIN. CODE ch. 299)	Texas Commission on Environmental	Private and publicly owned dams in Texas that	Conduct required analysis and submit to Dam Safety

Permit, Approval, or Certification	Responsible Agency	Applicability Criteria	Required Actions
	Quality	meet one or more criteria: 1) 25 feet or more & store 15 acre-feet; (2) 6 feet or more & 50 acre-feet; (3) a high- or significant-hazard dam; or (4) provide pumped or terminal storage.	Program for review and approval.
Texas Antiquities Code (TEX. NAT. RES. CODE ch. 191)	Texas Historical Commission	Construction on land owned or controlled by a political subdivision of the State.	Conduct cultural resources evaluation.
Endangered and Threatened Species (TEX. PARKS & WILD. CODE chs. 67, 68 & 88)	Texas Parks and Wildlife Department	Construction in an area where threatened or endangered species or habitat could be impacted as a result of the construction and/or operation of the proposed facility.	Review of State threatened and endangered species list. Perform threatened and endangered species review and survey within the project area.
Marl, Sand, Gravel, Shell, or Mudshell Permit (TEX. PARKS & WILD. CODE ch. 86)	Texas Parks and Wildlife Department	Disturbance or take of materials within state-owned perennial streams or those more than 30 feet wide.	Obtain permit if needed.
Clean Water Act Construction Stormwater Permit (Section 402) (TEX. WATER CODE CH. 26; 30 TEX. ADMIN. CODE ch. 305)	Texas Commission on Environmental Quality (U.S. Environmental Protection Agency delegated this authority to the State)	Construction of any facility that disturbs 1 acre or more of land.	Prepare a Notice of Intent and Stormwater Pollution Prevention Plan for Construction, Submit the Notice of Intent at least 7 days prior to disturbance of earth start of construction.
Authorization to construct in state right-of-way (TEX. TRANSP. CODE ch. 431)	Texas Department of Transportation (TXDOT)	Required if pipelines or project facilities are to be constructed under a roadway or in TXDOT right-of-way.	Develop and submit drawings of road crossing to TXDOT for review.
Oil & Gas Well Plugging (16 TEX. ADMIN. CODE § 3.14 ( Rule 14))	Railroad Commission of Texas	May be required if oil and gas wells are located at the off-channel reservoir site.	Complete appropriate Railroad Commission form and plug wells according to technical specifications.
Invasive species (Harmful or potentially harmful fish, shellfish and aquatic plants, 31 TEX. ADMIN. CODE §§ 57.111- 57.137)	Texas Parks and Wildlife Department	It is an offense to release into the water of this state, import, sell, purchase, transport, propagate, or possess any species defined as a harmful or potentially harmful.	A permit and control plan may be required.
Federal consistency review/certification (Texas Public Lands Management Act & Federal Coastal Zone	General Land Office	Projects within the Coastal Management Zone (approximately 40 miles inland from coast in	Consultation and certification by the General Land Office that the project is consistent with coastal

Permit, Approval, or Certification	Responsible Agency	Applicability Criteria	Required Actions
Management Act; 31 TEX. ADMIN. CODE ch. 501)		some or all of 17 counties).	management goals.
Miscellaneous Easement for right-of-way across state-owned land under the management authority of the General Land Office (TEX. NAT. RES. CODE § 51.291), or under the management authority of another state agency	General Land Office	Required for crossings of and construction of infrastructure within state-owned riverbeds/navigable streams.	Submittal of application and payment of fees.
Public Water Supply system approval for potable water supply (30 TEX. ADMIN. CODE ch. 290)	Texas Commission on Environmental Quality	May be required if potable water supply is needed during construction or on a permanent basis for administrative or office buildings at the reservoir.	Submittal of plans prepared by a licensed engineer.

### 2.3 Regional and Local Regulations/Permits

#### 2.3.1 Floodplain Authorization

##### Applicability, Authority and Jurisdiction

The Federal Emergency Management Agency defines floodplains throughout the United States. Floodplain administration within designated floodplains is generally managed at the local level by cities and counties. While the Federal Emergency Management Agency defines adverse impacts to floodplains broadly to include increased flood elevations or velocities upstream or downstream, modifying the function or value of the floodplain, they encourage local administrators to more specifically define adverse impacts. Many local floodplain administrators have design criteria manuals or codes that specify requirements related to construction in a floodplain.

Please see Section 4.2.3 for discussion of applicability to the Lane City Reservoir.

##### Key Requirements

Identify affected floodplains and model potential adverse or positive impacts to the floodplain and submit application to the local administrator in accordance with their rules. In some counties, overall site development plans may be required in addition to floodplain authorizations. Additionally, if it is determined that a project will modify the hydrology or hydraulic characteristics of an existing regulatory floodway (one that is mapped by the Federal Emergency Management Agency), then a Conditional Letter of Map Revision or Letter of Map Revision may be required. This entails the project sponsor working with the local floodplain administrator to request such a change in the Flood Insurance Rate Maps or other related maps, designations or reports. While both processes to obtain such a designation from the Federal Emergency Management Agency may take a considerable amount of time to process, a Conditional Letter of Map Revision is generally a faster process in that it allows the project to be constructed followed by a request to change the Flood Insurance Rate Maps in the affected area.

### 2.3.2 Other Regulations/Permits

Other local or regional regulations or permits may apply to off-channel reservoir projects. For example, some water districts have watershed or water quality protection rules that could apply to a specific project. In some areas, multiple jurisdictions have agreements with their local council of governments or regional planning entity regarding land use and project development.

Other areas may be part of a habitat conservation plan for federally-listed threatened or endangered species or those proposed for listing with special requirements related to project development such as the Texas Conservation Plan for the Dunes Sagebrush Lizard in west Texas counties. These will be site-specific and are, therefore, not addressed in detail in this report. Table 3 summarizes some potential local and regional permits and regulations that may apply to specific off-channel reservoir projects.

Best Practice
It is helpful to check with entities such as councils of governments and regional water supplies regarding specific land use, floodplain or water quality requirements.

**Table 3. Summary of Local and Regional Regulations/ Permits**

Permit, Approval, or Certification	Responsible Agency	Applicability Criteria	Required Actions
Road crossings or relocations	County or City	Requirements vary by entity; many follow Texas Department of Transportation design standards.	Generally, plans and profiles sheets of the crossing are reviewed; permits are sometimes required.
Building permits and associated inspections	County or City	Requirements vary by entity.	Requirements vary by entity.
Onsite sewage disposal (septic tank)	County, City, or other local delegated entity	May be required if an administrative building is constructed or potentially for temporary construction facilities if onsite sewage disposal is required.	Submit application, obtain permit and comply with construction and operating requirements.
Groundwater well drilling, production or closure permit	Groundwater conservation districts	May be required if groundwater will be used during construction, for drinking water at administrative facilities at the site or to close existing wells.	Submit application or other information and comply with construction and operating requirements in the district's rules.
Development and/or water quality permits	Councils of governments, river authorities, regional water management districts or supplier, cities	May be required on a case by case basis.	Requirements vary by entity.

### 3 Schedule and Cost Considerations

The permitting plan for each off-channel reservoir will be tailored for unique conditions of the site, the project design and intended operations. When it comes to permitting a reservoir, there is not a “one size fits all” approach, budget or schedule; however, there are some general guidelines related to scheduling and cost estimates that can be discussed for planning purposes. It is a good idea to coordinate with legal counsel and technical advisors early in project development to assess how various federal, state and local regulations apply to an individual project and develop a strategy for acquiring the necessary permits and approvals. Additionally, it is a good practice to reevaluate estimated schedule and costs associated with construction and operation of an off-channel reservoir as project development progresses from concept phase through preliminary and final design. As more detailed information about the project is determined based on the location, design, and feedback from regulatory agencies, estimates can be refined.

#### 3.1 Schedule Considerations

Several factors affect the necessary schedule relating to acquiring necessary approvals and permits. For example, factors affecting the schedule to prepare a Clean Water Act Section 404 permit, include the extent recent applicable data can be used to assess the site’s current conditions and the proposed project’s potential effects, the need for additional field surveys, the suitability for a general or standard permit, and the requirement for public notice regarding the proposed permit. The project sponsor has some ability to affect the overall schedule with respect to completing the needed evaluations and providing timely responses to U.S. Army Corps of Engineers requests for additional information. Other aspects of the schedule, however, hinge on public comments, permit contests and review by other federal agencies, as well as procedural requirements related to the U.S. Army Corps of Engineers being able to make a finding that the project will have no significant impact or if an environmental impact statement will be required. If endangered species or cultural resources are expected to be impacted, consultation with the appropriate agencies, additional studies and development of acceptable mitigation plans can also affect the schedule. More information about U.S. Army Corps of Engineers permitting processes can be found at the appropriate District website or at the headquarters website: <http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/ObtainPermit.aspx> .

As noted previously in this report, the schedule for needed water rights permits or amendments is correlated to whether a new or amended permit is required, the complexity of any changes to existing water rights or use of more than one source of water or water right. In addition to variations in the technical evaluations, procedural requirements for notice (if applicable), the process to resolve potential permit contests and lengthy contested case hearings may also affect the schedule required. Some simple amendments may be processed in a matter of months while other major water right permits associated with reservoirs can take years. Meeting with the Texas Commission on Environmental Quality staff early in the process to provide information about the proposed off-channel reservoir and discuss surface water permit implications will help define the anticipated requirements and refine the schedule. More information about Texas Commission on Environmental Quality water rights requirements is available at the following website: [http://www.tceq.texas.gov/permitting/water\\_rights](http://www.tceq.texas.gov/permitting/water_rights).

Similar factors affect the schedule for obtaining other permits; however, the Clean Water Act Section 404 and water rights permits are generally considered to be the critical path schedule items. Table 4 presents a range of potential durations associated with various major permits that are likely to be required to construct an off-channel reservoir for general planning purposes; actual schedules for each project will differ.

### 3.2 Cost Considerations

Obtaining necessary permits entails more than just preparation of permit applications and submittal packages. Effective permitting processes integrate environmental analyses, water rights approval(s), as well as engineering and legal services; determining which expenditures are made to support permitting efforts and which would be required absent permitting will vary among projects and among project sponsors. Costs required to conduct evaluations and prepare permit applications will vary widely between projects and may involve field work, computer modeling and other analyses. Unlike project facilities such as pipelines, pump stations or intake structures, there are no “cost curves” or readily available databases like one might find in Engineering News Report with recent “bid” prices or standard costs. Necessary studies and evaluations are highly variable as are permit review schedules and mitigation requirements.

For Regional Water Planning, the TWDB costing methodology assumes that environmental studies and mitigation costs will be equal to 100 percent of land costs unless more detailed information is available. For pipelines, the recommended cost-estimate for permitting and mitigation is \$25,000 per mile of pipeline. These costs do not include legal fees but may provide a reasonable basis for estimate at a *conceptual planning level* (TWDB 2013, p. 41). Please note that final construction costs may vary.

The estimated costs presented in this section reflect the professional judgment of the authors and should be verified for any project under consideration.

**Clean Water Act Section 404 Permits.** A common element for most permits is the preliminary engineering that is required to define the off-channel reservoir components, footprint and basic operation. Reservoir and impoundment engineering generally requires geotechnical borings and analysis as well as land surveying earlier in the design process than many other capital projects given the sensitivity of the project to soil type and variability. Input and drawings from the design team will be needed to prepare certain applications such as Clean Water Act Section 404 applications. Much of the preliminary engineering, geotechnical work and survey needed during the permit phase would be required even if permits were not required; however, it may be useful for planning and budgeting purposes to consider the level of engineering support needed during the permitting phase. For an off-channel reservoir with a capacity of 30,000-40,000 acre-feet, engineering-focused activities during the permitting phase could be as much as \$5 million, or more.

Additionally, field evaluations to delineate wetlands and other waters of the U.S. and surveys of archeological and cultural resources, and federally endangered and threatened species and habitat may be required. Surveys for protected species such as bald and golden eagles and migratory birds and their habitat should also be conducted. The size and location of the off-channel reservoir will impact the cost of field work – for example, the number and quality of wetlands per acre in east Texas tend to be far greater than that in west Texas. Additionally, the amount of brush and the terrain will affect time required in the field. Assuming a minimum of one day and

a maximum of five days per acre for each of the biological and archeological teams (between two to ten days), a general estimate for these studies could be as much as \$ 35,000 per acre, or more. The number of water features – especially stream features - will extend the time required for field surveys and water feature mapping. This estimate does not include preliminary desk top assessments and mapping, mobilization, or report writing. If species or archeological resources are observed, additional costs would be expected.

An environmental assessment and preparation of the permit application package for a standard individual permit, if required, may be as much as \$250,000, or more, depending on the number of alternatives analyzed in detail and the extent of resource evaluations required, with additional costs to address U.S. Army Corps of Engineers and consulting agencies’ requests for information and to respond to public comments. Preparation of the permit application submittal package, mitigation planning and consultation with the agencies could require an additional \$100,000 - \$200,000. Preparation of a nationwide permit preconstruction notification, however, may only cost approximately \$40,000. This estimate does not include mitigation – which can be a considerable expense. For example, costs were obtained for a wetland mitigation bank in southeast Texas that indicate a current rate as much as \$70,000 per Functional Capacity Unit depending on the number of units purchased. A Functional Capacity Unit measures the ecosystem services provided by a particular wetland (e.g., for habitat, nutrient retention, flood control and similar services); impacted wetlands may provide multiple Functional Capacity Units per acre. For example, if the mitigation ratio is 1.5:1 (protecting or creating 1.5 acres for every acre impacted), cost to mitigate impacts to twenty acres at \$35,000 per Functional Capacity Unit would be \$1,050,000. The cost is variable based on acreage affected, quality of the wetlands and available banks in the area. Archeological and historic resource mitigation also has significant variability – ranging from documentation of the resource (in the \$20,000 range) to moving a cemetery which would be considerably more expensive.

**Surface water rights permits.** As noted previously, the complexity of the water right application will influence the technical evaluations required. A simple amendment with little technical modeling may cost as much as \$30,000, or more, whereas technical evaluations and legal support associated with complex water rights or contested case hearings may range in the multiple millions of dollars.

**Dam Safety Program.** Meeting the safety requirements of the Dam Safety Program requires submittal of hydrologic and hydraulic modeling results, plans and specifications and an emergency action plan for the proposed project. Much of the engineering would be required even if the coordination with Texas Commission on Environmental Quality and regulatory reviews were not required. A rough estimate for required coordination and submittals associated with the Dam Safety Program could be as much as \$100,000, or more.

**Table 4. Planning Level Schedule Estimates Related to Potentially Needed Major Permits**

Permit, Approval, or Certification	Schedule	Notes
Clean Water Act, Section 404 – General permits	45-60 days after all required information is submitted	Evaluations such as wetlands delineations, cultural resource surveys and habitat/species surveys generally include desk top evaluations and mapping followed by field investigations. Vegetation, terrain, number of water features and the presence of known species and

Permit, Approval, or Certification	Schedule	Notes
		cultural resources will extend the timeline.
Clean Water Act, Section 404 – Standard Individual Permit	2 – 3 years	If the U.S. Army Corps of Engineers determines that an Environmental Impact Statement is required or if there is a contested permit, additional time will be required and costs will increase. Mitigation of impacts to waters of the U.S. can add considerable time if design and implementation of constructed wetlands are required. Considerably faster (but potentially more costly), mitigation credits may be available through a mitigation bank.
National Historic Preservation Act/ Texas Antiquities Code – Cultural Resources Report	3- 12 months; included within the estimate for Clean Water Act Section 404 Permit	Costs and schedule are highly dependent on the location, cultural and archeological resources identified and the acreage within the Area of Potential Effect. Consultation with the Advisory Council on Historic Preservation and/ or Tribal Historic Preservation Officer will add to the timeline, if required.
Endangered Species Act, Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act	3-6 months; included within the estimate for Clean Water Act Section 404 Permit	If a detailed biological assessment, consultation with U.S. Fish and Wildlife Service and/or a Habitat Conservation Plan are required, the timeline and costs would be expected to increase.
Chapter 11, Texas Water Code and associated regulations	4 months – 4 years	Water rights review and approval processes can range from several months to many years depending on the complexity of the water right application and contested case hearings.
Dam Safety Review	30 days after submittal of complete package and all information requested.	The Texas Commission on Environmental Quality Dam Safety Program team may ask for additional information after reviewing the initial package. The schedule provided does not include preparation of the detailed engineering report and other analyses and materials required.
Floodplain and site development permit	3 weeks – 6 months	Projects with minimal impact to the floodways and floodplains may be reviewed quickly. Those requiring detailed modeling will require additional time for analyses and coordination with local floodplain administrator. If a Conditional Letter of Map Revision or Letter of Map Revision is required from the Federal Emergency Management Agency due to modification of a floodway, the schedule could be extended by months.

## 4 Lower Colorado River Authority Lane City Reservoir Case Study

### 4.1 Project Description

The Lower Colorado River Authority’s (LCRA’s) Lane City Reservoir is an off-channel reservoir under construction in Wharton County adjacent to LCRA’s existing Gulf Coast Irrigation Division Plant No. 2. The reservoir will hold approximately up to 40,000 acre-feet of water, but the water could be used and the reservoir refilled multiple times over the course of a

year, making it capable of adding up to 90,000 acre-feet per year of firm water to the region’s supply. Figure 3 provides a schematic of the reservoir and associated facilities.

The existing conveyance system that serves the irrigation division is comprised of a horizontal river pump station and intakes, a vertical turbine pump station and intake, and the Lane City Canal (“Existing Canal” in Figure 3) that feeds the canal system on the east side of the river. The proposed project uses the existing pump stations and existing water right on the river amended to include storage. When available per the terms of the water right, water will be pumped from the river into the Lane City Canal. From the canal, the water can either be directed farther down the canal system (via the Lane City Canal) to meet irrigation and/or industrial demands, or diverted via a new re-lift pump station into the new off-channel reservoir for storage.

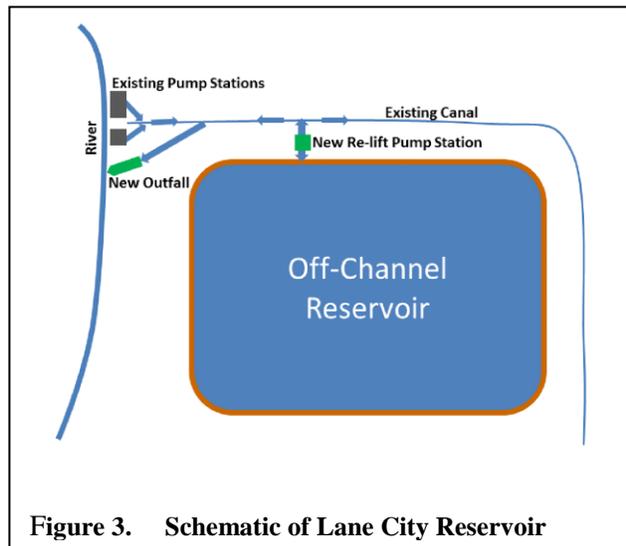


Figure 3. Schematic of Lane City Reservoir

LCRA intends to release stored water in the Lane City Reservoir back into the canal and, then, direct it either to the downstream canal system or back to the river through the new river outfall. The project requires upgrades to the existing pump stations, upgrades to the canal system, construction of the new river outfall, construction of the new re-lift pump station, construction of the new off-channel reservoir, and supporting site access and security infrastructure.

## 4.2 Unique Permitting Conditions

### 4.2.1 Water Right

LCRA had a pre-existing water right, but did require minor amendments. No changes were required to the authorized place or rate of diversion, resulting in a simplified amendment process. This may not be the case for other off-channel reservoirs.

### 4.2.2 Clean Water Act

LCRA considered environmental impacts and regulatory requirements from the earliest stages of project development. Environmental constraints such as potentially jurisdictional waters of the U.S., endangered species habitat and known archeological sites were key factors as alternative sites were evaluated and selected. Additionally, the ability to incorporate existing infrastructure was also a significant consideration for site selection and project design. Including the permitting team early in the site evaluation process allowed LCRA to select a site that facilitated simplified permitting reviews and approvals.

Once the site was selected, the permitting team engaged with the U.S. Army Corps of Engineers early in the design process – U.S. Army Corps of Engineers staff provided suggestions for the design process (e.g., maintain natural riparian buffers along the creek flowing through the site

(Jarvis Creek) to the maximum extent practicable and use natural bank stabilization measures where feasible to elevate the creek/river function and off-set adverse impacts from the construction activities). While in most cases, an off-channel reservoir will require a standard individual permit or letter of permission, LCRA was able to use several nationwide permits to authorize needed upgrades to existing facilities and other construction activities needed for the Lane City Reservoir. In one reach of the creek flowing through the site, several nationwide permits were relied upon to authorize repair and replacement of existing site features and construction of new infrastructure.

#### Best Practice

Coordinate with the U.S. Army Corps of Engineers early in project development to get input on project design as well as required evaluations. This will help focus efforts on those studies that the District requires based on the specific site or regional conditions.

One of the issues that LCRA was required to address during the review and approval process for their Clean Water Act 404/ River and Harbors Act Section 10 permits included consultation required by Section 106 of the National Historic Preservation Act. During the cultural/archeological resources project review by the State Historic Preservation Officer, the existing Lane City Canal and the horizontal pump station building were deemed eligible for listing on the National Register of Historic Places. The facilities were not found to be particularly unique structures or important examples of period architecture/engineering; their significance lies in their contribution to the economic development of the region. The canal was constructed in the early 1900's and the pump station in 1949. Because they are eligible structures, LCRA was required to mitigate for any adverse direct and indirect impacts to them. In this case, direct impacts include inundation of a portion of the original, main canal and enlargement of the pump station building. Potential indirect impacts result from construction of the reservoir embankment and modification of the view shed from the eligible structures. LCRA was required to develop a mitigation plan that includes:

- Photo-documentation of the structures in their existing condition; provision of topographic lidar data of the canal within the project area; and compilation of historical plan and profile drawings of the pumping plant complex and pump station. Copies of these documents have been provided to the U.S. Army Corps of Engineers, State Historic Preservation Officer, Wharton County Library and Wharton County Historical Commission.
- Preparation of a brochure/pamphlet describing the history and development of irrigation and agriculture in the Lane City area and distribution of the pamphlet to local libraries and businesses. The pamphlet will also be available on the LCRA website.
- Preparation and installation at the site of an informational display, including at least one interpretive panel about the history and development of irrigation and agriculture in the Lane City area.
- Application for Official Texas Historical Marker status and installation of the marker at the site if approved.

A Memorandum of Agreement between LCRA, the State Historic Preservation Officer and the U.S. Army Corps of Engineers defining the approved mitigation plan to resolve the adverse impacts to the eligible structures had to be fully executed by all parties before the Clean Water

Act Section 404 permit verification letter could be issued. Although the Advisory Council on Historic Preservation declined the invitation to participate in consultation, the process to invite them and await their responses added time to the permit review process. This provides a good example of unanticipated and site-specific conditions that can affect both the schedule and cost related to permitting significant projects such as off-channel reservoirs.

#### ***4.2.3 Floodplain Permit***

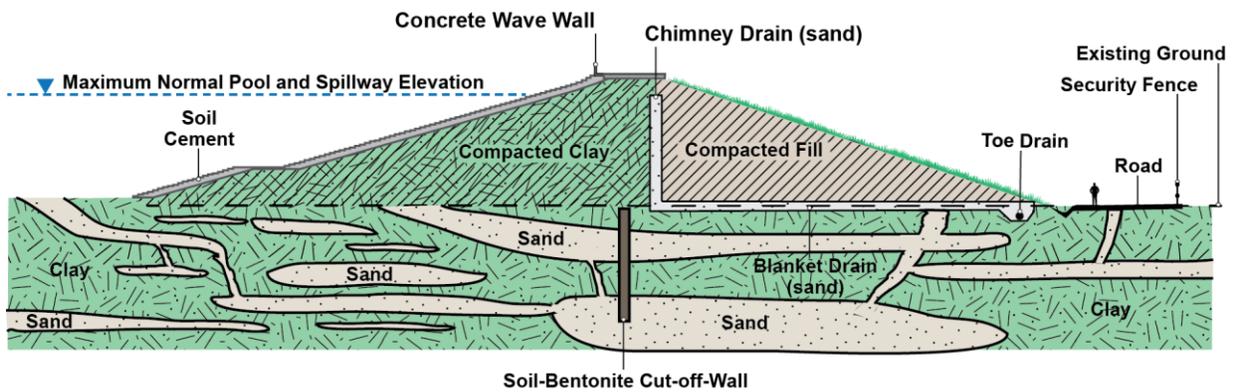
Wharton County is the floodplain administrator with jurisdiction over the Lane City Reservoir site. The project site is located within the Jarvis Creek watershed. The Jarvis Creek watershed has a drainage area of approximately 23.9 square miles and represents a very minor tributary within the much larger Colorado River watershed, which encompasses approximately 42,344 square miles.

As part of the planning and design process, the design team assessed potential impacts to the floodplain associated with the proposed modifications within the Jarvis Creek watershed including the off-channel reservoir, improvements to the canal flume, and a new bridge for County Road 120 to provide all-weather access which included removal of two low water crossings. Largely due to the removal of the low water crossings, LCRA was able to demonstrate a net increase in stream function even with the construction of the project and new fill within the watershed. Based on results of comparative water surface profile modeling conducted, encroachment of the composite Colorado River and Jarvis Creek floodplain demonstrated that there would be no increase in 100-year water surface elevations, and actually indicated a minor decrease in the water surface elevations between existing conditions and post project conditions at the flume crossing. These results indicated that the construction of the project will result in no adverse impacts to the floodplain. Similar analyses are likely to be required for any off-channel reservoir project.

#### ***4.2.4 Dam Safety Program Approval***

The design and operation of the Lane City Reservoir includes three elements that were critical for approval through the Dam Safety Program and provided innovations that significantly reduced construction costs. These innovative design features include: 1) the wave wall; 2) the chimney drain; and 3) the outfall capacity – each of which are discussed in more detail in this section. Used in combination, these components meet the dam safety and operational requirements of the reservoir while allowing for a lower embankment than if these features were not part of the design.

The Texas Commission on Environmental Quality's guidelines require that impoundment structures include freeboard, or height above the operating water level within the reservoir, to prevent flow over the top of the impoundment (overtopping) in the event of an extreme flood or wind event. Generally, the minimum freeboard height should be greater than or equal to the maximum wave height expected in the design storm. The Dam Safety Program allows exceptions to this general rule if the analyses verify that proposed reservoir design can prevent overtopping of the reservoir without the standard impoundment height. The design of the Lane City Reservoir included innovative features that meet the safety requirements with a lower impoundment height. A generalized sketch of the wave wall and chimney drain are shown in Figure 4.



**Figure 4. Reservoir Embankment Section showing Wave Wall and Chimney Drain**

### Wave Wall

One of the unique design features of the Lane City Reservoir is a vertical wall that will be constructed at the top of the interior embankment slope to reflect wind-generated waves and limit overtopping of the embankment during extreme wind events when the reservoir is nearly full. The wave wall element was developed to minimize the required embankment height while providing an equivalent level of overtopping protection. The ultimate goal was to reduce the volume of earth and ultimately the reservoir embankment cost by reducing the embankment height relative to the height required if the wall was not present. Understanding optimum construction sequencing contributed to an innovative engineering design that is estimated to save costs for both the reservoir construction of earth and soil cement facing compared with traditional designs.

### Zoned Chimney Drain

Typical embankment designs have a wide chimney drain, up to eight feet wide, to control seepage through the embankment and prevent the embankment from becoming saturated. These must be constructed using high-quality sand that is uniformly graded and highly permeable to form a continuous vertical face along the entire embankment. The chimney drain must be constructed with no intervening clay layers that could interfere with the lateral or vertical flow of seepage.

After a constructability investigation, the team determined that the availability of suitable materials for a chimney drain of that size was limited in the project area. The project team investigated alternative designs to both meet the dam safety requirements and use available materials. To reduce the costs associated with implementing the standard design, the chimney drain design now includes a construction method that avoids mixing clay in the sand, to enable construction of a narrower chimney drain (LCRA 2015a, p. 39).

Best Practice
<p>Consider practical construction constraints such as materials availability during design and prepare analyses to demonstrate how innovative design elements meet regulatory requirements.</p>

The vertical zoned chimney filter/drain that will be constructed for the reservoir will be approximately half the width of that typically designed for similar projects. The chimney filter/drain will be constructed in zones that include native sand adjacent to upstream clay fill and sand imported from offsite between the native sand and downstream random fill.

### **River Return System**

One important function of the Lane City Reservoir is the ability to store and release water throughout the year for use downstream. Using the existing improved Lane City Canal in conjunction with a new river return structure, LCRA was able to incorporate another cost-saving measure to return water to the river from storage (LCRA 2015a, p 39). The use of the existing improved canal system to both deliver water to the reservoir and return water to the river saved construction costs. The new river return structure was designed to minimize impacts to waters of the U.S., including the use of natural bank stabilization measures. Further, the capacity of the river return system and operating protocols will provide safe handling and discharge of water in high flood or wind events with a discharge capacity that can more than double the flow rate of typical operating procedures. Combined with the wave wall and zoned chimney drain, this project component further reduced required freeboard height to optimize the cost of embankment construction.

#### **4.2.5 Summary**

The specific design approaches used for the Lane City Reservoir will not be applicable to every off-channel reservoir. However, they demonstrate that integrating site-specific construction considerations and a thorough understanding of safety, operational and regulatory requirements can result in cost-effective solutions. Specifically, for the Lane City Reservoir project, the ability to use existing intake facilities and LCRA's site selection process allowed LCRA to use a relatively simple water rights permitting process and nationwide permits to comply with Clean Water Act Section 404, which resulted in a faster permitting process than is more typical of complex projects, like reservoirs.

## **5 References**

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