DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

December 24, 2014

Programs and Project
Management Division

Mr. Brad Brunett
Brazos River Authority
Water Services Planning Manager
4600 Cobbs Drive
P.O. Box 7555
Waco, Texas 76714-7555

Dear Mr. Brunett:

Please find enclosed the draft report for the Middle Brazos Systems Assessment, Phase II, Aquilla Lake Reallocation. To date, the report has only received a local supervisory review, and it must still undergo the Corps' complete review and approval process. The information contained in the report is shared with the Brazos River Authority (BRA) as our cost sharing partner and member of the project delivery team. We encourage you to review and comment on the draft report as part of our District Quality Control review. The report is not releasable to the public until this review and the Agency Technical Review are complete. The District will coordinate with BRA in advance of releasing the report for public review and comment, and encourage BRA's active participation in the planning and conduct of the public review process.

It is our understanding that BRA will utilize this draft report as an internal decision document. Please be advised that further Corps efforts on this study are now being suspended until we are advised of your decision on whether or not to continue pursuit of the reallocation. If BRA elects to continue, non-Federal funds in the amount of $341,836.93 would be required to fully fund the study to completion, as per the Feasibility Cost Sharing Agreement. However, if BRA elects to terminate the agreement, a final accounting will be conducted, and a lesser amount currently estimated at approximately $75,000 would be due.

If you have any questions or concerns, please contact Mr. Tim Horn, Three Rivers Regional Office, Operations Project Manager, (254) 399-9026 or Tim.A.Horn@usace.army.mil for additional information. An alternate point of contact for specific questions about the reallocation study or the resulting report is Ms. Stacy Gray, Project Manager, (817)886-1787 or Stacy.L.Gray@usace.army.mil.

Sincerely,

Elston D. Eckhardt

Elston D. Eckhardt, P.E.
Chief, Civil Program Management Branch

US Army Corps
of Engineers

Fort Worth District

AQUILLA LAKE

BRAZOS RIVER BASIN, TEXAS

REALLOCATION STUDY

NOTE:

1) ***All elevations listed in this report are referenced to NGVD.***

April 2013

CESWF-EC-HL

US Army Corps of Engineers®
Fort Worth District

MIDDLE BRAZOS SYSTEMS ASSESSMENT, PHASE II AQUILLA, WATER SUPPLY REALLOCATION REPORT AND ENVIRONMENTAL ASSESSMENT

Aquilla Lake, Hill County, Texas

EXECUTIVE SUMMARY

STUDY DESCRIPTION AND PURPOSE

The Phase II Aquilla Lake Water Supply Reallocation study is intended to investigate the reallocation of storage capacity within Aquilla Lake. The findings of the study are presented in this integrated reallocation report and environmental assessment (EA). Aquilla Lake is a U.S. Army Corps of Engineers (USACE) reservoir located in rural central Texas just southwest of the City of Hillsboro in Hill County. The lake was formed in 1983 by the impoundment of Aquilla Creek. Aquilla Dam is located at river mile 23.3 on Aquilla Creek. The primary inflows into the lake are Aquilla Creek and Hackberry Creek, with discharges from the lake flowing into Aquilla Creek below the dam. The non-federal sponsor for the study is the Brazos River Authority (BRA). The Aquilla reservoir covers a surface area of approximately 7,000 acres at the top of flood pool elevation of 556 feet, and 3,280 acres at the top of conservation pool elevation of 537.5 feet,

PLANNING PROBLEMS/OPPORTUNITIES/OBJECTIVES

The projected yield of Aquilla Lake will not be able to completely supply the future needs of the cities it supplies. As a result, the BRA asked the USACE to conduct this reallocation study within Aquilla Lake, reallocating storage from the flood pool to the conservation pool for municipal and industrial (M&I) water supply. According to the Water Supply Agreement (WSA) between the U.S. Government and BRA entered into on 5 April 1976, BRA has the right to use to the total useable storage below elevation 537.5 (estimated in 1976 to contain 33,600 acre- feet (AF) of storage) in Aquilla Lake for municipal and industrial (M&I) water supply, subject to availability of water. BRA currently contracts to Aquilla Water Supply District, City of Cleburne and Lake Whitney Water Company for a total of 11,403 acre feet per year of water. While the demand is expected to remain constant, Aquilla Lake looses between 84 AF per year and 218 AF per year of conservation storage space due to sedimentation. Additionally, the extended period of drought has resulted in less inflow. This decline in yield is expected to result in water supply shortages beginning as early 2040, with the shortage in 2060 forecasted to be approximately 11,403 AF.

The alternatives evaluated in the reallocation study offered opportunities to reduce water shortage faced by the BRA in a way that complements other water supply activities while maintaining the authorized project purposes for Aquilla Lake. There is also an opportunity at the local level to educate the public on water conservation activities currently practiced, and recommend any additional conservation activities that might be undertaken.

The objective of the study is to provide a means to meet, to the extent practicable, the forecasted water demand on Aquilla Lake water user groups.

RECOMMENDED PLAN

The recommended plan would reallocate storage from the flood pool to the conservation pool. Currently, the top of the conservation pool is 537.5 feet and has a storage capacity of 44,577 AF. The top of the flood pool is 556 feet, with a spillway crest of 556 feet.

The recommended plan would be to increase the top of conservation pool 4.5 feet into the flood storage pool, making the top of conservation pool at 542 feet. This will reallocate approximately 15,073 AF of storage from the flood pool to the conservation pool. The estimated increase in yield with this reallocation is 2,483 AF per year.

The proposed reallocation would require placement of 2-foot thick rock riprap to protect the dam embankment, but no changes in the dam or spillway height. Some current recreation features, including restrooms, boat ramps and picnic tables, will need to be relocated. The estimated first cost of construction is estimated at $7.97 million, and the cost of storage is estimated at $14.18 million.

ENVIRONMENTAL COMPLIANCE

The reallocation report contains an integrated EA which demonstrates compliance with the National Environmental Policy Act, Endangered Species Act, and other pertinent environmental laws and executive orders. It has been determined through the findings of the EA that some mitigation is anticipated for riparian woodland habitat impacted and/or permanently lost as a result of the pool raise. A mitigated Finding of No Significant Impact (FONSI) has been prepared.

PUBLIC COORDINATION

NON-FEDERAL SPONSOR SUPPORT

The BRA supports the recommended plan that would increase the top of conservation pool 4.5 feet into the flood storage pool.

AREA OF CONTROVERSY AND UNRESOLVED ISSUES

Aquilla Lake Dam was screened by a national risk cadre as part of the Fiscal Year 2005 Screening Portfolio Risk Assessment (SPRA) and categorized as a Dam Safety Action Classification (DSAC) 3 (Moderate Urgency). Corps criteria does not allow for the reallocation of flood storage on projects with a DSAC of 3 or less, without exception from the Dam Safety Officer (DSO) for the Corps. The Fort Worth District implemented Interim Risk Reduction Measures (IRRMs) to improve project conditions and further evaluate the known Dam Safety concerns. In September 2012, a re-evaluation was completed which recommended that DSAC be changed from 3 to 4 based on IRRM implementation, as concurred by the DSO or Chief of Engineers for Civil Works (CECW-CE) in Memo dated August 27, 2013. Which allows for reallocation of flood storage, as authorized by the District/Division DSO, such that the risks associated with the project remain below the Corps Tolerable Risk Guidelines for the final changes to reservoir operations and/or flood storage.

In November 2014, the Fort Worth District conducted a Potential Failure Mode Analysis (PFMA) of the existing conditions for the Aquilla Lake Dam to better define the risks associated with operation of the Federal Project. This is a crucial step to confirming that the 4.5-ft change to the conservation pool, will not substantially increase the risks for the project. Preliminary PFMA results confirm the need to further evaluate site conditions and downstream consequences with a Semi-Quantitative Risk Assessment (SQRA) to confirm the DSAC and allow for safe pool reallocation. This will be conducted in Spring 2016 with the first Periodic Assessment of the project, in conjunction with Periodic Inspection #11.

MAJOR FINDINGS AND CONCULSIONS

The USACE has the authority to reallocate at its own discretion up to 50,000 AF or 15 percent of the total flood storage, whichever is less. Since raising the conservation pool 4.5 feet will reallocate 15,073 AF, this amount is in the USACE discretionary authority.

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* Indicates this section satisfies one or more of the requirements of the National Environmental Policy Act

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CHAPTER 1: INTRODUCTION

Reservoirs owned by the USACE typically serve multiple functions, including flood control, water supply, and recreation. Most USACE reservoirs contain a significant amount of storage dedicated to flood control. This flood control storage is used to temporarily hold flood waters in the top few feet of the reservoir to reduce flooding downstream. It is possible to increase the available water supply from these reservoirs by changing some of the flood control storage to the reservoir storage dedicated to water supply, or conservation storage. This process is called reallocation. Reallocations are a change in the use of storage in an existing reservoir project from its present use to Municipal and Industrial (M&I) water supply. Typically a reallocation is authorized by the Water Supply Act of 1958. Reallocations or addition of storage that would seriously affect the purpose for which the project was authorized, planned, or constructed, or which would involve major structural or operational changes, must be approved by Congress. The USACE has the authority to reallocate at its own discretion up to 50,000 AF or 15% of the total flood storage, whichever is less. Additional reallocation of flood storage to conservation storage requires the approval of Congress.

Aquilla Lake was developed as series of flood risk management projects to reduce flood risk along the mainstem of the Brazos River to the Gulf of Mexico. Since its impoundment in 1983, Aquilla Lake has prevented an estimated $47,582,600 (September 2014 prices) in flood damages. In 2008, the USACE in conjunction with the Brazos River Authority (BRA) prepared a feasibility study for reallocating flood control storage to water supply storage for nine lakes in the Brazos River Basin, one of those lakes being Lake Aquilla. The results of the study determined that Lake Aquilla would be assessed in an independent study to determine if reallocation is the appropriate solution for addressing the future water demands. This report documents the independent study referred to as Phase II.

NON FEDERAL SPONSOR

The non-federal sponsor for this study is the Brazos River Authority.

STUDY PURPOSE AND NEED*

The purpose of this Phase II reallocation study is to determine whether reallocation at Aquilla Lake is the most efficient and effective solution for addressing the water supply needs in the area currently served by Aquilla Lake. The Aquilla Lake is currently contracted to provide 33,600 AF of storage capacity to BRA for M&I water supply. The BRA estimates a deficiency of 11,403 AF, as identified in the 2011 Brazos G Regional Water Plan and the 2012 Texas State Water Plan (http://www.twdb.state.tx.us/waterplanning/swp/2012/index.asp).

PROBLEMS AND OPPORTUNITIES

The projected yield of Aquilla Lake will not be able to completely supply the future needs of the cities it supplies. This decline in yield is expected to result in water supply shortages beginning as early 2040, with the shortage in 2060 forecasted to be approximately 11,403 AF.

The alternatives evaluated in this reallocation study offer opportunities to reduce water shortage faced by the BRA in a way that complements other water supply activities while maintaining the authorized project purposes for Aquilla Lake. There is also an opportunity at the local level to

educate the public on water conservation activities currently practiced, and recommend any additional conservation activities that might be undertaken.

STUDY OBJECTIVE

The objective of the study is to provide a means to meet, to the extent practicable, the forecasted water demand on Aquilla Lake water user groups.

SCOPE*

The scope of this study is to identify and quantify the new demand for capacity within Aquilla Lake, evaluate alternatives for addressing the forecasted water supply shortage, evaluate the impacts of reallocation on other project purposes, and determine the environmental effects of the reallocation alternatives. This report identifies the price of storage to be charged to the user, and any compensation required for reallocation of capacity within Aquilla Lake. An Environmental Assessment (EA) has been integrated with this reallocation report. The EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, and also serves as compliance for other pertinent laws related to this study, such as the Fish & Wildlife Conservation Act, Endangered Species Act, etc. The EA evaluates the environmental effects associated with four alternatives, including the No Action alternative.

STUDY AUTHORITY

This study is authorized by the 1958 River and Harbor Act (PL 85-500), Section 301, as amended in 43 U.S.C. 390b. The law commonly known as the "Water Supply Act of 1958" as amended by Section 10, PL 87-88 and Section 932, PL 99-662 states:

> *"(a) It is hereby declared to be the policy… that the Federal Government should participate and cooperate with States and local interests in developing such water supplies…*
> *(b) In carrying out the policy set forth in the section, it is hereby provided that storage may be included in any reservoir project… planned, surveyed and/or constructed by the Corps of Engineers… to impound water for present or anticipated future demand or need for municipal or industrial water…*
> *(d)Modifications of a reservoir project heretofore authorized, surveyed, planned or constructed to include storage as provided in subsection (b), which would seriously affect the purposes for which the project was authorized, surveyed, planned, or constructed, or which would involve major structural or operational changes, shall be made only upon the approval of Congress as now provided by law."*

STUDY LOCATION*

Aquilla Lake is located in rural Central Texas, approximately seven miles southwest of the city of Hillsboro in Hill County, Texas. The reservoir covers a surface area of approximately 7,000 acres at the top of flood pool elevation of 556 feet, and 3,280 acres at the top of conservation pool elevation of 537.5 feet. It is bordered to the north by State Highway 22 and to the south by FM

310 (Figure 1). The predominant adjacent land use is agriculture. The lake was formed by the impoundment of Aquilla Creek just downstream of its former confluence with Hackberry Creek. Little Aquilla Creek, Rocky Branch, Jacks Branch, and various other unnamed tributaries empty into the reservoir. Aquilla Creek resumes flow below the spillway and ultimately empties into the Brazos River approximately 24 miles downstream.

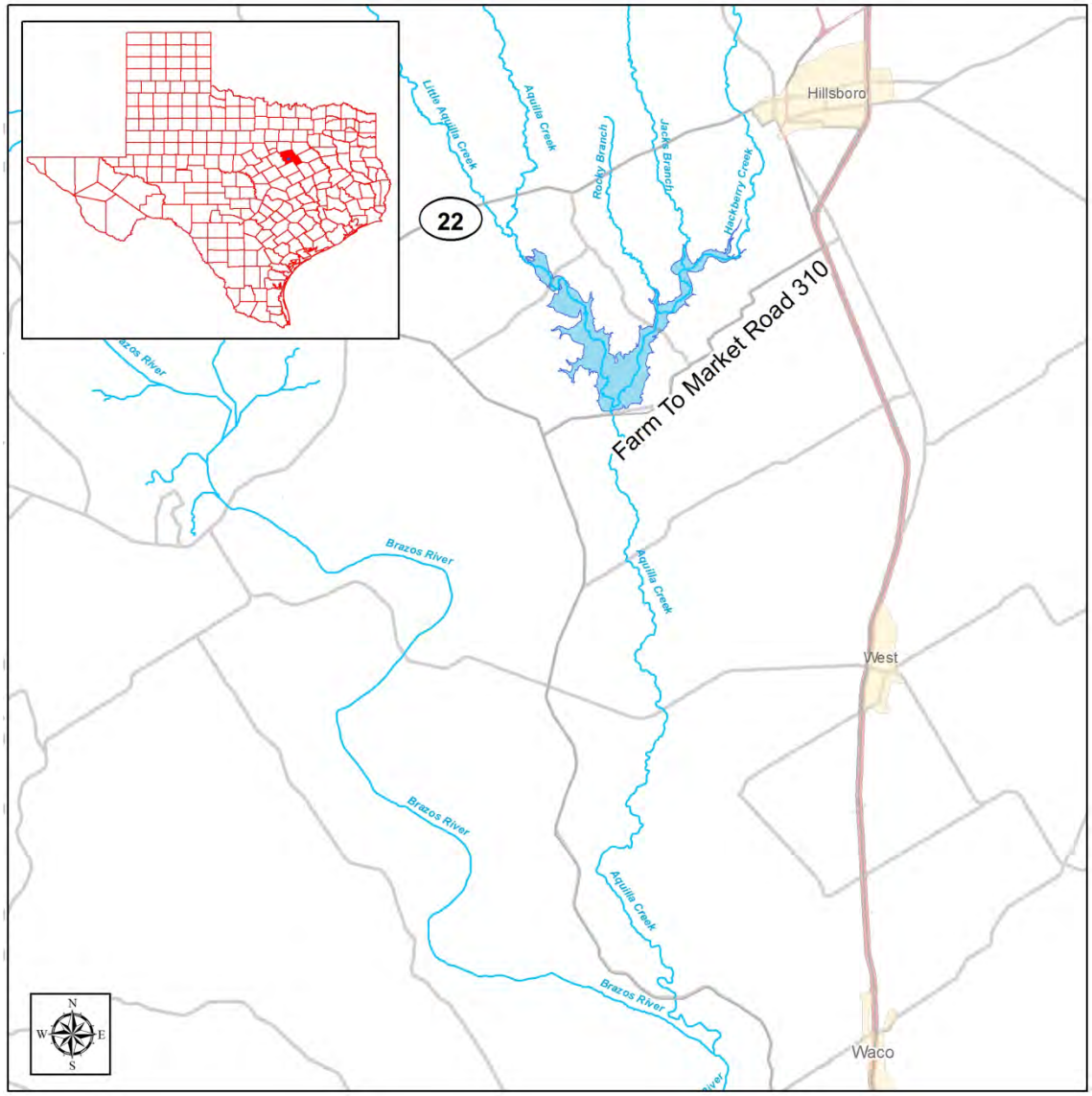

Figure 1. Aquilla Lake Study Area

PREVIOUSLY CONSTRUCTED PROJECTS

Aquilla Lake and dam (Figure 2) were constructed by the USACE as part of the overall Flood Risk Management (FRM) project in the Brazos River basin under the Flood Control Act of 1968,

Public Law 90-483 (82 Stat. 741) 90th Congress, approved August 13, 1968. This authorization was based on the recommendation of the Chief of Engineers in Senate Document Numbered 52 and states:

> *The project for the Aquilla Dam and Reservoir, Aquilla Creek, Texas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers, in Senate Document Numbered 52, Ninetieth Congress, at an estimated cost of $23,612,000.*

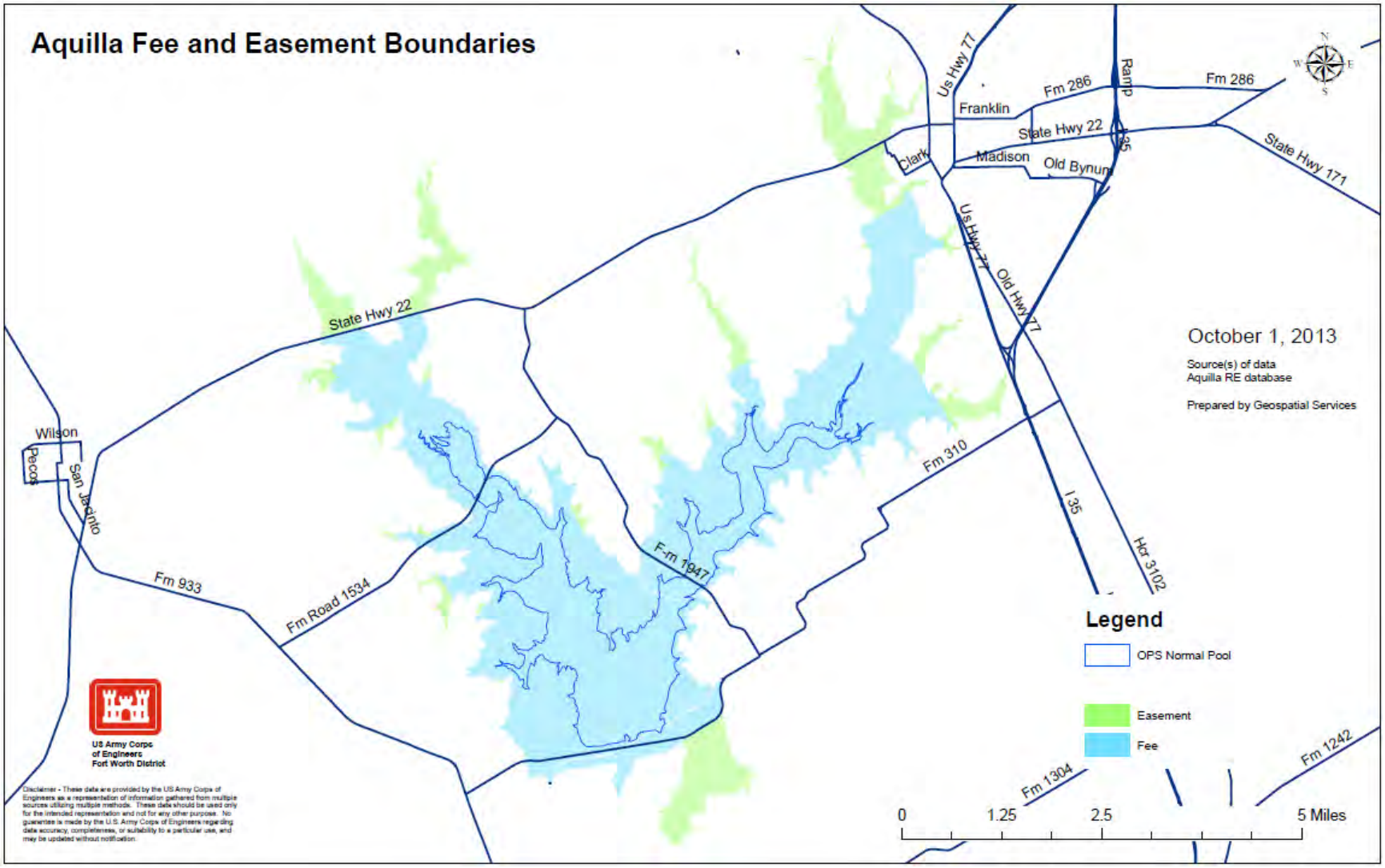

Figure 2. Aquilla Lake Project Area

The document referenced in this authorizing law provided four authorized purposes for Aquilla Lake: flood control, municipal and industrial (M&I) water supply, general recreation, and fish and wildlife enhancement. Access and facilities are provided for minimum recreation, but water is not controlled for that purpose. The resulting cost allocation for the project is shown in Table 1.

Table 1. Cost Allocation for Construction of Aquilla Lake and Dam

	Flood Control	Water Supply	Recreation	Total
Specific Facilities Costs	0	0	$408,000	$408,000
Joint Use Facilities Costs	$28,225,100	$9,499,000	$1,886,900	$39,611,000
Interest During Construction	$2,293,300	$1,214,900	$160,300	$3,668,500
Total Allocation Investment	$30,518,400	$10,713,900	$2,455,200	$43,687,500
Allocation Percentage	69.9%	24.5%	5.6%	100%

The major components of the Aquilla Dam consist of a rolled fill earthen embankment, an outlet works gated conduit, and an uncontrolled broad crested weir spillway. Table 2 includes pertinent data related to Aquilla Lake.

Table 2. Aquilla Lake Pertinent Data

Feature	Elevation (feet NGVD)	Area (acres)	Capacity (acre feet)	Equivalent Runoff (inches)
Top of Dam	582.5	------	------	------
Spillway Crest	564.5	------	------	------
Top of Flood Control Pool	556.0	6,999	136,910 (1,3)	10.2
Top of Conservation Pool	537.5	3,060	44,577 (1, 3)	3.3
Sediment Storage	------	------	25,700 (2)	1.9
Flood Control Storage	537.5-556.0	------	92,333 (3)	6.9
Conservation Storage	≤ 537.5	------	44,471 (3)	3.3
Streambed	478.0	------	------	------

(1) Cumulative total (2) Total estimated sedimentation 1976 – 2076 (3) Based on 2008 survey

Year Complete: 1983

USACE Parks/Accesses: 6 (1,101 acres)

Drainage Area: 255 square miles

Length of Dam: 11,890 feet

Fee Information: 10,212 acres at or below 564.5 feet (NGVD)

Since its impoundment in 1983, the lake has prevented an estimated $47,582,600 (September 2014 prices) in flood damages. According to the Water Supply Agreement (WSA) between the U.S. Government and BRA entered into on 5 April 1976, BRA has the right to use to the total useable storage below elevation 537.5 (estimated in 1976 to contain 33,600 AF of storage) in Aquilla Lake for M&I water supply, subject to availability of water. The U.S. Government reserves the right to draw down the lake elevation to 537.5 feet above mean sea level in the course of FRM operations. Based on the 2011 Brazos G Regional Water Plan, Aquilla Lake is currently permitted by TCEQ to provide 45,003 AF annually for M&I water supply, but is experiencing a decline in yield. Comparisons of capacities at conservation pool elevation derived from current and previous surveys suggest Aquilla Lake looses between 84 AF per year and 218 AF per year of conservation storage space due to sedimentation. The loss is equivalent to 0.33 – 0.85 AF per square mile of drainage area. Additionally, the extended period of drought has resulted in less inflow. This decline in yield is expected to result in water supply shortages beginning as early 2040, with the shortage in 2060 forecasted to be approximately 11,403 AF. The lake had approximately 104,000 visitors in 2012 that came to hike, boat, hunt, fish, and swim at the existing recreation areas.

CHAPTER 2: EXISTING AND FUTURE WITHOUT PROJECT CONDITIONS*

This chapter describes the study area in the context of site conditions, environmental setting, and habitat evaluation for current conditions and expected future conditions if no Federal action is taken.

CLIMATE

The Aquilla Creek watershed experiences a continental type of climate characterized by a wide range between annual extremes of temperature. The watershed has cool winters and hot, humid summers. Tropical air masses from the Gulf of Mexico play a dominant role in the climate from late spring to early fall. Polar air masses determine the winter climate, occasionally causing snowfall and freezing temperatures. The mean annual precipitation is approximately 35 inches. However, seasonal rainfall is largely the result of thunderstorm activity, and amounts vary in intensity and location. Heavy showers of short duration may occur at any time of year.

While the area is not expected to be affected by sea level rise within the forecast period, some forecasts predict an increase in average temperature of 4-6 degrees Fahrenheit and a 10-15 percent decline in precipitation for the region over the 50 year period of analysis. Additionally, long range forecasts predict that while precipitation will be less frequent, the storms themselves are likely to be of higher intensity.

REGIONAL GEOLOGY, SOILS, AND TOPOGRAPHY

The Aquilla Lake drainage basin lies predominantly within the Eastern Cross Timbers subdivision of the West Gulf Coastal Plain physiographic province. The Eastern Cross Timbers is formed on erosion prone sandstone and shale beds of the Woodbine Formation, which overlies the formations of the Grand Prairie. The Woodbine and soils developed on this formation support a moderate growth of timber, giving rise to the name of this subdivision. The Woodbine Formation is comprised of a basal sandstone member, a middle shale member, which is the thickest member containing a few scattered sandstone beds, and an upper member composed of massive sand and sandstone beds with shale interbeds. The sandstone beds are comparatively thin in the lower reaches of Aquilla Creek but thicken in an upstream direction. The total thickness of the Woodbine Formation is about 125 feet (Aquilla EIS, 1974).

Overburden soils mantling the bedrock in the Aquilla Creek Valley consist of clay underlain by a few feet of sandy or gravelly clay. Usually, only a thin soil cover is present on the valley slopes, but its thickness varies from about 20 to 30 feet or more in the central part of the valley. Soils mantling the bedrock along Hackberry Creek are chiefly clay with a thin basal clayey, sandy gravel. Thickness of these materials varies from a few feet to as much as 20 feet (Aquilla EIS, 1974).

The topography of the watershed, the soil characteristics, and the nature of the rainfall lend themselves to flash flooding. These flash floods have the potential to occur any time of year.

PRIME FARM LANDS

Soils in the western portion of the study area transition from gravelly soils near Aquilla Lake to clay loam and clay soils that support cultivated fields between Whitney and Aquilla Lakes. Approximately 45-percent of the soils located within the 120 acre western extension of the study area for the NEPA analysis of all alternatives in the final array are comprised of soils designated as prime farmland soils by the Natural Resources Conservation Service.

DAM COMPOSITION AND MONITORING

The dam is founded on clay shale materials interbedded with limestone and underlain by limestone with interbedded shale. The embankment itself is constructed as three zones of materials topped with a clay cap for improved subgrade capacity. The innermost layer of the dam is an impervious core of clay materials. The core is surrounded by compacted fill made up of clay and clayey sands. The outermost layer is semi-compacted fill excavated from the spillway and outlet works during construction.

The embankment is monitored using a system of piezometers, relief wells, and collection weirs. Seepage is discharged through laterals that exit the headwall for flow measurements. Instrumentation evaluations indicate the project is performing as intended. A periodic inspection was conducted in 2011The next Periodic Assessment is scheduled for April 2016.

LAND USE

The floodplain use is primarily agricultural with woody vegetation adjacent to the creek channels. Almost half of the land in Hill County is used for field crops. Approximately one third of the land is pasture. Urban usage and water combined only account for approximately six percent of the total land use in Hill County.

There are approximately 6,860 acres of Natural Resources Management Areas (NRMA's) surrounding the lake area that are managed primarily for wildlife habitat. The Natural Resource Management budget for the Lake is limited, consequently over the 25 year life of the existing project these areas have been left to develop naturally. One method USACE employs to manage these NRMA's around the lake is through the use of Agricultural Grazing Leases. These leases allow for cattle grazing in the management areas in return for a cash payment or work abatement which may take the form of habitat management as needed. Even with tools such as Grazing Leases to supplement the management of the natural areas, most land at Aquilla Lake is not intensely managed. The future trend for this area and acreage is expected to remain much the same with respect to land management.

DEMOGRAPHICS

Demographics are summarized from Appendix L, Economics.

HILL COUNTY

According to the 2010 census, Hill County has a population of 35,089, with growth projected to reach 40,402 by 2060. The annualized growth rate is 0.3%. The population is predominantly white (74%). 79% of the population has earned a high school diploma (or equivalent), with 49% attaining some measure of higher level education.

The largest employment sector is retail trade with 24% of total employment, followed by healthcare and social assistance with 19%, accommodation and food services with 15%, and manufacturing with 12% of total employment. The retail sector also supplies the largest number of establishments, with 25% of the total number, followed by accommodation and food services with 11%, other services with 10%, and health care and social services with 8%.

Hill County has more households in lower income ranges than the state average, with most of the households having incomes between $15,000 and $74,999. The median household income is $39,450, and approximately 17% of population is below the poverty level.

JOHNSON COUNTY

Johnson County is not in the study area, but Aquilla Lake is a significant source of water supply for the county through the contract between BRA and the City of Cleburne as well as numerous contracts with Aquilla Water Supply District.

The population of Johnson County according to the 2010 census is 150,934 with growth projected to reach approximately 347,000 by 2060. The annualized growth rate is 1.7%. The population is predominantly white (76%). 83% of the population has earned a high school diploma (or equivalent), with 49% attaining some measure of higher level education.

Retail trade provides the greatest employment, with 15% of total employment, followed by manufacturing with 14%, health care and social assistance with 12%, accommodation and food services with 10% and transportation and warehousing with 8%t. In terms of number of establishments, retail trade comprises 15% of the total number of establishments, followed by construction with 13%t, other services with 11%, health care and social assistance with 9%, and accommodation and food services with 8%.

Information from the 2010 census indicates household incomes for Johnson County and the state overall fall predominantly between $25,000 and $149,999. The median household income for Johnson County is $57,016, and approximately 11% of population is below the poverty level.

HYDROLOGY AND HYDRAULICS

The watershed is almost entirely rural with a few small communities and roads. As a result the watershed is predominantly composed of pervious surfaces. While some population growth is projected (less than 1% per year), dense residential and commercial development accompanied by stream channelization would need to occur to affect any change on run-off potential. As a result the anticipated urbanization affects on hydrology for the study are in the future are considered statistically insignificant.

The spillway at Aquilla Dam is at elevation 564.5 feet. The top of the flood control pool is 556 feet with the top of conservation pool at 537.5 feet. The spillway crest elevation has an approximate exceedance probability of 1/500, or 0.2 % Annual Chance Exceedance (ACE). For events that do not overtop the spillway, the outflow is limited to 3,000 cubic feet per second (cfs) by a gated outlet works. Any flooding downstream is a result of local run-off and run-off from Cobb Creek. Cobb Creek confluences with Aquilla Creek approximately 3.5 stream miles downstream of Aquilla Dam.

WATER CONTROL PLAN

The USACE Brazos River Basin flood risk management projects are operated as a system with the primary goal of minimizing downstream flood damages. Flood releases from Aquilla Dam are coordinated with releases from the other six USACE projects in the Brazos River Basin such that the releases are made once the capacity is available downstream. Lake levels are lowered to conservation pool elevation at the earliest possible date to provide available flood storage for future events. If Aquilla Lake elevation is forecasted to rise above spillway crest elevation 564.5 feet, then releases and spillway discharges are monitored to not exceed the capacity at the downstream control points. By elevation 565.7 feet, the spillway discharge is 3,000 cfs, and all gates are closed, and as the elevation rises downstream controls are exceeded by necessity. Additional information on capacities and operation is provided in Appendix A, Reservoir Control.

RECREATION

Lake Aquilla is a popular recreation lake. In 2012, approximately 104,000 visitors came to hike, boat, hunt, fish and swim at the existing recreation areas. Existing operating recreation areas at Aquilla Lake include two boat ramps and associated amenities, a fishing platform at the outlet works, a USACE operated access area, and one access area leased to and operated by Hill County. Multiple access areas are also maintained for hunting and fishing. The boat ramps generate the highest annual visitation at Aquilla Lake. Both boat ramps are single lane and have vault-type masonry restrooms, and paved parking lots. The boat ramp at Dairy Hill also has a courtesy boat dock.

Visitor totals year to year fluctuate greatly at Aquilla Lake as a result of floods and droughts. The average visitation per year for 2002-2009 was 76,421.

AQUATIC RESOURCES

SURFACE WATER

At conservation elevation of 537.5 feet, water depth averages 16 feet in the main body of the lake. The shallow depth generates more fluctuation in water temperatures than experienced in deeper reservoirs.

Aquatic vegetation adjacent to the shoreline in the main body of the lake is relatively sparse and consists mainly of cocklebur *(Xanthium strumarium)* and buttonbush *(Cephalanthus occidentalis)*. The majority of the vegetation directly adjacent to the shoreline in the main body of the lake is switchgrass *(Panicum virgatum)*. The switchgrass remains from the relatively flat grasslands that were adjacent to the creeks before the reservoir was impounded and thrive in the moist environment provided adjacent to the lake surface. Aquatic vegetation is more prevalent in the shallower areas upstream in both arms of the lake and consists of rattlebush *(Sesbania sp.)*, cocklebur *(Xanthium strumarium)*, peppervine *(Ampelopsis arborea)* and teal lovegrass *(Eragrostis hypnoides)*.

The Hackberry Creek arm of the lake tends to be gently rolling to almost flat. The area downstream of the FM 1947 Bridge was cleared of timber during the construction of the reservoir. Above the bridge, standing timber along the inundated creek channels and fence lines contribute to excellent fishery production. The water tends to be very shallow over the flat terrain, making it attractive to waterfowl for feeding and resting.

The Aquilla Creek arm has more of a sloping shoreline with stands of Post Oak, Blackjack Oak, and other species extending along the shorelines all the way to the inundated creek channels creating favorable fish habitat. Aquilla Creek was cleared of timber from the Old School Boat Ramp Area to the dam.

Fish species within the reservoir include largemouth bass *(Micropterus salmoides)*, blue catfish *(Ictalurus furcatus)*, channel catfish *(Ictalurus punctatus)*, white crappie *(Pomoxis maculatus)*, white bass *(Morone chrysops)*, and various sunfish species *(Lepomis sp.)* (TPWD 2008).

Aquilla Lake has both a limentic zone and a littoral zone. The limentic zone is the deep water area identified by the characteristic that light generally does not penetrate to the bottom of the lake. The littoral zone is the shallow area of the lake, frequently near the shoreline. These zones are more fully described in Appendix E, Environmental Resources. The deeper water makes up about 2281 acres, while the littoral zone, or shallow area, encompasses approximately 883 acres. Within these zones are different physical, chemical, and biological processes, along with varying species of fish, vegetation, and benthic organisms.

GROUNDWATER

Hill County is encompassed within the Northern Trinity/Woodbine aquifer system. The Trinity/Woodbine is one of the most extensive sources of groundwater in Texas and has supplied the vast majority of groundwater in the region for more than a century, especially near population centers such as Temple, Waco, Fort Worth, Dallas, and Sherman. Inflow to the Trinity and Woodbine aquifers occurs through the infiltration of precipitation in outcrop areas, interformational leakage, and through the interaction between surface-water bodies (streams, rivers, lakes) and the underlying aquifers. Artesian pressure declines of up to about 800 to 1,000 feet have occurred in major historical pumpage centers located in Dallas, Tarrant, and McLennan Counties. Despite the large artesian declines recorded in downdip areas, outcrop water levels have remained relatively constant during the last 50 years, indicating that there has been little reduction in the amount of water in storage in the Northern Trinity/Woodbine system. Decreases in artesian storage or water table storage that have occurred are insignificant compared to the amount of water still present in the aquifer and the overall water budget of the aquifer.

The current groundwater model indicates that a large majority (~90%) of the current discharge from the aquifer is occurring through natural, near-surface mechanisms, primarily evapotranspiration and baseflow to streams, springs, and seeps, not pumpage. However, the percentage is dependent on the amount of recharge that is occurring. The actual amount of this natural discharge and recharge are difficult to measure directly, but because of the large outcrop area and the stability of outcrop water levels it is reasonable to assume that a large percentage of the current recharge to the aquifers is being rejected through natural, near-surface mechanisms.

WETLANDS AND WATERS OF THE U.S.

Wetlands associated with the current conservation pool at Aquilla Lake are located along the fringe of the lake in areas that are inundated frequently enough to support hydric soils and wetland vegetation species. In addition to fringe wetlands around the lake, wetlands are located in the shallow areas along tributary creeks and streams in the upper reaches of the reservoir.

The study area does not contain navigable waters of the U.S. (covered under Section 10 of the Rivers and Harbors Act of 1899).

AQUATIC HABITAT

In-stream habitats of Aquilla Lake are located within four major tributaries: Aquilla Creek, Rocky Branch, Jack's Branch, and Hackberry Creek. Historically, Aquilla Creek and Hackberry creek were classified as intermittent streams. However, supplemental flows from a water treatment facility upstream of the lake provide perennial flows to Hackberry Creek. Jack's Branch and Rocky Branch are classified as ephemeral tributaries, or those which only flow for a short amount of time, dependent upon on seasonal flow and/or flooding circumstances. The four tributaries are contained within deeply incised channels. Due to the intermittent nature of Aquilla Creek, Jack's Branch, and Rocky Branch, in-stream habitat is limited and consists primarily of isolated, stagnant pools that are replenished during rainfall events or rising lake levels. The in-stream habitats of Aquilla Creek consist of very low flow pools resulting from log jams and beaver activity.

Table 3 includes a summary of the in-stream habitat associated with the Aquilla Lake project area, including the four major tributaries. Linear feet and acreage were calculated with GIS analysis, and includes the area from the current normal operations pool level up to the fee boundary area. GIS analysis also assumed a twenty five foot buffer on each side of the stream to develop existing conditions acreage.

Table 3. Summary of In-Stream Habitat Areas Associated with Aquilla Lake

Stream Name	Water Identification	Hydraulic Characteristic	Total Linear Feet from Conservation Pool to Fee Boundary	In-Stream Acreage
Aquilla Creek	Tributary	Intermittent	20,692	24.5
Rocky Branch	Tributary	Ephemeral	7,275	18.7
Jack's Branch	Tributary	Ephemeral	4,865	9.7
Hackberry Creek	Tributary	Perennial	48,283	216.3

WATER QUALITY

Due to the clay soils and predominantly agricultural land use surrounding Aquilla Lake, the water is generally turbid and high in suspended solids. None of the lakes tributaries or the reservoir itself appears on the Texas Commission on Environmental Quality (TCEQ) 303 (d) list of impaired water bodies. There was however, concern over high levels of the herbicide Atrazine in the reservoir in the late 1990's which caused the reservoir to be listed as an impaired water body (TCEQ Website 2009). The source for Atrazine was from farming activities around the lake and subsequent runoff of the herbicide during large rain events.

The high levels of the herbicide triggered projects to address agricultural sources of the herbicide by the TCEQ, the Texas State Soil and Water Conservation Board (SWCB) and other agencies. The campaign to restore water quality in Aquilla Lake drew multiple partners, ranging from a host of government entities to local farmers. Through education, cooperation and improved farming practices over the last ten years the levels of Atrazine in the reservoir are down by about 60% from the levels of the late 1990's.

Even though the Lake is no longer listed as an impaired water body, it is listed on the TCEQ's 305 (b) list for several concerns. The 305(b) list is a state-wide assessment of all the waters in the state, regardless of status on the 303(d) list. These concerns include nickel and arsenic in

sediment; nitrate in water and low levels of Atrazine in finished drinking water. The nitrate and Atrazine concerns could potentially be improved by increasing the dilution factor. However, sediment concerns would more than likely not be affected.

VEGETATION

The Eastern Cross Timbers natural vegetational area is characterized historically as a narrow band of woody vegetation between the Blackland Prairie and the Grand Prairie occurring largely on sandy soil formations. Vegetation composition is variable, ranging from open savanna with oak overstory to dense brush. Woody overstory consists primarily of post oak *(Quercus stellata)* and blackjack oak *(Quercus marilandica).* In addition to the characteristic oaks, other woody species commonly found include cedar elm *(Ulmus crassifolia)*, hackberry *(Celtis spp.)*, pecan *(Carya illinoensis)*, juniper *(Juniperus spp.)*, and mesquite *(Prosopis grandulosa)*. Common grasses include hairy gramma *(Bouteloua hirsuta)*, side-oats gramma *(Bouteloua cirtipendula)*, tall dropseed *(Sporobolus composites)*, switch grass *(Panicum virgatum)*, Canada wildrye *(Elymus canadensis)*, and Texas winter grass *(Nassella Leucotricha)* (Correll & Johnson 1970). Past mismanagement and cultivation have caused many uplands to be populated by scrub-type oak, mesquite, and juniper with mid- and short-grasses beneath. (Hatch et al. 1990)

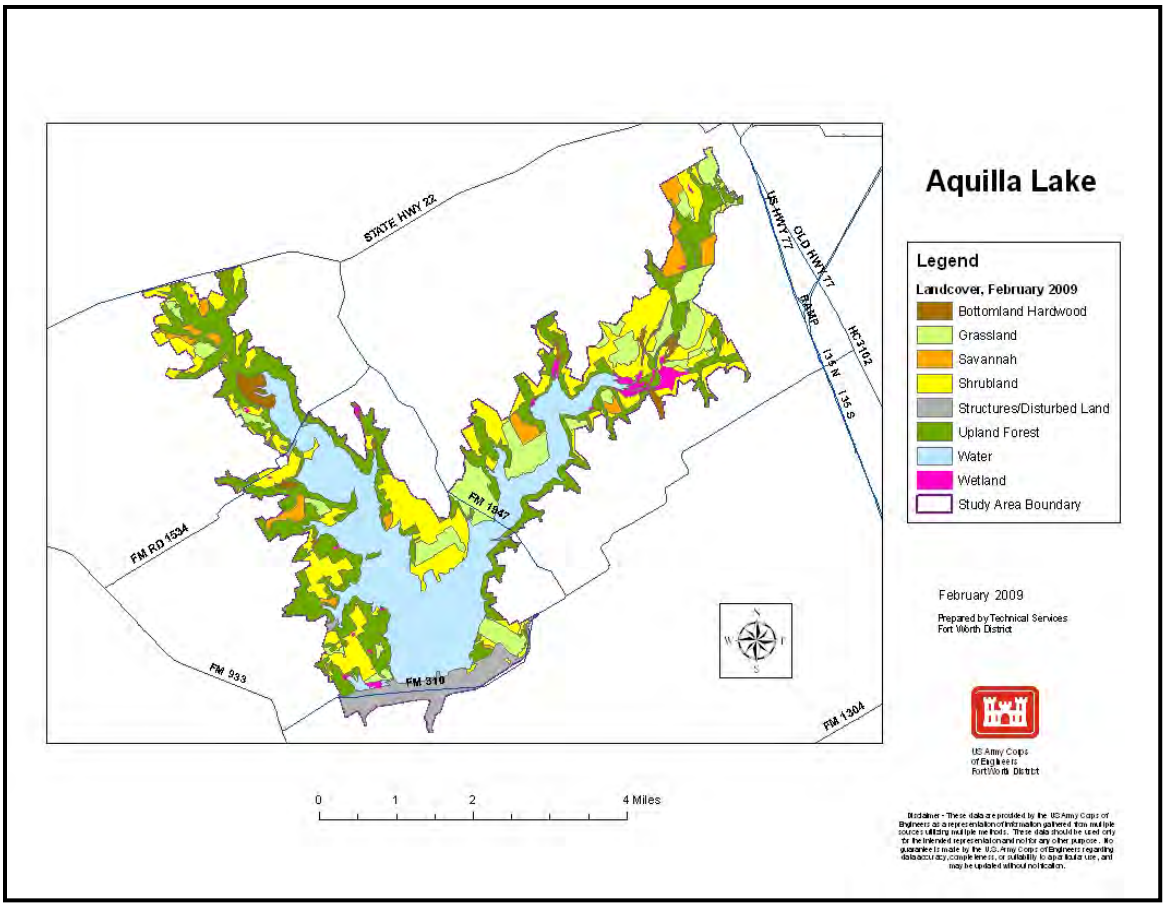

Figure 3. Aquilla Lake Landcover

Six terrestrial wildlife habitat types (or landcover) were observed and described with the assistance of the United States Fish and Wildlife Service (USFWS). The study area consists of

approximately 3,164 acres (30.9%) of open water, 2,802 acres (27.3%) of upland forests, 2,042 acres (19.9%) of shrubland, 1,199 acres (11.7%) of grassland, 366 acres (3.6%) of savanna, 334 acres (3.3%) of riparian woodland, and 113 acres (1.1%) of wetlands. Additionally, 231 acres (2.2%) consists of structures or other disturbed areas such as highway crossings, the USACE project office complex, the dam itself, and recreation areas including boat ramps and associated amenities.

WILDLIFE

The study area is used by both resident and migratory wildlife species, including those typically intolerant of human activity. Migratory waterfowl and shorebirds utilize the reservoir, its tributaries, and local herbaceous wetlands for foraging and brood rearing. The woodlands are used by a variety of migratory and resident passerine, owl, and hawk species. Common bird species observed in the study area are sparrow, northern mockingbird *(Mimus polyglottos)*, American robin *(Turdus migratorius)*, northern cardinal *(Cardinalis cardinalis)*, blue jay *(Cyanocitta cristata)*, Carolina chickadee *(Parus carolinensis)*, scissor-tailed flycatcher *(Tyrannus forficatus)*, downy woodpecker *(Picoides pubescens)*, common crow *(Corvus brachyrhynchos)*, American kestrel *(Falco sparverius)*, barred owl *(Strix varia)*, and red-tailed hawk *(Buteo jamaicensis)*. Mammal species that sometimes utilize habitat in the study area include raccoon *(Procyon lotor)*, striped skunk *(Mephitis mephitis)*, opossum *(Didelphis virginiana)*, coyote *(Canis latrans)*, bobcat *(Lynx rufus)*, eastern cottontail *(Sylvilagus floridanus)*, foxsquirrel *(Sciurus niger)*, and small rodents. Various species of frogs and turtles are found within the reservoir and wetlands, while lizards and snakes are found throughout the study area. A list of faunal species that were observed during field investigations is included on each site observation sheet in Appendix H with the USFWS Planning Aid Report.

THREATENED AND ENDANGERED SPECIES

The federally listed threatened or endangered species known to occur in Hill County include the endangered whooping crane *(Grus americana)*, black-capped vireo *(Vireo atricapilla)*, and golden-cheeked warbler *(Dendroica chrysoparia)*. Two candidate species for listing, the smalleye shiner *(Notropis buccula)* and sharpnose shiner *(Notropis oxyrhynchus)* have also been recorded in Hill County.

The whooping crane may be encountered in all of the north central Texas counties during its migration. Autumn migration normally begins in mid-September, with most birds arriving on the wintering grounds at Aransas National Wildlife Refuge between late October and mid-November. Spring migration occurs during March and April. Whooping cranes prefer isolated areas away from human activity for feeding and roosting, with vegetated wetlands and wetlands adjacent to cropland being utilized along the migration route. Foods consumed usually include frogs, fish, plant tubers, crayfish, insects, and waste grains in harvested fields. It is possible that whooping cranes may temporarily utilize habitats present within the study area during their annual migration but an encounter would be a rare occurrence. It is unlikely that continuing any of the current activities would have an adverse impact on this species.

The habitat evaluation team did not encounter any habitats that appeared suitable for nesting golden-cheeked warblers or black-capped vireos. Therefore, it is not likely that either species would be present within the study area or that any adverse impacts would to occur due to project actions.

The bald eagle *(Haliaeetus leucocephalus)* was removed from the Federal threatened and endangered species list effective August 8, 2007. However, bald eagles are still afforded safeguards under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

The smalleye and sharpnose shiners are candidate species with no current federal protections. However, the USFWS recommend that potential impacts to these species be considered during project planning. USFWS records indicate that both of these species historically occurred in Hill County within the Brazos River area now occupied by Whitney Lake. There are no current records of either species' presence within the Aquilla Lake study area, therefore no impacts to either species is anticipated to occur.

In addition to federal species of concern, there are also various state species of concern known to occur in Hill County. The American Peregrine Falcon (*Falco peregrines anatum)* is a year-round resident and local breeder in Texas, and is state listed as Threatened. The Interior Lest Tern *(Sterna antillarum athalassos)* is state listed as endangered, and is known to nest along sand and gravel bars within braided streams and rivers. The Peregrine Falcon *(Falco peregrines)*, also state threatened, breeds in Texas. Both the White-faced Ibis *(Plegadis chihi)* and the wood stork *(mycteria americana)* utilize freshwater marshes for feeding and nesting. Two state listed threatened mollusks are known to occur in the streams and rivers of the Brazos, the Smooth pimpleback *(Quadrula houstonensis)* and the Texas fawnsfoot *(Trunchilla macrodon)*.

AIR QUALITY

Air quality is defined by ambient air concentration of specific pollutants determined to be of concern with respect to the health and welfare of the general public. Under the Clean Air Act Amendments of 1990, the EPA established National Ambient Air Quality Standards (NAAQS), including six "criteria pollutants:" lead (Pb), ozone (O3), sulfur dioxide (SO2), oxides of nitrogen (NOX), carbon monoxide (CO), and particulate matter less than 10 microns in diameter (PM10). Areas that exceed a Federal air quality standard are designated as non-attainment areas. The nearest area listed as a non-attainment area by the EPA is the Dallas Fort Worth Nonattainment Area which is located approximately 60 miles north of Hill County. Hill County and Aquilla Lake are not expected to be designated as non-attainment in the duration of the forecast period.

There are relatively few industrial and commercial businesses in the county that could potentially have a negative effect on air quality. The predominant industries in the county are agriculture and farming. Due to the fact that the Hill County area is not highly industrialized and in a predominantly rural setting the air quality in the region is generally considered to be good.

TERRESTRIAL HABITAT EVALUATIONS

METHODS

An interagency biological team, including USACE, Texas Parks and Wildlife Department (TPWD), and the USFWS, conducted a habitat evaluation of the study area in July 2008. The USFWS Habitat Evaluation Procedures (HEP) (U.S. Fish and Wildlife Service 1980) were used to analyze and describe the various existing habitats in the study area. The team collected field data on July 14 – 17, 2008. HEP data was collected at 42 sites (Figure 4) randomly selected within the six terrestrial habitat types in the study area: riparian woodlands, grasslands, upland deciduous woodlands, shrubland, savanna, and herbaceous wetlands.

Thirteen wildlife indicator species were selected to represent the wildlife communities that use the six habitats evaluated (Table 4). The raccoon, fox squirrel, Carolina chickadee, barred owl, wood duck *(Aix sponsa)*, and downy woodpecker were selected to represent those species that use riparian woodlands. The raccoon, green heron *(Butorides striatus)*, and wood duck were selected to represent the wildlife community in herbaceous wetlands. The eastern meadowlark *(Sturnella magna)*, eastern cottontail, fox squirrel, scissor-tailed flycatcher, and American kestrel were selected to represent the wildlife communities in the savanna. The eastern cottontail, scissor-

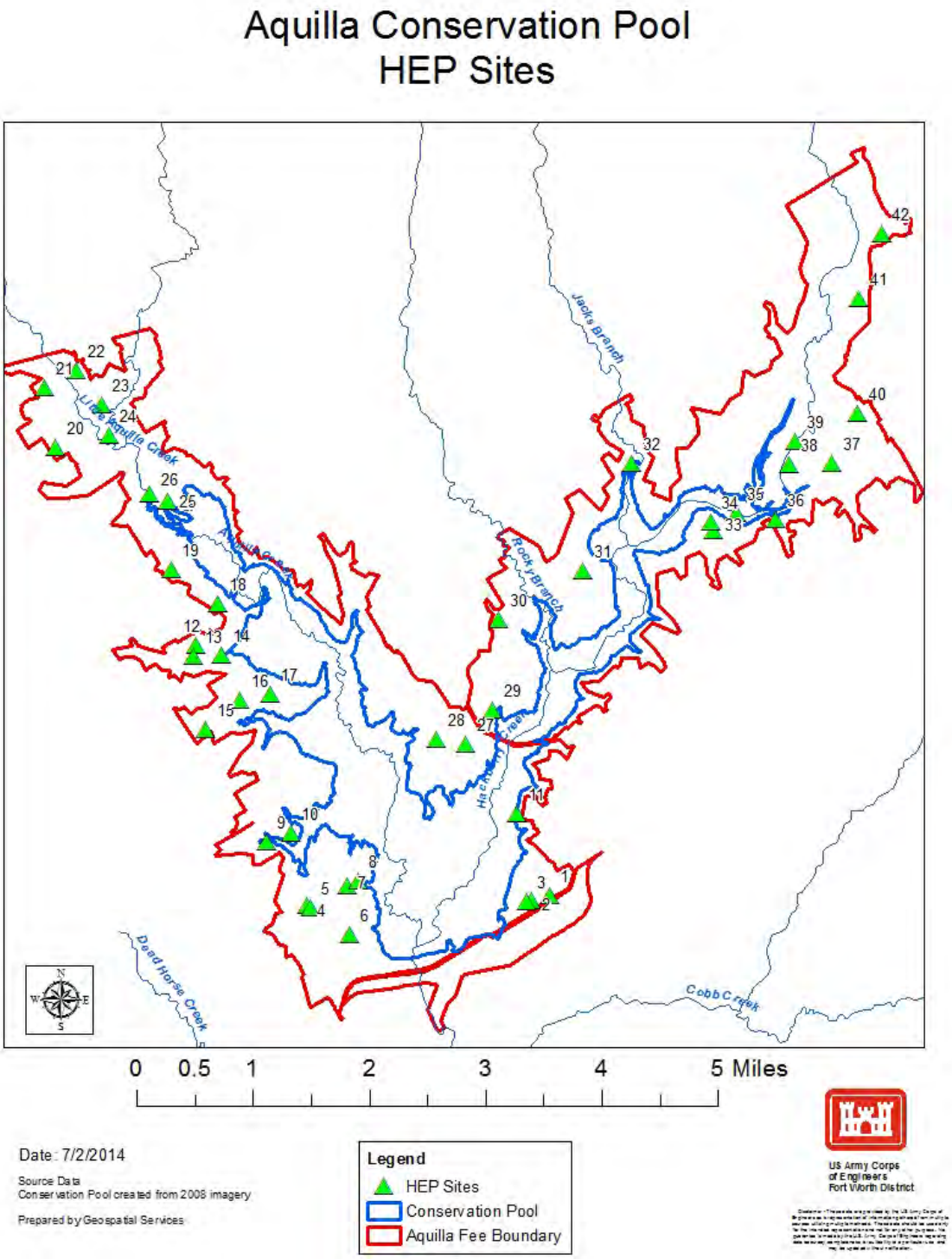

Figure 4. Habitat Evaluation Sites for Aquilla Lake

Table 4. Indicator Species for HEP Evaluations for Aquilla Lake

Indicator Species	Habitat Type					
	Riparian	Grassland	Shrubland	Savanna	Herbaceous	Upland
Raccoon	X				X	X
Fox Squirrel*	X					X
Carolina chickadee	X					X
Barred owl*	X					X
Wood duck*	X				X	
Downy woodpecker*	X					X
Green heron					X	
Eastern meadowlark*		X		X		
Eastern cottontail*		X	X	X		
Scissor-tailed flycatcher			X	X		
Northern bobwhite*			X			
Racer (snake)			X			
American kestrel		X		X		

* models approved for use by the USACE ECO-PCX

tailed flycatcher, northern bobwhite, and racer *(Coluber constrictor [snake])* were selected to represent the wildlife communities in shrubland. The downy woodpecker, raccoon, Carolina chickadee, barred owl, and fox squirrel were selected to represent the upland deciduous forest community. The eastern meadowlark, eastern cottontail, and American kestrel were selected to represent the wildlife communities in grasslands.

HEP requires the use of Habitat Suitability Index (HSI) models developed for each indicator species. The HSI models contain a list of structural habitat composition variables that are contained in optimum habitat. All the variables for each species representing each habitat are compiled and measured in the field. These variables are measured or estimated within a tenth-acre data plot within the habitat they represent. They are used as indicators of habitat condition or value.

Of the thirteen HSI models utilized for habitat evaluations, seven are approved for use by the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) and are listed on the Ecosystem Restoration Model Library approval list. Approval indicates the model is presently approved for regional and/or nationwide use in accordance with documented geographic range, best practices and its designated limitations. Additionally, the ECO-PCX is comfortable with application of the planning model and/or the model has been reviewed and issues concerning the model and its documentation have been resolved to the satisfaction of the PCX (USACE Ecosystem Restoration Gateway – Ecosystem Restoration Model Library). While all thirteen HSI models are not approved, the seven approved models offer analysis of all six habitats under evaluation.

Baseline habitat conditions are expressed as a numeric function (HSI value) ranging from 0.0 to 1.0, where 0.0 represents no suitable habitat for an indicator species and 1.0 represents optimum conditions for the species. HSI values ranging from 0.01 to 0.24 are considered "poor" habitat, 0.25 to 0.49 are considered "below average" habitat, 0.50 to 0.69 are "average" habitat, 0.70 to 0.89 are "good" habitat, and 0.90 to 1.00 are considered "excellent" habitat. Habitat units (HUs) are calculated by multiplying the HSI for each habitat by the amount of acres of that specific habitat.

RESULTS

A complete list of plant and animal species observed, detailed scores for variables, photo information, and site observation sheets are contained in Appendix H, USFWS Coordination, Planning Aid Report.

A summary of the HSI values and HUs associated with each habitat type is listed in Table 5. The Upland Deciduous Forest scored an overall habitat value of "good," while grasslands scored and overall "below average" value. The other four habitat evaluations scored "average." An in-depth discussion of each habitat precedes the summary table including acreages and percent of project areas.

RIPARIAN WOODLANDS

Riparian woodlands are primarily located along the various inflows to the reservoir. Many of these woodlands are periodically flooded and are predominately composed of cedar elm, green ash *(Fraxinus pennsylvanica)*, pecan, black willow *(Salix nigra)*, and box elder *(Acer negundo)*. Other trees species present include bur oak *(Quercus macrocarpa)*, red mulberry *(Morus rubra)*, honey locust *(Gleditsia triacanthos)*, cottonwood *(Populus deltoides)*, and sugar hackberry *(Celtis laevigata)*. Considering the relative newness of the reservoir (1983), it is likely that areas along the shoreline will develop further riparian woodland characteristics as vegetation matures. (USFWS, Planning Aid Report 2009)

There are seven data sites in riparian woodlands in the study area. Most of the riparian sites are dominated by over story trees that are at the lower extent of that which would be considered optimal (> 12 inches diameter breast height [dbh]).

The most limiting factor for raccoon habitat was the temporal availability of water in three of the data plots.

The winter food requisite was the most limiting factor for fox squirrels. The required number of mast producing trees greater than 10 inches dbh needed for optimum fox squirrel habitat was absent in four of the seven data sites and grain availability was too low in all of the data sites.

Each of the life requisites was well above average or excellent for the Carolina chickadee. This was consistent across each of the data sites.

The value of this cover type was poor for the wood duck and below average throughout the study area due to the low number of potentially suitable nest cavity trees and the lack of brood and winter cover across all cover types.

The average HSI value for the riparian woodland within the study area is 0.67 (average habitat value) with 224.05 HUs.

Table 5. Average HSI Values and HUs for Aquilla Lake

Indicator species	Riparian woodland	Upland deciduous forest	Herbaceous wetland	Grassland	Shrubland	Savanna
Barred owl*	0.71	0.45				
Carolina chickadee	0.95	0.95				
Raccoon	0.71	0.80	0.71			
Wood duck*	0.03		0.03			
American kestrel				0.43		0.43
Fox squirrel*	0.61	0.55				
Downy woodpecker*	1.00	0.95				
Green heron			0.87			
Eastern cottontail*				0.46	0.46	0.46
Scissor-tailed flycatcher					1.00	1.00
Eastern meadowlark*				0.54		0.85
Racer (snake)					1.00	
Northern bobwhite*					0.09	
HSI Average	0.67 Average	0.74 Good	0.54 Average	0.48 Below Average	0.63 Average	0.54 Average
Habitat Units	224.05	2073.78	61.01	575.50	1287.05	197.35

* models approved for use by the USACE ECO-PCX

Source: USFWS Planning Aid Reports 2009 and 2011

UPLAND DECIDUOUS FOREST

Deciduous forests are upland hardwood areas dominated by trees and with a minimal tree canopy cover of 25 percent. White-tailed deer *(Odocoileus virginianus)*, small mammals, turkey *(Meleagris gallopavo)*, bobwhite quail *(Colinus virginianus)*, and many other species of birds utilize these stands for food and/or cover. Upland deciduous forests were evaluated at six data sites. Cedar elm, post oak, and hackberry dominate this cover type. Other tree species associated with this forest type include mesquite, eastern red cedar *(Juniperus virginiana)* and blackjack oak. The shrub layer consists of gum bumelia *(Bumelia lanuginosa)*, hackberry, cedar elm, post oak, red mulberry, deciduous holly *(Ilex decidua)* and coralberry *(Symphoriacarpos orbiculatus)*.

The HSI values for each species for this cover type range from below average for the barred owl, average for the fox squirrel, good for the raccoon, to excellent for the Carolina chickadee and downy woodpecker. The most limiting factors in this cover type are (1) the lack of large trees required by the fox and barred owl; (2) tree canopy closure required by the barred owl, and (3) a lack of mast producing trees required by the fox squirrel. The upland deciduous forest average HSI value within the study area is 0.74 (good habitat value) with 2073.78 HUs.

HERBACEOUS WETLANDS

Herbaceous wetlands are wetland areas dominated by non-woody vegetation. These wetlands provide food and cover for fish, resident and migratory birds, small mammals, invertebrates, and the predators that feed on these species. Wetlands are important nesting habitat for wading birds and waterfowl. This cover type is comprised primarily of reservoir, creeks, and seasonally flooded areas. Some of these wetlands are permanent, but most are likely seasonal.

There were eight data sites in herbaceous wetlands. HSI values ranged from good for the green heron and raccoon to poor for the wood duck. Poor cover and the number of potential nest cavities for the wood duck were the limiting factors in this cover type. The most limiting factor for the raccoon was the seasonable availability of water. The herbaceous wetland average HSI for the study area is 0.54 (average habitat value) with 61.01 HUs.

GRASSLANDS

Grasslands are dominated by grasses, native or introduced, that are not regularly planted or mowed, and have a minimal canopy cover of 25 percent. Much of the grassland within the study area would be classified as unmanaged grasslands when considering the residual effects of prior agricultural uses. Unmanaged grasslands are fallow fields also containing a combination of native and introduced grasses, forbs, and trees, but the composition is different from those in native grasslands indicative of this ecoregion. The grass species found in the data plots were coastal bermuda *(Cynodon dactylon)*, littlebluestem *(Schizachyrium scoparium)*, inland seaoats *(Chasmanthium latifolium)*, Canada wildrye, switchgrass *(Panicum virgatum)*, panic grass *(Dichanthelium sp.)* Johnsongrass *(Sorghum halepense)*, and sideoats gramma *(Bouteloua cirtipendula)*.

There were seven data sites in grasslands in the study area. The HSI values ranged from 0.43 for the kestrel, 0.46 for the eastern cottontail, to 0.54 for the eastern meadowlark. The American kestrel is a multi-cover type species, and the value of each cover type applicable to this species is weighted within an overall value for the species within the entire study area. The HSI value in grassland alone was 0.96, considerably higher than the overall study area-wide value of 0.43. Likewise, the eastern cottontail is a multi-cover type species. The HSI value for eastern cottontail in grassland alone was 0.64, somewhat higher than the overall study area-wide value of 0.46. However, HSI values for multi-cover type species must be expressed as a single value giving appropriate weight to each of the cover types present which may be utilized by that species. The most limiting factor for cottontails in grasslands throughout the study area is insufficient cover, such as shrubs, trees, or persistent herbaceous plants. An insufficient number of large nest and perch trees are the most limiting factors for the eastern meadowlark. Each of these deficiencies may be at least partially due to the prior agricultural use and slow recovery time of these now fallow fields. The average HSI value for grasslands within the study area is 0.48 (slightly below average habitat value) with 575.50 HUs.

SHRUBLANDS

Shrublands are defined as non-wetland areas dominated by shrubs and with a minimum shrub canopy cover of 25 percent. Shrublands provide open space, a seed and insect food source for passerines, forage for cottontails, and cover for escape and nesting by means of tall grass, scattered brush piles, and shrubs for a variety of animals. Red-tailed hawks hunt for prey in shrublands. The grass species found in the data sites are Johnsongrass, coastal bermuda, Canada wildrye, panicgrass, and switchgrass. The predominant shrub species are mesquite, cedar elm, hackberry, gum bumelia, eastern redcedar, Chickasaw plum *(Prunus angustifolia)*, and western soapberry *(Sapindus saponaria)*.

There were seven survey sites in shrublands. The shrubland HSI values per species ranged from poor for northern bobwhite (0.21) to optimal for scissor-tailed flycatcher (1.0), eastern cottontail (1.0), and racer (1.0). The overall HSIs for multi-cover type species evaluated in shrublands total 0.09 for northern bobwhite and 0.46 for eastern cottontail. The shrubland HSI value for both of these species was higher than the overall value of all cover types utilized by these species within the entire study area. The most limiting factors for northern bobwhites within shrublands are the lack of bare open ground allowing access to seeds while foraging, and the lack of canopy cover of woody shrubs less than 2 meters in height needed for cover. The average HSI for shrubland was 0.63 with 1,287.05 HUs.

SAVANNA

Savanna is a non-wetland area with a shrub and/or tree canopy cover between 5-25 percent, but with a total canopy cover of all vegetation greater than 25 percent. The area between the trees and shrubs is typically dominated by grasses or other herbaceous vegetation. Savannas provide open space, a food source for passerines and the eastern cottontail, and cover for escape and nesting by means of tall grass, scattered brush piles, and shrubs for a variety of animals.

Unmanaged savannas such as those within the study area typically consist of fallow fields also containing a combination of native and introduced grasses, forbs, and trees, but the composition is different from those in the short grass areas. The grass species found in the data plots were Johnsongrass, little bluestem, Canada wildrye, coastal bermuda, switchgrass, sideoats gramma, and three awn. Tree and shrub species found within the savanna sites include mesquite, hackberry, hawthorne *(Crataegus sp.)*, gum bumelia, coralberry, Mexican plum *(Prunus mexicana)*, honey locust, and deciduous holly.

There are seven data sites in this cover type. The HSI for this cover type was optimal (1.0) for scissor-tailed flycatcher, good (0.85) for eastern meadowlark, and below average for eastern cottontail (0.46) and kestrel (0.43). The overall HSIs for multi-cover type species evaluated in savannas total 0.46 for northern bobwhite and 0.64 for eastern cottontail. The savanna HSI value for kestrel was higher than the overall value of all cover types utilized by this species within the entire study area. However, the limiting factor for savannas throughout the study area is the insufficient persistent herbaceous plants which provide essential winter cover for cottontails. The average HSI for savanna is 0.54 (average habitat value) with 197.35 HUs.

FUTURE WITHOUT PROJECT

A large scale flood event was not considered when evaluating how the habitats on the project site would change over time. It is impossible to predict when or even if a large scale event will occur at a given site. However, it is expected that a large flood event such as the 1% ACE would have negative effects on the plant communities immediately surrounding Aquilla Lake, as has happened at other reservoirs that have experienced flooding of this size. The magnitude of those negative effects would depend on several factors that cannot be predicted such as the time of year the flood happens and the duration of inundation based on the release rate of flood waters from the reservoir.

RIPARIAN WOODLANDS

The trend of conversion or influence of adjoining streams on the project site to create areas of riparian woodland is expected to continue into the future. It is estimated that the total conversion of upland deciduous forests to riparian woodland will be approximately 50 acres over the 50 years.

Due to the initial impoundment of the reservoir and the loss of the highest quality bottomland hardwood and riparian woodlands the habitat that exists now is considered to be only of average habitat value, with an average HSI of 0.67. It is expected that due to the limited habitat management at Aquilla Lake that the habitat quality over the next 50 years will increase only minimally due to the increased patch size of the riparian woodlands and the continued maturation of the areas that currently exist. The estimated HSI for this habitat type at year 50 is expected to be 0.70, which is on the lowest end the HSI scale for good habitat value. This will increase the HUs for Riparian Woodlands from 223.78 for the existing conditions to a value of 268.80 at year 50. Table 6 shows the Average Annual HUs for each vegetation type over the fifty year period of analysis, as well as the calculations of the size and quality of habitat on the project site for 1, 5, 10, 25 and 50 year without project conditions.

Table 6. Future Without Project Riparian Woodland Habitat Unit Projections for Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.67	0.67	0.67	0.68	0.68	0.70
Acres	334.40	334.40	339.40	344.40	359.40	384.10
Target year HU	223.78	223.78	227.13	233.92	244.12	268.80
Interval HU		223.78	901.82	1152.58	3585.30	6409.42
Cumulative HUs						12272.90
Average Annual HUs						245.46

UPLAND DECIDUOUS FOREST

Approximately 50 acres of upland deciduous forest is expected to be converted to riparian woodland over the next 50 years. This loss is expected to be offset by the conversion of shrubland or savanna habitat to upland deciduous forest habitat over the next 50 years resulting in no net loss of acreage for this habitat type.

It is expected that the overall habitat quality will remain relatively unchanged with only slight decreases over the next 10-25 years due to the lower quality of the early successional forest land from the conversion of shrubland and savanna habitat to upland forest. As this newly converted land matures over the next 25-50 years the average HSI for the upland forest habitat is expected to increase to a value back to the level of the currently existing habitat which is 0.74.

The HU'S for upland forest for the existing conditions is 2073.78. This value will decrease slightly at year 5 and 10 to 2045.46 due to the lower HSI values for the newly converted forest land, but will increase due to maturation of the newly converted forest back to existing condition levels at years 25 and 50. Table 7 shows the calculations of the size and quality of habitat on the project site for 1, 5, 10, 25 and 50 year without project conditions.

Table 7. Future Without Project Upland Deciduous Forest Habitat Unit Projections for Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.74	0.74	0.73	0.73	0.74	0.74

Acres	2802.00	2802.00	2802.00	2802.00	2802.00	2802.00
Target year HU	2073.48	2073,48	2045.46	2045.46	2073.48	2073.48
Interval HU		2073.48	8237.88	10227.30	30892.05	51837.00
Cumulative HUs						103267.71
Average Annual HUs						2065.35

HERBACEOUS WETLANDS

The acreage of herbaceous wetlands at the project site is not expected to change significantly over the next 50 years. However, the quality of this habitat type is expected to increase due to the maturation of the adjacent trees and potential cover area for the wood duck. The maturation of the adjacent trees will significantly increase the average HSI value for the wood duck causing the overall average HSI value for wetlands to increase to 0.65 over the 50 year time span.

Due to the increase in average HSI values for the wood duck, the HU'S for wetland areas will increase from 61.01 for the existing conditions to 73.45 HU'S at year 50. Table 8 shows the calculations of the size and quality of habitat on the project site for 1, 5, 10, 25 and 50 year without project conditions.

Table 8. Future Without Project Herbaceous Wetland Habitat Unit Projections for Aquilla Lake

Target Year **Interval (years)**	**0** **0**	**1** **1**	**5** **4**	**10** **5**	**25** **15**	**50** **25**
HSI	0.54	0.54	0.57	0.60	0.62	0.65
Acres	112.98	112.98	112.98	112.98	112.98	112.98
Target year HU	61.02	61.02	64.41	67.80	70.06	73.44
Interval HU		61.02	250.86	330.53	1033.95	1793.88
Cumulative HUs						3470.23
Average Annual HUs						69.40

GRASSLAND

Due to the limited management at Aquilla Lake, it is expected that the overall acreage of grasslands on the project site will decrease over the next 50 years due to their conversion to shrub savanna or tree savanna habitat. This will decrease the overall acreage from 1198 for existing conditions to 898 acres at year fifty.

Due to the encroachment of woody species into the grasslands over the next fifty years resulting in decreased patch size for this habitat it is expected that the average HSI value for grassland will decrease slightly to 0.45 at year 50. The HUs are also expected to decrease over the next 50 years to 404.53 due to the loss of acreage and habitat value for this habitat type. Table 9 shows the calculations of the size and quality of habitat on the project site for 1, 5, 10, 25 and 50 year without project conditions.

Table 9. Future Without Project Grassland Habitat Unit Projections for Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.48	0.47	0.46	0.45	0.45	0.45
Acres	1198.00	1164.00	1079.00	1019.00	959.00	898.00
Target year HU	575.50	547.53	496.37	458.58	431.63	404.53
Interval HU		561.46	2087.23	2386.88	6676.56	10,451.98
Cumulative HUs						22,164.12
Average Annual HUs						443.28

SHRUBLANDS

Due to the limited habitat management at Aquilla Lake that trend of grassland to tree savanna to shrubland is expected to continue over the next 50 years. Shrubland acreage at the project site is expected to increase to 2082 acres at year 50. Due to the increased patch size and other factors it is expected that the average HSI for shrubland will increase slightly to 0.67 at year 50. HU'S for shrubland are expected to increase to 1394.94 due to the increase in both acreage and quality of this habitat type. Table 10 shows the calculations of the size and quality of habitat on the project site for 1, 5, 10, 25 and 50 year without project conditions.

Table 10. Future Without Project Shrublands Habitat Unit Projections for Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.63	0.63	0.64	0.65	0.66	0.67
Acres	2043.00	2043.00	2048.00	2058.00	2070.00	2082.00
Target year HU	1287.09	1287.09	1310.72	1337.70	1366.20	1394.94
Interval HU		1287.05	5195.93	6622.03	20,282.10	34,519.16
Cumulative HUs						67,896.34
Average Annual HUs						1357.93

SAVANNA

Once the existing savannas have matured beyond the 25 percent thresholds they are considered shrublands. The maturation trend is expected to continue over the next 50 years. Savanna habitat is expected to increase to 576.37 acres at year 50. The average HSI is expected to increase slightly over a 50 year period to 0.58 due to increased patch size and additional diversity of species and maturation of existing conditions. The HUs are also expected increase to 334.08 due to the increase in both acreage and quality of this habitat type. Table 11 shows the calculations of the size and quality of habitat on the project site for 1, 5, 10, 25 and 50 year without project conditions.

Table 11. Future Without Project Savanna Habitat Unit Projections for Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.54	0.54	0.55	0.56	0.57	0.58
Acres	365.46	397.46	474.96	519.96	552.86	576.37
Target year HU	197.10	214.38	261.25	291.20	315.21	334.08
Interval HU		205.74	950.74	1380.75	4547.25	8115.17
Cumulative HUs						15,199.65
Average Annual HUs						303.99

Table 12 provides a summary of AAHUs for all habitat types.

Table 12. Future Without Project Condition Annual Average Habitat Units

Habitat Type	**AAHUs**
Riparian Woodland	245.46
Upland Deciduous Forest	2065.35
Herbaceous Wetland	69.40
Grassland	443.28
Shrublands	1357.93
Savanna	303.99
Aquatic	2373.0
Total	**6858.94**

AQUATIC HABITAT EVALUATIONS

METHODS

An interagency biological team including USACE, and USFWS conducted an aquatic habitat evaluation at Aquilla Lake. The team collected field data in August 2011. A fisheries survey and IBI evaluation was conducted on three tributaries of the lake - Aquilla Creek, Jack's Branch, and Hackberry Creek. See Figure 5 for location of IBI aquatic habitat evaluation sites. Rocky Branch was completely dry during the sampling period, so no samples were taken on this tributary.

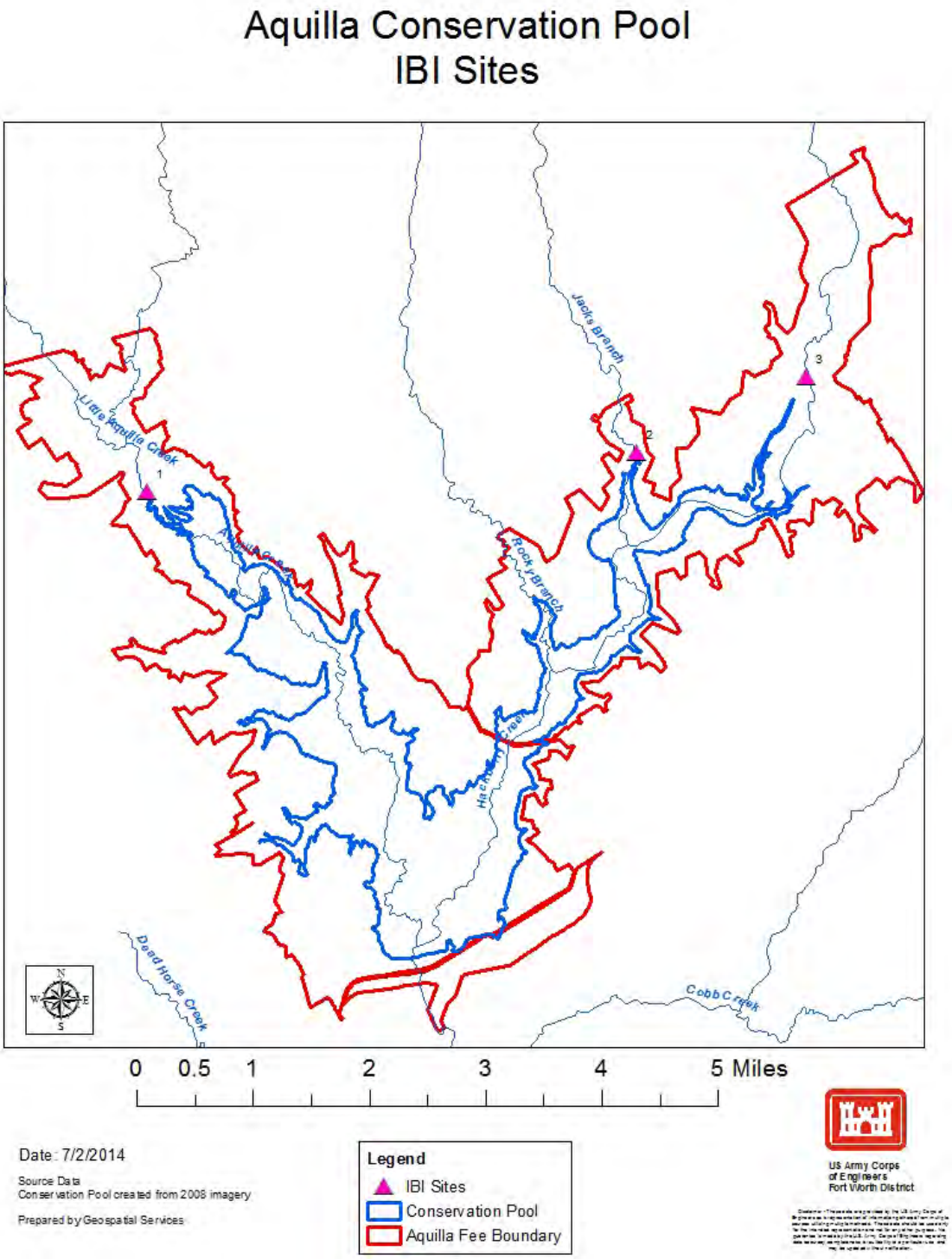

Figure 5. IBI Evaluation Sites for Aquilla Lake

To establish a baseline for project evaluation, the study team quantified the existing value of the aquatic resources in the within the littoral zone area and the upstream tributary areas. A regionalized Index of Biotic Integrity (IBI) assessment was utilized to evaluate and describe the

various existing aquatic habitats in the study area (Linam et.al. 2002). Various metric scoring criteria are used for evaluation among the sites chosen to sample, including:

- Total number of fish species
- Number of native cyprinid species
- Number of benthic invertivore species
- Number of sunfish species
- Percent of individuals as tolerant species
- Percent of individuals as omnivores

Each metric is scored with a value ranging from low (1) to high (5). Aquatic life use values are determined by adding each metric score to calculate a total score. These aquatic life use values can range from limited to exceptional. The scoring for aquatic life use subcategories within the ecoregion that includes the Aquilla Lake are as follows (Linam et al. 2002):

- >49 = Exceptional;
- 41-48 = High;
- 35-40 = Intermediate; and
- <35 = Limited

HUs are calculated by multiplying the HSI for each habitat by the amount of acres of that specific habitat.

In order to make the aquatic habitat index values in the IBI comparable to the HSI values in HEP for evaluation purposes, aquatic habitat index values from 0.0 to 1.0 were calculated by dividing the total score from the sampling location by the total points possible from the statewide IBI. This provided a normalized value that could then be compared to the HSI values of the other habitat types. Habitat units are then calculated by multiplying the normalized IBI by the number of acres of aquatic habitat.

RESULTS

Aquilla Creek is a perennial stream. During the IBI field work, it was noted that the average stream width was 9 meters (30 feet) and water depth averaged 1 meter (3 feet). Substrate was dominated by clay and silt with areas of abundant organic debris.

Jack's Branch is an ephemeral stream, with an average stream width of about 5.5 meters (18 feet). Water depth averaged 1.2 meters (4 feet). Substrate was dominated by clay and silt with areas of abundant organic debris.

Hackberry Creek is a perennial stream, with an average stream width of 7.6 meters (25 feet). Water depth average is about 1 meter (3 feet) and substrate is dominated by clay and silt with areas of abundant organic debris.

In-stream habitat at the Aquilla Creek and Jack’s Branch sites consisted of disconnected, deeply incised stagnant pools, while the Hackberry Creek site also has a deeply incised channel with a long, continuous pool, likely because it is fed by releases from an upstream wastewater treatment plant. No riffle or run habitat existed at any of the sampling sites. All sites had numerous in-stream obstacles, such as logs, fallen branches, and root wads.

A total of 935 fish comprising 14 identifiable species from eight families, were collected from the three sampling sites. The complete results including fish composition are detailed in Appendix H, USFWS Coordination, Planning Aid Report. The regional IBI assessment results demonstrated a limited aquatic life use value for the fish community sampled at Aquilla Creek (score of 33), and a high aquatic life use value for the fish assemblages at Jack's Branch and Hackberry Creek (scores of 47 and 43 respectively). The mean IBI score for the three sites characterized the study area as high (mean score of 41), and the fish community within the overall study area was characterized as high (score of 45). See Table 13 for a summary of the IBI metrics and scores.

Table 13. Regional Metrics and IBI for Aquilla Lake

Metric	Count	IBI Score
Total number of fish species	14	5
Number of native cyprinid species	1	1
Number of benthic invertivore species	4	5
Number of sunfish species	5	5
Percent of individuals as tolerant species (excluding mosquito fish)	36	3
Percent of individuals as omnivores	6	5
Percent of individuals as invertivores	87	5
Percent of individuals as piscivores	7	3
Number of individuals per seine haul	72	3
Number of individuals per minute of electrofishing	na	na
Percent of individuals as non-native species	<1	5
Percent of individuals with disease or other anomaly	0	5
IBI Total Score		**45**

While all of the IBI sampling sites at Aquilla Lake were taken within the in-stream tributary habitat classification, the areas also displayed characteristics of the littoral and transitional zones. Disconnected, stagnant pools, and the absence of riffle/run habitat characterized the transition zone between the littoral and the in-stream. The high score of 45 serves as an indication of the dynamics and complexity of the transition zone between the littoral zone and in-stream habitat areas.

Considering the limited flow conditions and lack of riffle or run aquatic habitat available at each site, the overall fish community score of 45 seems to be more representative of the reservoir itself. If it were not for migration from the reservoir, there would likely be no fish in the pools found in Aquilla Creek and Jack's Branch. Hackberry Creek is likely to be continually connected to the reservoir allowing for fish migration, but the lack of any in-stream structure would limit the diversity of the fish populations on its own.

FUTURE WITHOUT PROJECT CONDITIONS

The current surface water acreage of Aquilla Lake is expected to remain relatively constant in the future under normal conditions. Without a project, lake conditions would remain under current operations, and therefore aquatic habitat would remain as is, with little to no changes. The IBI aquatic assessment normalized value for the entire project area is 0.75 (Table 14).

Table 14. Future Without Project Aquatic Habitat Unit Projections for Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.75	0.75	0.75	0.75	0.75	0.75
Acres	3164	3164	3164	3164	3164	3164
Target year HU	2373.00	2373.00	2373.00	2373.00	2373.00	2373.00
Interval HU		2373.00	9492.00	11865.00	35595.00	59325.00
Cumulative HUs						118650.00
Average Annual HUs						2373.00

CULTURAL RESOURCES

A cultural resources survey and site assessment was conducted in November 2010. Thirty-nine sites were revisited and assessed, and ten previously unsurveyed areas were assessed. The ten new areas were found to be highly eroded with steep gradients, or in wetland settings. Two of these areas yielded previously unknown sites containing pre-historic lithic scatter. Additionally, a site lying outside the survey areas was discovered consisting of a hand-dug, stone-lined well within a concrete box. Only one of the new sites is recommended for additional work to determine eligibility for listing in the National Register of Historic Places. Of the 39 sites reassessed, six are recommended for further testing to determine their eligibility for listing based on the presence of intact buried cultural deposits.

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

A search of available environmental records was conducted in December 2011 to identify any hazardous substances that may have been released to soil, groundwater, or surface water, and to assess their potential impacts on reallocation. No sites were identified where hazardous substances or petroleum products had been released, and no water, oil, or gas well locations were identified within the search area.

CHAPTER 3: PLAN FORMULATION

This chapter documents the need for water reallocation, the preliminary screening of reallocation alternatives, and the final reallocation alternatives to evaluate in detail. The evaluation of alternatives was guided by USACE's Environmental Operating Principles (EOP) and compliance with the Campaign Plan.

During plan formulation, the goal is to identify and perform an initial evaluation of preliminary alternatives for water supply. Consideration of all reasonable alternatives is required under the Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. The National Environmental Policy Act (NEPA) requires Federal agencies to incorporate environmental considerations in their planning and decision-making process. The Planning Guidance Notebook, Engineering Regulation (ER 1105-2-100), Appendix E and Appendix H, require the formulation and evaluation of a full range of reasonable alternative plans. Alternatives are formulated to take into account the overall problems, needs, and opportunities afforded by the proposed action. Those alternatives are assessed consistent with the national objective of contributing to National Economic Development (NED) and protecting the Nation's Environment, and consistent with Federal laws and regulations. The NED objective for water supply is to provide the most cost-effective water supply source to meet the region's future M&I requirements when considering economic, social, and environmental impacts of the potential reallocation. M&I water supply is considered the primary responsibility of the municipalities or other non-Federal entitities. However, M&I storage space may be recommended for inclusion in USACE reservoirs pursuant to the Water Supply Act of 1958, as amended. In 1998, a feasibility study was performed to make an assessment of the basin-wide water resource needs for the Middle Brazos River. The feasibility report from that study identified Aquilla Lake as the most likely USACE reservoir where reallocation would be economically efficient. That study also indicated consideration of three reallocation levels for bracketing: a 2.5 foot pool raise, 4.5 foot pool raise and a 6.5 pool raise, all reallocation flood storage space to water supply storage.

All three raises were initially considered and analyzed with the expection of the final report document continuing the feasibility study path. During the course of the study, with vertical team coordination, it was determined a reallocation report was more appropriate and given the sponsor's current and future water demand and supply, the 4.5 foot pool raise was identified as the reallocation alternative.

PROBLEMS AND OPPORTUNITIES

Problem: The Brazos G Regional Water Planning Group is projecting a water supply shortage of 11,403 AF on existing Aquilla Lake contracts in 2060. There will be insufficient water supply for water user groups in the district to draw against contracts already in place due to accumulation of sedimentation.

Based on the 2011 Brazos G Regional Water Plan, Aquilla Lake is currently permitted by Texas Commission on Environmental Quality (TCEQ) to provide 45,003 AF annually for M&I water supply, but is experiencing a decline in yield. Comparisons of capacities at conservation pool elevation derived from current and previous surveys suggest Aquilla Lake looses between 84 AF per year and 218 AF per year of conservation storage space due to sedimentation. The loss is equivalent to 0.33 – 0.85 AF per square mile of drainage area. Additionally, the extended period of drought has resulted in less inflow. This decline in yield is expected to result in water supply shortages beginning as early 2040, with the shortage in 2060 forecasted to be approximately 1,913 AF per year.

With the exception of the City of Cleburne, municipal water demand is expected to be relatively flat over the planning period, consistent with the projected population growth. Current usage for all users except Cleburne is currently 3,388 AF per year and is forecasted to be approximately 3,830 AF per year in 2060. Cleburne's usage is expected to grow from 4,165 AF per year currently to 9,879 AF per year in 2060. Usage rates for the area served range from 106 to 188 gallons per capita per day (gcpd). With the conservation and re-use plans in place, usage is expected to be reduced to 92 to 175 gcpd by 2060. A large portion of this reduction is attributed to the 1991 State Water-Efficient Plumbing Act effectively reducing usage rates by 7-11 gcpd.

Industrial demand for water is expected to increase moderately in Hill County and significantly in Johnson County. This includes demand for manufacturing, and steam-electric generation. Hill County currently demands approximately 67 AF per year for manufacturing, and demand is forecasted for 2060 at 140 AF per year. Johnson County currently demands approximately 1,533 AF per year for manufacturing, and demand is forecasted for 2060 at 3,994 AF per year. Additionally, there is no current usage for steam-electric generation, but it is currently being developed in Johnson County and is expected to generate a demand for 7,000 AF per year beginning in 2020 and continuing beyond 2060.

BRA contracts to Aquilla Water Supply District, City of Cleburne and Lake Whitney Water Company for a total of 11,403 AF per year of water. While the demand is expected to remain constant, sedimentation is resulting in a projected loss of water from the reservoir with firm yield currently at 13,746 AF and declining to 9,490 AF by 2060.

It is anticipated that Aquilla Water Supply District will be short 150 AF per year of meeting its contracted obligations by 2060 in spite of conservation efforts currently practiced and those to be implemented. Potential impacts include manufacturers in Hill County producing window treatments, cabinets, horticultural machinery, concrete buildings, plastics manufacturing equipment and expanded polystyrene.

The City of Cleburne is expected to experience shortages by 2050, with shortages of approximately 1,954 AF per year in 2060. The City has plans to access its contracted water in Whitney Lake, employ conservation measures, and expand its existing water re-use programs. However, additional uses generated by growth in Johnson County stand to adversely impact water supply. These include requests from manufacturing industries and steam-electric generation. The largest of these include manufactured homes, cabinets, exterior concrete fiber siding, conveyor systems, truck bodies sheet metal fabrication, and work wear textiles. The combined shortages from these industries to address their needs amounts to approximately 8,888 AF per year. Plans include conservation to reduce the need by 770 AF per year, leaving a shortage of 8,118 AF per year for these markets. The total shortage for City of Cleburne as a BRA customer is projected to be in excess of 10,000 AF per year.

Opportunity 1: Reduce water shortage faced by the Texas Water Development Board (TWDB) and BRA in a way that complements other water supply activities while maintaining the authorized project purposes for Aquilla Lake.

Opportunity 2: Complement local efforts to educate the public on water conservation activities currently practiced, and recommend any additional conservation activities that might be undertaken at a local level.

GOALS, OBJECTIVES, AND CONSTRAINTS

The first and foremost goals of USACE and BRA are to maintain the authorized purposes of flood risk management, water supply, and recreation at Aquilla Lake. BRA wishes to execute their charge to develop, manage, and protect the water resources within the Brazos River Basin. USACE and BRA have engaged in this study for the specific purpose of determining how best to address the water supply shortage forecasted in 2060 while meeting those goals.

Objective: Provide a means to meet, to the extent practicable, the forecasted water demand on Aquilla Lake water user groups of 45,503 AF (40.62 mg/d) in 2060 as identified in the 2012 Texas State Water Plan.

Universal constraints are the constraints placed on every study. Universal constraints are dictated by and documented in law or policy, and they may be Federal, State, or local. These constraints include but are not limited to requirements to not induce flood damages, minimize adverse effects to the environment, and minimize the requirement for acquisition of real estate. One universal constraint specific to State legislation does bear mentioning for its potential impacts on both the existing project and any project that may be recommended. There is a pending policy action in the State of Texas where many reservoirs may be required to make releases in an amount not yet determined to support downstream aquatic habitat. Because the release amounts are still being determined, it is not yet known what impacts these new requirements might have on the existing project in the future or any project that might be recommended as a result of this study. This is further documented as a project risk.

Some constraints are limited to a specific study and play a significant role in determining the recommendation or outcome of the study. For instance, cutting off the existing water supply while constructing a new one is not an option, particularly since Texas and the southwestern United States in general are in the midst of a severe and prolonged drought.

WATER SUPPLY MEASURES

Measures considered to resolve the forecasted water supply shortage include conservation, use of other water supply sources, and reallocation of Aquilla Lake. These were formulated into the preliminary alternatives documented in this section. The array of alternatives were built from a combination of the following management measures identified below.

•Conservation Strategies – Conservation happens by either reducing demand for water supply or increasing the efficiency of the available water supply. It is usually not capital intensive and as such is typically the first recommendation made by State agencies to any water supply entity. A variety of conservation strategies were discussed and considered by BRA as part of the 2011 Brazos G Regional Water Plan. These strategies and their current levels of implementation were reviewed as part of the Aquilla Reallocation study.

•Construct a pipeline from Whitney Lake to Aquilla Lake – The USACE Middle Brazos System Assessment conducted 2005-2008 explored the use of other water supply sources within the Brazos River Basin including but not limited to building new reservoirs, construction of pipelines to move water from one area to another, purchasing additional water through contracts with major water providers, obtaining additional water rights, and changing the operational framework for the system of reservoirs managed by BRA and/or USACE. Of those the most cost effective and therefore most likely alternative to reallocation at Aquilla Lake is to construct a pipeline to take water from Whitney Lake to Aquilla Lake. .

•Reallocate storage from the flood pool to the conservation pool.

SCREENING AND ALTERNATIVES

No action – The no action alternative would involve no action on the part of the USACE. The existing capacity and pool elevations would remain. This alternative is used as the basis for comparison to all action alternatives considered. Currenlty, Aquilla Lake has a reservoir capacity of 44,577 AF at the top of conservation pool elevation of 537.5 feet. However, surveys suggest that the lake loses 84-218 AF of conservation storage space per year. Critical period yield is approximately 16,445 AF per year and declining due to sedimentation and prolonged drought.

Conservation strategies – There are multiple conservation strategies already in place or planned for well into the future at an average annual cost of $738/acre foot and reducing usage by approximately 41,800 AF through 2060 (2012 TSWP). All water supply entities and major water rights holders in the state of Texas are required by Texas Senate Bill 1 to submit a Drought Contingency and Water Conservation Plan to the Texas Commission on Environmental Quality (TCEQ) for approval. These plans must detail the water supply entities' plans to reduce water demand at times when the demand threatens the total capacity of the water supply delivery system or overall water supply is low *(2011 Brazos G Regional Water Plan, September 2010)*. Additionally, conservation is recommended by the Regional Water Plan for every municipal water user group with a projected need shortage and a per capita water use rate greater than 140 gallons per day in 2060. Water re-use programs are in place and plans have been made and permits requested for expansion of these systems. The TWDB is currently working on an in place initiative to replace 100 percent of the existing plumbing fixtures with water efficient fixtures by 2045. All new construction is required to have water efficient plumbing fixtures. Consumer education programs are in place and utilized. Review of the conservation strategies employed and recommended by Region G and the TWDB shows they are proactively maximizing the use of conservation to reduce water usage and reduce the shortages over the long term. As a result, no USACE recommendations for further conservation are identified and conservation is not carried into the final array of alternatives.

Divert Water from Whitney Lake to Aquilla Lake (next best alternative to reallocation) – The alternative would provide an estimated 14,700 AF. This alternative would experience less evaporation than surface water solutions, so the yield is more efficient. The main stem of the Brazos River in the vicinity of Whitney Lake has high levels of total dissolved solids (TDS). The high salt concentration will need mitigation by blending with higher quality water or treating the water in advance of moving it into Aquilla Lake. Approximately 70-85% of the water would need to be treated to achieve and maintain acceptable water quality. A potential concern is the return of brine reject water to Whitney Lake. A significant amount of flow is generated to

support hydropower operations on Whitney Lake. Additional studies would be required to determine the impact on water quality. If brine reject cannot be returned to Whitney Lake, then deep well injection or evaporation ponds could be used. These options would, however, add significant cost to the project. This alternative is carried into the final array of alternatives.

REALLOCATION ALTERNATIVES

2.5 foot conservation pool raise – This alternative would raise the conservation pool elevation 2.5 feet to elevation 540.0. At this elevation conservation storage capacity is increased by approximately 8082 AF for a total of 52,659 AF. Critical period yield is approximately 17,749 AF per year. Flood pool storage elevation would be raised to 558.5 feet elevation which is still six feet below the elevation of the emergency spillway. This alternative provides an eight percent increase in critical yield for a total of 15.8 mg/d and storage capacity for 52,659 AF. This alternative would meet the capacity requirement for the forecasted time period, however, due to the trend in declining yield, this pool raise would not provide a long-term sustainable solution. The long term increase in storage capacity is only 8,082 AF, falling short of the necessary 11,403 AF by 3,321 AF. *Therefore, this alternative is not carried into the final array of alternatives.*

4.5 foot conservation pool raise – This alternative would raise the conservation pool elevation 4.5 feet to elevation 542.0. At this elevation conservation storage capacity is increased by approximately 14,983 AF for a total conservation capacity of 59,560 AF. Critical period yield is approximately 18,908 AF per year. Flood pool storage elevation would be raised to 560.5 feet elevation which is still four feet below the elevation of the emergency spillway. This alternative provides a 15 percent increase in critical yield for a total of 16.9 mg/d and storage capacity for 59,650 AF. At this elevation conservation storage capacity is increased by approximately 14,983 AF for a total conservation capacity of 59,560 AF. This alternative would meet the requirement of an additional 11,403 AF for more than 50 years accounting for the current rate of decline in yield. *This alternative is carried into the final array of alternatives.*

6.5 foot conservation pool raise – This alternative would raise the conservation pool elevation 6.5 feet to elevation 544.0. At this elevation conservation storage capacity is increased by approximately 23,567 AF for a total conservation capacity of 68,144 AF. Critical period yield is approximately 20,213 AF per year. Flood pool storage elevation would be raised to 562.5 feet elevation which is still two feet below the elevation of the emergency spillway. This alternative provides 23 percent increase in yield for a total of 18.0 mg/d and storage beyond the required capacity at 68,144 AF so it is not included in the final array. However, at sponsor's request USACE conducted a more detailed analysis on this alternative due to uncertainties surrounding the interpretation and implementation of Texas Senate Bill 3 and Texas House Bill 3. These bills are discussed in more detail in the next section.

ASSUMPTIONS AND RISKS

The following are the major assumptions and risks that could affect the ability to implement a project successfully.

•There is erosion damage to the upstream embankment that must be repaired, prior to implementing any change in the conservation pool. It is assumed this will be completed in advance of any construction effort that might be associated with the recommended plan.

•Sedimentation rates are assumed to continue at the current trend of 84-218 AF per year.

•It is assumed that all rights of way necessary for design and construction will fall within the fee simple and fee easement boundaries of the existing project.

•Up to six archeological sites may be impacted if the conservation pool is raised. Additional archeological testing during design is required to determine if these sites are eligible for listing in the National Register of Historic Places and to what extent mitigation and curation may be required. This is documented in the Cost Schedule Risk Analysis in Appendix K, Cost Estimating, and a 32 percent contingency has been applied to the cost estimate.

The 4.5 foot and 6.5 foot conservation pool raise alternatives are evaluated with respect to known Dam Safety concerns. Initial results indicate the pool raise alternatives are technically viable. However, a risk assessment is required during design to confirm the impacts of a conservation pool raise on the embankment. This risk assessment will be conducted immediately following the Periodic Assessment scheduled for April 2016. If the risk assessment determines adverse affects to the embankment are expected if the pool is raised, these risks will have to be mitigated prior to any construction associated with a potential conservation pool raise. Because the risk would be driven by the conservation pool raise rather than the normal OMRR&R, they would not be included in the normal dam safety operation and maintenance activities, and must be funded by the non-Federal sponsor and implemented as part of the project costs. This is documented in the Cost Schedule Risk Analysis in Appendix K, Cost Estimating, and a 32 percent contingency has been applied to the cost estimate.

Texas Senate Bill 3 and Texas House Bill 3 put in place a statutory requirement for TCEQ to set and adopt mandatory environmental flow releases downstream for purposes of maintaining aquatic ecosystems. It is not yet known what the flow release requirements will be or the impact they might have on Aquilla Lake or the existing and future water supply. If BRA is unable to meet the requirement for environmental flows on Aquilla Lake, they may be unable to obtain the necessary permits to store and withdraw any additional M&I water supply at this facility. The existing Aquilla Lake project authorization does not provide for the accommodation of environmental flows. If the TCEQ requirement is set at a level above which BRA can accommodate and still meet the demand for M&I water supply, BRA will not be able to obtain the necessary water rights and permits. This would result in the termination of any proposed project.

WATER DEMAND AND SUPPLY ANALYSIS

The water demand and supply analysis is taken from the *2011 Brazos G Regional Water Plan*, prepared for the *Water for Texas 2012 State Water Plan*. BRA holds the contracts for storage of water in Aquilla Lake, and sells the untreated water to the City of Cleburne, Lake Whitney Water Company, and the Aquilla Water Supply District. The Aquilla Water Supply District then supplies water to the City of Hillsboro and five water supply corporations.

DEMAND

With the exception of the City of Cleburne, municipal water demand is expected to be relatively flat over the planning period, consistent with the projected population growth (explained in further detail in the Appendix L, Socio-Economics). Current usage for all users except Cleburne is currently 3,388 AF per year and is forecasted to be approximately 3,830 AF per year in 2060. Cleburne's usage is expected to grow from 4,165 AF per year currently to 9,879 AF per year in 2060. Usage rates for the area served range from 106 to 188 gallons per capita per day (gcpd). With the conservation and re-use plans in place, usage is expected to be reduced to 92 to 175 gcpd by 2060. A large portion of this reduction is attributed to the 1991 State Water-Efficient Plumbing Act effectively reducing usage rates by 7-11 gcpd.

Industrial demand for water is expected to increase moderately in Hill County and significantly in Johnson County. This includes demand for manufacturing, and steam-electric generation. Hill County currently demands approximately 67 AF per year for manufacturing, and demand is forecasted for 2060 at 140 AF per year. Johnson County currently demands approximately 1,533 AF per year for manufacturing, and demand is forecasted for 2060 at 3,994 AF per year. Additionally, there is no current usage for steam-electric generation, but it is currently being developed in Johnson County and is expected to generate a demand for 7,000 AF per year beginning in 2020 and continuing beyond 2060.

SUPPLY

BRA contracts to Aquilla Water Supply District, City of Cleburne and Lake Whitney Water Company for a total of 11,403 AF per year of water. While the demand is expected to remain constant, sedimentation is resulting in a projected loss of water from the reservoir with firm yield currently at 13,746 AF per year and declining to 9,490 AF per year by 2060.

It is anticipated that Aquilla Water Supply District will be short 150 AF per year of meeting its contracted obligations by 2060 in spite of conservation efforts currently practiced and those to be implemented. Potential impacts include manufacturers in Hill County producing window treatments, cabinets, horticultural machinery, concrete buildings, plastics manufacturing equipment and expanded polystyrene.

The City of Cleburne is expected to experience shortages by 2050, with shortages of approximately 1,954 AF per year in 2060. The City has plans to access its contracted water in Whitney Lake, employ conservation measures, and expand its existing water re-use programs. However, additional uses generated by growth in Johnson County stand to increase water supply demand. These include requests from manufacturing industries and steam-electric generation. The largest of these include manufactured homes, cabinets, exterior concrete fiber siding, conveyor systems, truck bodies sheet metal fabrication, and work wear textiles. The combined shortages from these industries to address their needs amounts to approximately 8,888 AF per year. Plans include conservation to reduce the need by 770 AF per year, leaving a shortage of 8,118 AF per year for these markets. The total shortage for City of Cleburne as a BRA customer is projected to be in excess of 10,000 AF per year.

GROUNDWATER

While there are six major aquifers and nine minor aquifers in Region G, less than half have any potential for further development, and only seven of the fifteen extend into the planning area. The Trinity Aquifer is the most significant in the study area and currently produces small to moderate amounts of water for seventeen counties in north and central Texas.

DERIVATION OF USER COSTS

STORAGE/YIELD ANALYSIS

The summary results for critical water supply yield utilizing RiverWare system simulation are presented in Table 15. Critical period yield is the constant rate of withdrawal that can be supported through the simulated drought of record. The value represents a best estimate of the average continuous rate of withdrawal a water supply user might expect to sustain during a simulated drought if the user has unlimited contract rights to the same storage space, and the user's withdrawal facilities support withdrawals at the lowest invert of the outlet works. The yield

available varies due to uncertainties involved in estimating critical period yield and the volume of contracted storage space. For example, the BRA has contracted 33,600 AF of Aquilla Lake conservation storage below elevation 537.5. The yield study conducted at the time of contract execution indicated 33,600 AF of storage space was expected to provide a critical period yield of approximately 15 Million Gallons per Day (MGD). The yield study conducted in association with this reallocation study indicates the critical period yield associated with that same 33,600 AF is approximately 17 MGD. It is important to note that as the surface area of the pool increases as it would with the pool raise alternatives discussed below, so does the evaporation loss. This means that as the surface area of the pool increases, the efficiency of the storage decreases.

Table 15. Critical Yield Analysis for Aquilla Lake

Alternative	Top of Conservation Pool (feet)	Critical Yield (cfs)	Critical Yield (mgd)	Increase in Critical Yield (%)
Existing Condition	537.5	22.7	14.7	NA
2.5 foot raise	540.0	24.5	15.8	8
4.5 foot raise	542.0	26.1	16.9	15
6.5 foot raise	544.0	27.9	18.0	23

Table 16. Predicted Sedimentation for Aquilla Lake

Top of Conservation Pool Elevation in Feet	Current EAC Table Acre-Feet (2008)	Lower Bound Sedimentation Rate Acre-Feet (2060)	Upper Bound Sedimentation Rate Acre-Feet (2060)
537.5	13,000	11,200	11,000
540.0	14,300	12,100	11,500
542.0	15,400	13,400	12,500
544.0	16,800	14,600	13,700

According to the 2011 Brazos G Regional Water Plan, the 2060 local demand for Aquilla Lake is approximately an additional 11,400 AF. The 2060 Elevation-Area-Capacity (EAC) was predicted using the 2008 EAC developed by the Texas Water Development Board (TWDB) and a sedimentation analysis conducted by USACE utilizing bathymetric surveys conducted by TWDB in October 1995 and April 2008. The complete sedimentation analysis is documented in Appendix A, Reservoir Control. Table 16 shows the predicted yield accounting for sedimentation.

COST OF STORAGE ANALYSIS

As described in the Planning and Guidance Notebook, ER 1105-2-100, the cost allocated to the non-Federal sponsor will normally be established as the highest of : (i) benefits forgone; (ii) revenues forgone; (iii) replacement cost; or (iv) the updated cost of storage.

Flooding from the tributaries downstream of the dam surpasses that of overflows from the spillway, therefore any damages downstream of the dam are attributable to flooding unrelated to overtopping of the uncontrolled spillway. As such, no flood risk management benefits provided

by the dam are foregone. Additionally, no loss of recreation benefits is expected as a result of reallocation. Since no benefits are foregone, benefits foregone is not used to calculate cost of storage.

There are no hydropower resources at Aquilla Lake. No revenues will be foregone if storage is reallocated, therefore revenues foregone is not used to calculate the cost of storage.

The methodology for updating the cost of storage is documented in Appendix L, Economics. Cost of storage was calculated consistent with ER 1105-2-100, IWR Report 96-PS-4 (Revised Dec 1998), and EM 1110-2-1304 (revised Sep 2013). The updated cost of storage for raising the conservation pool to 542.0 feet elevation and reallocating 15,073 AF of storage is $14,179,846 at October 2014 prices.

COST ACCOUNT ADJUSTMENTS

The conservation pool elevation can be raised up to eight feet without adversely impacting flood storage capacity at Aquilla Lake. None of the potential conservation pool raise alternatives reach that limit, therefore there are no adjustments for flood storage capacity.

There are no hydropower activities at Aquilla Lake, therefore, no adjustments are required for hydropower.

There are no major modifications to the operation or structure of the dam and embankment. As such there are no related cost account adjustments.

EVALUATION

NO ACTION

The no action or future without project alternative is documented in Chapter 2 of this report. To summarize, the no action alternative will result in the existing water users for Aquilla Lake having insufficient water supply to meet their day to day needs. The yield study conducted in association with this reallocation study indicates the critical period yield associated with 33,600 AF is approximately 17 MGD.

DIVERT WATER FROM WHITNEY LAKE TO AQUILLA LAKE

The alternative would require a deep water intake, diversion pump station to take water out of Whitney Lake, an advanced water treatment facility for the Whitney Lake water, blending tanks, a booster pump station, and a pipeline to connect the Whitney Lake supply to either the existing Barkman Pipeline (runs between Aquilla Lake and City of Cleburne, Texas) or Aquilla Lake. While locations of facilities and pipeline routes have not been identified, costs were developed by a BRA contractor at a planning level of detail for use in making decisions with regard to regional and state water supply.

The pipeline alternative calls for an intake and pump station at Whitney Lake, approximately seven miles of 30-inch pipe, membrane treatment facilities, and a discharge structure in Aquilla Lake. Reject water from the membrane treatment would be returned to Whitney Lake. BRA projects water delivered by this means to Aquilla Lake would be withdrawn almost immediately by existing users, resulting in little to no elevation change in Aquilla Lake. The estimated yield is 14,700 AF per year. Estimated first costs were presented in the 2011 Brazos Region G Water Plan and have been updated to October 2014 prices. The first cost is $125,506,349 and annual OMRR&R costs are estimated at $6,288,972.

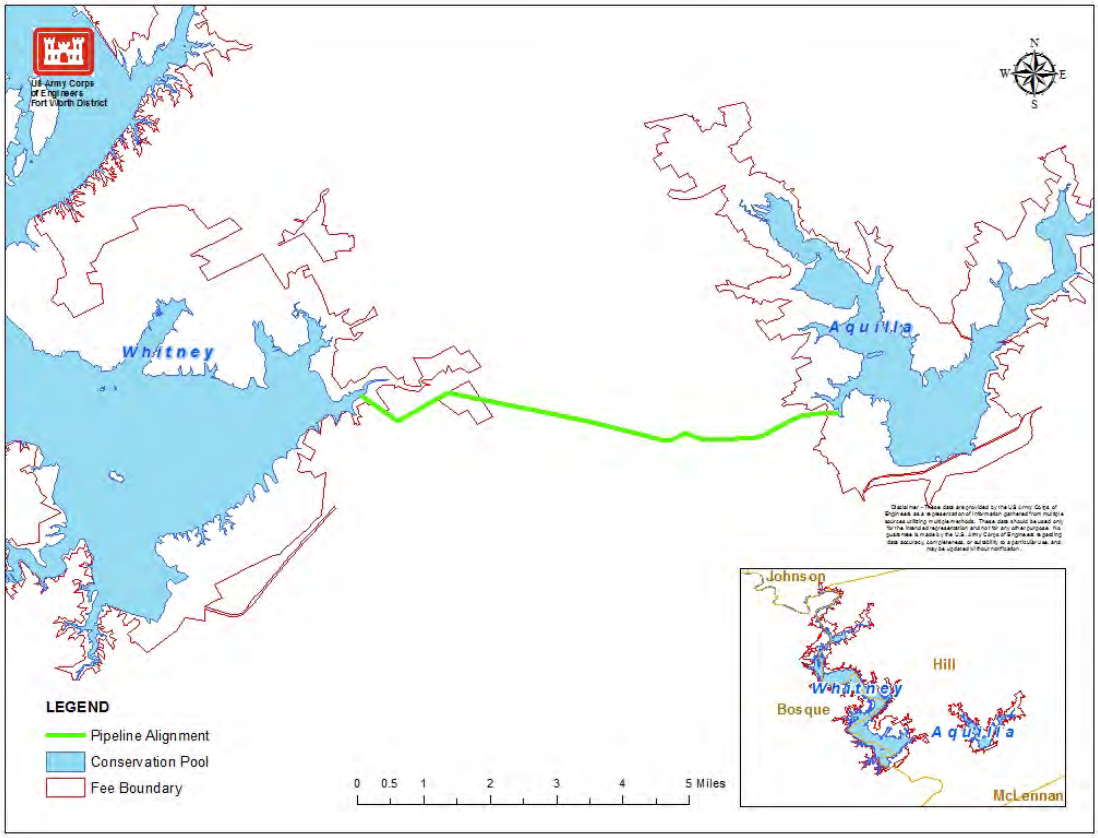

Figure 6. Diversion Pipeline Alternative

POOL RAISE ALTERNATIVES

The change in pool elevation-duration relationship corresponds directly to the change in conservation pool elevation. For example, raising the top of conservation pool elevation 4.5 feet to elevation 542.0 is expected to increase the pool elevation associated with any given duration by approximately 4.5 feet. The pool elevation-duration curves for both the 4.5 foot pool raise alternatives are provided in Appendix A, Reservoir Control.

The total dam discharge would increase only for events less frequent than the 1/300 or 0.33% ACE. The effect of reallocation on discharge-duration is deemed insignificant for discharges greater than 500 cfs. The increase in duration of discharges ranges from 2% for 500 cfs discharge to a maximum of 7% for a 100 cfs discharge. The increase in duration increases with the magnitude of reallocation. While raising the top of the conservation pool imposes very little risk for failure of the uncontrolled spillway, raising the pool will likely require repairs to be made following each over flow event.

The hydrologic and hydraulic modeling indicate the peak pool elevations on Aquilla Lake for flood frequency events equal to or more frequent than the 1/250 or 0.4% ACE are lower than the emergency spillway crest elevation of 564.5 feet. Additionally, the modeling shows that all flooding on Aquilla Creek downstream of the dam is a result of runoff from the lower watershed

with the greatest run off contribution resulting from Cobb Creek. Cobb Creek intersects Aquilla Creek approximately three miles downstream of the dam. It is not until the 0.2% ACE that the spillway peak flow exceeds the flow from the upper portion of Cobb Creek. Flooding from Cobb Creek and local run-off peaks approximately 35 hours before any flooding from the spillway would peak. As a result, the increased spillway use between the 0.4% ACE and the 0.2% ACE does not affect the maximum extent of downstream flooding, but may increase duration for some low frequency flood events.

Maximum expected wave height is 3.8 feet. Wave run-up was determined to be near zero due to the combined effects of very shallow water at the toe of the dam and a relatively flat, rip-rap covered slope. The average depth is 23 feet over 2.25 miles. The embankment slope is 1 foot vertical and 8 feet horizontal (1V:8H). Depth at the toe ranges 2-4 feet below the water surface.

Design files were examined for major county roads crossing the lake. Farm to Market Road 1534 only has slope protection to elevation 540.5 on the downstream side. Slope protection (rip-rap stone) would need to be added to both the upstream and downstream side in the event of a pool raise. All other major roads and bridges are currently above elevation 559 feet.

Impacts to recreation features at were assessed based on inundation, site attributes, support facilities, and shoreline stability with the impacts ranked as major, significant, minor or no impact. Additional information on the assessment and rankings is available in Appendix I, Recreation. The specific impacts for each pool raise are documented in the detailed alternative discussions below.

An addditional 15,073 AF of water could be stored for a total reservoir capacity of 59,650 AF at elevation 542.0 feet. The estimated increase in yield is 2,483 AF per year.

The period of record covers 71 years, however, no rainfall events greater than the 2% ACE have been recorded. Aquilla Lake Design Memorandum No. 1 has the 2% ACE elevation documented at 556.0 feet elevation with an initial elevation of 542.0 feet. However, the simulated period of record for this elevation results in a maximum elevation of 554.5 feet. To establish more confidence in the frequency curves additional inflow volume duration frequencies, joint probability elevation frequency, and hypothetical storms were run to add better definition to the less frequent events. This analysis is documented in Appendix A, Reservoir Control.

Under the 4.5 foot pool raise alternative, the 1/100 or 1% ACE would be expected to reach elevation 559 feet, and discharge from the gates would be 2,800 cfs, an increase of 50 cfs over current operating conditions. The 0.33% ACE would overtop the emergency spillway by 0.5 feet for a combined discharge of 3000 cfs, an increase of 100 cfs over current operating conditions. The 0.2% ACE discharge would increase from 2,950 cfs to 8,550 cfs. The gates would be closed and the 0.2% ACE discharge would pass over the emergency spillway.

Raising the conservation pool to 542 feet elevation will shorten the heel of the dam by 36-54 feet. If erosion continues to proceed at a rate of approximately one foot per year, it would be advanced 30-60 years at this elevation. Protection will be required to prevent further bank erosion. Twenty-four inch thick rip-rap is recommended for stations 30+00 through 84+00 (20,111 tons and 13,407 cubic yards). Additionally, nine inch bedding is recommended beneath the rip-rap (5670 tons and 4050 cubic yards).

ONCOR (power) would need to replace two steel lattice towers within the existing lake to support a permanent conservation pool raise to 542.0 feet elevation.

At 542 feet elevation, the top deck of the raw water intake tower for Aquilla Water Supply District would go from 5.5 feet of freeboard to 1.0 feet of freeboard. Since the reservoir rises

above the top of the current conservation pool (537.5 feet elevation) frequently, it is expected that continued operation of the structure will require the full 5.5 feet of freeboard.

Recreation impacts at the frequently visited Dairy Hill boat ramp include 12,800 square feet of paved park road, 1,600 square feet of trailer parking, one utility pole, the concrete boat ramp, 400 linear feet of pipe rail fencing, five directional/instructional signs, four bouys, and the dock, walkway and concrete bulk head. Additionally, stabilization of the shoreline near the boat ramp, courtesy dock, and parking area would be required.

Recreation impacts at the Old School boat ramp include the vault style restroom, 3,100 square feet of paved parking, 20,300 square feet of paved road, 1,000 square feet of concrete sidewalk, three utility poles, four buoys, five directional/instructional signs, the concrete boat ramp, a boat dock, a walkway, and a concrete bulkhead. These recreation features would be relocated to higher ground. Additionally, 650 linear feet of post and cable fence would need to be relocated but would be replaced with pipe rail fencing to match the fencing in the rest of the recreation areas. Stabilization of the shoreline near the boat ramp and parking areas would also be required.

Impacts to recreation at the access area on FM 1534 include 14,800 square feet of gravel parking lot, 9,200 square feet of gravel park road, and 980 linear feet of pipe rail fence.

Impacts of the 4.5 foot conservation pool raise to the Hackberry Creek access area currently leased and operated by Hill County include 1,800 square feet of parking, 9,000 square feet of paved road, 530 linear feet of pipe rail fence, 630 square feet of sidewalk concrete, two utility poles, three buoys, one directional/instructional sign, and a vault restroom that is closed and has not been used since 2006. These features would be relocated to higher ground. Additionally, the single lane, packed gravel boat ramp for shallow draft boats would be relocated.

The recreation impacts identified at the currently closed Aquilla Creek access area for the 4.5 foot conservation pool raise include a vault restroom, 2,400 square feet of parking, 6,900 square feet of paved road, 6,500 square feet of gravel road, 500 linear feet of pipe rail fence, one light pole, and four directional/instructional signs. All of these recreation features would be relocated to higher ground as part of this alternative. Additionally, stabilization of the shoreline near the parking area would be required.

FINANCIAL FEASIBILITY

Table 17 shows the calculation of annual costs of the diverting water from Whitney Lake and reallocation (4.5 foot pool raise) at Aquilla Lake using a 50 year period of analysis and a 3.375 percent Federal discount rate. The annual costs include annualized Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R). The annual costs for the Whitney Lake diversion alternative are $11,882,883. The annual costs for the Aquilla Lake reallocation alternative are significantly less at $1,357,445.

Table 17. Derivation of Annual Costs (October 2014 Prices) for Financial Feasibility of Reallocation at Aquilla Lake

Investment	Whitney Lake Diversion	Aquilla Lake Reallocation
Estimated First Cost	$125,506,349	$7,969,239
Updated Cost of Storage	$0	$14,,179,846
Economic Costs	$125,506,349	$22,149,085
Annual Interest Rate	3.375%	3.375%

Period of Analysis (years)	50	50
Construction Period (months)	48	24
Compound Interest Factor	51.31	24.79
Capital Recovery Factor	0.0416773	0.0416773
Interest During Construction	$8,713,259	$751,751
Investment Costs	$134,219,608	$22,900,836
Annual Charges		
Interest	$4,529,912	$772,903
Amortization	$1,063,999	$181,542
OMRR&R (Average Annual)	$6,288,972	$403,000
Total Annual Charges	$11,882,883	$1,357,445
Annual Benefits		
Total Annual Benefits	$11,882,883	$11,882,883
Net Benefits	**$0**	**$10,525,438**
Benefit to Cost Ratio	**1:1**	**8.75:1**

Table 18 provides the annual cost per acre foot of water provided by the alternatives. Diverting water from Whitney Lake to Aquilla Lake would cost $808 per acre foot of water per year. Reallocation at Aquilla Lake would cost $72 per acre foot of water per year.

Table 18. Calculation of Annual Cost Per Acre-Foot (October 2014 Prices) for Aquilla Lake

Element	Divert Water from Whitney Lake	Reallocation at Aquilla Lake
Yield (acre-feet per year)	14,700	18,908
Annual Investment Cost	$5,593,911	$954,444
Annual OMRR&R	$6,288,972	$403,000
Total Annual Cost	$11,882,883	$1,357,445
Annual Cost Per Acre-foot per year	$808	$72

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES*

This section describes the potential impacts, both beneficial and adverse, of the no action and potential action alternatives on the human and natural environment. Impacts can be direct or indirect and short-term, long term, or permanent. They can vary from a negligible change in the environment to a total change. Impacts that would result in substantial changes to the environment should receive the greatest attention in the decision making process.

The alternatives included in this consequences discussion include two potential reallocation plans that were identified in the plan formation process, the diversion of water from Whitney Lake to Aquilla Lake via pipeline, and a "no action" alternative, which is equivalent to the future without project conditions.

CLIMATE

Climate models predict an average increase of temperatures in Texas of 4° F by 2050. Although future predictions of the effects of climate change in annual precipitation are highly variable and uncertain, the models are consistent that future precipitation patterns will be more intense with even longer prolonged periods of drought. With a corresponding increase in evaporation and transpiration attributed to an increase in temperatures, available water within the watershed will become increasingly scarce.

None of the action alternatives will have an attributable impact on climate change; however, each of them offer a partial solution to the declining water supply expected as the result of climate change.

REGIONAL GEOLOGY, SOILS, AND TOPOGRAPHY

None of the proposed alternatives would alter the geological, soil, or topographic characteristics of the study area.

PRIME FARMLANDS

As required by Section 1541(b) of the Farmland Protection Policy Act (FPPA) of 1980 and 1995, 7 U.S.C. 4202(b), federal and state agencies, as well as projects funded with federal funds, are required to (a) use the criteria to identify and take into account the adverse effects of their programs on the preservation of farmland, (b) consider alternative actions, as appropriate, that could lessen adverse effects, and (c) ensure that their programs, to the extent practicable, are compatible with state and units of local government and private programs and policies to protect farmland.

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, soils would remain under the current conditions with the current conservation pool, and no prime farmland would be adversely impacted.

4.5 FOOT POOL RAISE: Approximately 142 acres of prime farmland soil area would be impacted as a result of permanent inundation at the target pool rise elevation. However, these soils are not being farmed currently and haven't been for over 30 years since they became part of the lake

project lands so there would be no loss of prime or unique farmlands with implementation of this alternative.

6.5 FOOT POOL RAISE: Approximately 257 acres of prime farmland soil area would be impacted as a result of permanent inundation at the target pool rise elevation. However, these soils are not being farmed currently and haven't been for over 30 years since they became part of the lake project lands so there would be no loss of prime or unique farmlands with implementation of this alternative.

DIVERSION PIPELINE: Approximately 56 acres of prime farmland soils would be temporarily disturbed by the construction of the pipeline between Whitney Lake and Aquilla Lake. However, these impacts would be temporary as existing agricultural operations would continue after the installation of the pipeline.

LAND USE

It is assumed the Natural Resource Management Area (NRMA) budget for Aquilla Lake would continue to be limited, consequently, after project implementation, habitat areas would be left to develop naturally. Management of NRMA areas around the lake would continue through the use of Agricultural Grazing Leases, however most land at Aquilla Lake would continue in its trend to have minimal land management, thus areas would develop in natural succession.

Although the pool raise alternatives would result in a larger conservation pool, the land use of the study area would not change. Aquilla Lake would still be managed for water supply and recreational areas. None of the proposed alternatives would alter land uses within the study area.

HYDROLOGY AND HYDRAULICS

None of the proposed alternatives would alter the floodplain characteristics of the study area.

WATER CONTROL PLAN

RECREATION

AQUATIC HABITAT

SURFACE WATER

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, the conservation pool of Aquilla Lake would remain under the current conditions, encompassing approximately 3,029 acres. No streams flowing into Aquilla Lake would be inundated by increased conservation pool levels. In addition, no streams would be impacted due to pipeline construction activities.

4.5 FOOT POOL RAISE: The 4.5 foot pool raise would increase the conservation pool of Aquilla Lake by an additional 683 acres encompassing 3,712 acres. The increased pool will inundate approximately 5,225 linear feet of Aquilla Creek (745 lf), Rocky Branch (1,865 lf), Jack's Branch (325 lf), and Hackberry Creek (2,290 lf). As the lake level fluctuates, the lake pool and stream lengths will vary inversely.

6.5 FOOT POOL RAISE: The 6.5 foot pool raise would increase the conservation pool of Aquilla Lake by an additional 1,045 acres encompassing 4,074 acres. The increased pool will inundate approximately 9,060 lf of Aquilla Creek (1,875 lf), Rocky Branch (2,865 lf), Jack's Branch (1,650 lf), and Hackberry Creek (2,670 lf). As the lake level fluctuates, the lake pool and stream lengths will vary inversely.

DIVERSION PIPELINE: The proposed pipeline alternative would not impact streams as the pipeline would be installed under the two stream crossings (Whiterock Creek and the Towash tributary) utilizing boring or directional drilling techniques. Temporary impacts would occur at Whitney and Aquilla Lakes during the construction of the intake and outlet structures.

GROUND WATER

Analyses of 2007 Northern Trinity/Woodbine Aquifers' groundwater model results indicate that groundwater levels in the Northern Trinity/Woodbine system are not particularly sensitive to recharge, suggesting that the system is relatively resistant to drought conditions. This is consistent with the comparatively low rate with which the groundwater flows horizontally through the aquifer and large outcrop areas associated with the modeled aquifers. Simulation of the aquifer response to future projected pumpage (based on the Region G Water Planning Group's and Texas Water Development Board's pumpage estimates) shows a recovery of the artesian pressure in the Trinity/Woodbine of many hundreds of feet because of a predicted reduction in pumpage. However, projected growth throughout the IH-35 corridor will likely exert pressure to continue use of the Trinity/Woodbine aquifers at existing, or possibly greater, levels in the future.

NO ACTION ALTERNATIVE: Selection of the No Action alternative would have no direct impact on groundwater resources; however, in the absence of development of new surface water supplies, it would be expected that population growth and the associated greater water demands would increase the use of groundwater in the future. This could eventually have a negative effect on groundwater availability if aquifers are drawn down faster than they can recharge.

4.5 FOOT POOL RAISE: Implementation of Alternative 2 would provide 15,073 AF of additional water supply; just over the 11,403 AF of projected need in Region G by 2060. Therefore, implementation of Alternative 3 should preclude the need for increasing withdrawal of groundwater to make up for any anticipated shortfalls.

6.5 FOOT POOL RAISE: Similar to Alternative 2, implementation of Alternative 3 would provide for greater water supply availability than the projected need for Region G. Therefore, implementation of Alternative 3 should preclude the need for increasing withdrawal of groundwater to make up for any anticipated water supply shortfalls.

DIVERSION PIPELINE: The pipeline alternative would supplement the existing water supply demands on Aquilla Lake. Therefore, as with the pool raise alternatives, demands on groundwater would be alleviated.

WETLANDS AND WATERS OF THE U.S.

Wetlands are classified as those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and, under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE 1987).

Wetlands associated with the current conservation pool at Aquilla Lake would be impacted by both reallocation alternatives. Wetland areas inundated by the pool rise would experience a loss

of non-woody vegetation from the addition of permanently standing water. While most of the wetlands along Aquilla Creek are located in the shallow areas along tributary creeks and streams in the upper reaches of the reservoir, many of these areas would be permanently and adversely impacted as a result of inundation. Essentially, wetlands would be transformed from their current conditions and/or reduced with changing pool elevations.

NO-ACTION ALTERNATIVE: Acreage of wetlands is not expected to change significantly over time under the no-action alternative, however habitat value of wetlands would be expected to increase over time due to the maturation of the adjacent trees and potential cover area.

4.5 FOOT POOL RAISE: Approximately 46 acres of current wetland areas would be permanently and adversely impacted by inundation. Many of these wetland areas would be alternately inundated and exposed as the water levels fluctuate. However, as areas of inundation establish over time, other wetland areas would begin to be populated with non-woody vegetation and wetland species in areas adjacent to and upstream of the new inundation locations. In addition, isolated wetland areas on the fringe of the raised conservation pool may become hydrologically connected with the lake system. A re-distribution of wetlands would therefore be anticipated over time.

6.5 FOOT POOL RAISE: Approximately 80 acres of current wetland areas would be permanently and adversely impacted by inundation. Many of these wetland areas would be alternately inundated and exposed as the water levels fluctuate. However, as areas of inundation establish over time, other wetland areas would begin to be populated with non-woody vegetation and wetland species in areas adjacent to and upstream of the new inundation locations. In addition, isolated wetland areas on the fringe of the raised conservation pool may become hydrologically connected with the lake system. A re-distribution of wetlands would therefore be anticipated over time.

DIVERSION PIPELINE: The proposed pipeline right-of-way was routed to avoid potential wetland areas. Wetlands associated with Whiterock Creek and the tributary of Towash Creek would be avoided by utilizing boring or directional drilling techniques.

Waters of the U.S. that could be impacted if the proposed alternative is implemented include Aquilla Lake, tributaries present within the proposed project area, upstream and downstream of the proposed project area, and those waters located within the Region of Influence. Navigable waters of the U.S. are not present within the study area.

Implementation of any of the pool-raise alternatives would result in a rise the Aquilla Lake pool elevation. However, the pool raise would be achieved solely through modification of dam operations. Activities associated with the construction of roads, revetments, groins, breakwaters, levees, dams, dikes, weirs, stabilization with riprap, or intake structures in waters of the U.S., would not occur. Based on the proposed design of the pool-raise alternatives, none would result in the discharge of dredged or fill material into waters of the U.S. or result in effects to navigable waters of the U.S. Therefore, authorizations under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act would not be required.

WATER QUALITY

The overall water quality in Aquilla Lake is good despite agricultural land use surrounding the lake and its general impacts to turbidity and suspended solids. However, even though neither the lake nor its contributing streams are listed on TCEQ's 305 (b) list as "impaired water bodies", there are identified concerns, including nickel and arsenic in the sediment and nitrates and low levels of atrazine in the water. The nitrate and atrazine concerns could potentially be improved

by the increased dilution factor that would result from the potential pool raise. However, sediment concerns would probably not be affected by a pool raise.

NO-ACTION ALTERNATIVE: Without project implementation, water quality would remain under its current conditions.

POOL-RAISE ALTERNATIVES: Implementation of any of the pool raise alternatives would permanently inundate currently vegetated soils, adding to water turbidity and increasing levels of suspended solid for a short time. The degree of turbidity and the level of suspended solids would be expected to increase commensurately with the number of acres of land inundated. Thus, implementation of the 6.5 foot pool raise would be expected to increase turbidity and suspended solid levels over implementation of the 4.5 foot pool raise. In any case, these adverse impacts to turbidity and levels of suspended solids would be temporary and would be expected to improve over time as the increase in lake volume resulting from a pool raise would dilute the amount of suspended solids currently entering the lake from upstream or as runoff from adjacent agricultural lands.

In addition, implementation of any of the pool raise alternatives would also increase the dilution factor for nitrates and atrazine in the water column, lowering the levels of these pollutants, thus providing long term benefits to water quality. While bottom depths of the lake temperature may be slightly cooler with added depth, it is anticipated to have little impact on the quality of lake conditions and/or downstream waters. Finally, the sediments at the bottom of the lake should remain undisturbed by implementation of any of the pool raise alternatives so there should be no concern regarding a disturbance to the sediments re-suspending nickel and arsenic into the water column. These constituents should remain trapped in the sediments.

DIVERSION PIPELINE ALTERNATIVE: Water quality modeling of the pipeline alternative was conducted for four scenarios resulting in 6.36 million gallons per day (MGD), 8.3 MGD, 10.8 MGD, and 12.7 MGD. Chloride, sulfate, and TDS concentrations in Whitney Lake are significantly higher than concentrations in Aquilla Lake. Although the pipeline alternative includes water treatment to improve the water quality prior to pumping to Aquilla Lake, the treated water (Whitney Lake Feed) would still have higher concentrations of chloride, sulfate, and TDS. Once introduced into Aquilla Lake, the water quality would decrease (Table 19).

VEGETATION

Aquilla Lake has been in existence for over 30 years, and the region has experienced bouts of both drought and severe flooding conditions, thus, vegetation type and quality have developed as such under these conditions. The lake also continuously experiences variations in water levels according to both drought and flooding conditions (see Appendix B, Hydrology and Hydraulics for details of flooding occurrences and flood return periods), therefore such events have continuous impacts on habitats over time. These dynamics in fluctuating water elevations and effects on the surrounding plant communities of Aquilla Lake make it difficult to predict definite impacts. However, an attempt was made to determine the most likely occurring impacts utilizing the duration of inundation of the vegetative communities based on the release rate of flood water from the reservoir from an operations perspective.

While most of the riparian woodlands that existed along Aquilla and upland creeks were initially lost when the lake was impounded in 1983, there is still a narrow corridor of riparian woodland directly adjacent to these tributary streams.

Table 19. Expected Water Quality Concentrations for Pipeline between Whitney Lake and Aquilla Lake Alternative

	Cl (mg/L)	SO4 (mg/L)	TDS (mg/L)
Scenario 1 (6.36 mg/d)			
Whitney Lake	437	220	1,254
Whitney Feed	140	70	401
Aquilla Existing	19	71	263
Aquilla Future	15	89	359
Scenario 2 (8.3 mg/d)			
Whitney Lake	437	220	1,254
Whitney Feed	112	49	323
Aquilla Existing	19	71	263
Aquilla Future	49	85	343
Scenario 3 (10.8 mg/d)			
Whitney Lake	437	220	1,254
Whitney Feed	96	49	277
Aquilla Existing	19	71	263
Aquilla Future	50	80	322
Scenario 3 (10.8 mg/d)			
Whitney Lake	437	220	1,254
Whitney Feed	91	46	261
Aquilla Existing	19	71	263
Aquilla Future	51	77	322

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, the acreages of existing terrestrial vegetation types are expected to alter slightly as some conversion of one habitat type to another following natural disturbances and through natural succession processes.

POOL-RAISE ALTERNATIVES: Project implementation of either of the pool-raise alternatives would result in permanent adverse impacts to the various vegetation types surrounding the lake. While most of the terrestrial vegetation that existed along Aquilla and upland creeks was initially lost when the lake was impounded in 1983, implementation of pool-raise alternatives would adversely impact vegetation alongside the current lake shore as well as upstream tributary areas. Permanent adverse impacts caused by the loss of riparian woodlands will have to be mitigated for. Existing vegetation would be lost along the reservoir margins, potentially opening a niche for fast colonizing weeds and non-native species to become established. Table 20 provides the loss of various habitat types and acres that would result from implementation of either of the potential pool raise alternatives.

DIVERSION PIPELINE ALTERNATIVE: Approximately 80-percent of the pipeline right-of-way utilizes transportation corridors, cultivated croplands, and pastures. The proposed construction of the pipeline would temporarily impact the vegetation in these areas; however, once complete, the vegetation would be restored to preconstruction conditions. The remaining areas that support woody vegetation would be permanently impacted as woody vegetation would not be allowed to return within the pipeline easement. Therefore, approximately 32 acres of woodland and shrubland vegetation would be converted to grassland.

Table 20. Vegetation Impacts of Project Implementation at Aquilla Lake

Vegetation Type	No Action (acres)	4.5 foot Pool Raise (acres)	6.5 foot Pool Raise (acres)	Pipeline (acres)
Riparian Woodland	0	66	103	6
Upland Deciduous Forest	0	257	442	14
Herbaceous Wetland	0	46	49	
Grassland	0	115	179	30
Shrubland	0	152	216	12
Savanna	0	1	2	
Total		637	991	62

WILDLIFE

NO-ACTION ALTERNATIVE: The current terrestrial habitat in the project area is in general "average" habitat. Under the No-Action Alternative, habitat conditions for wildlife would remain intact. Due to the limited habitat management conducted at the lake, natural succession of habitat would be expected to occur, including the conversion of grasslands to savanna, shrubland, and riparian woodland habitats.

POOL-RAISE ALTERNATIVES: Acres of habitat and their associated ecological functions are expected along the shoreline near the new target pool elevations for each of the various pool-raise alternatives. Affected habitats include those listed in Table 20. While various acreages of total wildlife habitat (Table 21) is expected to be adversely impacted by inundation caused by the pool level rise, wildlife would itself would not be expected to be significantly impacted, as species would move into adjacent wildlife areas not impacted by the pool rise. In addition, inundation would be expected to provide an increase in snags and downed trees, which would be expected to provide valuable roosting habitat for raptors and various water birds such as herons and potential nesting sites for cavity nesting birds and other various aquatic life.

Table 21. Summary of Impacted Acreage for 4.5 Foot Pool Raise Alternative

Habitat Type	Existing Acres	Acres Impacted by 4.5 foot Pool Raise	Acreage Following 4.5 foot Pool Raise
Riparian Woodland	334	66	268
Upland Deciduous	2802	257	2545
Herbaceous Wetland	113	46	84
Grassland	1199	115	1084
Shrubland	2042	152	1890
Savanna	365	1	364
Disturbed Areas	231	24	230
Lake Surface	3164	661	3786
Total	10251		10251

DIVERSION PIPELINE ALTERNATIVE: Wildlife habitat associated with woody vegetation communities would be transformed to grassland habitats within the permanent pipeline easement. Therefore, wildlife that prefer grassland and edge habitats would benefit from the modified habitat created by the pipeline easement. However, wildlife species that prefer unfragmented habitats would be impacted by the creation of the edge habitat along the pipeline easement. Impacts to wildlife habitat were minimized by routing the pipeline right-of-way along transportation corridors and across agricultural landscapes as much as feasible.

THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (ESA) requires Federal agencies to determine the affects of their actions on threatened and endangered species of fish, wildlife, and plants and their critical habitats, and to take steps to conserve and protect these species.

The Fish and Wildlife Coordination Act provides that fish and wildlife conservation receive equal consideration with other project features. It also requires that USFWS investigations be made an integral part in determining means and measures to prevent the loss of or damage to fish and wildlife resources, as well as to provide concurrently for the improvement of such resources. The USFWS Planning Aid Letter and USFWS Coordination Act Report (Appendix H) has done this through the development of mitigation and enhancement measures and recommendations.

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, there would be no adverse impacts to threatened and endangered species.

POOL-RAISE ALTERNATIVES: There are no designated critical habitat areas located within any of the pool-raise alternatives inundation areas. While there are three currently listed species that occur within Hill County, these species are not expected to occur within the project area itself, therefore no adverse impacts to any of the discussed species would be anticipated. For example, while golden-cheeked warbler and black-capped vireo have been known to occupy Hill County, during habitat evaluations, the team did not encounter any habitat that appeared suitable for the two species. While the whooping crane may utilize the habitat at Aquilla Lake during its migration in spring and autumn, it was determined by USFWS that an increase in conservation pool level “it is unlikely that an increase in pool rise would have an adverse impact on this species”(PAL, USFWS).

DIVERSION PIPELINE ALTERNATIVE: There are no designated critical habitat areas located within the proposed pipeline right-of-way. However, suitable habitat for the Golden-cheeked Warbler and Black-capped Vireo exists in the woodland and shrubland habitats within the proposed pipeline right-of-way. Consultation with the USFWS would be required to assess the potential impacts of the construction of the pipeline on these species.

AIR QUALITY

The Clean Air Act (CAA) sets national primary and secondary ambient air quality standards as a framework for air pollution control. The 1990 amendments to the CAA specifically define “conformity” for Federal projects in relation to a state’s implementation plan and require that an agency’s action not cause new violations, increase the severity of any existing violations, increase the severity of any existing violations, or delay attainment.

As previously mentioned in the Environmental Settings section, the project area’s nearest location of a non-attainment area by the EPA is the Dallas Fort Worth area located approximately 60 miles

north of the Hill County Area. Therefore the project area is not expected to exceed any Federal air quality standards designated as non-attainment areas.

NO-ACTION ALTERNATIVE: There would be no impacts to air quality without the project implementation.

POOL-RAISE ALTERNATIVES: Minimal short term adverse impacts could occur as a result of fugitive dust being released during the relocation and reconstruction of recreational use facilities including boat ramps and marina equipment associated with Aquilla Lake. Minor emissions of NOX, CO, SO2, volatile organic compounds (VOC's), hydrocarbon (HC), and PM could occur during the deconstruction/construction activities due to refueling, vehicle/engine exhaust, painting, and the application of water proofing chemicals. However, such mentioned adverse impacts would be minimal and short term. No adverse long term impacts are anticipated with project implementation of any of the proposed reallocation alternatives.

DIVERSION PIPELINE: Minimal short term adverse impacts could occur as a result of fugitive dust being released during the construction of the pipeline and clearing for the pump and intake facilities. Minor emissions of NOX, CO, SO2, volatile organic compounds (VOC's), hydrocarbon (HC), and PM could occur during the construction activities due to refueling and vehicle/engine exhaust. However, such mentioned adverse impacts would be minimal and short term. No adverse long term impacts are anticipated with project implementation of the pipeline alternative.

TERRESTRIAL HABITAT EVALUATIONS

Similar to the future without project conditions, the project area consists of and would remain as 10,251 acres of land area owned by USACE. The project site would continue to be managed as a multipurpose reservoir with authorized uses of flood risk management, water supply, and recreation. The Whitney/Aquilla Project office located at Whitney Lake would also continue as the main management authority.

The Natural Resource Management Area (NRMA) budget for the Lake would continue to be limited, consequently, after project implementation, habitat areas would be left to develop naturally. Table 22 provides a summary of habitat acreage changes from implementation of the recommended reallocation plan over the 50 year life of the project. Table 23 provides a summary of the AAHUs.

Table 22. Expected Habitat Acreage Changes Resulting from the Proposed Project at Aquilla Lake

Habitat	Existing Acres	Year 1	Year 5	Year 10	Year 25	Year 50
Riparian Woodlands	334	268	270	273	277	318
Upland Deciduous Forest	2802	2545	2520	2495	2520	2433
Herbaceous Wetlands	113	67	77	87	100	113
Grasslands	1199	1100	1084	1034	934	890
Shrubland	2043	1890	1895	1906	1920	1930
Savanna	365	364	388	439	483	550
Disturbed Areas	231	231	231	231	231	231
Lake Surface at Conservation Pool	3164	3786	3786	3786	3786	3786
Total Acres	10251	10251	10251	10251	10251	10251

Table 23. Summary of AAHUs for the Proposed Project at Aquilla Lake

Habitat	No Action AAHUs	4.5 Foot Pool Raise AAHUs	Net Change in AAHUs
Riparian Woodlands	245	195	-49
Upland Deciduous Forest	2065	1840	224
Herbaceous Wetlands	69	59	-9
Grasslands	443	412	-30
Shrubland	1358	1259	-98
Savanna	304	271	-32
Lake Surface at Conservation Pool	1423	1700	277
Total AAHUs	5907	5736	283

RIPARIAN WOODLANDS

The greatest impact on the environment from the reallocation of storage in Lake Aquilla will be the loss of riparian woodland habitat due to higher lake levels. Project implementation would result in an overall net loss of riparian woodland habitat (Table 24).

Table 24. Future With Project Riparian Woodland Habitat at Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.67	0.67	0.67	0.68	0.68	0.70
Acres	334.00	268.00	270.00	273.00	277.00	318.00
Target year HU	223.78	179.56	180.90	185.64	188.36	222.60
Interval HU		201.67	720.92	916.33	2805.00	5133.58
Cumulative HUs						9777.50
Average Annual HUs						195.55

UPLAND DECIDUOUS FOREST

The future without project conditions estimated that approximately 50 acres of this habitat type would be expected to be lost to conversion to riparian woodland habitat over the next fifty years. However, this loss would be offset by the conversion of shrubland or savanna habitat to upland forest over the next fifty years, resulting in no net loss of acreage for this habitat type

With the pool raise of 4.5 feet, approximately 257 acres would be impacted by inundation, resulting in a loss of habitat acreage at year one. However, similar to the future without project analysis, over time, 50 acres of this habitat type is expected to be lost to conversion to riparian woodland. This loss would be offset by the conversion of shrubland or savanna habitat to upland forest over the next fifty years, resulting in no net loss of acreage for this habitat type when comparing year one to year 50. Habitat value is expected to increase, as initial limiting factors, such as larger trees and canopy cover, increase over time.

Table 25. Future With Project Upland Deciduous Forest Habitat at Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.74	0.74	0.73	0.73	0.74	0.74
Acres	2802.00	2545.00	2520.00	2495.00	2520.00	2433.00
Target year HU	2073.50	1883.30	1839.60	1821.40	1864.80	1800.40
Interval HU		1978.40	7445.60	9152.40	27645.50	45815.30
Cumulative HUs						92037.10
Average Annual HUs						1840.70

HERBACEOUS WETLAND

Initially the amount of acres of wetlands was not expected to change significantly over the 50 year period of analysis, however habitat value was expected to increase due to the maturation of the adjacent trees and potential cover area. However, with project implementation, existing wetlands would be impacted, decreasing both H.S.I value and acreage at year one.

Approximately 46 acres would be impacted by inundation under the 4.5-foot pool raise at year one. Habitat value would decrease slightly due to inundation, but would increase again over the period of analysis.

Limiting factors for herbaceous wetlands included poor cover and the number of potential nest cavities, along with seasonable availability of water. The loss of nest cavities due to inundation would create a decrease in habitat value, however, H.S.I. would be expected to increase over time due to the maturation of the adjacent trees and potential cover area in the wetland areas that are relocated and/or re-establish following inundation. Wetlands are expected to re-establish in and along the new conservation pool according to each pool raise. Habitat value is also expected to increase as these new areas of inundation become established as wetland areas.

Table 26. Future With Project Herbaceous Wetland Habitat at Aquilla Lake

Target Year **Interval (years)**	**0** **0**	**1** **1**	**5** **4**	**10** **5**	**25** **15**	**50** **25**
HSI	0.54	0.54	0.57	0.60	0.62	0.65
Acres	113.00	67.00	77.00	87.00	100.00	113.00
Target year HU	61.02	36.18	43.89	52.20	62.00	73.45
Interval HU		48.60	159.94	239.98	855.85	1691.50
Cumulative HUs						2995.87
Average Annual HUs						59.91

GRASSLANDS

Due to the limited management at Aquilla Lake, future without project predictions concluded that the overall acreage of grasslands would decrease over the next 50 years due to the conversion to shrub savanna or tree savanna habitat. Approximately 300 acres would be expected to convert over the 50 yr period.

Initial inundation of resulting from a 4.5 pool raise would result in the loss of 179 acres of grassland habitat, and thus a slight decrease in habitat value. However, acreage of this habitat would be expected to continue to decrease over time due to both inundation impacts as well as conversion to other habitat types.

Table 27. Future With Project Grassland Habitat at Aquilla Lake

Target Year **Interval (years)**	**0** **0**	**1** **1**	**5** **4**	**10** **5**	**25** **15**	**50** **25**
HSI	0.48	0.46	0.45	0.44	0.42	0.40
Acres	1199.00	1134.00	1084.00	1034.00	934.00	890.00
Target year HU	575.52	521.64	487.80	454.96	392.28	356.00
Interval HU		548.36	2018.55	2356.48	6349.30	9349.83
Cumulative HUs						20622.53
Average Annual HUs						412.45

SHRUBLAND

The trend of grassland to tree savanna and shrubland would be expected to continue even with project implementation due to the limited habitat management at the lake. Similarly, this habitat quality is expected to increase over time along with acreage as the canopy cover of woody shrubs needed for cover develops over time.

A 4.5-foot pool raise would result in an initial loss of 152 acres due to inundation, along with a decrease in habitat quality. However, the trend of the conversion of approximately 40 acres of grassland to Savanna and shrubland habitat over the 50 year time period would still be expected. Habitat value would also be expected to increase over time as vegetation matures and develops.

Table 28. Future With Project Shrubland Habitat at Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.63	0.63	0.64	0.65	0.66	0.67
Acres	2042.00	1890.00	1895.00	1905.00	1920.00	1930.00
Target year HU	1286.40	1190.70	1212.80	1238.25	1267.20	1293.10
Interval HU		1238.58	4806.97	6127.54	18790.50	32003.33
Cumulative HUs						62966.92
Average Annual HUs						1259.34

SAVANNA

Minimal impacts or changes to this habitat type are expected due to project implementation.

The trend predicted in the future without project conditions would be expected to continue following project implementation, and therefore a gain of approximately 200 acres of this habitat type by the conversion of other habitat types (such as grasslands) to this habitat over the 50 year time period would be expected. Similarly, as this habitat acreage increases, habitat value would be expected to increase over the 50 year period of analysis.

Table 29. Future With Project Savanna Habitat at Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.54	0.54	0.55	0.56	0.57	0.58
Acres	365.00	364.00	389.00	439.00	489.00	552.00
Target year HU	197.10	196.56	213.95	245.84	278.73	320.16
Interval HU		196.83	820.85	1149.06	3933.03	7483.50
Cumulative HUs						13583.27
Average Annual HUs						271.67

AQUATIC HABITAT EVALUATIONS

The current surface water acreage of Aquilla Lake is 3164 acres. Surface water acreage would be expected to increase with project implementation. In one year, a 4.5-foot pool raise would result in increasing the lake acreage from 3164 to 3786.

A change in the location of lake zone function would occur as a result of the pool rise. An alteration, or transition, of areas current experiencing certain zone functions would shift, or re-locate as a result of the pool raise. The littoral zone would migrate further upstream as the water depth increased. Similarly, current in-stream habitat would be converted to more characterized littoral habitat. Essentially, water types and zone acreage would be altered as a result of the pool rise.

While upstream tributary streams would be impacted by inundation as a result of the pool rise, the aquatic life use of the creeks would not change. The creeks are located within deeply incised channels which would contain the proposed pool raise. Therefore, although the depth of the streams would increase, the existing low-velocity, pool habitats of Hackberry Creek would not change. A potential benefit of the pool raise to the creeks would be the increased thermal cover provided by the increased depth of the creeks and the extended inundation the pool raise provides to the intermittent and ephemeral streams. Because there would not be a loss of aquatic habitat, aquatic life use (habitat value) is expected to remain the same across the 50 year period of analysis.

Table 30. Future With Project Aquatic Habitat at Aquilla Lake

Target Year	**0**	**1**	**5**	**10**	**25**	**50**
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**
HSI	0.45	0.45	0.45	0.45	0.45	0.45
Acres	3164.00	3786.00	3786.00	3786.00	3786.00	3786.00
Target year HU	1423.80	1703.70	1703.70	1703.70	1703.70	1703.70
Interval HU		1563.70	6814.80	8518.50	25555.50	42592.50
Cumulative HUs						85045.00
Average Annual HUs						1700.90

Aquatic habitat evaluations demonstrated an overall high aquatic life use value in the in-stream habitat of Aquilla Lake tributaries. Habitat evaluations and site assessments of the in-stream habitats indicate that any in-stream habitats (low velocity pools) that would be inundated would be replaced with similar, although deeper, aquatic habitats. Therefore, no net loss of aquatic life use value within each tributary is anticipated.

NO-ACTION ALTERNATIVE: Without project implementation, aquatic habitat availability and quality would remain under their current conditions. Under its current management and operation as a Corps lake, little to no changes in aquatic habitat would be anticipated.

4.5 FOOT POOL RAISE: Approximately 683 acres of additional surface water would be added to the lake as a result of implementation of this alternative, thereby increasing aquatic habitat acreage from 3,029 to 3,712 acres. Habitat evaluations and site assessments of the in-stream habitats indicate that approximately 5,225 linear feet of in-stream habitat (low velocity pools) that would be inundated, would be replaced with similar, although deeper, aquatic habitats. Therefore, no net loss of aquatic life use value within each tributary is anticipated.

6.5 FOOT POOL RAISE: Approximately 1,045 acres of additional surface water would be added to the lake as a result of implementation of this alternative, thereby increasing aquatic habitat acreage from 3,029 to 4,074 acres. Habitat evaluations and site assessments of the in-stream habitats indicate that approximately 9,060 linear feet of in-stream habitat (low velocity pools) that would be inundated would be replaced with similar, although deeper, aquatic habitats. Therefore, no net loss of aquatic life use value within each tributary is anticipated.

DIVERSION PIPELINE: The pipeline would not impact aquatic habitat. However, the intake and outfall structure would add artificial hard structure habitats to the lakes aquatic habitats. Screened fish excluder devices would be incorporated into the design of the intake structures to ensure that aquatic organisms would not be adversely impacted by water treatment processes or inadvertently transported to Aquilla Lake.

HTRW

No sites were identified where hazardous substances or petroleum products had been released, and no water, oil, or gas well locations were identified within the search area impacted by the proposed pool raise. Additional studies would be required to identify any impacts associated with the pipeline alternative. Due to the extreme cost differential between the pool raise and pipeline alternatives, these studies were not pursued as part of this study.

NOISE

The Noise Control Act of 1972 (Public Law 92-574) establishes a policy “to promote an environment free from noise harmful to health or welfare. Federal agencies must comply with state and local requirements for the control and abatement of environmental noise, where applicable.

Noise is defined as “unwanted sound” and in the context of protecting public health and welfare implies potential effects on people and on the environment. Ambient sound levels in a wilderness setting range from DNL 20 to 30 dB, while residential areas range between DNL 30 to 50 dB, and urban residential areas average from DNL 60 to 70 dB (FICON 1992). However, in outdoor areas where quiet is a basis for use, “there is no reason to suspect that the general population would be at risk for any of the identified effects of noise” (i.e., activity interference or annoyance) when sound levels are DNL 55 dB or less (EPA 1978). The American National Standard Institute (ANSI) has also suggested that land uses in “extensive natural wildlife and recreational areas” are likely to be considered compatible with DNL 60 dB or less (ANSI 1990).

NO-ACTION ALTERNATIVE: No adverse impacts to noise are anticipated under the no-action alternative.

POOL-RAISE ALTERNATIVES: Background noise in and around the Aquilla Lake area is primarily derived from recreational boats and vehicles in and around Aquilla Lake. Minimal short term adverse impacts could occur as a result of disturbance related to the demolition and construction of various recreational use facilities including boat ramps

and marina equipment associated with Aquilla Lake being removed to prevent inundation impacts. Minimal long term impacts could potentially include those noises associated with increased recreational use of the lake due to improved fish habitat which could result in increased visitors, boat use, picnicking, camping, and other activities associated with the lake. However, it would not be expected that noise levels would increase above the annoyance level for a majority of the population.

DIVERSION PIPELINE ALTERNATIVE: Minimal short term adverse impacts could occur as a result of disturbance related the construction of the pipeline and ancillary facilities. However, there would be no increase in noise levels resulting from the operation of the pipeline facility.

LIGHT

NO-ACTION ALTERNATIVE: No adverse impacts to light are anticipated under the no-action alternative.

POOL-RAISE ALTERNATIVES: Minimal short term impacts to light could occur during the demolition and construction of various recreational use facilities including boat ramps and marina equipment as a result of inundation, if activities occur during night hours requiring lighting. Once construction was complete, no further adverse impacts to light would occur.

DIVERSION PIPELINE ALTERNATIVE: No adverse impacts to resulting from lighting are anticipated under the no-action alternative.

SOCIOECONOMIC RESOURCES

The purpose of EO 12898 (Environmental Justice) is to avoid the disproportionate placement of adverse environmental, economic, social, or health impacts from Federal actions and policies on minority and low-income populations.

The Region of Influence (ROI) encompasses all inhabitants and related economic activity within Hill County, TX. The ROI surrounding the proposed Aquilla Pool Rise in Hill County, Texas experienced a decline in population from 1910 to 1970. Population has begun to slowly increase over the past 30 years, with a current population of 35,089. The largest town within the county is Hillsboro, which is less than ten miles from Aquilla Lake. No significant impacts are anticipated related to any of the potential alternatives.

CUMULATIVE IMPACTS

The Council on Environmental Quality (CEQ) regulations define a cumulative impact as an effect which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions CFR Section 1508.7. Relatively minor individual impacts may collectively result in significant cumulative impacts over a period of time.

The initial step of the cumulative impacts analysis uses information from the evaluation of direct and indirect impacts in the selection of environmental resources that should be evaluated for cumulative impacts. A proposed action would not contribute to a cumulative impact if it would not have a direct or indirect effect on the resource. Similarly, CEQ guidance recommends

narrowing the focus of cumulative impacts analysis to important issues of national, regional, or local significance. Therefore, the cumulative impact analysis for Aquilla Lake was focused on those resources that were substantially directly or indirectly impacted by the proposed action and resources that were at risk or in declining health even if the direct/indirect impacts were insignificant. The resources considered for cumulative impacts assessment include: in-stream habitat, wetlands, and terrestrial vegetation, including riparian habitat. These resources would be substantially directly impacted by implementation of any pool raise associated with reallocation of flood storage to water supply storage at Aquilla Lake, either negatively or positively.

Review of aerial photography for the period beginning with 1968 indicates the area around Aquilla Lake has remained primarily agricultural (including grasslands). Other identified actions within the area being considered for cumulative impact assessment include:

- 1985 – Expansion and improvement of the Waco Metropolitan Area Regional Sewerage System (downstream of Aquilla Lake). The new plant uses an activated sludge process and has a treatment capacity of 38.5 million gallons per day. This expansion reflects the growing needs in the Waco area, which is the first major populated area downstream of Aquilla Lake.
- 1989 – Lake Granbury (upstream of Aquilla) Surface Water and Treatment System in Hood County began operations. This expansion reflects the growing needs upstream of Aquilla Lake.

Aquilla Lake and dam were constructed by the USACE as part of the overall Flood Risk Management project in the Brazos River basin under the Flood Control Act of 1968, Public Law 90-483 (82 Stat. 741) 90th Congress, approved August 13, 1968. The dam/lake was completed in 1983. The four authorized purposes for Aquilla Lake include: flood risk management, municipal and industrial water supply, general recreation, and fish and wildlife enhancement. While access and facilities are provided for minimum recreation, water is not controlled for that purpose. Since its impoundment in 1983, the lake has prevented an estimated $47,582,600 (September 2014 prices) in flood damages.

In order to insure that future water supply needs are met, the Brazos River Authority (BRA) requested a systems assessment of the USACE constructed lakes in the Brazos River Basin to determine potential water availability as a function of changes in conservation and flood control storage in each of the lakes (reallocation). Thus, alternatives have been developed to meet the water demand on Aquilla Lake as documented in the 2012 Texas State Water Plan.

A 4.5 foot raise (the TSP) in the conservation pool will meet the forecasted demand for 2060 (11,403 AF) on Aquilla Lake. Analysis shows this can be accomplished without requiring major modifications to the existing dam or adversely affecting the authorized purpose of flood control up through and including the 500-yr flood event.

Cumulative impacts resulting from past, present and future activities including the establishment of the environmental mitigation plan proposed would occur to the following resources as discussed by section.

LAND USE

Past land use changes in the region include the conversion of farm and rangeland to a highly managed area (by the USACE). Currently, there are no significant on-going land use changes in the immediate study area. However, reasonably foreseeable future changes to land use within the

region would include intensification of residential and commercial development within the Brazos River Basin.

While the immediate study area would be expected to remain under management of the USACE as a managed lake area, the cumulative effects of land use changes associated with this project, include a more developed area, both residential and commercial, in and among the larger Brazos River Basin.

VEGETATION

Past, on-going, and future residential and commercial development in the Brazos River Basin results in cumulative loss or conversion of agricultural and riparian forested resources. The proposed environmental mitigation plan would accelerate conversion of floodplain grasslands and shrublands to riparian forest.

WILDLIFE

Cumulative impacts to wildlife on grasslands and non-floodplain lands would result from additional loss and fragmentation of habitats due to land clearing and construction activities for future residential and commercial development projects. Dedication and management of lands within Aquilla Lake environmental mitigation land would improve low quality wildlife habitat in forested riparian areas along existing waters of the U.S. and these areas would be provided long-term protection. Therefore, cumulative impacts to wildlife in the region would continue as a result from continued growth in the Brazos River Basin, however, the cumulative effect on wildlife resulting from the proposed Corps project including environmental mitigation would be minimal.

THREATENED AND ENDANGERED SPECIES

There are currently three threatened and endangered (T&E) species that are known to occur within the counties associated with Aquilla Lake, or have associated habitat that may be utilized. However, as increased growth continues within the Brazos River Basin due to project implementation and meeting the water demands, T&E species and their associated habitat could be adversely impacted. Increased residential and commercial growth in the river basin could result in a decrease in T&E species habitat availability.

For example, while golden-cheeked warbler and black-capped vireo have been known to occupy Hill County, during habitat evaluations, the team did not encounter any habitat that appeared suitable for the two species. While the whooping crane may utilize the habitat at Aquilla Lake during its migration in spring and autumn, it was determined by USFWS that an increase in conservation pool level would likely not have an adverse impact on species.

WETLANDS AND OTHER WATERS OF UNITED STATES

The environmental project cumulatively adds to protection of waters of the United States. The pool rise would increase surface area of the lake, thus increasing limnetic zone (deep water) and littoral zone (shallow, shoreline) areas.

AIR QUALITY

No short term direct impacts to air quality would occur during project, since pool levels would be raised according to modifications in operations of the dam rather than construction efforts; the

operation activities would not impair State's ability to implement their air quality control plans. There would be no long-term cumulative impacts to air quality from project implementation.

MITIGATION ANALYSIS

The Council of Environmental Quality (CEQ) and NEPA guidelines provide that damages to fish and wildlife resources be prevented to the extent practicable through good planning and design incorporating mitigation principles. Mitigation plans are to contain the most efficient and least costly measures appropriate to reduce fish and wildlife resource losses. If project lands cannot fulfill the mitigation requirements, then separable public lands adjacent to project lands, to the extent possible, should be considered for acquisition. Subsection 906 (a) of the Water Resource Development Act of 1986 requires that the USACE maintain the power of eminent domain, the right to take private property for public use. The intent is to maintain the integrity and viability of significant natural resources and their contributions to local or regional ecosystems by applying sound ecosystem management techniques.

The ultimate goal of the USACE Mitigation Policy is to avoid significant areas, such as wetlands and critical habitat (Resource Category 1); avoid or replace in-kind, such as Riparian Bottomland Hardwoods (Resource Category 2 Areas); minimize impacts while providing no net loss of habitat for areas such as upland hardwoods (Resource Category 3 areas); and minimize impacts and habitat loss for areas such as successional grassland/old field or active pasture lands (Resource Category 4 areas). Generally, these goals can be accomplished by avoiding negative impacts, restoring impacted areas, compensating for impacts by creating or improving habitats at a different location, or through a combination of these measures. The areas determined to have the greatest potential for mitigation yielding the greatest habitat value increase as mitigation include acres of land categorized as riparian bottomland hardwoods. As outlined in the Existing Conditions, Environmental Consequences, and Future With Project sections above, implementation of the Proposed Action would not adversely impact aquatic habitats. In fact, increasing the pool elevation and adding pool habitat into the creeks and tributaries that feed Aquilla Lake is expected to benefit aquatic habitat over the life of the project; therefore, no aquatic mitigation is required or proposed.

TERRESTRIAL MITIGATION

Mitigation is anticipated for Riparian Woodland habitat adversely impacted and/or permanently lost as a result of project implementation and inundation as a result of the pool rise. With each alternative, acres of riparian woodland are impacted, and habitat units are lost. The No Action Condition provides 245 AAHUs. The proposed 4.5 foot pool raise provides 195.55 AAHUs. The net loss is 49.91 AAHUs. Thus, the 4.5 foot pool raise would require 49.91 AAHUs or riparian woodland mitigation.

- Certain assumptions were made during the evaluation of mitigation evaluation and preliminary plan development, including:
- Existing habitat will not degrade over time
- Lands designated as mitigation lands will be planted with native hardwood seedlings and or mature trees, with a minimum survival rate of 75-80% after two growing seasons.
- Management activities would be implemented to assist in the overall success of the mitigation areas.
- Public recreation use of the wildlife mitigation areas would be restricted to compatible, low-density activities. Mowing and intensive maintenance activities should be restricted to the late fall and winter months and will be restricted to the removal of invasive, woody species

and not scheduled on a regular basis. No mowing should occur upon successful reestablishment of woody vegetation.

Preliminary mitigation areas were chosen based GIS analysis. Suitable soil types were determined using the NRCS soil layer specific to Hill County. "Hydric" soils and "Soils Suitable for Forestland Site Preparation" were among those identified when identifying suitable areas for mitigation. Elevation contours were also used to determine areas suitable for mitigation. Similarly, the most recent (2011) aerial photography were utilized to visually identify areas for potential preliminary mitigation development (Figure 7).

There were several areas which were determined to be available for mitigation within the fee boundary according to the correct soil types (hydric), contours, and location in relation to riparian woodlands. However, upon further evaluation, it was determined that the most successful area for mitigation efforts, from a management perspective, would be the area located in the far north east area of the lake, or that area associated with Hackberry Creek (Figure 8). From a management perspective, it would be of greater benefit to keep mitigation efforts to a single area, thus eliminating having to manage areas separate from one another. Similarly, efforts concentrated to one particular area would have greater success in terms of monitoring and operations and maintenance over the 50 year project period. Thus it was determined that terrestrial mitigation efforts would be better suited, and therefore have higher potential of success were they to be conducted in the concentrated and suitable area on Hackberry Creek. The mentioned mitigation development strategy also serves to meet the requirements and guidance as described in ER 1105-2-100 (Planning Guidance Notebook, Mitigation Planning & Recommendations, Incremental Cost Analysis (C-15). While a formal incremental cost analysis (described as the least cost mitigation plan that provides full mitigation of losses) utilizing IWR software was not developed, it was determined that the incremental cost recommendation was met, in that mitigation efforts were concentrated in a central/combined location, rather than dispersed throughout the project lands; thus less costs overall were assumed for the long term range of the project from a management perspective.

Preliminary mitigation measures and associated costs were then developed for the loss of riparian woodland. Mitigation measures were developed using the limiting factors associated with the riparian habitat evaluations, including the temporal availability of water, available winter food and lack of mast producing trees, and minimal number of potential suitable nest cavities and lack of brood and winter cover. Various measures include excavation & soil preparation, invasive species control, native tree & shrub plantings, addition of nest boxes. A minimum diameter at breast height (dbh) for the proposed tree plantings was established at 5 inches dbh due to the high wild hog activity in the proposed mitigation area. The larger diameter tree would be able to withstand destructive grubbing of the wild hogs better than seedlings or smaller diameter trees during establishment of the mitigation vegetation. The selective clearing of existing vegetation and planting density of the native trees and shrubs would optimize the habitat quality of the mitigation area. Annualization tables such as those used for the Future-With-Project and Future-Without-Project conditions were utilized to determine how many AAHU's would result as a conversion of other habitat types to riparian woodlands (Appendix H). Detailed tables for each of the measures and associated costs and AAHU's over the 50 year period of analysis are found in Appendix H.

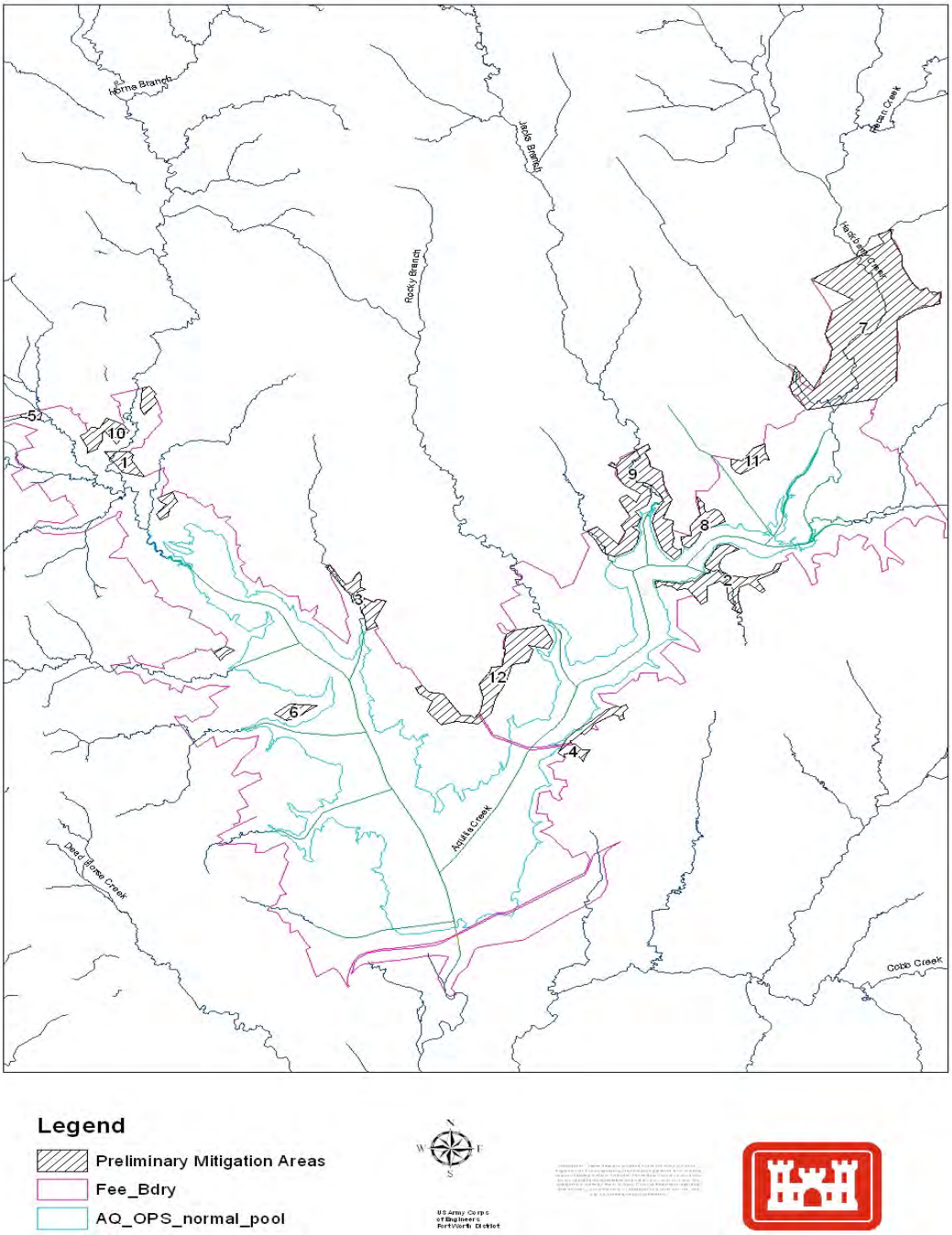

Figure 7. Preliminary Mitigation Areas Within Fee Simple Boundary at Aquilla Lake

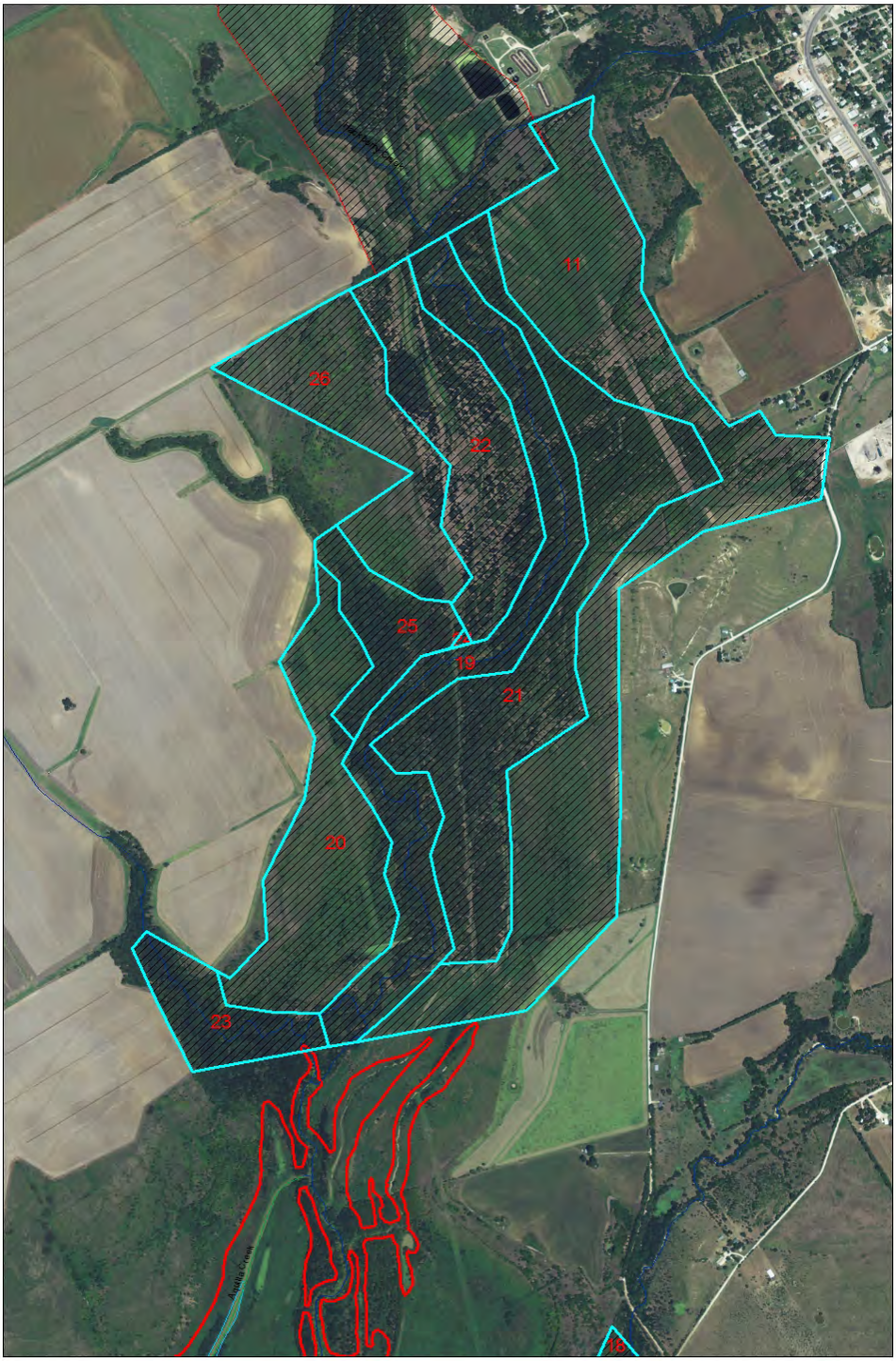

Figure 8. Suggested Mitigation Area on Hackberry Creek

Mitigation costs for the 4.5 foot pool raise are outlined in Table 31. Sufficient habitat units would be gained in order to meet mitigation requirements and recompense habitat loss due to impact of the pool rise. Development of the preferred plan will determine final costs associated with terrestrial mitigation efforts. Along with construction costs, O&M costs would be anticipated for the success of the mitigation efforts. Specific tasks might include nest box maintenance, continued efforts for invasive species control, and perimeter fencing addition and maintenance to protect planted mitigation areas. A preliminary cost of $10,000 per year over the 50 year project period is estimated for the 4.5 foot pool raise.

Table 31. Preliminary Costs for Mitigation of Riparian Woodlands at Hackberry Creek

Habitat	Acres	Tract	AAHUs Gained	Cost per Acre	Total Cost
Riparian Woodland	86.43	19	15.56	$1,603.85	$138,623.05
Riparian Woodland	24.43	23	4.40	$1,603.85	$39,175.88
Grassland	71.66	20	30.10	$5,126.00	$367,331.05
Total	182.52		50.05		$545,129.98

MONITORING AND ADAPTIVE MANAGEMENT

The Water Resources Development Act of 2007, Section 2039 states, “Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits.

This section discusses the preliminary feasibility level monitoring and adaptive management strategies for the terrestrial mitigation efforts based on the tentatively selected plan. This preliminary plan briefly describes the monitoring and adaptive management activities proposed for the project and estimates their cost and duration. A Monitoring and Adaptive Management Plan will be developed to assess the development and success of the terrestrial mitigation features proposed in the mitigation plan during the pre-construction, engineering, and design (PED) phase as specific mitigation design details are made available.

The primary intent of this Monitoring and Adaptive Management Plan is to develop monitoring and adaptive management actions appropriate for the project’s mitigation goals and objectives. The presently identified management actions permit estimation of the adaptive management program costs and duration for the mitigation plan. The monitoring and adaptive management plan is based on currently available data and information developed during plan formulation of the mitigation plan. Uncertainties remain regarding the exact project features, monitoring elements, and adaptive management opportunities. Components of the monitoring and adaptive management plan, including costs, were estimated using currently available information. Uncertainties will be addressed in PED, and a detailed monitoring and adaptive management plan, including cost breakdown, will be drafted by the project delivery team (PDT) as a component of the design document.

CHAPTER 5: RECOMMENDED PLAN

This chapter describes the recommended plan, and the process through which the proposed project would be implemented if authorized. In addition, USACE recommends TWDB, BRA, and the water user groups continue their existing conservation efforts and modify or update them if and when technology allows.

PLAN DESCRIPTION

The proposed action would be to increase the top of conservation pool 4.5 feet into the flood storage pool, making the top of conservation pool at 542 feet. This will reallocate approximately 15,073 AF of storage from the flood pool to the conservation pool. The estimated increase in yield with this reallocation is 2,483 AF per year.

Table 32. Existing and With Project Elevations and Storage for Aquilla Lake Reallocation

	Existing Conditions		4.5 ft. Pool Raise	
Pool	**Elevation**	**Acre-Ft**	**Elevation**	**Acre-Ft**
Bottom of Conservation Pool	503	106	503	106
Top of Conservation Pool	537.5	44,577.0	542.0	59,650
Top of Flood Pool	556.0	136,910.0	560.5	136,910
Spillway Crest	564.5	204,644.0	564.5	204,644.0
Maximum Design Water Surface	577.5	350,978.0	577.5	350,978.0
Gain in Conservation Pool			4.5	15,073

The proposed reallocation would require placement of two foot thick rock riprap to protect the dam embankment. No changes in the dam or spillway height would be made. Recreation features including restrooms, boat ramps, parking areas, and picnic tables will need to be relocated as described in the recreation appendix. Costs for these changes are included as part of the cost estimate.

USACE has four accounts that are considered as part of the planning process. The accounts are National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects. The recommended plan supports NED and RED, and as the lowest cost alternative resolve the water supply shortage is considered the NED plan. EQ is maintained at current levels. Though not quantifiable, OSE is believed to improve as a result of ensuring the storage capacity for water supply to support the surrounding population and activities.

CONSIDERATION OF THE PLANNING GUIDELINES CRITERIA

The planning guidelines criteria are identified in Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (March 1983) as completeness, effectiveness, efficiency, and acceptability. The recommended plan is complete in that it accounts for all necessary investments to ensure the realization of the planned effects. This assumes no adverse impacts from the TCEQ environmental flow requirements which have yet to

be determined. The recommended plan is effective in that it provides a long-term solution for the identified problem and is consistent with protecting the Nation's environment. The recommended plan is efficient in that it is the most cost effective means of alleviating the identified problem consistent with protecting the Nation's environment. The recommended plan is also acceptable in that it is a viable plan meeting the needs of the State, local entities, and general public while being compatible with existing laws, regulations and policies. The recommended plan satisfies the planning guidelines and criteria.

Considerations for Dam Safety (see comment below and revised text from Jason)

CONSIDERATION OF THE ENVIRONMENTAL OPERATING PRINCIPLES

The environmental operating principles were established in 2006 and updated in 2012. These principles were considered during the formulation process. The recommended plan supports the environmental operating principles in the following ways:

1. Foster sustainability as a way of life throughout the organization – BRA and the communities they serve have in place a wide array of conservation measures, and continue to educate the public and expand the use of these conservation measures. Additionally, water re-use facilities are already in place, and permits have been requested to expand the use of these facilities.

2. Proactively consider environmental consequences of all USACE activities and act accordingly – There are no adverse impacts to aquatic environment as a result of the recommended plan. Impacts to terrestrial habitat are mitigated within the existing fee simple boundary. Mitigation requires monitoring and adaptive management to ensure long term success of the replenished habitat and allows USACE to ensure that native species are provided an opportunity to thrive.

3. Create mutually supporting economic and environmentally sustainable solutions – The recommended plan provides storage for water needed to support a growing population without endangering aquatic ecosystems. Furthermore, the plan provides for supporting recreation and terrestrial features near the shoreline such that the interaction between humans and environment continues to be compatible to ensure a sustainable solution.

4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE which may impact human and natural environments – The recommended plan complies with all Federal, State and local laws and policies, and is supported by U.S. Fish and Wildlife Service and Texas Parks and Wildlife.

5. Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs – The evaluation was initiated with an analysis of the entire Brazos River system. Aquilla Lake was determined to be a location where reallocation is possible while maintaining the existing level of flood risk management for lands outside the existing fee simple and fee easement boundaries from a previously authorized project.

6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner – USACE was able to scale the level of modeling analysis to the level of risk as appropriate and included components of a dam safety study into the reallocation study to ensure the safety of human lives. Modeling was conducted at only the level of detail necessary to ensure the risk to human life is minimal. USACE also collaborated with natural resource agencies

to ensure the risk to the environment is minimal and there is interagency consensus on the recommended plan.

7. Employ an open transparent process that respects views of individuals and groups interested in USACE activities – The recommended plan supports growing populations at the edge of urbanized areas while continuing to serve the flood risk management function for populations downstream and preserve environment. Public meetings are conducted for NEPA scoping and during the public review of the Draft Aquilla Reallocation Report and EA review. Copies of the Draft Aquilla Reallocation Report and EA are available in hard copy and online at http://www.swf.usace.army.mil/. Comments are accepted and documented throughout the planning and review process.

CONSIDERATION OF DAM SAFETY AND RISK MANAGMENT

Aquilla Lake Dam was screened by a national risk cadre as part of the Fiscal Year 2005 Screening Portfolio Risk Assessment (SPRA) and categorized as a Dam Safety Action Classification (DSAC) 3 (Moderate Urgency). Corps criteria does not allow for the reallocation of flood storage on projects with a DSAC of 3 or less, without exception from the Dam Safety Officer (DSO) for the Corps. The Fort Worth District implemented Interim Risk Reduction Measures (IRRMs) to improve project conditions and further evaluate the known Dam Safety concerns. In September 2012, a re-evaluation was completed which recommended that DSAC be changed from 3 to 4 based on IRRM implementation, as concurred by the DSO or Chief of Engineers for Civil Works (CECW-CE) in Memo dated August 27, 2013. Which allows for reallocation of flood storage, as authorized by the District/Division DSO, such that the risks associated with the project remain below the Corps Tolerable Risk Guidelines for the final changes to reservoir operations and/or flood storage.

In November 2014, the Fort Worth District conducted a Potential Failure Mode Analysis (PFMA) of the existing conditions for the Aquilla Lake Dam to better define the risks associated with operation of the Federal Project. This is a crucial step to confirming that the 4.5-ft change to the conservation pool, will not substantially increase the risks for the project. Preliminary PFMA results confirm the need to further evaluate site conditions and downstream consequences with a Semi-Quantitative Risk Assessment (SQRA) to confirm the DSAC and allow for safe pool reallocation. This will be conducted in Spring 2016 with the first Periodic Assessment of the project, in conjunction with Periodic Inspection #11.

PROJECT IMPLEMENTATION PLAN

PRECONSTRUCTION ENGINEERING AND DESIGN

If the proposed project is authorized for construction and funds are appropriated for the pre-construction engineering and design (PED) phase, a number of activities will take place. These activities include completion of a design agreement, detailed design report (to include the mitigation plan), and value engineering study, the development of plans and specifications, and the development of a Project Partnership Agreement.

DESIGN AGREEMENT

The Design Agreement is the first action during PED. The Design Agreement is a contract between the Federal Government and the non-Federal sponsor that describes the rights and responsibilities, including cost sharing, of each party during project design.

DETAILED DESIGN REPORT

The Detailed Design Report (DDR) completes final design of project features. For the proposed project these features are modifications to recreational facilities, environmental and cultural mitigation, relocation of utilities, and improvement of roads impacted by the 4.5 foot rise. Additionally the proposed project would add stone rip rap to the embankment to minimize erosion at the higher elevation. All cultural resource investigations and mitigation requirements will be finalized prior to the final project design. The DDR will be completed within one year of the initiation of PED.

PLANS AND SPECIFICATIONS

Plans and Specifications (P&S) includes the development of construction drawings, construction specifications, estimation of final quantities, and the government cost estimate. These documents (with the exception of the government cost estimate) are made available to contractors interested in bidding on the construction of the proposed project. It is anticipated that up to four sets of P&S will be developed for the demolition of structures, recreational amenities, special aquatic features, and riparian vegetation. All cultural resource investigations and mitigation requirements will be finalized prior to the final project design.

PROJECT PARTNERSHIP AGREEMENT

Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

CULTURAL RESOURCES

Additional 5 sites will need to be mitigated (Cultural Appendix), only 41HI74/114,41HI134, and 41HI146 would be adversely impacted by the 4.5 foot pool raise and therefore warrant additional investigations prior to impoundment

PROJECT CONSTRUCTION

REAL ESTATE ACQUISITION

No acquisition is necessary for the proposed project. The mitigation, recreation, storage of water, and other amenities associated with the proposed project fall within the existing fee simple boundary of the previously authorized and constructed project.

MONITORING AND ADAPTIVE MANAGEMENT

ER 1105-2-100 allows for monitoring and adaptive management of environmental components during and after construction. The cost of adaptive management is limited to three percent of the

total project cost excluding monitoring costs. Monitoring and adaptive management measures are proposed for the environmental mitigation associated with the proposed project.

Pre-construction, during construction, and post construction monitoring shall be conducted by utilizing a Monitoring and Adaptive Management Team (MAMT) consist of representatives of the U.S. Army Corps of Engineers (USACE), Brazos River Authority (BRA), and contracted personnel.

Monitoring will focus on evaluating mitigation success and guiding adaptive management actions by determining if the project has met Performance Standards. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that restoration objectives associated with the mitigation plan have been achieved for both biological and physical resources. Effectiveness monitoring will be implemented to confirm that project construction elements perform as designed. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007. Monitoring objectives have are summarized in Table 33.

Table 33. Monitoring Criteria, Performance Standards, and Adaptive Management Strategies for Mitigation Area of Proposed Aquilla Lake Project

Measurement	Performance Standard	Adaptive Management
Woody Stem Density	Achievement of a specified density of assigned habitat category	Replacement of dead woody vegetation; modification of woody species composition or location within the assigned habitat category area; allowance of natural succession of native woody species within the assigned habitat category area
Herbaceous Percent Canopy	> 80% canopy cover	Remedial planting/seeding; modification of plant species composition; amending soil; increased irrigation
Non-Native Vegetation	< 10% canopy cover; no areas > 0.25 acres in size with > 10% non-native species	Remedial planting/seeding; modification of plant species composition; amending soil; increased irrigation; herbicide application; biological control; mechanical removal
Non-Native and Noxious Weeds	No areas > 0.25 acres in size with > 10% non-native or noxious weed species	Chemical and mechanical removal

A baseline vegetation inventory of the mitigation site will be conducted prior to construction of the mitigation alternatives. Vegetation metrics to be collected include woody stem density;

percent canopy cover of the overstory, shrub, and herbaceous layers; percent cover for each species; and percent of native/non-native species.

Woody stem density goals are dependent on the woody vegetation measure assigned to the particular area of the mitigation area. (Statement of woody vegetation density measures). The woody stems per acre measurement should be able to meet these performance standards. Any planted woody vegetation that has died within the warranty period shall be replaced. Post warranty period, adaptive management could include replacement of woody vegetation, modifying the woody species composition or location within the assigned habitat category area and allowance of natural succession of native woody species within the assigned stem density area.

Restoration of the herbaceous vegetation would be considered successful when the herbaceous canopy percent cover of the mitigation site is at least 80%. Adaptive management could include remedial planting/seeding, modifying the species composition, amending the soil, and/or increased irrigation to ensure establishment of herbaceous canopy.

The percent canopy cover of non-native vegetation in a 0.25-acre area within the mitigation site should be less than 10%. On an annual basis, or more frequently if needed, areas greater than or equal to 0.25 acres in size that have more the 10% areal cover of non-native vegetation shall be treated per mitigation plan. This typically includes the use of chemical and mechanical methods for management of non-native weeds. Noxious weeds shall also be monitored with a performance standard of less than or equal to 10%.

Evaluation of the success of the mitigation plan will be assessed annually until all performance standards are met. Site assessments will be conducted annually by the MAMT and an annual report will be submitted to the U.S. Fish and Wildlife Service (USFWS), TPWD, and other interested parties by January 30 following each monitoring year.

Permanent locations for photographic documentation will be established to provide a visual record of habitat development over time. The locations of photo points will be identified in the pre-construction monitoring report. Photographs taken at each photo point will be included in monitoring reports.

Costs to be incurred during PED and construction phases include drafting of the detailed monitoring and adaptive management plan. Cost calculations for post-construction monitoring are displayed as a ten-year (maximum) total. If ecological success is determined earlier (prior to ten years post-construction), the monitoring program will cease and costs will decrease accordingly.

It is intended that monitoring conducted for the terrestrial and aquatic mitigation will utilize centralized data management, data analysis, and reporting functions associated at the Fort Worth District. All data collection activities will follow consistent and standardized processes established in the detailed monitoring and adaptive management plan. Cost estimates include monitoring equipment, photo point establishment, data collection, quality assurance/quality control, data analysis, assessment, and reporting for the proposed monitoring elements.

Total Project Cost

Project costs amount to $7,969,239 including Pre-construction Engineering and Design (PED), and construction management. Fish and Wildlife Mitigation costs include plantings, monitoring, and adaptive management activities. PED costs include surveys, archeological studies, geotechnical studies, and project design. Storage allocation costs are $14,179,846, making total project costs $22,148,085.

Table 34. Total Project Costs for Aquilla Lake Reallocation

Cost Item	Cost	Contingency	Total
Real Estate	$0	$0	$0
Relocations	$574,477	$188,642	$783,915
Storage Allocation	$14,179,846	$0	$14,179,846
Fish and Wildlife Mitigation	$898,271	$294,967	$1,225,755
Levees and Floodwalls (Rock Rip Rap)	$1,900,745	$624,151	$2,593,703
Recreation Facilities	$1,198,607	$393,589	$1,635,585
Pre-Construction Engineering and Design	$720,002	$236,428	$982,494
Construction Management	$548,001	$179,948	$747,787
Total Costs	$20,019,949	$1,917,725	**$22,148,085**

Operation, Maintenance, Repair, Rehabilitation, and Replacement

The present total storage volume contracted to the Brazos River Authority at Aquilla Lake, Texas is 33,600 AF. This volume gives an approximate yield of 10,860 AF per year. Currently 75.87% or 25,493 AF is activated with the remainder reserved for future use. The initial activation on Aquilla Lake was 10% or 3360 AF with subsequent segments activated since impoundment until present. Five (5) additional segments of varying percentages have been activated since the initial 10%. Each subsequent segment was activated based on BRA's exceedance of the corresponding yield of the activated storage that was in place at the time. See Table 35 for activated segments amounts and year activated.

Table 35. Active Storage at Aquilla Lake

Year	Segment #	Storage Acre-Feet	Yield Acre-Feet	Percent of Total Storage %	O&M Portion %
Initial Activation	1	3360	1086	10.00	5.34
1995	2	3444	1113	10.25	5.48
1999	3	1856	600	5.52	2.95
2007	4	7116	2300	21.18	11.32
2009	5	6074	1963	18.08	9.66
2012	6	3643	1177	10.84	5.79
Current Totals		25493	8240	75.87	40.54
Fully Activated Totals		33600	10860	100.00	53.43

In the event of reallocation of flood control storage for water supply use, it is recommended that BRA activate the remaining future use storage of the original 33,600 AF allocated to them below the current conservation elevation of 537.5' MSL as specified in the original water supply contract, number DACW63-76-C-0090. It is also recommended that any new contracted water

supply storage occurring through reallocation be fully activated when that storage is first made available for use.

Low frequency events (0.33% ACE or less frequent) may result in an event based increase in repair costs to repair erosion associated with overtopping the uncontrolled spillway. However, due to the low frequency and the absence of any historical data associated with events less frequent than the 2% ACE, it is expected that the change in average annual cost would be quite small.

IMPLEMENTATION SCHEDULE

The implementation schedule and costs are identified in Table 36. No real estate needs to be acquired. However, some utility and road relocations or improvements are needed to implement the proposed project. Some existing recreation facilities will need to be demolished and replaced to support the proposed project. The existing embankment will be reinforced with rip rap to support the proposed reallocation. Terrestrial environmental habitat adversely impacted by the proposed project will be mitigated, and monitoring and adaptive management will take place to ensure success of the new habitat areas. Once construction is complete and impoundment begins, BRA will initiate payment for storage allocation costs. These costs may be paid in one lump sum when impoundment begins or BRA may elect to make payments over a 30 year period.

Table 36. Implementation Schedule and Costs for Proposed Aquilla Lake Reallocation

Project Feature	Total Cost for Feature	Costs in 2016	Costs in 2017	Costs in 2018	Costs in 2019	Costs in 2020
Real Estate	None					
Relocations	$664,362			$664,362		
Embankment	$2,198,145		1,000,000	$1,198,145		
Recreation Facilities	$1,419,395	$100,000	$347,237	$547,354	$424,804	
Environmental Mitigation	$1,805,320			$367,020	$305,786	$412,514
Construction Totals	$5,367,220	$100,000	$1,347,237	$2,776,881	$703,590	$412,514
Pre-construction Engineering and Design (PED)	$855,133	$491,803	363,330			
Construction Management	$644,066	$100,000	$126,246	$166,246	$130,946	$120,628
Total PED & Construction Costs	$6,866,421	$691,803	$1,836,813	$2,943,127	$861,536	$533,142
Storage Allocation	$13,797,339					$13,797,339
Total Project Costs	$20,663,759					

Cost Sharing

The sponsor will provide 100% of the funding for the proposed reallocation project in accordance with Section 103 Water Resource Development Act of 1986.

Financial Plan and Capability Assessment

BRA & Econ self certification letter comes in after draft report and cost cert

Views of the Local Sponsor(s)

BRA letter of support/request for reallocation comes in after draft report and cost cert

Views of the Resource Agencies

Env & PM-C PAL, partnership in field work with USFWS and TPWD, pending letter from USFWS saying "we're good and not providing a CAR" or get a CAR

Views of Other Federal Agencies (If applicable)

PM- C state no airfields, water quality, air quality, etc issues; be sure we get them all a letter, say who we're sending letters to here.

CHAPTER 6: PUBLIC INVOLVEMENT*

Native American coordination was initiated in 2008 and continues as the study progresses.

Coordination with the Texas Historical Commission is ongoing since 2012. Costs for additional archaeological studies have been included in accordance with correspondence with the State Historic Preservation Officer. Check to see if we sent letters announcing feasibility study and EA. Discuss public meetings associated with State Water Plan and the incorporation of Aquilla reallocation as an alternative in the water.

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