APPENDIX B

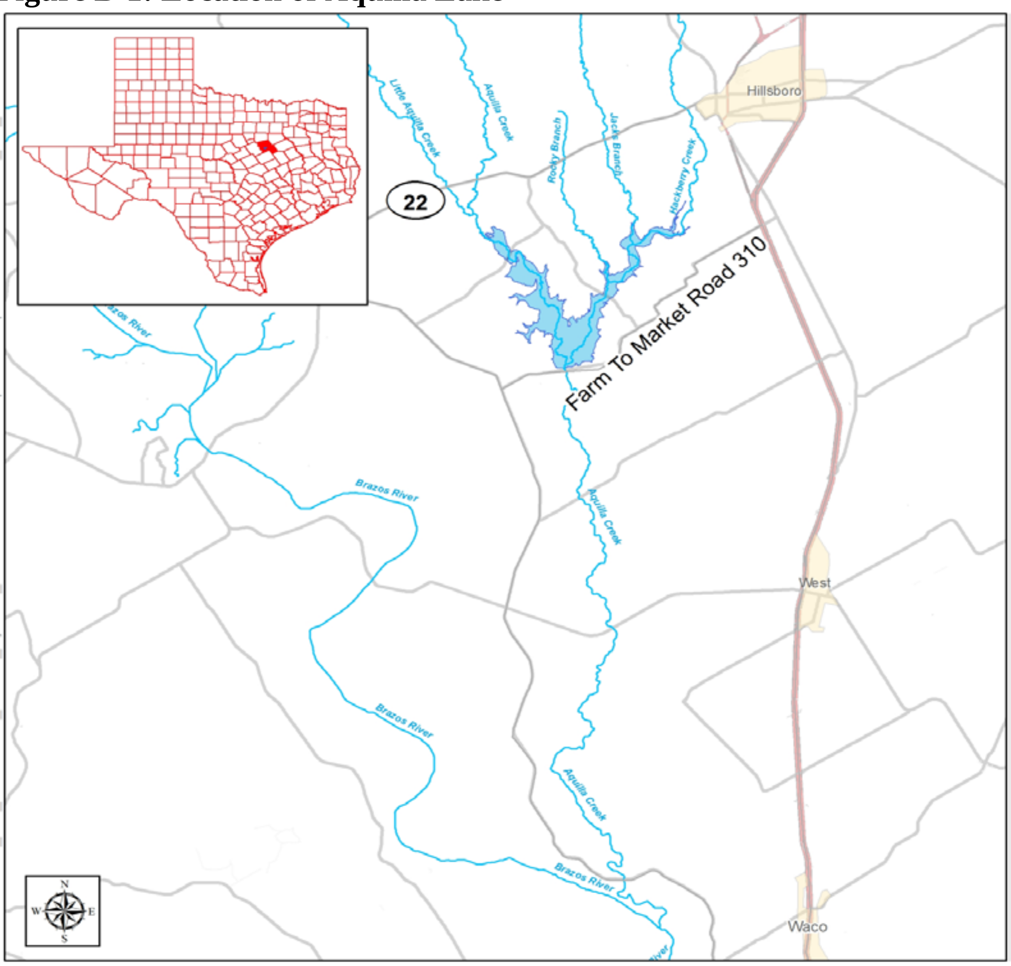
ENVIRONMENTAL RESOURCES

ENVIRONMENTAL SETTING

General Description

Aquilla Lake, an approximately 7,000-acre reservoir constructed by the U.S. Army Corps of Engineers (USACE), is located southwest of the city of Hillsboro in Hill County, Texas (Figure B-1). The lake is bordered to the north by State Highway 22 and to the south by FM 310. Agriculture is the primary land use adjacent to the Aquilla Lake area. 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 other smaller unnamed tributaries empty into the reservoir. Below the spillway, Aquilla Creek resumes flow and ultimately empties into the Brazos River approximately 24 miles downstream.

Figure B-1: Location of Aquilla Lake



The Aquilla Lake study area, approximately 11,430 acres in size, encompasses the lake, adjacent USACE-owned property, and a 150-foot wide corridor between Aquilla and an existing pipeline between Pat Cleburne and Aquilla Lakes (see Figures B-2 and B-3). Six terrestrial wildlife habitat types (or landcover), open water, and structures/disturbed were identified and delineated with the assistance of US Fish and Wildlife Service personnel. Figure B-4 displays the various landcover types surrounding Aquilla Lake, while Tables B-1 and B-2 present the associated acreage and relative percent coverage of the study area. The disturbed area designation (253 acres) consists of highway crossings, the project office complex, the dam area and several boat ramps and recreational access areas. The current conservation pool elevation for Aquilla Lake is 537.5 feet NGVD, with a flood pool elevation of 556 feet NGVD.

Figure B-2. Aquilla Lake Study Area

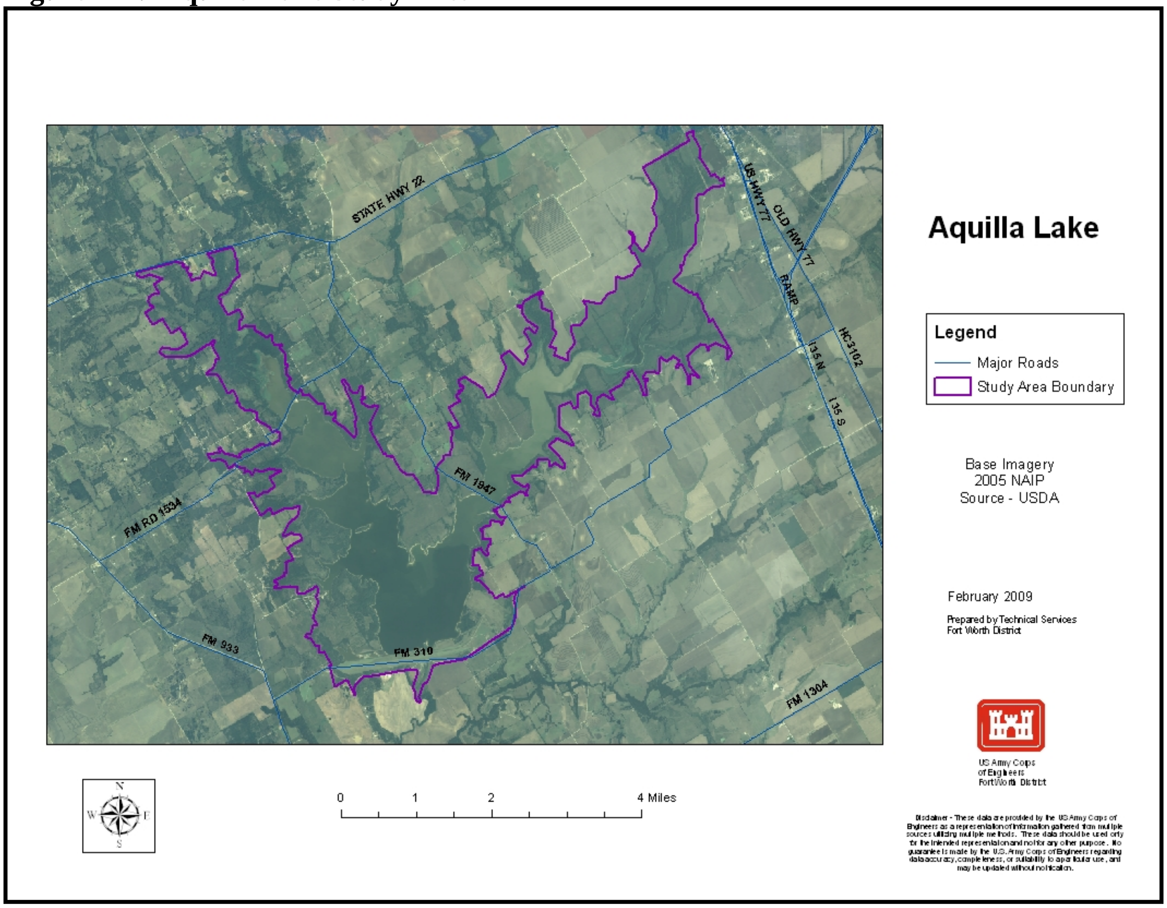


Figure B-3. Whitney Pipeline Study Area

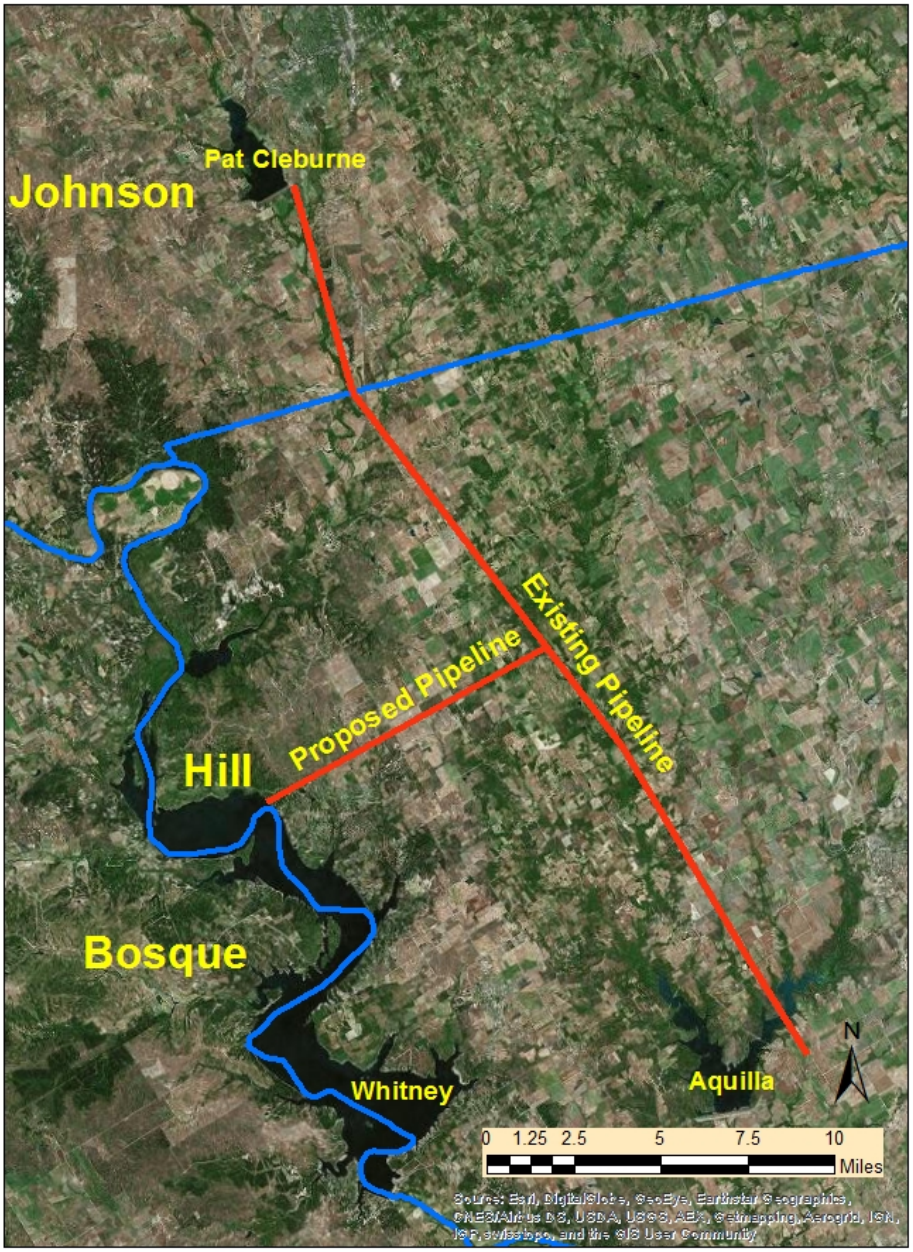


Figure B-3. Aquilla Lake Landcover Map

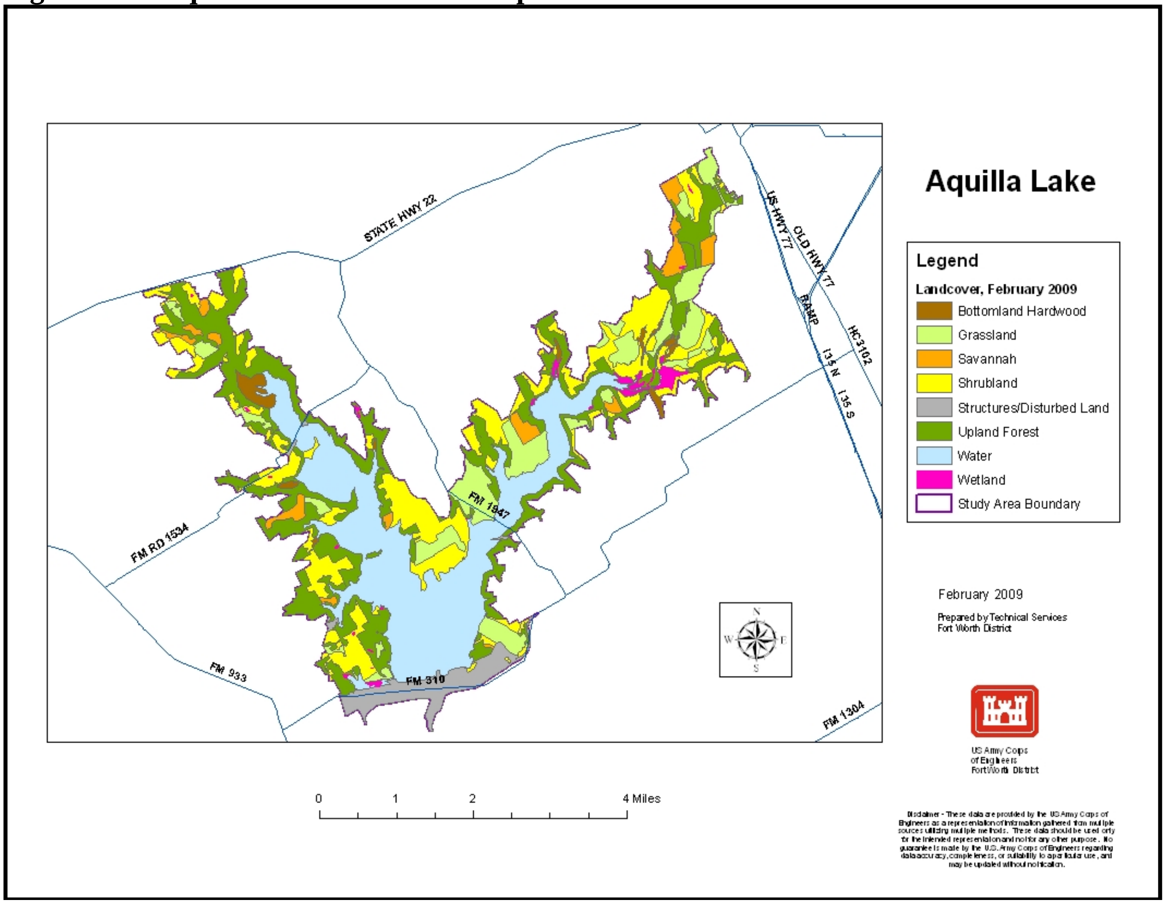


Table B-1. Aquilla Lake Project Lands

Type	Lake Surface (conservation pool)	Disturbed Areas	Riparian Woodland	Upland Forest	Herbaceous Wetland	Grassland	Deciduous Shrubland	Savanna
Acres	3164*	231	334	2802	113	1199	2043**	365*
Percent of Aquilla Lake Area	30.9%	2.3%	3.3%	27.3%	1.1%	11.7%	19.9%	3.6%

*Note: Number of acres is different from Table 1. Aquilla Lake Pertinent Data, in the Main Report, because of slight errors associated with GIS overlays.
**USFWS PAL due to correction of rounding errors.

Table B-2. Lands Associated with 150 –foot Wide Pipeline Corridor

Habitat Type	Riparian Woodland	Upland Forest	Riparian Herbaceous	Grassland	Shrubland	Crops
Acres	11.3	51.4	5.8	79.7	4.0	29.4
Percent of Pipeline Area	6.2%	28.3%	3.2%	43.9%	2.2%	16.2%

Climate

The climate of Hill County is humid subtropical with hot summers and mild winters. The temperature ranges between an average high of 97° F in August and an average low of 36° in January. The lowest minimum recorded temperature is -5°F and the highest maximum temperature is 112°F. The average annual rainfall varies from 36-40 inches in the eastern part of the county to 32-36 inches in the western portion. The wettest portion of the year is late spring and summer with approximately 56% of the average annual rainfall occurring between April and September. (NOAA 2008) The mild temperatures and adequate rainfall provide a growing season of 230 days a year.

Land Use

As of the 2010 census, Hill County had a population of 35,089 and is comprised of 657,452 acres of land. Almost half of the land in Hill County is used for field crops, with an additional third being pasture. Urban usage and water combined only account for approximately 6 percent of the total land use in Hill County (Handbook of Texas Online, Hill County 2009).

Of the government-owned property that make up the Aquilla Lake Project lands, approximately 6,860 acres are in Natural Resource Management Areas (NRMAs), managed primary for wildlife habitat. With the restricted Natural Resource Management budget at the lake over its 33-year life, most of the NRMA lands 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 that allow for cattle grazing in management areas in return for cash payment or work abatement, which may take the form of habitat management, as needed. Even with tools such as Grazing Leases to supplement management of the natural areas, most lands at Aquilla Lake are not intensely managed.

Regional Geology and Soils

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 a narrow, north-south trending belt bounded on the west by the Grand Prairie subdivision and on the east by the Blackland Prairie subdivision. 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 soils of the Woodbine 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, 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).

Immediately west of Aquilla Lake, the study area overlies the Grayson Marl, Mainstreet Limestone, and the Pawpaw Formation and Weno Limestone undivided. The Grayson Formation is a chalky, yellow-white to gray marl with gray shale beds. The transition from the Grayson to the overlying Woodbine Formation represents a regression of Cretaceous seas. The Mainstreet Formation is a resistant limestone formed from supersaturated lime mud. The Pawpaw Formation is comprised of shales and clays with some sandstone ledges formed in shallow marine waters. Weno Limestone is comprised of soft, chalky limestone in the upper unit, calcareous clay with occasional lenses of sand-sized shell fragments in the middle unit, and limestone with some sand in the lower unit.

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).

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 is comprised of soils designated as prime farmland soils by the Natural Resources Conservation Service.

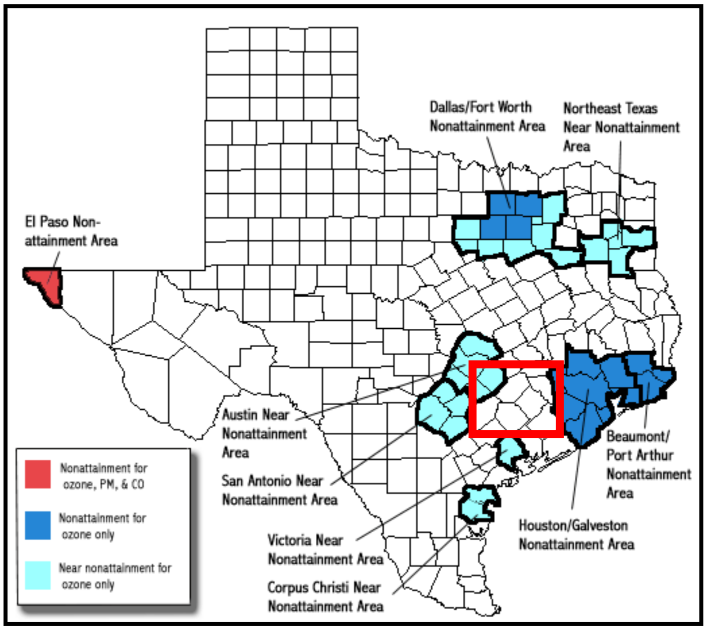
Air Quality

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 (see Figure B-4).

The nearest area of the state listed as a non-attainment area by the EPA is the Dallas Fort Worth Nonattainment Area which is located approximately 60 miles north of the Hill County Area (outlined in red on Figure B-3).

Hill County has a total population of approximately 35,000 residents. 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. Since Hill County area is a predominantly rural setting and not highly industrialized, the air quality is generally considered to be good.

Figure B-4. EPA Nonattainment Areas in Texas



Aquatic Resources

Surface Water

Aquilla Lake is a relatively small, multipurpose reservoir whose main purposes are flood risk management and water supply. Recreational use is limited with the reservoir having only two permanent boat ramps and several multipurpose access areas. At the conservation pool elevation of 537.5 feet NGVD, the lake is approximately 3,164 surface acres. Aquilla Creek and Hackberry Creek comprise the two major arms of the lake, with each being roughly equal in size and running along a north-south axis. Due to the generally clayey soils and cropland in the drainage area, lake water tends to be moderately turbid. Water depths average 16 feet in the main body of the lake. Water temperatures fluctuate more in this relatively shallow lake than they do in deeper reservoirs.

The Hackberry Creek arm of the Aquilla 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 channel 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 of the lake 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 channel, creating favorable fish habitat. Aquilla Creek was cleared of timber from the Old School Boat Ramp Area to the dam.

Whitney Lake is located on the main stem of the Brazos River approximately 38 miles upstream of Waco, Texas. Whitney Lake was constructed primarily for flood risk management; however, other purposes include water conservation, hydroelectric power, and recreation. At the conservation pool elevation of 533.0 NGVD, the lake is approximately 23,560 acres with a maximum depth of 108 feet.

Lake Zones

There are different zones of biological communities within the open/surface water habitat at Aquilla Lake. These include:

- Limnetic zone (deep water)
- Littoral zone
- Transition zone between the littoral and the in-stream
- In-stream

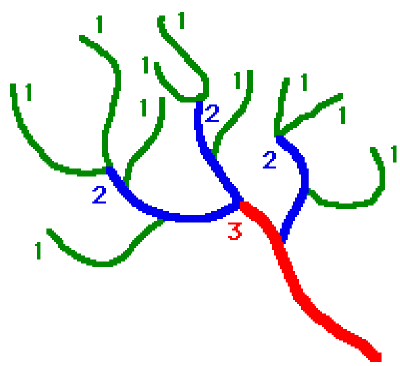
The deep water region, or the limnetic zone, is often characterized by an open water area where light does not generally penetrate all the way to the bottom of the lake. The productivity of this zone largely depends upon the organic content of the sediment, the amount of physical structure, and, in some cases, upon the rate of fish predation. Sandy substrates contain relatively little organic matter (food) for organisms and poor protection from predatory fish. Higher plant growth is typically sparse in sandy sediment because the sand is unstable and nutrient deficient. A rocky bottom has a high diversity of potential habitats offering protection (refuge) from predators, substrate for attached algae (periphyton on rocks), and pockets of organic "ooze" (food). A flat mucky bottom offers abundant food for benthic organisms but is less protected and may have a lower diversity of structural habitats, unless it is colonized by plants. The layer of water below the surface where sunlight is still sufficient for photosynthesis to occur is called the euphotic zone, which is also found within this deep water region.

The littoral zone is that area inhabiting the shore and/or shallow area of a lake. The littoral zone is subject to a wide range of environmental conditions, including wave-energy action and intermittent periods of flooding and drying along with the associated fluctuations in exposure to solar radiation and extremes of temperature (American Heritage Science Dictionary). The depth of water associated with this zone is often great enough to restrict light penetration making it too dark on the bottom for macrophytes to grow. However, emerged plants, and submerged plants are associated with this zone.

The transition zone between the littoral and the in-stream can be characterized by the existence of stagnant water or slackwater pools, along with the absence or lack of riffle/run habitat. While this zone is not necessarily a formal lake ecological zone, it is an area of dynamic transition between a functioning lake and stream system. This area also serves as an important transition zone between lake fish and benthic communities versus typical in-stream fish and benthic species.

There is a recognized hierarchy of stream segment ordering classification system (Figure B-5). In this system, channel segments are ordered numerically from a stream's headwaters to a point somewhere downstream. Numerical ordering begins with the tributaries at the stream's headwaters being assigned the value 1. A stream segment that results from the joining of two 1st order segments is assigned an order of 2. Two 2nd order streams form a 3rd order stream, and so on.

Figure B-5. Example of stream ordering classification



In-stream habitat and stream systems can be highly dynamic and diverse, with a number of recognized habitat features. Pools and riffles are the most common types, while others include, but are not limited to, plunge pools, lateral scour pools, backwater pools, dammed pools, glides, rapids, cascades, falls, and side channels (Bisson et al. 1982). Within these features there are also various characteristics, including flow, substrate, and water depth, all of which are essential in determining what biotic stream organisms are found within each feature. These characteristics determine species growth, reproduction, and survival.

Streams can contain a diverse fauna of invertebrates, salamanders, and fish. Animal communities vary according to elevation and stream size. The variations are related to changes in temperature, stream chemistry, flow, and local geomorphology (Scott 2001). The interacting communities of biologic organisms within a stream (including microbes, plants, and animals) are highly variable across space and dynamic through time. Layers of slime on stones, wood, sand grains, and other surfaces comprise rich communities of bacteria, fungi, diatoms, and algae. Generally, high-gradient streams support less plant community diversity than low-gradient streams, lakes, and reservoirs. Shade and high current velocities may also limit plant species and communities.

The project area at Aquilla includes the various "lake zone" areas (Table B-3 and Figure B-6). While the entire lake surface encompasses approximately 3,164 acres, when examined more closely according to "zones", the limnetic zone makes up about 2,281 acres, while the littoral zone encompasses approximately 883 acres. Within these zones are different physical, chemical, and biological processes, along with varying species of fish, vegetation, and benthic organisms. Figures B-7 and B-8 are examples of the various zone areas located in and along Hackberry and Aquilla creeks, the two major tributaries of Aquilla Lake.

Table B-3. Summary of Water Types or "zones" within the Aquilla project area.

	Existing conditions
Water Type / Zone	**acres**
Lake surface (conservation pool)	3,164
Limnetic (Deep water)	2,281
Littoral zone (shallow)	883

Figure B-6. Lake "zones" associated with Aquilla Lake.

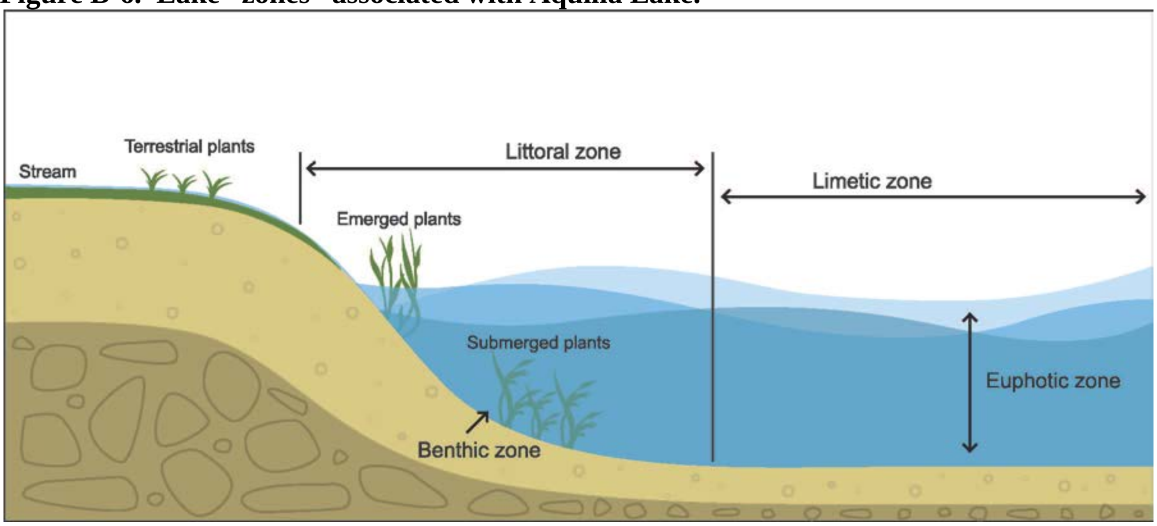


Figure B-7. Lake zones associated with Hackberry Creek.

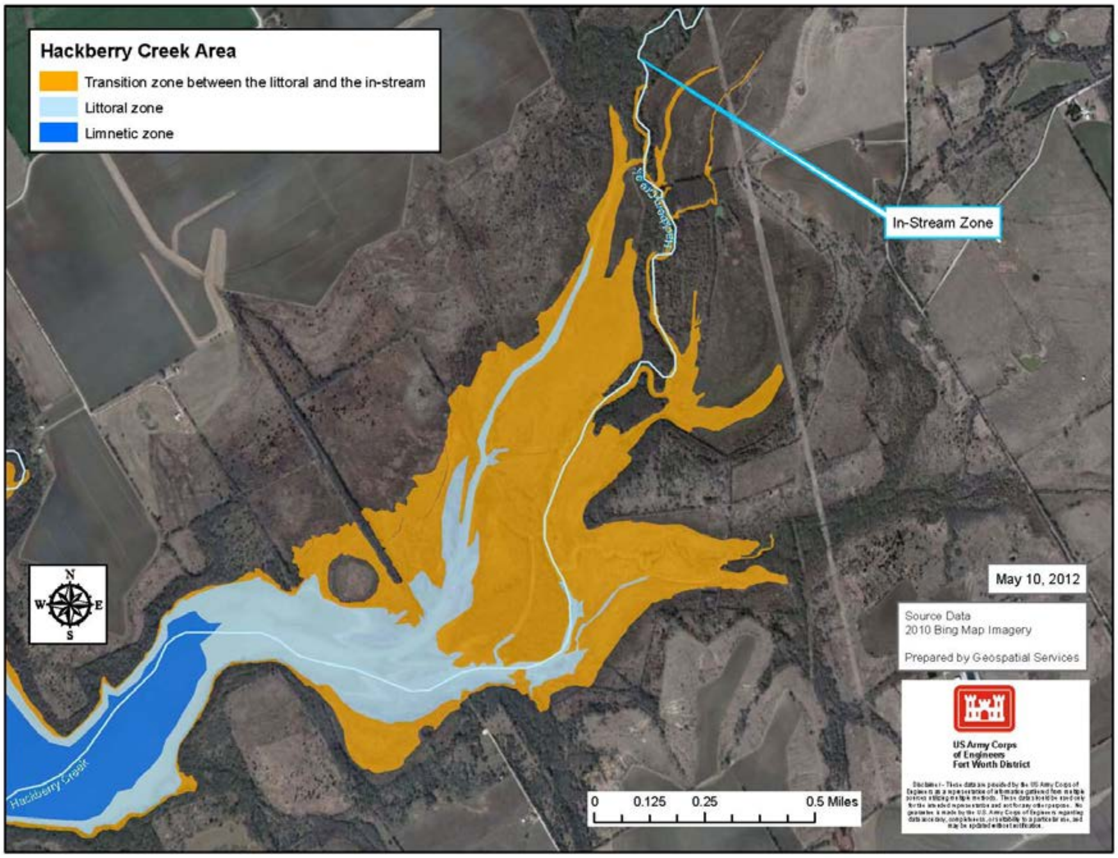
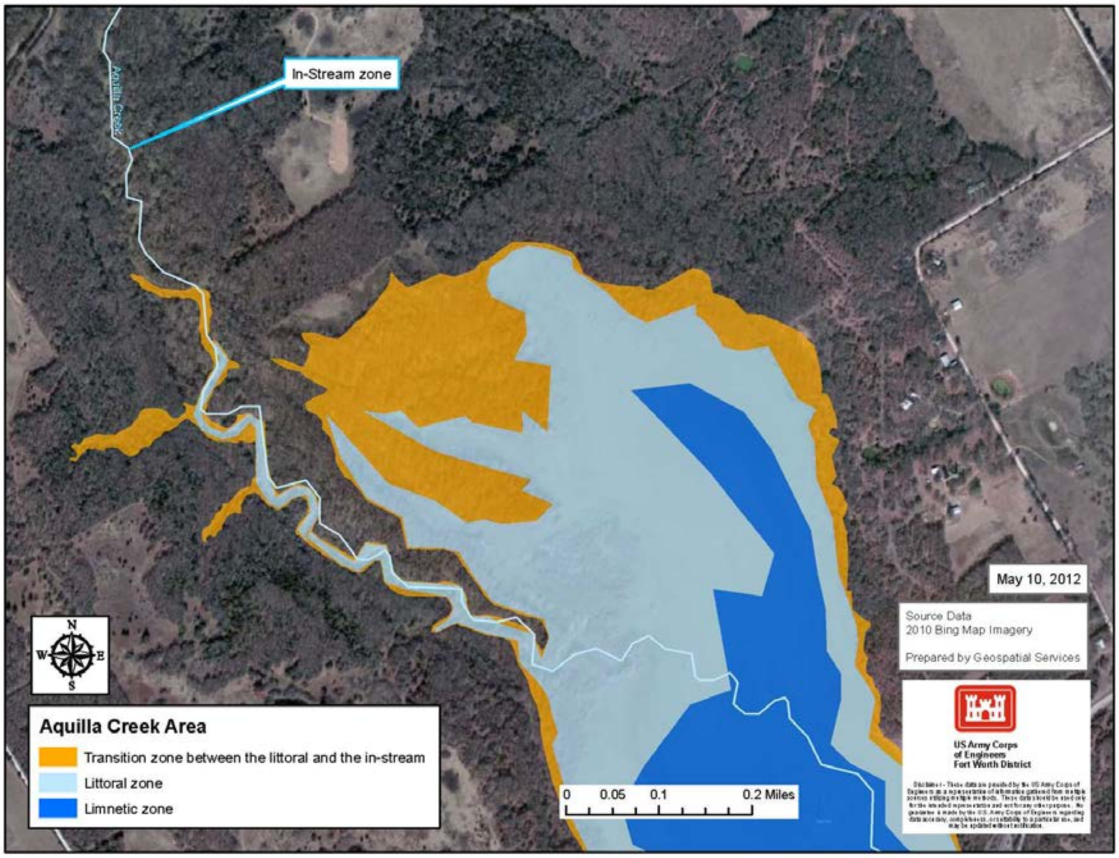


Figure B-8. Example of the various lake "zones" on an area of Aquilla Lake (Aquilla Creek area).



In-stream habitats of Aquilla Lake are located within the four major tributaries (Figure B-9): 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 B-4 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.

Figure B-9. Various tributaries to Aquilla Lake.

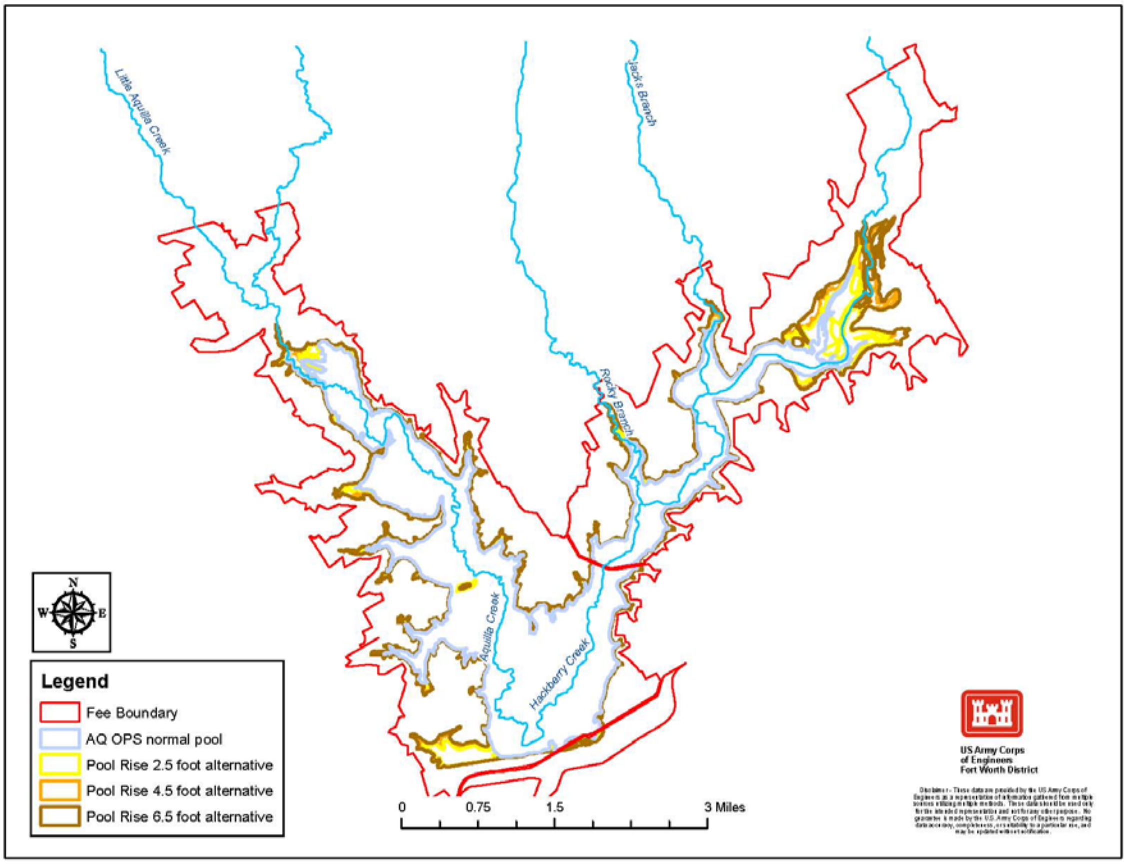


Table B-4. Summary of in-stream habitat / tributary areas of the Aquilla project area

Stream Name	Water Identification	Hydraulic characteristic	Total linear ft (from pool ops to fee boundary	In-stream acreage
Aquilla Creek	Tributary	Intermittent	20,691.84	24.51
Rocky Branch	Tributary	Ephemeral	7,275.45	18.65
Jack's Branch	Tributary	Ephemeral	4,864.92	9.66
Hackberry Creek	Tributary	Perennial	48,283.32	216.26

In addition to the creeks draining into Aquilla Lake, two creeks bisect the pipeline portion of the study area between Whitney and the existing pipeline between Aquilla and Pat Cleburne Lakes: Cedar Creek and Bear Creek. These creeks are intermittent supporting forested riparian habitats.

Floodplains

Floodplains in the study area are located along the banks of the streams and rivers in the study area and along the shoreline of Aquilla Lake. Since the lake is in a rural area there is little known development encroaching on the floodplains within the study area.

EO 11988 requires federal agencies to avoid "to the extent possible the long- and short- term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative." In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce risk of flood loss, to minimize impact of flooding on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities" for:

- Acquiring, managing, and disposing of federal lands and facilities;
- Providing federally undertaken, financed, or assisted construction and improvements; and
- Conducting federal activities and programs affecting land use, including, but not limited to water and related land resources planning, regulation, and licensing activities.

Groundwater

Hill County is encompassed within the Northern Trinity/Woodbine aquifer system. Covering over 30,000 square miles and extending from approximately 40 miles north of the Red River, the system includes all or part of 46 Texas, nine Oklahoma, and five Arkansas counties. 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 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 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.

Waters of the U.S. (CWA Section 328.3[2]) are those waters used in interstate or foreign commerce, subject to ebb and flow of tide, and all interstate waters including interstate wetlands. Waters of the U.S. are further defined in 33 CFR 328.3, as all other waters such as intrastate lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, natural ponds/impoundments of waters, tributaries of waters and territorial seas. Under Section 404 of the Clean Water Act the USACE regulates the discharge of dredged and fill material into waters of the U.S., including wetlands. The USACE responsibility under Section 10 of the Rivers and Harbors Act of 1899 is to regulate any work in, or affecting, navigable waters of the United States. In accordance with the Section 404(b)(1) guidelines, prior to issuing a Section 404 permit for discharges of dredged and fill material, the USACE must determine that potential impacts to waters of the U.S. have been *avoided* and *minimized* “to the maximum extent practicable.” Further, in order for an action to be permitted, the Corps must determine the proposed project represents the least environmentally damaging practicable alternative (LEDPA). After the LEDPA determination is made, compensatory mitigation, sufficient to offset unavoidable adverse impacts to waters of the U.S., is required.

There are no navigable waters of the U.S. (covered under Section 10 of the Rivers and Harbors Act of 1899) are present within the above referenced areas.

EO 11990 requires that governmental agencies, in carrying out their responsibilities, provide leadership and “take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance natural and beneficial values of wetlands.” Each agency is to consider factors relevant to a proposed project’s effect on the survival and quality of the wetlands by maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish and wildlife. If no practicable alternative can be demonstrated agencies are required to provide for early public review of any plans or proposals for new construction of wetlands.

Water Quality

The overall water quality in Aquilla Lake is good. Chloride and sulfate concentrations average 110 parts per million (ppm) and 310 ppm respectively. Due to the agricultural land use surrounding the lake, it is generally turbid and with a Total Dissolved Solid (TDS) concentration of 600 ppm.

None of the lake’s tributaries or the reservoir itself currently appears on the Texas Commission on Environmental Quality (TCEQ) 303 (d) list of impaired water bodies. However, there were concerns 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 in the past (TCEQ Website 2009). The source for the Atrazine was its use in farming activities around the lake and subsequent runoff during large rain events.

Concerns over the high levels of the herbicide triggered actions to address agricultural sources of the herbicide by the TCEQ, the Texas State Soil and Water Conservation Board 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 Aquilla Lake is no longer listed as an impaired water body, it is listed on the TCEQ's 305 (b) list for several concerns. These concerns include nickel and arsenic in sediment; nitrate in water, and low levels of atrazine in finished drinking water.

Although Whitney Lake chloride (435 ppm) and TDS (1,255 ppm) concentrations are significantly higher that Aquilla Lake, Whitney Lake meets the water quality standards established by TCEQ. Sulfate concentrations in Whitney Lake (220 ppm) are lower than concentrations in Aquilla Lake.

Biological Resources

Vegetation

Hill County contains portions of the Cross Timbers and Prairies and the Blackland Prairies ecological areas of Texas (Gould, 1962) and the study area lies within the Eastern Cross Timbers natural vegetational area (Diggs et al., 1999). The Eastern Cross Timbers 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 uplands to be populated by scrub-type oak, mesquite, and juniper with mid- and short-grasses beneath (Hatch et al. 1990).

Aquatic vegetation adjacent to the shoreline in the main body of Aquilla 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 is switchgrass *(Panicum virgatum)*. Aquatic vegetation is more prevalent in the shallower areas upstream in the arms of the lake and consists of rattlebush *(Sesbania sp.)*, cocklebur *(Xanthium strumarium)*, peppervine *(Ampelopsis arborea)* and teal lovegrass *(Eragrostis hypnoides).*

Wildlife

The study area is used by both resident and migratory wildlife species, likely 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 that may be 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 may 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 may be found within the reservoir and wetlands, while lizards and snakes can be found throughout the study area. A list of faunal species that were observed during field investigations in the study area is included on each site observation sheet in Appendix B of the USFWS Planning Aid Report.

Fish species within the reservoirs 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).

Threatened & 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 any of the current activities or an increase in conservation pool level would have an adverse impact on this species.

The golden-cheeked warbler's habitat is generally described as mature (at least 12 feet tall) oak-juniper woodlands, with 50 percent or greater canopy cover, although warblers have been found in habitat with as little as 30 percent canopy cover. Steep, narrow canyons, with deciduous trees located along the drainage bottoms and juniper on the side slopes, provide an ideal mix of vegetation for this species. However, suitable habitat may also occur on hilltops or other relatively flat areas. Ideal habitat areas have a diverse mixture of juniper and hardwood trees, including oaks, hackberry, sycamore, and cedar elm.

The black-capped vireo is a habitat specialist, nesting in mid-successional brushy areas (i.e., before the area develops into a mature woodland) where the dominant woody species are oaks, sumacs, persimmon, and other broad-leaved shrubs. Juniper may be common in vireo habitat, but juniper prominence is not essential or even preferred by the birds. Typical nesting habitat is composed of a shrub layer extending from the ground to about six feet covering about 35-55% of the total area, combined with a tree layer that may reach to 30 feet or more. Open, sometimes grassy spaces separate clumps of trees and shrubs. The vireo also depends on broad-leaved shrubs and trees, especially oaks, which provide insects on which the vireo feeds.

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 adversely impacted due to proposed 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 U.S. Fish and Wildlife Service (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.

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 Least 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, is also a breeder 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*). Although habitat for these mussel species occurs in the study area, they were not observed during aquatic site visits and the TPWD Diversity Database does not identify any species occurrence in the study area.

Birds of Conservation Concern. The U.S. Fish and Wildlife Service (USFWS) published the *Birds of Conservation Concern (BCC) 2002* in December of 2008. "The overall goal of the BCC is to identify the migratory and non-migratory bird species (beyond those already designated as Federally threatened or endangered) that represent the highest conservation priorities and draw attention to species in need of conservation action." Twenty three species on the BCC lists may utilize the habitat types within the study area. These include: little blue heron (*Egretta caerulea*) - inlands marshes and ponds; northern harrier (*Circus cyaneus*) - marshes, prairies, and savannas; peregrine falcon (*Falco peregrinus*) – generalist; American golden-plover (*Pluvialis dominica*) - prairies, and savannas; long-billed curlew (*Numenius americanus*) – open water, prairies, and savannas; Hudsonian godwit (*Limosa haemastica*) - inlands marshes; buff-breasted sandpiper (*Tryngites subruficollis*) - prairies, margins of lakes; red-headed woodpecker (*Melanerpes erythrocephalus*) – woodlands; scissor-tailed flycatcher (*Tyrannus forficatus*) – prairies, savannas, and open shrubland; loggerhead shrike (*Lanius excubitor*) – open savanna, shrubland; Bell's vireo (*Vireo bellii*) - dense thicket; Sprague's pipit (*Anthus spragueii*) - short grass prairie; prothonotary warbler (*Protonotaria citrea*) – riparian woodland; worm-eating warbler (*Helmitheros vermivorus*) – woodlands; Swainson's warbler (*Limnothlypis swainsonii*) - riparian woodland; Kentucky warbler (*Oporornis formosus*) - riparian woodland; field sparrow (*Spizella pusilla*) – old fields, scrubland, forest edge; Henslow's sparrow (*Ammodramus henslowii*) – grasslands with scattered shrub; Le Conte's sparrow (*Ammodramus caudacutus*) – thick, damp grassy areas, wetlands; Harris' sparrow (*Zonotrichia querula*) - scrub, undergrowth in open woodlands, and savanna, thickets, brushy fields, and hedgerows; Smith's longspur (*Calcarius pictus*) – short grassland; chestnut-collared longspur (*Calcarius ornatus*) - shortgrass prairie, plowed field, and overgrazed pasture; painted bunting (*Passerina ciris*) - riparian and thorn forest, oak woodlands, savanna, brushy pastures, and hedgerows.

Invasive Species

Executive Order (EO) 13112, dated February 3, 1999 directs federal egencies to expand and coordinate their efforts to combat the introduction and spread of invasive species (i.e. noxious plants and animals not native to the U.S.). Non-native flora and fauna can cause significant changes to ecosystems, upset ecological processes and relationships, and cause harm to our nation's agricultural and recreational sectors. Numerous factors can facilitate the spread of plant and animal species outside their natural range, both domestically and internationally.

Until the National Invasive Species Council defines an approved national list of invasive plants, known invasive plants are defined as those on the official noxious weed list of the state in which the activity occurs. In Texas, the Texas Department of Agriculture defines and regulates prohibited and restricted weed seeds in accordance with Texas Agriculture Code (TAC), Chapter Section 61.008 (Texas Seed Law). Consistent with TAC Title 4, Part 1, Chapter 9, subchapter T, Section 19.300(a), a noxious weed know to occur in the project area is hydrilla (*Hydrilla verticillata*), which was identified as impacting roughly 10 acres of surface water in 2005.

A second invasive species known to occur in the project area is the import red imported fire ant (*Solenopsis invicta*), which occurs on 100 percent of the project's terrestrial lands.

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 percent 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 effects on hydrology for the study are in the future and are considered statistically insignificant.

The spillway at Aquilla Dam is at elevation 564.5 ft-msl. The top of the flood control pool is 556 ft-msl with the top of conservation pool at 537.5 ft-msl. The spillway crest elevation has an approximate exceedance probability of 1/500, or 0.2 percent 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.

Hazardous, Toxic, and Radioactive Wastes

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.

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. Five of the 39 sites assessed are potentially eligible for listing in the National Register of Historical Places (NRHP) pending additional investigations.

Recreational Resources

There are minimal recreation resources at Aquilla Lake. Existing operating recreation areas include two boat ramps and associated amenities, a fishing platform at the outlet works, a Corps 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. In 2012, approximately 104,000 visitors came to the lake to hike, bike, boat, hunt, fish, picnic, and swim at the existing facilities.

Recreation facilities at Whitney Lake are much more extensive and include 13 USACE parks, Lake Whitney State Park, 4 marinas, 28 boat ramps, 91 picnic sites, 872 camping sites, 9 playgrounds, 3 fishing docks, and miles of hiking and biking trails. In 2012, Whitney had approximately 1,558,300 visitors came to the lake.

Socio-economic Resources

The objective of socioeconomic analysis is to provide an open, realistic, and documented assessment of potential socioeconomic impacts from project implementation. The Region of Influence (ROI) is used for the purposes of assessing socioeconomic impacts of proposed actions as defined as the geographic limits of the project area. The ROI encompasses all inhabitants and related economic activity within Hill County, TX.

The ROI surrounding the proposed Federal action in Hill County, Texas experienced a decline in population from 1910 to 1970. Population has begun to slowly increase over the past 30 years. According to the 2010 census, Hill County has a population of 35,089 with growth projected to reach 45,989 by 2070 (2016 Brazos Region G Regional Water Plan, 2015). The largest town within the county is Hillsboro, which is less than ten miles from Aquilla Lake.

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

HABITAT EVALUATIONS

Terrestrial Habitat Evaluation Methods

An interagency biological team, including USACE, Texas Parks and Wildlife Department (TPWD), and the USFWS, conducted a habitat evaluation of the study area. The USFWS Habitat Evaluation Procedures (HEP) (USFWS 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. Forty-three survey sites were randomly selected within the six terrestrial habitat types in the study area: riparian woodlands, grasslands, upland deciduous woodlands, shrubland, savanna, and herbaceous wetlands (Table B-5 and Figure B-10). HEP data was collected in 42 of these sites.

Table B-5. HEP sites and associated habitat types for Aquilla Lake

	HEP site #							
Habitat Type								
Bottomland Hardwood	14	23	25	26	32	36	39	
Grassland	1	4	17	21	27	34	37	
Shrubland	2	5	13	20	28	40	42	
Savannah	3	10	16	24	31	33	41	
Emergent Wetland	6	8	12	18	22	29	35	38
Upland D. Forest	7	9	11	15	19	30		

Thirteen wildlife indicator species were selected to represent the wildlife communities that use the six habitats evaluated (Table B-5). 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 communities 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-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.

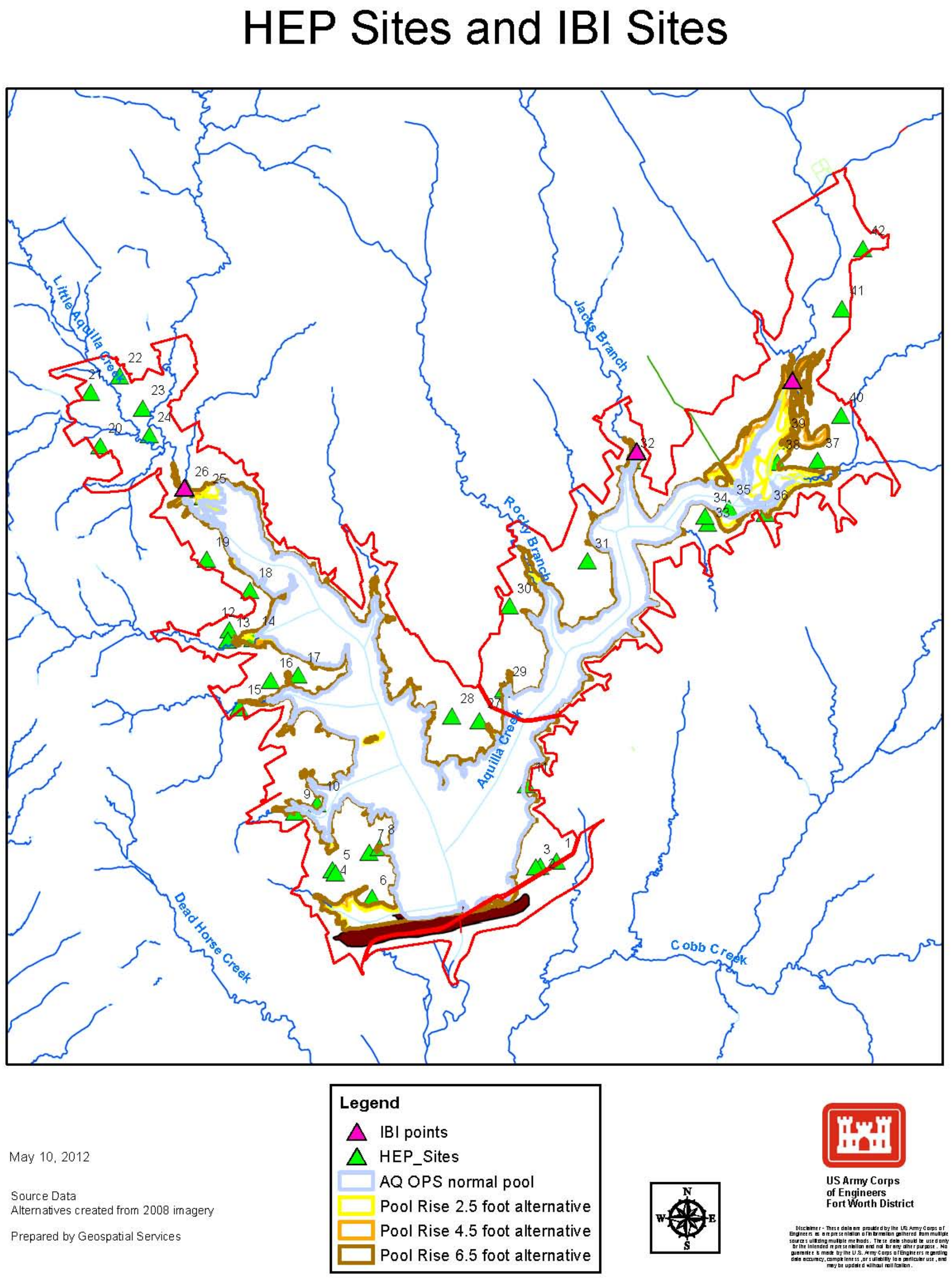
Of the thirteen HEP models that were utilized for habitat evaluations, seven are approved for use by the USACE Planning Center of Expertise (PCX) and are listed on the Ecosystem Restoration Model Library approval list. While all of the HEP models are not approved, the models which are approved offer analysis of all six habitats under evaluation (Table B-6). 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 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*).

Table B-6. Indicator species chosen for HEP evaluations with their represented habitat types. Indicator species with asterisks (*) are approved for use by the USACE PCX.

Indicator Species	**Habitat Type**					
	Riparian woodlands	Grassland	Shrubland	Savanna	Herbaceous Wetland	Upland Deciduous Forest
Raccoon	x				x	x
* Fox squirrel	x			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		

HEP requires the use of Habitat Suitability Index (HSI) models developed for each indicator species that use the habitats. The HSI models contain a list of structural habitat composition

Figure B-10. Habitat Evaluation sites (HEP & IBI) for Aquilla Lake



variables that are contained in optimum habitat. All the variables for each species representing each habitat are compiled and measured in the field. Eighteen variables were evaluated for the riparian woodlands. There were 12 variables measured for herbaceous wetland habitat, 18 savanna variables, 15 shrubland variables, 12 grassland habitat variables and 16 upland forest habitat variables. These variables were measured or estimated within a tenth-acre data plot within the habitat they represent. They are used as indicators of habitat condition or value. Photographic information, maps, and detailed scores for variables are contained in Appendices D, E, and F of the attached Planning Aid Report from USFWS.

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

Terrestrial Habitat Evaluation Results

A complete list of plant species observed during the surveys is included in Appendix A of the USFWS Planning Aid Report. Appendix B of the Planning Aid Report includes the individual site observation sheets that contain a description of each site, photographs taken in each compass direction from the center of each survey site, and a list of plants and animals observed at the site.

There are six distinct terrestrial habitat types in the study area: riparian woodlands, grasslands, upland deciduous woodlands, shrubland, savanna and herbaceous wetlands. A summary of the HSI values and habitat units associated with each habitat types is listed in Table B-7. The Upland Deciduous Forest scored an overall habitat value of “good”, while grasslands scored an overall “below average” value. The other four habitat evaluations, including riparian woodlands, herbaceous wetlands, deciduous shrublands, and savanna, scored “average”. An in-depth discussion of each habitat precedes the summary table including acreages and percent of project areas.

Table B-7. Average HSI values and habitat units for terrestrial habitat types

Indicator Species	Riparian Woodland (334 Ac)	Upland Forest (2802 Ac)	Herbaceous Wetland (113 Ac)	Grassland (1199 Ac)	Deciduous Shrubland (2043 Ac)	Savanna (365 Ac)
Barred Owl	0.71	0.45				
Carolina Chickadee	0.95	0.93				
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					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	**223.78**	**2073.48**	**61.02**	**575.52**	**1287.09**	**197.10**

Source: (USFWS, Planning Aid Reports 2009 & 2011)

Riparian Woodlands (334 acres)

Riparian woodlands are typically bottomland hardwoods, however, the study area contains some riparian woodlands that could be classified as upland influenced by an adjoining stream. The HEP defines the bottomland hardwood cover type as wetland areas dominated by deciduous trees, usually along streams, and that are occasionally flooded. In optimum conditions, this cover type provides food, cover, nesting habitat, and living space to riparian forest dependent species. Large trees are important as nesting habitat for the fox squirrel, wood duck, and barred owl, and escape cover for raccoons, wood ducks, and passerines. Large mast producing trees and shrubs provide food for the fox squirrel. Brush piles and snags provide necessary food, cover, and shelter for the raccoon and passerines. The close proximity to water is important for the raccoon and wood duck. Riparian forest habitats are essential in maintaining biodiversity and providing important wildlife travel corridors.

Riparian woodlands make up approximately 3.3% of the study area and 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.

Upland Deciduous Forest (2,802 acres)

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 223.78 HUs.

Deciduous forests are upland hardwood areas dominated by trees with a minimal tree canopy cover of 25%. Upland forests provide food, cover, nesting habitat, and living space to upland forest dependent species. Five species were utilized to represent the upland forest guild: barred owl, raccoon, Carolina chickadee, fox squirrel, and downy woodpecker. Large trees are important as nesting habitat for the fox squirrel and barred owl. 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 forest makes up 27.3% of the study area and six data sites were evaluated. 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 squirrel 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 2,073.48 HUs.

Herbaceous Wetlands (113 acres)

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 makes up only 1.10% of the study area. It is comprised primarily of reservoir and creeks, and seasonally flooded areas. Some of these wetlands are permanent, but most are likely seasonal.

There were eight data sites in herbaceous wetlands. The three species representing the herbaceous wetland cover type are the raccoon, green heron, and wood duck. 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 61.02 HUs.

Grasslands (1,199 acres)

Grasslands are dominated by grasses, native or introduced, that are not regularly planted or mowed, and have a minimal canopy cover of 25%. Grasslands 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. Red-tailed hawks hunt for prey in open grasslands. Grasslands make up 11.7% of the study area.

Much of the grassland within the study area could 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),* little bluestem *(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. Three indicators species represent the grassland guilds: eastern meadowlark, American kestrel, and the eastern cottontail. The HSI values per species 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 that 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 575.52 HUs.

Deciduous Shrublands (2,043 acres)

Shrublands are defined as non-wetland areas dominated by shrubs with a minimum shrub canopy cover of 25%. 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. Shrublands make up 19.9% of the study area. 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 red cedar, Chickasaw plum *(Prunus angustifolia),* and western soapberry *(Sapindus saponaria).* There were seven survey sites in shrublands. Four indicator species represent the shrubland guild: northern bobwhite, scissor-tailed flycatcher, racer, and eastern cottontail. The deciduous 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 deciduous shrubland was 0.63 (average value) with 1,287.09 HUs.

Savanna (365 acres)

Savanna is a non-wetland area with a shrub and/or tree canopy cover between 5% - 25%, but with a total canopy cover of all vegetation greater than 25%. 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. Savanna makes up 3.6% of the study area.

There are seven data sites in this cover type. 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. Five indicator species represent the savanna guild: eastern meadowlark, American kestrel, fox squirrel, scissor-tailed flycatcher, and the eastern cottontail. 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 that provide essential winter cover for cottontails. The average HSI for savanna is 0.54 (average habitat value) with 197.10 HUs.

Aquatic Habitat Evaluation Methods

To establish a baseline for project evaluation, the study team needed to quantify the existing value of the aquatic resources within the lake's littoral zone area and in the upstream tributary areas that could be potentially impacted by modifications associated with the proposed reallocation project. USFWS provided direction into appropriate survey methods for the area, thus, 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 of the metrics is scored with values ranging from low (1) to high (5). In turn, aquatic life use values are determined by adding each metric score for a total score. These aquatic life use values can range from limited to exceptional. The total score for aquatic life use subcategories within the Subhumid Agricultural Plains (Ecoregions 27, 29, and 32), which includes the Aquilla Lake area, were as follows: >49 = Exceptional; 41-48 = High; 35-40 = Intermediate; and <35 = Limited (Linam *et al.* 2002).

An interagency biological team, including USACE and USFWS, conducted an aquatic habitat evaluation of the aquatic study area at Aquilla Lake. The team collected field data on August 23, 30, and 31, 2011. A fisheries survey and IBI evaluation was conducted on three tributaries of the lake - Aquilla Creek, Jack's Branch, and Hackberry Creek, within the areas that would be directly impacted by implementation of the proposed activities. See Figure B-9 for location of IBI aquatic habitat evaluation sites. Rocky Branch, also a main tributary of Aquilla Lake, was not sampled due to being completely dry during the sampling period.

Aquatic Habitat Evaluation Results

Aquilla Creek is considered a 3rd order perennial stream, with an average width of 30 feet (9 meters) and an average water depth of 3 feet (1 meter). Substrate was dominated by clay and silt with areas of abundant organic debris.

Jack's Branch is a 1st order stream, with an average width of about 18 feet (5.5 meters) and an average water depth averaged of 4 feet (1.2 meters). Substrate was dominated by clay and silt with areas of abundant organic debris.

Hackberry Creek is a 3rd order stream, with an average stream width of 25 feet (7.6 meters). Water depth average is about 3 feet (1 meter) 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 fishes, comprising 14 identifiable species from 8 families, were collected from the Aquilla Lake tributaries 3 main sampling sites. The complete results, including fish composition, are detailed in the USFWS Supplemental Planning Aid Letter 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). 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 B-8).

Table B-8. Regional IBI Metric Calculations (IBI Score) for Overall Study Area.

1. Total # of fish species:	14 (5)	7. % of individuals as invertivores:	87 (5)
2. # of native cyprinid species:	1 (1)	8. % of individuals as piscivores:	7 (3)
3. # of benthic invertivore species:	4 (5)	9a. # of individuals/seine haul:	72 (3)
4. # of sunfish species:	5 (5)	9b. # of individuals/minute of electro-fishing:	na
5. % of individuals as tolerant species (excluding mosquitofish):	36 (3)	10. % of individuals as non-native species:	<1 (5)
6. % of individuals as omnivores:	6 (5)	11. % of individuals with disease or other anomaly:	0 (5)
IBI Total Score: 45 (High)			

Source: (USFWS, Supplemental Planning Aid Letter, 2011)

The regionalized 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 fish assemblages at Jack's Branch and Hackberry Creek (scores of 47 and 43, respectively). The fish community within the overall study area was characterized as high, with a score of 45 and the mean IBI score for the three sites also characterized the study area as high, with a mean score of 41.

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.

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 of 0.45 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, in this case 0.45 X 3,164 = 1,423.8 IBI HUs.

FUTURE WITHOUT PROJECT CONDITIONS

The future without project condition is equivalent to a description of the "no action" alternative. In order to effectively evaluate changes to the environment of the study area if proposed modifications to the conservation pool are implemented, it is necessary to forecast likely future conditions if they are not. Under the "no action" alternative there would be no raise of the conservation pool at Aquilla Lake; however, it is anticipated that normal O&M activities by USACE and natural ecological processes will continue to occur in the study area. The following is a general description of the likely future conditions in the study area under the No Action Alternative over the 50-year life of the project.

Construction of Aquilla Lake was completed by the USACE in 1983. The project area consists of 10,251 acres of land area owned by USACE. The project site is managed as a multipurpose reservoir with uses including water supply, flood risk management, and recreation. The project is managed through the Whitney/Aquilla Project office located at Whitney Lake, which is approximately 15 miles to the west of Aquilla Lake. Aquilla Lake is a relatively small lake with very limited recreational development. 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 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 such tools such to supplement the management of the natural areas, most land at Aquilla Lake is not intensely managed and that land management trend is expected to continue in the future (Table B-9).

Table B-9. FWO Project Expected Change in Aquilla Land Use Acreages (rounded to the nearest acre

Land Use	**Existing** (acres)	**Ultimate** (acres)
Riparian Woodlands	334	384
Upland Forest	2802	2802
Herbaceous wetlands	113	113
Grasslands	1199	899
Deciduous Shrubland	2043	2082
Savanna	365	576
Disturbed areas	231	231
Lake Surface (conservation pool)	3164*	3164*
Total	**10251**	**10251**

*The discrepancy in the lake's surface acreage from that found in Table 2. Aquilla Lake Pertinent Data (3,060 acres), in Main Report is because of slight errors associated with GIS overlays.

A large scale flood event, such as a 100 year flood in which the reservoir reaches maximum capacity with regard to flood control storage, was not considered when evaluating how the habitats on the project site would change over time. A large flood event would have negative effects on the plant communities surrounding Aquilla Lake, as has happened at other reservoirs that have experienced such flooding. The reason this was not considered in the formulation of the future without project conditions was due to fact that it is impossible to predict when or if a large scale event will occur at a given site. The negative effects of the flood would depend on several factors that cannot be predicted, such as the time of year the flood happens and the duration of inundation of the vegetative communities based on the release rate of flood water from the reservoir.

Summary of Existing Condition Habitat Units

After conducting HEP and IBI habitat evaluations, habitat units were calculated. Utilizing the HSI and normalized IBI values (takes the IBI scores and puts them into a 0 – 1.0 scale so the habitat values are comparable to HSI values) provides an average habitat from each of the habitat evaluations, terrestrial and aquatic habitat resource conditions were assessed. The final step to calculate the Average Annual Habitat Units (AAHU's) for each habitat was to calculate the habitat units (HU's) contained in a habitat for each evaluation species at each target year and then sum all the HU's to get the cumulative HU's. The cumulative HU's are then divided by the period of analysis (50 years) to get the AAHU's that can then be compared with similar habitats AAHUs in a mitigation plan to ensure adequate compensation for project impacts (losses). Table B-10 presents the AAHU's calculated for each evaluation habitat under Future Without Project conditions. Addendum B-1 provides the detailed tables of AAHU analysis.

Table B-10. Summary of Future Without Project conditions Annual Average Habitat Units (AAHU's) for evaluation habitat types.

Habitat Type	AAHU's
Riparian Woodland	245.46
Upland Deciduous Forest	2065.35
Herbaceous Wetland	69.40
Grassland	445.84
Deciduous Shrublands	1357.93
Savanna	303.99
Water / Aquatic (Lake)	1423.80
Disturbed	0.00
TOTAL	**5911.77**

The following is a discussion of the six habitat types that exist in the project site and their expected trends over the next fifty years.

Riparian Woodlands

Riparian Woodlands currently make up approximately 3.3% of the project area. Most of the Bottomland Hardwood and Riparian Woodlands that existed along Aquilla and Hackberry Creeks prior the impoundment of Lake Aquilla were lost when the lake was impounded in 1983. The impoundment of the lake left a thin corridor of riparian woodland directly adjacent to these streams. Consequently the majority of Riparian Woodlands left on the project site can be characterized as Upland Woodlands influenced by adjacent streams (USFWS, 2008). This trend of conversion or influence of adjoining streams on the project site to create areas of Riparian Woodland can be expected to continue into the future thereby increasing the total number of acres of this habitat type. It is estimated that the total conversion of Upland Woodland to Riparian Woodland will be approximately 50 acres over the 50-year lifespan of the project.

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 Habitat Suitability Index (HSI) of 0.67. It is expected that, due to the limited habitat management at Aquilla Lake, 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 Habitat Units (HU'S) for Riparian Woodlands from 223.78 for the existing conditions to a value of 268.80 at year 50. Table B-11 shows the Average Annual Habitat Units (AAHUs) over the fifty year period of analysis, as well as the calculations of the size and quality of Riparian Woodlands habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

Table B-11. Aquilla Future Without-Project Riparian Woodland habitat calculation of habitat units (HU) and average annual habitat units (AAHU).

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**		
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**Cumulative HU**	**AAHU**
Woodlands	HSI	0.67	0.67	0.67	0.68	0.68	0.70		
	Acres	334	334	339	344	359	384		
	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	12272.90	245.46

Upland Deciduous Forest

Upland Forest currently makes up approximately 27.3% of the project area. The average HSI for the existing habitat is 0.74 which is considered to be good habitat value. Approximately 50 acres of this habitat type is expected to be lost to conversion to Riparian Woodland over the next 50 years. This loss will be offset by the conversion of Shrubland or Savanna habitat to Upland 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 for Upland Forest 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 2073.48. 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 B-12 shows the AAHUs over the fifty year period of analysis, as well as the calculations of the size and quality of Upland Deciduous Forest habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

Table B-12. Aquilla Future Without-Project Upland Deciduous Forest habitat calculations of habitat units (HU) and average annual habitat units (AAHU)

Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
HSI	0.74	0.74	0.73	0.73	0.74	0.74		
Acres	2802	2802	2802	2802	2802	2802		
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	103267.71	2065.35

Herbaceous Wetland

Wetlands make up approximately 1.1% of the project area. Most of this habitat type on the project area is made up of shallow areas along creeks and streams in the upper reaches of the reservoir and by small seasonal ponds located throughout the project area. The average HSI value for the existing wetlands is 0.54, which is considered average habitat value. The limiting factor for this habitat was poor cover and nest cavities for the wood duck which caused the wood duck to have an average HSI of 0.03, which is very poor.

The amount of acres of wetlands on 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, which 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 61.02 for the existing conditions to 73.45 HU'S at year 50. Table B-13 shows the AAHUs over the fifty year period of analysis, as well as the calculations of the size and quality of Herbaceous Wetland habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

Table B-13. Aquilla Future Without-Project Herbaceous Wetland habitat calculations of habitat units (HU) and average annual habitat units (AAHU)

Target Year	0	1	5	10	25	50	Cumulative HU	AAHU
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
HSI	0.54	0.54	0.57	0.60	0.62	0.65		
Acres	113	113	113	113	113	113		
Target Year HU	61.02	61.02	64.41	67.80	70.06	73.45		
Interval HU		61.02	250.86	330.53	1033.95	1793.88	3470.23	69.40

Grassland

Grasslands currently make up approximately 11.7% of the project area. Much of the grassland on the project site would be classified as unmanaged grasslands when considering the residual effects of prior agricultural uses. Unmanaged grasslands are fallow fields containing a combination of native and introduced grasses, forbs and trees, but the composition is different from those in native short grass prairie areas. 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 fifty years due to their conversion to shrub savanna or tree savanna habitat. This will decrease the overall acreage from 1199 acres for existing conditions to 899 acres at year fifty.

The existing average HSI for grasslands is 0.48 which is slightly below average. 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 fifty.

Existing HU'S for grasslands is 575.52. This value will decrease over the next fifty years to 404.55 due to the loss of acreage and habitat value for this habitat type. Table B-14 shows the AAHUs over the fifty year period of analysis, as well as the calculations of the size and quality of Grassland habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

Table B-14. Aquilla Future Without-Project Grassland habitat calculations of habitat units (HU) and average annual habitat units (AAHU)

Target Year	**0**	**1**	**5**	**10**	**25**	**50**		
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**Cumulative HU**	**AAHU**
HSI	0.48	0.47	0.46	0.45	0.45	0.45		
Acres	1199	1164	1079	1019	959	899		
Target Year HU	575.52	547.08	496.34	458.55	431.55	404.55		
Interval HU		561.30	2086.84	2387.23	6675.75	10451.25	22162.37	445.84

Deciduous Shrublands

Deciduous shrublands currently make up approximately 19.9% of the project area. They consist of mainly of fallow agricultural fields or grasslands that have been invaded by woody species that have increased in density enough to be above the threshold required to consider a tree or shrub savanna. 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 fifty years. Currently there are approximately 2042 acres of shrubland at the project site that is expected to increase to 2083 acres at year fifty.

The existing average HSI for shrublands is 0.63 which is of average value. 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 fifty.

Existing HU'S for shrubland is 1287.09. This value will increase to 1394.94 at year fifty due to the increase in both acreage and quality of this habitat type. Table B-15 shows the AAHUs over the fifty year period of analysis, as well as the calculations of the size and quality of Deciduous Shrublands habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

Table B-15. Aquilla Future Without-Project Deciduous Shrubland habitat calculations of habitat units (HU) and average annual habitat units (AAHU)

Target Year	0	1	5	10	25	50		
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**Cumulative HU**	**AAHU**
HSI	0.63	0.63	0.64	0.65	0.66	0.67		
Acres	2043	2043	2048	2058	2070	2082		
Target Year HU	1287.09	1287.09	1310.72	1337.70	1366.20	1394.94		
Interval HU		1287.09	5195.59	6620.97	20278.95	34513.75	67896.34	1357.93

Savanna

Savannas currently make up approximately 3.6% of the project area. They consist mainly of fallow agricultural fields and grasslands that have been invaded by trees and other woody species below a density of 25%. Once these savannas have matured beyond the 25 % thresholds they are considered shrublands. This trend is expected to continue over the next 50 years. Currently there are 365 acres of savanna at the project site that is expected to increase to 576 acres at year fifty.

The existing average HSI for savannas is 0.54 which is of average value. This average HSI is expected to increase slightly over a fifty year period to 0.58 due to increased patch size and additional diversity of species and maturation of existing conditions.

Existing HU'S for savannas is 197.10. This value will increase to 334.08 at year fifty due to the increase in both acreage and quality of this habitat type. Table B-16 shows the AAHUS over the fifty year period of analysis, as well as the calculations of the size and quality of Savanna habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

Table B-16. Aquilla Future Without-Project Savanna habitat calculations of habitat units (HU) and average annual habitat units (AAHU)

Target Year	0	1	5	10	25	50		
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**Cumulative HU**	**AAHU**
HSI	0.54	0.54	0.55	0.56	0.57	0.58		
Acres	365	397	475	520	553	576		
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	15199.65	303.99

Water/aquatic habitat

The current surface water acreage of Aquilla Lake is 3,164 acres. This value is expected to remain constant under normal conditions. Without the project, lake conditions would remain under current operations, therefore aquatic habitat would remain as is, with little to no changes. The IBI aquatic assessment normalized average value for the open water habitat in the project area is 0.45. Table B-17 shows the Average Annual Habitat Units over the fifty year period of analysis, as well as the calculations of the size and quality of the Water/Aquatic habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

Table B-17. Aquilla Future Without-Project Water/Aquatic habitat calculations of habitat units (HU) and average annual habitat units (AAHU)

Target Year	**0**	**1**	**5**	**10**	**25**	**50**		
Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**Cumulative HU**	**AAHU**
HSI	0.45	0.45	0.45	0.45	0.45	0.45		
Acres	3164	3164	3164	3164	3164	3164		
Target Year HU	1423.80	1423.80	1423.80	1423.80	1423.80	1423.80		
Interval HU		1423.80	5695.20	7119.00	21357.00	35595.00	71190.00	1423.80

PLAN FORMULATION

In order to insure that future water supply needs are met, the Brazos River Authority (BRA), the entity responsible for protecting, managing, and developing water resources in the Brazos River Basin, 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).

During Phase I of the Brazos Systems Assessment, a period of record analysis was done for each of the seven USACE constructed lakes assuming several different conservation pool elevations. Dependable yield curves were computed for each of the seven USACE lakes in the Brazos River Basin. The yield curves, analysis and recommendations were published in the Brazos Systems Assessment Interim Feasibility Study report for Phase I. Based on the report, the Project Delivery Team (PDT), which included BRA, recommended that the study proceed to Phase II, with Aquilla Lake being the project chosen to analyze in detail with respect to a change in conservation and flood control storage (raising the top of conservation pool).

Problems and Opportunities

The BRA customers with contracts from Aquilla Lake are projected to have needs above their currently available supplies by 2020. The projected 2020 needs range from approximately 2,800 to 3,700 AF per year. The needs are projected to increase to approximately 4,000 to 9,000 AF per year by 2040. The needs by 2070 are projected to be anywhere from 7,500 to 30,000 AF per year. There is insufficient water supply to meet the demands resulting from projected population growth.

Based on the 2016 Brazos G Regional Water Plan, Aquilla Lake is currently permitted by the TCEQ to provide 13,896 AF annually for M&I water supply. However, the firm yield of the lake is declining due to sediment accumulation. Comparisons of capacities at conservation pool elevation derived from current and previous surveys suggest Aquilla Lake loses between 97 AF per year and 269 AF per year of conservation storage space due to sedimentation. According to the Water Storage Agreement between the U.S. Government and BRA dated April 5, 1976, BRA has the right to the total useable storage below elevation 537.5 ft-msl (estimated in 1976 to contain 33,600 acre- feet AF after adjusting for expected future sedimentation) in Aquilla Lake for M&I water supply, subject to availability of water. Since Aquilla Lake began impounding water in 1983, over 7,800 AF of storage has been lost to sedimentation within the conservation pool. Reallocating storage from the flood control pool to the conservation pool will help restore a portion of the storage lost to sedimentation.

The City of Cleburne is expected to experience shortages by 2020. The City has short term plans to reduce demand through conservation as well as an aggressive reuse program. However, substantial increases in demand from manufacturing industries (manufactured homes, cabinets, exterior concrete fiber siding, conveyor systems, truck bodies, sheet metal fabrication, and work wear textiles) and for steam-electric generation are expected to outstrip supply. The combined shortages from these industries amounts to approximately 5,656 AF per year by 2070. The total 2070 shortage for the City of Cleburne is projected to be approximately 7,500 – 30,000 AF per year. Measures considered to resolve the forecasted water supply shortage include conservation, use of other water supply sources, and reallocation of storage in Aquilla Lake.

Opportunities identified for the study are as follows:

- To reduce water shortages faced by the BRA in a way that complements other regional water supply activities while maintaining the authorized project purposes at Aquilla Lake;
- To 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

BRA wishes to execute its charge to develop, manage, and protect the water resources within the Brazos River Basin and to meet future needs of its water supply customers. USACE and BRA have engaged in this study for the specific purpose of determining how best to address the water supply shortages forecasted for Aquilla Lake in 2020 and beyond.

The major objective of this study is to:

- Provide a means to help meet, to the extent practicable, the forecasted water demand of BRA Aquilla Lake customers, which is projected to reach 26,070 AF or more by 2070.

Constraints identified by the study team include, but are not limited to:

- Avoidance of induced flood damages;
- Minimization of adverse effects to the environment;
- Minimization of requirement for acquisition of real estate;
- Unknown environmental flow requirements resulting from State of Texas mandated legislation (Texas Senate Bill 3).

During plan formulation, the goal was 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 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 B and Appendix C, 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 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.

Alternatives

During the plan formulation process several measures were considered to resolve the forecasted water supply shortage including: conservation, reallocation of flood storage at Aquilla Lake to water supply, and use of other water supply sources, in addition to a 'no action' alternative. These are described below.

No Action - under the No Action Alternative there would be no new water supply developed at Aquilla Lake. The top of the conservation pool would remain at 537.5 ft-msl, but over time the reservoir capacity of 44,577 acre-feet would decrease as sedimentation continues to occur (surveys suggest that the lake loses 97-269 acre feet of conservation storage space per year). The No Action Alternative provides a baseline for comparison with the various action alternatives, but does not meet the study's goal or objective.

Conservation - Conservation measures, which consist of either reducing water demand or increasing the efficiency of the available water supply, were eliminated from further consideration in this study because the Brazos G Regional Water Plan has already identified and either implemented or plan to implement these conservation strategies as part of their future water supply planning efforts.

Water Diversion - The USACE Middle Brazos System Assessment conducted in 2005-2008 explored the use of other water supply measures within the Brazos River Basin including building new reservoirs, constructing pipelines to move water from one location to another, purchasing additional water through contracts with major water providers outside of the basin, obtaining additional water rights, and changing the operational framework for the system of reservoirs managed by BRA and/or USACE. Of those other water supply measures considered, the one that was determined to be the most viable in terms of preliminary costs and impacts was construction of a pipeline to divert water from Whitney Lake to an existing pipeline to Pat Cleburne Lake.

The diversion of water from Whitney Lake to the Pat Cleburne Lake pipeline would provide an estimated 14,700 acre-feet of annual water supply. This alternative would experience less evaporation than surface water solutions, so the yield is more efficient than with a reallocation alternative. The main stem of the Brazos River in the vicinity of Whitney Lake has high levels of total dissolved solids (TDS), requiring the need to mitigate the high salt concentration by blending with higher quality water or treating the water in advance of moving it into the pipeline. Approximately 70-85% of the water would need to be treated to achieve and maintain acceptable water quality in Pat Cleburne Lake. An environmental concern with implementation of this alternative is the disposal of the brine reject water. 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.

Storage Reallocation - A number of different storage reallocation alternatives were identified and evaluated by the study team.

- ***2.5 foot conservation pool raise* -** This alternative would raise the conservation pool elevation 2.5 feet to elevation 240.0 ft-msl. At this elevation conservation storage capacity is increased by approximately 8,082 acre-feet for a total of 52,659 AF. Critical period yield is approximately 17,749 acre-feet per year. Flood pool storage would be raised to 558.5 ft-msl elevation, six feet below the elevation of the emergency spillway. This alternative provides an eight percent increase in critical yield (using the TCEQ's Water Availability Model), which equates to 1,304 acre-feet per year and a storage capacity of 52,659 acre-feet. 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 acre feet, falling short of the necessary 11,403 acre feet by 3,321 acre feet. Therefore, this alternative was removed from further consideration.
- ***4.5 foot conservation pool raise* -** This alternative would raise the conservation pool elevation 4.5 feet to elevation 542.0 ft-msl. At this elevation conservation storage capacity is increased by approximately 15,073 acre-feet for a total conservation capacity of 59,560 acre-feet. Critical period yield is approximately 18,098 acre-feet per year. Flood storage elevation would be raised to elevation 560.5 ft-msl, which is still four feet below the elevation of the emergency spillway. This alternative provides a 15 percent increase in critical yield for an additional 2,463 acre-feet per year and storage capacity for 59,650 acre feet. This alternative is carried into the final array of alternatives.
- ***6.5 foot conservation pool raise* –** This alternative would raise the conservation storage pool elevation 6.5 feet to elevation 544.0 ft-msl. At this elevation conservation storage capacity is increase by approximately 23,567 acre-feet for a total conservation capacity of 68,144 acre-feet. Critical period yield is approximately 20,123 acre-feet per year. Fool pool elevation would be raised to elevation 562.5 ft-msl, which is still two feet below the elevation of the emergency spillway. The 6.5-foot pool raise was dropped from further consideration as the result of an incremental cost analysis that indicated that the raising of the top of the conservation pool by the additional 2 feet over the 4.5 feet pool raise has higher costs for the additional gain in yield; therefore it is less cost effective.

Based on the plan formulation and preliminary evaluations briefly described above, the alternatives being included in more detailed analysis are as follows:

- **Alternative 1 – No Action**
- **Alternative 2 – 4.5 foot pool raise**
- **Alternative 3 – Pipeline diversion of water from Whitney Lake to Pat Cleburne Lake**

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 one potential reallocation plan that was identified in the plan formation process, the diversion of water from Whitney Lake to the

Pat Cleburne Lake pipeline, and a "no action" alternative, which is equivalent to the future without project conditions. Table B-18 provides a summary of the environmental consequences associated with both the No Action and Proposed Action alternatives. More detailed descriptions of the impacts to the resources that have identified impacts follow the table.

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.

Land Use

Although the pool raise alternative would result in a larger conservation pool, the land use of the study area would not change. The deeply incise nature of the creeks that feed into Aquilla Lake at the upstream end of the reservoir allows any backwater effects resulting from an increase of the conservation pool to remain within the channel and not flood additional property beyond the USACE owned fee and flowage easement lands. 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.

Geology and Soils

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

Prime and Unique 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

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.

Alternative 2 (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.

Alternative 3 (Pipeline): Approximately 92 acres of prime farmland soils would be temporarily disturbed resulting from the construction of the pipeline between Whitney Lake and

Table B-18. Summary of Environmental Consequences of the No Action and Proposed Action Alternatives

Resources	No Action	4.5 ft pool raise	Pipeline
Climate	-	-	-
Land Use	-	-	-
Geology & Soils	-	-	-
Prime Farm Land	-	-	-
Air Quality	-	-	-
Aquatic Resources			
Surface Water	-	↑	-
Floodplains	-	-	-
Groundwater	-	-	-
Wetlands/Waters of the U.S.	-	-	-
Water Quality	-	-	↓
Aquatic Habitat	-	-	-
Biological Resources			
Vegetation	-	↓	-
Wildlife	-	-	-
T&E Species	-	-	-
HTRW	-	-	-
Cultural Resources	-	-	↓
Recreation Resources	-	↓	-
Socio-economics	-	-	-
Noise	-	-	-
Light	-	-	-

- Status quo; ↑ Beneficial impacts; ↓ Negative impacts

and the Pat Cleburne Lake pipeline. However, these impacts would be temporary as existing agricultural operations would continue after the installation of the pipeline.

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.

Alternative 2 (4.5 foot pool raise): 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 associated with Aquilla Lake. Minor emissions of NO_X, CO, SO_2, 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 alternative.

Alternative 3 (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 NO_X, CO, SO_2, 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.

Aquatic Resources

Surface Water

No-Action Alternative: Under the No-Action Alternative, the conservation pool of Aquilla Lake would remain under the current conditions, encompassing approximately 3,164 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.

Alternative 2 (4.5 foot pool raise): The 4.5 foot pool raise would increase the conservation pool of Aquilla Lake by an additional 661 acres encompassing 3,786 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. Additional open water acres would be a beneficial result of implementation of the pool raise alternative.

Alternative 3 (Pipeline): The proposed pipeline alternative would not impact streams as the pipeline would be installed under the two stream crossings (Cedar and Bear Creeks) utilizing boring or directional drilling techniques. Temporary impacts would occur at Whitney Lake during the construction of the intake structures.

Floodplains

All Alternatives: None of the alternatives would alter the floodplain characteristics of the study area.

Groundwater

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.

Alternative 2 (4.5 foot pool raise): Implementation of this alternative would provide 2,463 acre-feet of additional water supply; less than the 7,500 acre-feet per year to approximately 30,000 acre-feet per year of project need by 2070. Therefore, implementation of the alternative should reduce the need for increasing withdrawal of groundwater to make up for any anticipated shortfalls.

Alternative 3 (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.

Alternative 2 (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. Therefore, no adverse long-term impacts to wetlands are anticipated with implementation of this alternative, in fact there is projected to be habitat gains.

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, and those waters located within the ROI. Navigable waters of the U.S. are not present within the study area. Since implementation of the pool raise alternative would increase the surface acres of these water, there would be no adverse impacts, but potentially beneficial impacts instead.

Implementation of the pool-raise alternative 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. Riprap work on the embankment and work on the intake structure would occur above the existing pool elevation so would not 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. In addition, the proposed project would not require a Section 401, State of Texas Water Quality Certificate.

Alternative 3 (Pipeline): Potential wetland areas and waters of the U.S. within the proposed pipeline right-of-way are relatively small and scattered and could be easily avoided. The final design of the proposed pipeline will be routed to avoid impacts to wetland areas. Wetlands associated with Cedar and Bear Creeks would be avoided by utilizing boring or directional drilling techniques. Therefore, no adverse impacts to wetlands or waters of the U.S. are anticipated with implementation of this alternative.

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 303 (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.

Alternative 2 (4.5 foot pool raise): Implementation of the pool raise 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. 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 the pool raise alternative 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 a pool raise 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.

Alternative 3 (Pipeline): 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 Pat Cleburne Lake. Although the pipeline alternative includes water treatment to improve the water quality prior to pumping to Pat Cleburne Lake pipeline, the treated water (Whitney Feed) would still have higher concentrations of chloride, sulfate, and TDS. Once introduced into the pipeline, the water quality would decrease (Table B-19).

Table B-19. Expected Water Quality Concentrations under Pipeline Alternative

	Cl (mg/L)	SO_4 (mg/L)	TDS (mg/L)
Scenario 1 (6.36 MGD)			
Whitney Lake	437	220	1,254
Whitney Feed	140	70	401
Scenario 2 (8.3 MGD)			
Whitney Lake	437	220	1,254
Whitney Feed	112	57	323
Scenario 3 (10.8 MGD)			
Whitney Lake	437	220	1,254
Whitney Feed	96	49	277
Scenario 4 (12.7 MGD)			
Whitney Lake	437	220	1,254
Whitney Feed	91	46	261

Aquatic Habitat

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 by a pool raise 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.

Alternative 2 (4.5 foot pool raise): Approximately 622 acres of additional surface water would be added to the lake as a result of implementation of Alternative 2, thereby increasing aquatic habitat acreage from 3,164 to 3,786 acres. Habitat evaluations and site assessments of the in-stream habitats indicate that approximately 16,998 linear feet of in-stream habitat (low velocity pools) that would be inundated by implementation of Alternative 2, and be replaced with similar, although deeper, aquatic habitats. Therefore, no net loss of aquatic life use value within each tributary is anticipated.

Alternative 3 (Pipeline): The pipeline would not impact aquatic habitat. However, the intake 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 via the Pat Cleburne Lake pipeline.

Biological Resources

Vegetation

Aquilla lake/reservoir 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 D, 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.

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.

Alternative 2 (4.5 foot pool raise): Project implementation of the pool-raise alternative 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 the pool-raise alternatives would adversely impact vegetation alongside the current lake shore, but not along the upstream tributary areas as the backwater flow resulting from a pool raise would be contained within the deeply incised stream channels. Permanent adverse impacts caused by the loss of riparian woodlands will require mitigation. 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 B-20 provides the loss of various habitat types and acres that would result from implementation of the 4.5-foot pool raise.

Alternative 3 (Pipeline): Approximately 60-percent of the pipeline right-of-way utilizes 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 66 acres of woodland and shrubland vegetation would be converted to grassland.

Table B-20. Vegetation types and associated acreage impacted as a result of project implementation for various alternatives.

Vegetation Type	No Action	4.5 ft pool raise (acres)	Pipeline (acres)
Riparian Woodland	0	66	11
Upland Forest	0	257	51
Herbaceous Wetland	0	46	6
Grassland	0	99	80
Deciduous Shrubland	0	152	4
Savanna	0	1	0
Row Crops	0	0	29
TOTAL	0	621	181

Wildlife

No-Action Alternative: The current terrestrial habitat in the project area is in general "average" habitat (refer to Table B-2). 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.

Alternative 2 (4.5 foot pool raise): Acres of habitat and their associated ecological functions are expected along the shoreline near the new target pool elevation for the pool-raise alternative. Affected habitats include those listed in Table B-20. While various acreages of total wildlife habitat (reference Table B-31) are expected to be adversely impacted by inundation caused by the pool level rise, it is not anticipate that wildlife would be significantly impacted, as species would move into adjacent wildlife areas not impacted by the pool rise. In addition, inundation would 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.

Alternative 3 (Pipeline): 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/Birds of Conservation Concern

The Endangered Species Act (ESA) requires Federal agencies to determine the effects 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, if applicable. In addition, EO 13186 directs federal agencies to evaluate the impacts of their actions on migratory birds in NEPA documents and to conserve migratory birds, giving priority to species of concern and their important habitats, as applicable (listed in USFWS PAL, Appendix M).

No-Action Alternative: Under the No-Action Alternative, there would be no adverse impacts to threatened and endangered species or to migratory species of concern.

Alternative 2 (4.5 foot pool raise): There are no designated critical habitat areas located within the pool-raise alternative inundation areas. While there are three currently listed threatened or endangered 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. While the species listed as Birds of Conservation Concern may utilize the habitat at Aquilla Lake during its migration in spring and autumn, it was determined by USFWS that it is unlikely that an increase in pool rise would have an adverse impact on these species (see Appendix M, PAL). Therefore, USACE will be coordinating a determination of "no effect" with USFWS for impacts associated with implementation of the pool raise alternative on T&E and Birds of Conservation Concern species.

Alternative 3 (Pipeline): The proposed pipeline right-of-way would bisect medium to high quality golden-cheeked warbler habitat along the edge of Whitney Lake. In addition, black-capped vireo habitat also occurs within the pipeline footprint. Consultation with the USFWS would be required to assess the potential impacts of the construction of the pipeline on these species.

Invasive Species

No-Action Alternative: Under the No-Action Alternative, the invasive species in the study are would remain the same and care would be taken to try to reduce the chance of any more invasive species becoming established.

Alternative 2 (4.5 foot pool raise): Implementation of the pool raise would have no impacts on existing invasive species in the study area and best management practices (BMPs) would be written into any construction contract to ensure that the contractor didn't introduce any new invasive species with their equipment and as a result of their activities. Therefore, no significant adverse impacts associated with invasive species are anticipated from with the pool raise alternative.

Alternative 3 (Pipeline): The alignment design and construction of the pipeline would not be handled by USACE, but we would provide oversight of any impact associated with construction on project lands; therefore we could make sure that the contractor did not introduce additional invasive species from their equipment or as a result of their construction activities on project lands. Off project lands, we have no controls over the contractor so it is we can't say that this alternative would have no significant adverse impacts of introducing or spreading of invasive species outside federal properties.

Hydrology and Hydraulics

All Alternatives: None of the proposed alternatives would adversely alter the hydrology and hydraulics characteristics of the study area.

Hazardous, Toxic, and Radioactive Wastes

All Alternatives: 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.

Cultural Resources

No Action Alternative: Under the No-Action Alternative, there would be induced impacts to existing cultural resources at Aquilla Lake.

Alternative 2 (4.5 foot pool raise): A cultural resources survey and site assessment was conducted in November 2010 in order to be able to identify the existing cultural resources at Aquilla Lake and to serve as a basis for determining what actions would be required to mitigate for any adverse impacts that might be caused by implementation of a pool raise. Thirty-nine sites were revisited and re-evaluated, 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 (NRHP). Of the 39 sites reassessed, five are recommended for further testing to determine their eligibility for listing based on the presence of intact buried cultural deposits. Three of the five potentially eligible sites would be adversely impacted by implementation of the 4.5-foot pool raise and therefore warrant additional investigations. Prior to implementation of the pool raise alternative the additional work identified above will have to be completed in coordination with the State Historic Preservation Office. Impacts to sites determined eligible for nomination to the NRHP will be mitigated below the threshold for significance.

Alternative 3 (Pipeline): Approximately 60-percent of the pipeline right-of-way utilizes cultivated croplands and pastures, which have already experienced surface disturbance as the result of farming and ranching activities. However, the proposed construction methodology for the pipeline would be to trench and bury the line; thereby disturbing soils to a much greater depth, potentially impacting previously unknown intact cultural resources.

Recreation Resources

No-Action Alternative: Under the No-Action Alternative, there would be no impacts to existing recreational resources at Aquilla Lake.

Alternative 2 (4.5 foot pool raise): There would be significant adverse impacts to existing recreation facilities associated with a 4.5-foot pool raise.

At the frequently visited Dairy Hill boat ramp, inundation would adversely impact 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 buoys, 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. The recreation features would be relocated to higher ground and the boat ramp extended, as necessary.

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 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. Because all the recreation features, currently opened to the public, impacted by the pool raise alternative, will be relocated as part of project implementation, there would be only short-term impacts during the period of demolition of the impacted facilities and construction of the replacement features. While these might be temporary impacts, if they affect public accessibility or usage during some of the major summer holidays, the impacts could be considered significant.

Alternative 3 (Pipeline): Implementation of pipeline is not expected to adversely impact any recreational facilities as any of these could easily be avoided during project design and construction.

Socioeconomic Resources

The objective of socioeconomic analysis is to provide an open, realistic, and documented assessment of potential socioeconomic impacts from project implementation. EO 12898 (Environmental Justice) directs Federal agencies to avoid the disproportionate placement of adverse environmental, economic, social, or health impacts from Federal actions and policies on minority and low-income populations.

All Alternatives: Since all the project impacts would be to federally-owned lake properties under the 4.5-foot pool raise alternative no significant impacts to socioeconomic resources are anticipated from implementation of this alternative. The same is true for the pipeline diversion alternative since the alignment of the pipeline would avoid any impacts to residential and commercial facilities and any disproportionate adverse impacts to minority and low-income populations.

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.

Alternative 2 (4.5 foot pool raise): 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, etc. associated with the Aquilla Lake pool raise 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.

Alternative 3 (Pipeline): 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.

Alternative 2 (4.5 foot pool raise): 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.

Alternative 3 (Pipeline): No adverse impacts to resulting from lighting are anticipated under the no-action alternative.

TENTIVELY SELECTED PLAN

Based on the analyses and evaluation of viable alternative, the tentatively selected plan for this project is an increase of the top of conservation pool 4.5 feet into the flood storage pool, making the top of conservation pool at elevation 542 ft-msl. This proposed action will reallocate approximately 15,073 AF of storage from the flood pool to the conservation pool (Table B-21). The estimated increase in yield with this reallocation is 2,463 acre-feet per year. It was previously noted that none of the potential reallocation scenarios evaluated would meet the total need of the sponsor. The increase in yield would meet approximately 67 percent of the 2020 need and diminishing to only eight percent of the need in 2070. Table B-21 displays a summary of the pool elevations and storage capacity of both the existing and with project conditions.

Table B-21. 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 along the upstream shoreline to protect the dam embankment from bank erosion. No changes in the dam or spillway height would be made. Implementation of the proposed action will require relocation of applicable recreation features, including restrooms, boat ramps, parking areas, and picnic tables as described in Appendix G, Cultural resource investigations will need to be completed on three of the five potentially eligible sites for NRHP listing, which would be adversely impacted by implementation of the 4.5-foot pool raise. Prior to implementation of the pool raise alternative the additional work will have to be completed in coordination with the State Historic Preservation Office. Loss of riparian bottomland hardwood habitat will require mitigation actions be performed.

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 B-22 provides a summary of habitat acreage changes from implementation of the recommended reallocation plan over the 50 life of the project.

Table B-22. Summary of habitat acreage changes of Aquilla Lake Reallocation project 1, 5, 15, 25 and 50 years after implementation

		Proposed Action (4.5 foot pool raise)				
Land Use / Habitat	**Existing (acres)**	**Year 1**	**Year 5**	**Year 10**	**Year 25**	**Year 50**
Riparian Woodlands	334	268	270	273	277	318
Upland Forest	2802	2545	2520	2495	2532	2458
Herbaceous wetlands	113	67	103	127	127	127
Grasslands	1199	1100	1084	1034	934	890
Deciduous 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	3760	3747	3747	3747
Total	**10251**	**10251**	**10251**	**10251**	**10251**	**10251**

* The discrepancy in the lake's surface acreage from that found in Table 2. Aquilla Lake Pertinent Data in the Main Report is because of slight errors associated with GIS overlays for the various habitat types and rounding to whole numbers.

The following is a discussion of the six habitat types that exist in the project site and their expected trends over the next fifty years. Table B-23 is the projected change in land use acreage over a 50 year period of analysis following project implementation.

Table B-23 Summary of habitat acreage changes of Aquilla Lake Reallocation project after implementation.

Land Use / Habitat	**Existing** (acres)	**4.5' pool raise** (acres)	Δ (acres)
Riparian Woodlands	334	268	66
Upland Forest	2802	2545	257
Herbaceous wetlands	113	67	46
Grasslands	1199	1100	99
Deciduous Shrubland	2042	1890	152
Savanna	365	364	1
Disturbed areas	231	230	24
Lake Surface (at conservation pool)	3164*	3786	622
Total	**10251**	**10251**	

* The discrepancy in the lake's surface acreage from that found in Table 1. Aquilla Lake Pertinent Data is because of slight errors associated with GIS overlays for the various habitat types and rounding to whole numbers.

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 B-24 is a summary of impacted acreage associated with each alternative.

Table B-24 Aquilla Future-With-Project Riparian Woodland Habitat calculation of habitat units (HU) and average annual habitat units (AAHU) for the Aquilla project area.

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
4.5 '	HSI	0.67	0.67	0.67	0.68	0.68	0.70		
	Acres	334	268	270	273	277	318		
	Target Year HU	223.78	179.56	180.9	185.64	188.36	222.6		
	Interval HU		201.67	720.92	916.33	2805.00	5133.58	9777.50	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, Alternative 2, approximately 257 acres (Table B-20) would be impacted by inundation, resulting in a loss of habitat acreage at year one. However, similar to the

FWOP 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 fifty (see Table B-25). Habitat value is expected to increase, as initial limiting factors, such as larger trees and canopy cover, increase over time.

Table B-25. Aquilla Future-With-Project Upland Deciduous Forest Habitat calculation of habitat units (HU) and average annual habitat units (AAHU) for the Aquilla project area.

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative**	
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**HU**	**AAHU**
4.5 '	HSI	0.74	0.74	0.73	0.73	0.74	0.74		
	Acres	2802.0	2545.0	2520.0	2495.0	2532.0	2458.0		
	Target Year HU	2073.5	1883.3	1839.6	1821.35	1873.68	1818.92		
	Interval HU		1978.4	7445.8	9152.38	27712.73	46157.50	92446.79	1853.34

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 HSI value and acreage at year one.

Approximately 46 acres would be impacted by inundation under the 4.5-foot pool raise at year one (Table B-20). Habitat value (HSI) would temporarily 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, HSI 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 (Table B-26). 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 B-26. Aquilla Future-With-Project Herbaceous Wetland Habitat calculation of habitat units (HU) and average annual habitat units (AAHU) for the Aquilla project area.

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative**	
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**	**HU**	**AAHU**
4.5 '	HSI	0.54	0.45	0.60	0.65	0.65	0.65		
	Acres	113	67	103	127	127	127		
	Target Year HU	61.02	30.15	61.80	82.55	82.55	82.55		
	Interval HU		45.59	183.90	360.88	1238.25	2063.75	3892.36	77.52

Grasslands

Due to the limited management at Aquilla Lake, FWOP 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-year period.

Initial inundation of resulting from a 4.5 pool raise would result in the loss of 199 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 (see Table B-27).

Table B-27. Aquilla Future-With-Project Grassland Habitat calculation of habitat units (HU) and average annual habitat units (AAHU) for the Aquilla project area.

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
4.5 ‘	HSI	0.48	0.46	0.45	0.44	0.42	0.40		
	Acres	1199	1100	1084	1034	934	890		
	Target Year HU	575.52	506.00	487.8	454.96	392.28	356.00		
	Interval HU		540.43	1987.60	2356.90	6354.30	9353.50	20593.06	415.07

Deciduous shrublands

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 (HSI) would also be expected to increase over time as vegetation matures and develops (see Table B-28).

Table B-28. Aquilla Future-With-Project Deciduous Shrublands calculation of habitat units (HU) and average annual habitat units (AAHU) for the Aquilla project area.

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
4.5 ‘	HSI	0.63	0.63	0.64	0.65	0.66	0.67		
	Acres	2042	1890	1895	1905	1920	1930		
	Target Year HU	1286.4	1190.7	1212.8	1238.25	1267.2	1293.1		
	Interval HU		1238.58	4806.97	6127.54	18790.5	32003.33	62966.92	1259.34

Savanna

Minimal impacts or changes to this habitat type are expected due to project implementation (Table B-22).

The trend predicted in the FWOP conditions would be expected to continue following project implementation, and therefore a gain of approximately 185 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 (HSI values) would be expected to increase over the 50-year period of analysis (Table B-29).

Table B-29. Aquilla Future-With-Project Savanna calculation of habitat units (HU) and average annual habitat units (AAHU) for the Aquilla project area.

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
4.5 '	HSI	0.54	0.54	0.55	0.56	0.57	0.58		
	Acres	365	364	388	439	485	550		
	Target Year HU	197.1	196.56	213.40	245.84	276.45	319.00		
	Interval HU		196.83	819.92	1148.10	3917.18	7443.13	13525.15	269.06

Water/Aquatic habitat

The current surface water acreage of Aquilla lake is 3,164 acres. Surface water acreage would be expected to increase with project implementation (Table B-20). In one year, a 4.5-foot pool raise would result in increasing the lake acreage from 3,164 to 3,786 (Table B-20) post construction and levels out at 3,747 after 10 years when it is anticipated that fringe wetlands would be fully established along the expanded shoreline.

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. There would not be a loss of aquatic habitat and aquatic life use (habitat value) is expected to improve slightly the 50-year period of analysis (Table B-30).

Table B-30. Aquilla Future-With-Project water/aquatic calculation of habitat units (HU) and average annual habitat units (AAHU) for the Aquilla project area.

	Target Year	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative HU**	**AAHU**
	Interval (years)	**0**	**1**	**4**	**5**	**15**	**25**		
4.5'	HSI	0.45	0.45	0.47	0.48	0.48	0.48		
	Acres	3164	3786	3760	3747	3747	3747		
	Target Year HU	1423.8	1703.7	1767.20	1798.56	1798.56	1798.56		
	Interval HU		1563.7	6941.80	8914.40	26978.40	44964.00	89362.35	1780.12

Lake Zones

Acreages for the various lake "zone" areas were evaluated using GIS analysis. Utilizing lake contours and aerial imagery, acreages for each of the lake zones, including the limnetic zone (deep water), Littoral zone (shallow/shoreline area), and the in-stream water habitat.

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 (Table B-31)

Table B-31. Summary of water-zone impacts as a result of the pool rise.

	Existing conditions	**4.5-ft Pool Raise**
Water Type / Zone	**acres**	**acres**
Lake surface	3164	3786
Limnetic (Deep water)	2281	2903
Littoral zone (shallow)	883	883
In-stream		**Length (linear ft)**
	Aquilla Creek	838.01
	Rocky Branch	1981.17
	Jack's Branch	311.5
	Hackberry Creek	13867
	TOTAL	**16997.68**

Summary of Results

In summary, acreages and habitat types will be impacted as a result of project implementation. Results from the Future with project conditions analysis are found in Tables B-33 and B-34. While there will be loss in habitat types such as Riparian woodlands, Upland Forest, Grassland, Deciduous Shrubland, and Savanna; there will be an increase, or positive impact to lake surface (lake aquatics) habitat types. Wetlands are anticipated to mitigate themselves over time with the re-establishment of new wetlands as a result of new areas of inundation over time.

Table B-33. Summary of HU's for FWOP (50 year period of analysis) compared to the 4.5-foot pool raise alternative.

	FWOP	4.5' Pool Raise	
Habitat Type	HU's	HU's	Net HU Change
Riparian Woodland	269	223	-46
Upland Deciduous Forest	2073	1819	-254
Herbaceous Wetland	73	83	10
Grassland	405	356	-49
Deciduous Shrublands	1395	1293	-102
Savanna	335	319	-15
Water / Aquatic	1424	1780	356
Total AAHU's	**5973**	**5873**	**-100**

Table B-34. Summary of AAHU's for FWOP (50 year period of analysis) compared to the 4.5-foot pool raise alternative.

	FWOP	4.5' Pool Raise	
Habitat Type	AAHU's	AAHU's	Net AAHU Change
Riparian Woodland	245	196	-49
Upland Deciduous Forest	2065	1853	-212
Herbaceous Wetland	69	77	8
Grassland	446	415	-31
Deciduous Shrublands	1358	1259	-99
Savanna	304	269	-35
Water / Aquatic	1424	1780	356
Total AAHU's	**5911**	**5849**	**-62**

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.

Past Projects in the Region

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.

Reasonably Foreseeable Future Projects

Belton Lake to Stillhouse Hollow Pipeline – BRA would move water from Belton to Stillhouse to satisfy future water needs.

New Water Intake at Stillhouse and Associated Pipeline **-** Construction of a water intake structure at Stillhouse Hollow and associated pipeline to provide water supply from Stillhouse to Fort Hood and the City of Killeen.

Whitney Lake Reallocation – Current conservation pool storage elevation is 533.0 ft-msl. Rather than converting flood storage to water supply a potential scenario is the reallocation of hydropower storage and a portion of the inactive storage to water supply storage; could increase 2070 firm yield by as much as 21,000 acre-feet.

Stillhouse Hollow Lake Reallocation – Current conservation pool is 622.0 ft-msl. One potential scenario is to raise the conservation elevation to 629.0 ft-msl, an increase of 7 feet, corresponding to the maximum discretionary authority of the USACE.

Granger Lake Reallocation – Current conservation pool elevation is 504.0 ft-msl. One potential scenario is to raise the conservation elevation to 510.0 ft-msl, an increase of 7 feet, corresponding to the maximum discretionary authority of the USACE.

Generally these potential future projects are being discussed as part of long-term solutions to future water supply shortages, although not all of them are currently identified in the 2017 State Water Plan as a future water supply strategies by either Region G or Region H.

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). Aquilla, Whitney, Stillhouse, and Granger were all identified in that study as having potential for reallocation of flood storage to water supply. The Aquilla Lake study was initiated first since it would solve the short-term water supply needs of BRA.

Present Project

A 4.5-foot raise (the TSP) of the conservation pool will meet a portion of the forecasted demand in 2070 (7,000 – 30,000 acre-feet per year). Analysis shows the 4.5-foot raise 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-year 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. Table 35 provides a summary of the potential cumulative impacts of the TSP and Reasonably Foreseeable Future Projects within the region.

Table B-35. Summary of Potential Cumulative Impacts of the TSP and Reasonably Foreseeable Future Projects within the Region

Resources	Aquilla 4.5-ft pool raise	Belton to Stillhouse Pipeline	Stillhouse Hollow Intake & Pipeline	Stillhouse Hollow Reallocation	Granger Realloca-tion	Whitney Reallocation
Climate	-	-	-	-	-	-
Land Use	-	↓	↓	-	-	-
Geology & Soils	-	-	-	-	-	-
Prime Farm Land	-	↓	↓	-	-	-
Air Quality	-	-	-	-	-	-
Aquatic Resources						
Surface Water	↑	-	-	↑	↑	↑
Floodplains	-	-	-	*	*	*
Groundwater	-	-	-	-	-	-
Wetlands/Waters of U.S.	-	-	-	-	-	-
Water Quality	-	-	-	-	-	-
Aquatic Habitat	-	-	-	*	*	*
Biological Resources						
Vegetation	↓	↓	↓	↓	↓	↓
Wildlife	-	-	-	-	-	-
T&E Species	-	↓	↓	↓	↓	↓
Invasive Species	-	-	-	-	-	-
HTRW	-	-	-	-	-	-
Cultural Resources	-	-	-	-	-	-
Recreation Resources	↓	↓	↓	↓	↓	↓
Socio-economics	-	-	-	-	-	-
Noise	-	-	-	-	-	-
Light	-	-	-	-	-	-

- Status quo; ↑ Beneficial impacts; ↓ Negative impacts; * Unknown

Land Use

Past land use changes in the region include the conversion of farm and rangeland to open water reservoirs and their surrounding managed federal lands, in the case of the USACE, which has a total of seven reservoirs within the Brazos River Basin.

It is anticipated that moderate changes to land use within the region in the future as a result of population growth and urbanization. The potential future pipeline projects would be expected to adversely impact land use as existing lands would be acquired for utility easements. These impacts would be significant and long-term within the limited footprint of the pipeline easements as these lands are generally maintained as grasslands to reduce the chance of tree roots impacting the buried pipelines in the future. It is anticipated the potential reallocations actions at Stillhouse Hollow, Granger and Whitney Lakes would mainly impact federal project lands, so there would probably not be significant long-term impacts to land use associated with those actions.

The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to the potential adverse cumulative impacts to land use within the region.

Prime Farm Lands

Past and future cumulative impacts to prime farm lands would be very similar to the discussion regarding land use above. In the past prime farmlands were converted to open water and managed federal lands as reservoirs were constructed. Additional prime farm lands would be lost as a result of future urbanization as well as land acquisition and construction associated with the potential pipeline actions. Future reallocation activities would not be expected to adversely impact prime farm lands. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to prime farm lands within the region.

Aquatic Resources

Surface Water

It is anticipated that future implementation of reallocation at any of the lakes identified above would have similar benefits as Aquilla Lake as the result of increased acres of surface lake water over the long-term. It is anticipated that implementation of either/or both pipeline alternatives would be aligned and designed in such a way as to avoid adverse surface water impacts to lakes or streams. The one action that might have minor, short-term adverse impacts to surface waters would be the construction of a new water intake at Stillhouse Hollow Lake. It is anticipated that BMPs would be required to avoid or minimize those impacts to the extent possible, but the required siting of the structure within the lake means there would still be adverse impacts. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to surface waters within the region.

Floodplains

No floodplains would be adversely impacted by inundation as a result of the pool rise at Aquilla. Future implementation of either or both of the pipeline alternatives are not anticipated to adversely impact floodplains as pipeline alignment and design would allow siting to locate the pipeline right=of=way in areas that would avoid floodplain impacts or the pipelines could be bored underneath and rivers or streams that need to be crossed as a way to avoid impacts.

There is not enough information about the Whitney, Stillhouse Hollow and Granger Lakes potential reallocations at this time to determine or even to try to anticipate whether there would be adverse impacts to floodplains along the streams upstream and/or downstream of each reservoir. Certainly, compliance with NEPA, EOs, and USACE guidance and regulations prior to and during construction would avoid, minimize, or mitigate to the extent practicable any adverse impacts to floodplains associated with those federal actions. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to floodplains within the region.

Wetlands and Other Waters of United States

Implementation of the 4.5-foot pool raise at Aquilla would have temporary, adverse impacts to wetlands as a result of inundation, but this habitat would quickly return as the new inundated areas are converted from terrestrial habitats to wetlands. The pool rise would increase surface area of the lake, thus increasing limnetic zone (deep water) and littoral zone (shallow, shoreline) areas and increasing protection of waters of the United States. It is anticipated that this would be the same for any of the other potential reasonably foreseeable future reallocations. Future implementation of either or both of the pipeline alternatives are not anticipated to adversely impact wetlands as pipeline alignment and design would allow locating the pipeline right-of-way in areas that would avoid wetland impacts. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to wetlands within the region.

Aquatic Habitat

The surface water acreage of any of the proposed future reallocation actions would be expected to increase with project implementation, just like that of Aquilla Lake.

While upstream tributary streams would be impacted by inundation as a result of the pool rise at Aquilla, 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 the upstream creeks 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.

It is anticipated that either/or both pipeline alternatives would be aligned and designed in such a way as to avoid adverse aquatic habitat impacts. The one action that might have short-term adverse impacts to aquatic habitat would be the construction of a new water intake at Stillhouse Hollow Lake. It is anticipated that BMPs would be required to avoid or minimize those impacts to the extent possible, but the required siting of the structure within the lake means there would still be adverse impacts during construction.

There is not enough information about the Whitney, Stillhouse Hollow and Granger Lakes potential reallocations at this time to determine or even to try to anticipate whether there would be adverse aquatic habitat impacts to the upstream and/or downstream rivers or creeks of each reservoir. Certainly, compliance with NEPA, EOs, and USACE guidance and regulations prior to and during construction would avoid, minimize, or mitigate to the extent practicable any adverse impacts associated with those federal actions. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to aquatic habitat within the region.

Biological Resources

Vegetation Communities

Just as with the Aquilla Lake reallocation, all the potential reasonably foreseeable future reallocation projects would have adverse impacts to terrestrial vegetation resulting from the conversion of vegetational types as a result of the inundation associated with a pool raise. The higher the pool raise the greater the loss of vegetative habitat acreage on federal lands. As with the Aquilla reallocation, conversion of grasslands to shrublands, from shrublands to deciduous upland forests or riparian woodlands (depending on their moisture regime) will occur over the life of the projects, but there will be an overall loss of acreage of vegetation in any case. It is anticipated that vegetation types will be changed as the result of implementation of the potential pipeline alternative also, as the right-of –ways would be cleared of woody vegetation and restored and maintained as grasslands to reduce the potential of damage to the pipeline over time from tree roots. The losses to vegetative habitat as the result of the 4.5-foot pool raise at Aquilla will be mitigated. See the mitigation plan later in this appendix. Therefore, the 4.5-foot pool raise at

Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to terrestrial vegetation within the region.

Threatened and Endangered Species

Again, as discussed in the earlier Environmental Resources section, there are currently three T&E species known to occur within the counties associated with Aquilla, or have associated habitat that may be utilized – the golden-cheeked warbler, black-capped vireo, and the whooping crane All of these same species would be on the T&E species list in the location of each of identified reasonable foreseeable future projects. In fact, unlike Aquilla, the golden-cheeked warbler and black-capped vireo are either known to occur or have critical habitat within the federal lands surrounding Whitney, Stillhouse Hollow, and Granger reservoirs. It is anticipated that Section 7 consultation with USFWS would be required for all the other potential future projects identified, which leads to the expectation that there would be some measure of adverse impacts to T&E species resulting from implementation of any of the other potential reallocation and/or pipeline projects. Coordination with USFWS as part of Coordination Act requirements for the Aquilla study, determined that there would be no adverse impacts to T&E species, as the species do not occupy the area or have any of the critical habitat associated with their life requisites.

During investigations within the Aquilla Lake study area, the team of biologists from USACE, USFWS, and TPWD did not observe any of the T&E species identified nor encounter any habitat that appeared suitable for the golden-cheeked warbler or the black-capped vireo. 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 is unlikely to have an adverse impact on this species. Therefore, the 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to T&E species within the region.

OTHER CONSIDERATIONS REQUIRED BY NEPA

Unavoidable Adverse Impacts and Considerations That Offset These Impacts

Avoidance and minimization of adverse impacts to natural, cultural, and other environmental resources were integrated into the proposed action to the greatest extent possible and practicable. However, adverse impacts may not always be completely avoided and/or minimized. A mitigation plan has been developed and is included in this appendix, in addition, BMPs will be developed and required during construction to avoid and minimize adverse impacts to natural, cultural, and other environmental resources, as applicable. As the NEPA process progresses, additional mitigation measures and management actions may be revised based on consultation with federal and state regulatory agencies and comments received from the public. The EA will be updated to reflect these changes, including additional and revised SCMs, as applicable.

Relationships between Short-Term Uses of the Environment and Enhancement of Long-Term Productivity

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one development option reduces future flexibility in pursuing other options, or that giving over a parcel of land or other resource to a certain use often eliminates the possibility of other uses being performed at that site. Under the Proposed Action, short-term effects would be primarily related to construction activities and the use of associated vehicles and equipment that could be used for other purposes. In the long-term, the proposed reallocation would provide help an important water supply need. With implementation of BMPs, the Proposed Action would not result in any impacts that would reduce environmental productivity or narrow the range of beneficial uses of the environment.

Irreversible and Irretrievable Commitments of Resources

Resources that are irreversibly or irretrievably committed to a project are those that are used on a long-term or permanent basis. This includes the use of non-renewable resources such as metal and fuel. These resources are irretrievable in that they would be used for a project when they could have been used for other purposes. Human labor is also considered an irretrievable resource. In addition, the unavoidable destruction of natural resources that could limit the range of potential uses of that particular environment is also considered an irreversible commitment of resources. Implementation of the proposed action would require the consumption of materials typically associated with construction activities for the riprap on the embankment and the relocation and replacement of recreation features (e.g., concrete). In addition, the use of vehicles and construction equipment would result in the consumption of fuel, oil, and lubricants. An undetermined amount of human energy for construction would also be expended and irreversibly lost. However, the amount of these resources used would be relatively minor and these resources are readily available in large quantities. Therefore, implementation of the proposed action would not result in significant irreversible or irretrievable commitment of resources.

REGULATORY REQUIREMENTS

Status of Environmental Compliance

Table B-36 presents the status of compliance with all environmental laws and regulations for the proposed action.

Table B-36. Relationship of Plan to Environmental Protection Statutes and Other Environmental Requirements

Policies	Compliance of Plan
Public Laws	
Archeological and Historic Preservation Act, 1974, as amended	In Progress
Archeological Resources Protection Act, 1979, as amended	In Progress
Clean Air Act, 1977, as amended*	Compliant
Clean Water Act, 1972, as amended*	Compliant
Coastal Zone Management Act, 1972, as amended	Not Applicable
Endangered Species Act, 1973, as amended*	Compliant
Farmland Protection Policy Act	Not Applicable
Fish and Wildlife Coordination Act, 1958, as amended*	In Progress
Magnuson Fisheries Conservation and Management Act	Not Applicable
Migratory Bird Treaty Act, 1918, as amended*	Compliant
National Environmental Policy Act, 1969, as amended	In Progress
Rivers and Harbors Act, 1899	Compliant
Wild and Scenic Rivers Act, as amended	Not Applicable
Native American Graves Protection and Repatriation Act, 1990	Not Applicable
National Historic Preservation Act, 1966, as amended	In Progress
Executive Orders	
Environmental Justice (E.O. 12898)*	Compliant
Flood Plain Management (E.O. 11988)	Compliant
Protection of Wetlands (E.O. 11990)	Compliant
Invasive Species (E.O. 13112)*	Compliant
Migratory Birds (E.O. 13186)*	Compliant

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 and wetlands. 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 for surface waters and in-stream habitat over the life of the project; so no 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. Acres of riparian woodland are impacted, and average annual habitat units are lost (Table B-37).

Table B-37. Summary of Riparian habitat impacts as a result of the project alternatives.

	FWOP	**4.5' Pool Raise**	
Habitat Type	AAHU's	AAHU's	Net AAHU Change
Riparian Woodland	245.46	195.55	-49.91

The 4.5-foot pool raise would require 49.91 AAHU's of riparian bottomland hardwood 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 in the riparian bottomland hardwood mitigation areas.

Mitigation Plan Development

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 Wetland and 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 B-12).

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 portion of the lake, or that area associated with Hackberry Creek (see Figure B-13). 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, and the 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 and wetlands (Addendum B-2). Detailed tables for each of the measures and associated costs and AAHU's over the 50 year period of analysis are found in Addendum B-1.

Figure B-12. Preliminary mitigation areas within fee land boundary at Aquilla Lake

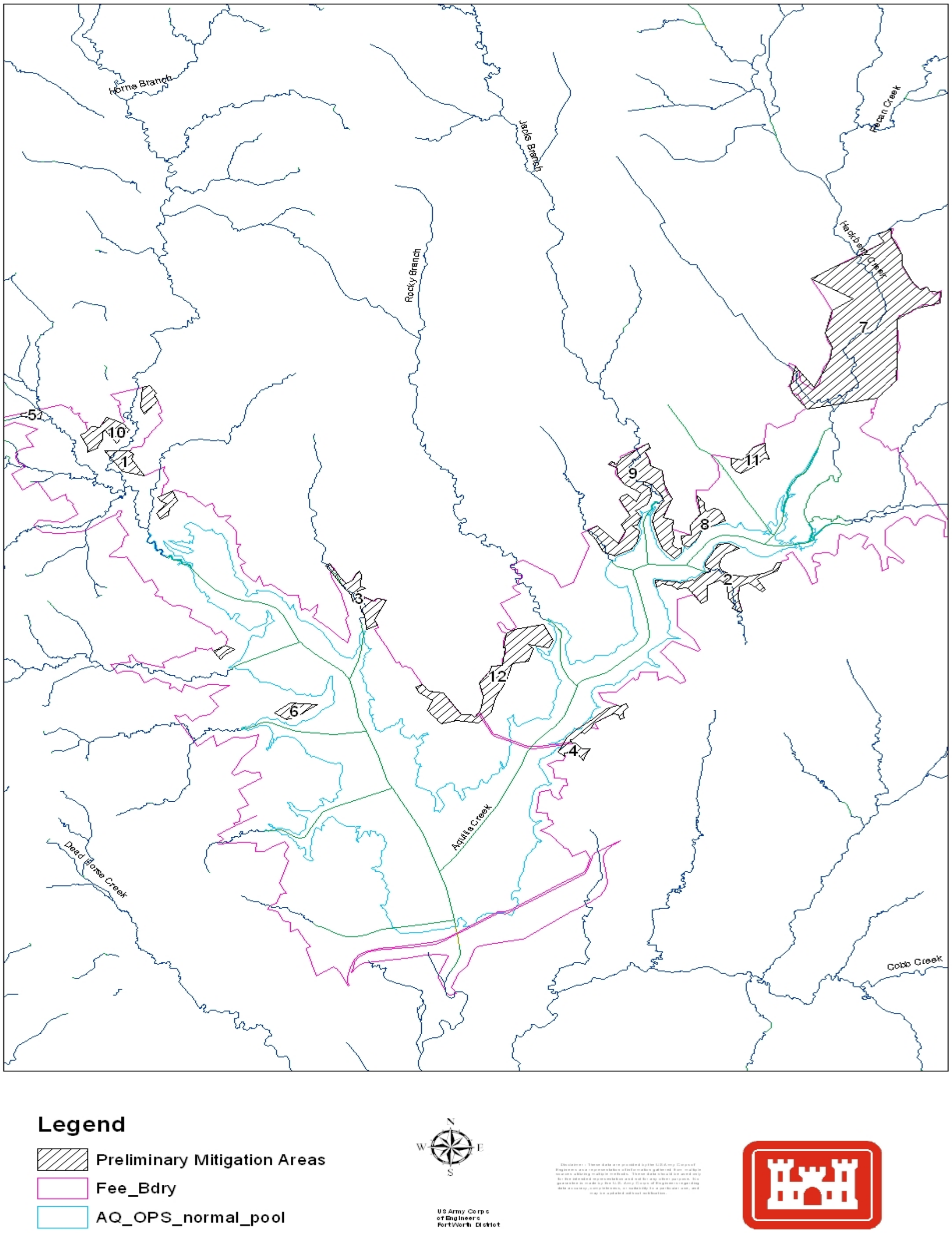
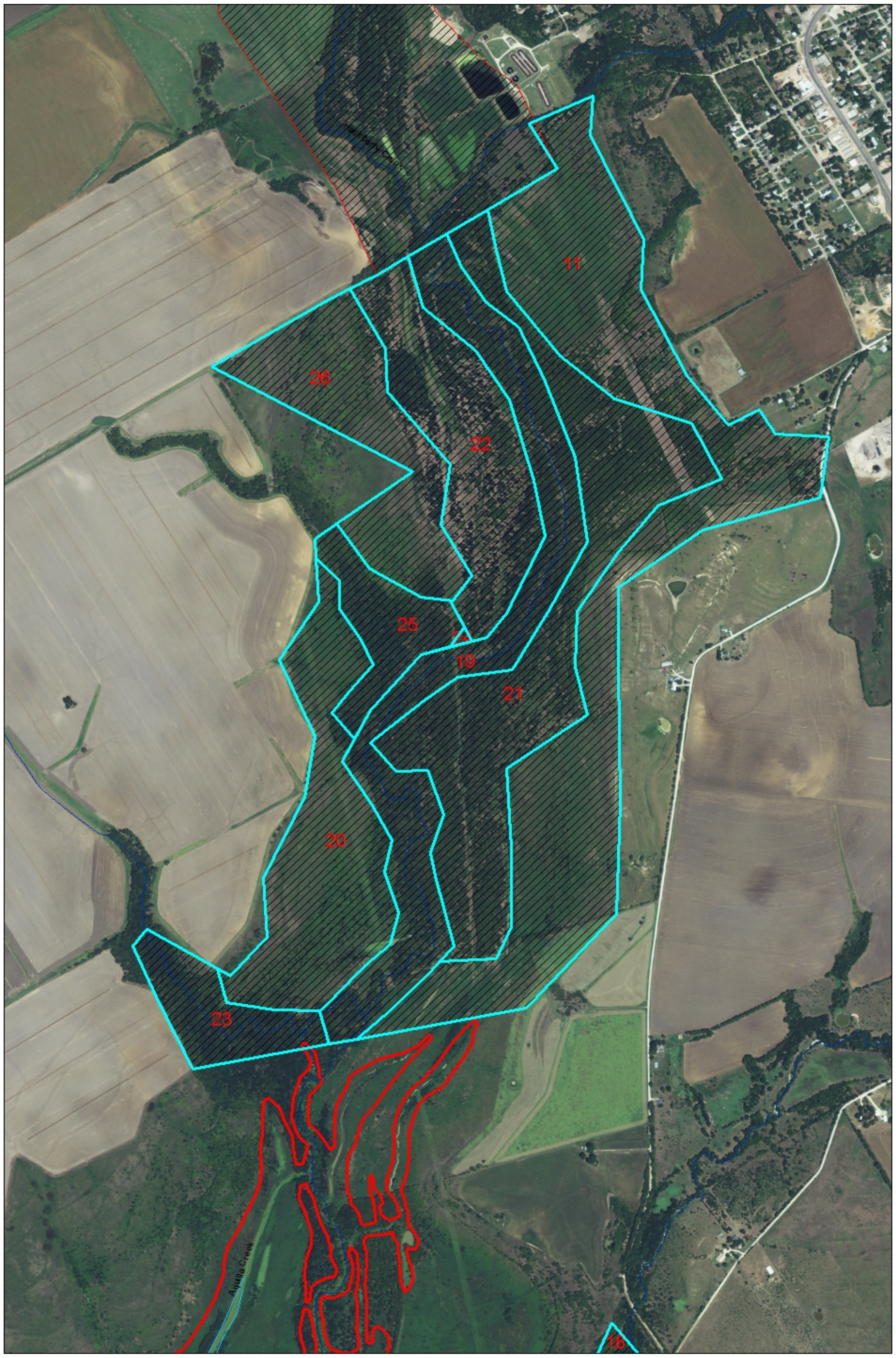


Figure B-13. Suggested mitigation area on Hackberry Creek


11
26
22
25
19
21
20
23
18

Mitigation costs for the 4.5-foot pool raise are outlined in Table B-38. 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 wetland and 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 B-38. Preliminary costs for riparian woodlands mitigation efforts

	Tract	Acres	Habitat Type	AAHU's gained	Cost/ per 1 acre	Total Cost (acreage * cost per 1 acre)
Mitigation	19	86.43	Riparian Woodland	15.56	$1,603.85	$138,623.05
	20	71.66	Grassland	30.10	$5,126.00	$367,331.05
	23	24.43	Riparian woodland	4.40	$1,603.85	$39,175.88
		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.

Authority and Purpose - Mitigation plans are required to include a strategy for monitoring the success of the restoration (Section 2039, WRDA 2007). "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." Section 2039 also directs that a Contingency Plan (Adaptive Management Plan) be developed for all ecological mitigation projects.

Implementation - 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 and discussed below.

Table B-39: Monitoring Criteria, Performance Standards, and Adaptive Management Strategies

Measurement	Performance Standard	Adaptive Management
Terrestrial Vegetation		
Woody Stem Density	Achievement of a specified density of assigned habitat category	Replacement of dead woody vegetation; modifying woody species composition or location within the assigned habitat category area; allowing natural succession of native woody species within the assigned habitat category area.
Herbaceous Percent Canopy	>80-percent canopy cover	Remedial planting/seeding; modification of plant species composition; amending the soil; increased irrigation.
Non-native Vegetation	<10-percent canopy cover of non-native species; and no areas >0.25 acres in size with >10-percent non-native species	Remedial planting/seeding; modification of plant species composition; amending the soil; increased irrigation; herbicide application; biological control; mechanical removal.
Non-native and Noxious Weeds	No areas >0.25 acres in size with >10-percent 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. 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 terrestrial vegetation would be considered successful when the herbaceous canopy percent cover of the mitigation site is at least 80-percent. 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-percent. 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-percent 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-percent.

Reporting - 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.

Monitoring and Adaptive Management Costs - 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 (Table B-40). The current total estimate for implementing the monitoring and adaptive management plan is $36,000. Unless otherwise noted, costs will begin at the onset of the PED phase and will be budgeted as construction costs.

Table B-40: Preliminary Cost Estimates for Implementation of the Monitoring and Adaptive Management Plan

Category	Activities	PED Set-up & Data Acquisition	1-year Construction	5-year Post Construction	Total
Monitoring: Planning and Management	Monitoring workgroup, drafting detailed monitoring plan, working with PDT on performance measures	$2,000	$1,000	$1,000	$4000
Monitoring: Data Collection	Vegetation	$3,000	$3000	$3,000	$9,000
Data Analysis	Assessment of Monitoring Data and Performance Standards	$1,000	$2,000	$2,000	$5,000
Adaptive Management Program	Detailed Adaptive Management Plan and Program Establishment	$6,000	-	-	$6,000
	Management of Adaptive Management Program	-	$4,000	$4,000	$8,000
Database Management	Database development, management and maintenance	$2,000	$1,000	$1,000	$4,000
Total		$14,000	$11,000	$11,000	$36,000

REFERENCES

Aquilla Lake Final Environmental Impact Statement, Tulsa District US Army Corps of Engineers, March 27, 1974.

Correll, D.S. & M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Diggs, G.M., Jr., B.L. Lipscomb, and R. J. O'Kennon.1999. Shinners & Mahler's illustrated flora of North Central Texas. Botanical Research Institute of Texas and Austin College. 1626 pp.

Gould, F.W. 1962. Texas Plants - A checklist and ecological summary. Texas Agric. Exp. Sta. Misc. Publ. 585:1-112.

Handbook of Texas Online Website: Hill County, accessed March 2009. http://www.tshaonline.org/handbook/online/articles/HH/hch15.html

Hatch, S.L., K.N. Gandhi, & L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. Misc. Publ. 1655:1-158.

Hill, R.T. 1901. Geography and geology of the Black and Grand Prairies, Texas. 21st Annual Report of the U.S. Geological Survey, Part VII - Texas, U.S. Government Printing Office, Washington D.C.

Hydrogeomorphic Approach for assessing stream functions, An overview of the HGM approach, www.el.erdc.usace.army.mil

Linam, G.W., L.J. Kleinsasser, and K.B. Mayes. 2002. Regionalization of the Index of Bitoic Integrity for Texas Streams (River Studies Report No. 17). Texas Parks and Wildlife Department. Austin, Texas.

NOAA. 2008. North Texas Climatology. http://www.srh.noaa.gov/fwd/ntexclima.html

South Forks Trinity River Mitigation Bank, Ellis County, Texas, Mitigation Banking Instrument, July 2006; Modified 07 October 2009

Steele Creek Mitigation Bank, Robertson County, Texas, Mitigation Banking Instrument, May 2004.

The Texas Rapid Assessment Method (TXRAM) Wetlands and Streams Modules, Final Draft for Public Review, USACE Regulatory Branch, for use within the Fort Worth and Tulsa Districts in the State of Texas, Version 1.0, October 2010.

Texas Commission on Environmental Quality (TCEQ) website: Water Quality at Aquilla Lake, accessed March 2009.
http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/pd/020/03-04/atrazine.html

Texas Parks and Wildlife Department. 2008. Aquilla Lake Fishing Page.

http://www.tpwd.state.tx.us/fishboat/fish/recreational/lakes/aquilla/index.phtml

U.S. Fish and Wildlife Service.1980. The habitat evaluation procedures. USDI Fish and Wildlife Service, Ecological Services Manual 102. 124 pp.

U.S. Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99 pp.

U.S. Fish and Wildlife Service, Existing Habitat Conditions Planning Aid Report for the Brazos Systems Assessment-Interim Feasibility Study Brazos River Basin Phase II, prepared by Sean Edwards USFWS, February 2009.

U.S. Fish and Wildlife Service. 2011. Brazos Systems Assessment-Interim Feasibility Study Brazos River Basin Phase II, Aquilla Lake Storage Reallocation Baseline Fisheries Survey, Supplemental PAL. Arlington Ecological Services office, October 2011.

Addendum B-1

Existing Conditions, FWO project & FW project conditions tables

Riparian Woodland

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without project conditions	Year Interval	0	1	4	5	15	25		
	HSI	**0.67**	**0.67**	**0.67**	**0.68**	**0.68**	**0.70**		
	ACRES	**334**	**334**	**339**	**344**	**359**	**384**		
	Target Year HU's	223.78	223.78	227.13	233.92	244.12	268.80		
	Interval HU's		223.78	901.82	1152.58	3585.30	6409.42	12272.90	245.46

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
with project conditions	Year Interval	0	1	4	5	15	25		
4.5 ft pool raise	**HSI**	0.67	0.67	0.67	0.68	0.68	0.70		
	ACRES	334	268	270	273	277	318		
	Target Year HU's	223.78	179.56	180.9	185.64	188.36	222.6		
	Interval HU's		201.67	720.92	916.33	2805.00	5133.58	9777.50	195.55
Net AAHU Change	**-49.91**								

Upland Deciduous Forest										
50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without project conditions	Year Interval	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's	2073.48	2073.48	2045.46	2045.46	2073.48	2073.48		
	Interval HU's		2073.483	8237.88	10227.30	30892.05	51837.00	103267.71	2065.35
50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
with project conditions	Year Interval	0	1	4	5	15	25		
4.5 ft pool raise	**HSI**	0.74	0.74	0.73	0.73	0.74	0.74		
	ACRES	2802.0	2545.0	2520.0	2495.0	2532.0	2458.0		
	Target Year HU's	2073.48	1883.30	1839.60	1821.35	1873.68	1818.92		
	Interval HU's		1978.39	7445.80	9152.38	27712.73	46137.50	92446.79	1853.34
Net AAHU Change	**-212.01**								

Herbaceous Wetland

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without project conditions	Year Interval	0	1	4	5	15	25		
	HSI	**0.54**	**0.54**	**0.57**	**0.60**	**0.62**	**0.65**		
	ACRES	**113**	**113**	**113**	**113**	**113**	**113**		
	Target Year HU's	61.02	61.02	64.41	67.80	70.06	73.45		
	Interval HU's		61.02	250.86	330.53	1033.95	1793.88	3470.23	69.40

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
with project conditions	Year Interval	0	1	4	5	15	25		
4.5 ft pool raise	**HSI**	**0.54**	**0.45**	**0.60**	**0.65**	**0.65**	**0.65**		
	ACRES	**113**	**67**	**103**	**127**	**127**	**127**		
	Target Year HU's	61.02	30.15	61.80	82.55	82.55	82.55		
	Interval HU's		45.59	183.90	360.88	1238.25	2063.75	3892.36	77.52
Net AAHU Change	**8.12**								

Grassland	**50 year Project Life**	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
	without project conditions	Year Interval	0	1	4	5	15	25		
		HSI	0.48	0.47	0.46	0.45	0.45	0.45		
		ACRES	1199	1164	1079	1019	959	899		
		Target Year HU's	575.52	547.08	496.34	458.55	431.55	404.55		
		Interval HU's		561.30	2086.84	2387.23	6675.75	10451.25	22162.37	445.84
	50 year Project Life	**Target Year's**	0	1	5	10	25	50	Cumulative Hu's	AAHU's
	with project conditions	Year Interval	0	1	4	5	15	25		
	4.5 ft pool raise	**HSI**	0.48	0.46	0.45	0.44	0.42	0.40		
		ACRES	1199	1100	1084	1034	934	890		
		Target Year HU's	575.52	506.00	487.80	454.96	392.28	356.00		
		Interval HU's		540.43	1987.60	2356.90	6354.30	9353.50	20593.06	415.07
	Net AAHU Change	**-30.77**								

Deciduous Shrubland

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without project conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.63	0.63	0.64	0.65	0.66	0.67		
	ACRES	2043	2043	2048	2058	2070	2082		
	Target Year HU's	1287.09	1287.09	1310.72	1337.70	1366.20	1394.94		
	Interval HU's		1287.09	5195.59	6620.97	20278.95	34513.75	67896.34	1357.93

50 year Project Life	**Target Year's**	0	1	5	10	25	50	Cumulative Hu's	AAHU's
with project conditions	Year Interval	0	1	4	5	15	25		
4.5 ft pool raise	**HSI**	0.63	0.63	0.64	0.65	0.66	0.67		
	ACRES	2042	1890	1895	1905	1920	1930		
	Target Year HU's	1286.46	1190.7	1212.8	1238.25	1267.2	1293.1		
	Interval HU's		1238.58	4806.97	6127.54	18790.50	32003.33	62966.92	1259.34
Net AAHU Change	**-98.59**								

Savanna

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without project conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.54	0.54	0.55	0.56	0.57	0.58		
	ACRES	365	397	475	520	553	576		
	Target Year HU's	197.10	214.38	261.25	291.20	315. 21	334.08		
	Interval HU's		205.74	950.74	1380.75	4547.25	8115.17	15199.65	303.99

50 year Project Life	**Target Year's**	0	1	5	10	25	50	Cumulative Hu's	AAHU's
with project conditions	Year Interval	0	1	4	5	15	25		
4.5 ft pool raise	**HSI**	0.54	0.54	0.55	0.56	0.57	0.58		
	ACRES	365	364	388	439	485	550		
	Target Year HU's	197.1	196.56	213.40	245.84	276.45	319.00		
	Interval HU's		196.83	819.92	1148.10	3917.18	7443.13	13525.15	269.06
Net AAHU Change	**-34.93**								

Water / Aquatic Habitat										
	50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
	without project conditions	Year Interval	0	1	4	5	15	25		
		HSI	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**		
		ACRES	**3164**	**3164**	**3164**	**3164**	**3164**	**3164**		
		Target Year HU's	1423.80	1423.80	1423.80	1423.80	1423.80	1423.80		
		Interval HU's		1423.80	5695.20	7119.00	21357.00	35595.00	71190.00	1423.80
	50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
	with project conditions	Year Interval	0	1	4	5	15	25		
	4.5 ft pool raise	**HSI**	**0.45**	**0.45**	**0.47**	**0.48**	**0.48**	**0.48**		
		ACRES	**3164**	**3786**	**3760**	**3747**	**3747**	**3747**		
		Target Year HU's	1423.80	1703.70	1767.20	1798.56	1798.56	1798.56		
		Interval HU's		1563.75	6941.80	8914.40	26978.40	44964.00	89362.35	1780.12
	Net AAHU Change	**356.32**								

Addendum B-2

Preliminary mitigation analysis tables (terrestrial)

Riparian Woodland									
50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without mitigation conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.67	0.67	0.67	0.68	0.68	0.70		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0.67	0.67	0.67	0.68	0.68	0.70		
	Interval HU's		0.67	2.68	3.38	10.20	17.25	34.18	0.68
50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
with mitigation conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.67	0.77	0.80	0.84	0.88	0.90		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0.67	0.77	0.80	0.84	0.88	0.90		
	Interval HU's		0.72	3.14	4.10	12.90	22.25	43.11	0.86
Net AAHU Change	**0.18**								

Upland Deciduous Forest

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without mitigation conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.40	0.40	0.40	0.40	0.40	0.40		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0.40	0.40	0.40	0.40	0.40	0.40		
	Interval HU's		0.40	1.60	2.00	6.00	10.00	20.00	0.40
50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	Cumulative Hu's	AAHU's
with mitigation conditions	Year Interval	0.00	1.00	4.00	5.00	15.00	25.00		
	HSI	0.40	0.50	0.55	0.60	0.65	0.75		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0.40	0.50	0.55	0.60	0.65	0.75		
	Interval HU's		0.45	2.10	2.88	9.38	17.50	32.30	0.65
Net AAHU Change	**0.25**								

Grassland / Savanna

50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without mitigation conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.00	0.00	0.00	0.00	0.00	0.00		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0.00	0.00	0.00	0.00	0.00	0.00		
	Interval HU's		0.00	0.00	0.00	0.00	0.00	0.00	0.00

50 year Project Life	**Target Year's**	0	1	5	10	25	50	Cumulative Hu's	AAHU's
with mitigation conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.00	0.20	0.25	0.35	0.45	0.55		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0	0.2	0.25	0.35	0.45	0.55		
	Interval HU's		0.10	0.90	1.50	6.00	12.50	21.00	0.42
Net AAHU Change	**0.42**								

Shrubland										
50 year Project Life	**Target Year's**	**0**	**1**	**5**	**10**	**25**	**50**	**Cumulative Hu's**	**AAHU's**
without mitigation conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.25	0.25	0.25	0.25	0.25	0.25		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0.25	0.25	0.25	0.25	0.25	0.25		
	Interval HU's		0.25	1.00	1.25	3.75	6.25	12.50	0.25
50 year Project Life	**Target Year's**	0	1	5	10	25	50	Cumulative Hu's	AAHU's
with mitigation conditions	Year Interval	0	1	4	5	15	25		
	HSI	0.25	0.35	0.45	0.55	0.65	0.70		
	ACRES	1	1	1	1	1	1		
	Target Year HU's	0.25	0.35	0.45	0.55	0.65	0.7		
	Interval HU's		0.30	1.60	2.50	9.00	16.88	30.28	0.61
Net AAHU Change	**0.36**								

Preliminary terrestrial mitigation measures and associated costs

Mitigation Measures		**Cost ($)**
Measures for 1 acre of Riparian Woodland improvement		
	Invasive species control (mechanical)	216.14
	Native tree planting (5 trees per acre with at least 5 dbh)	1115.70
	Insert nest/bird boxes (1 per acre)	272.01
		1603.85
Measures for 1 acre of Upland Forest converted to Riparian Woodland		
	Invasive species control (mechanical)	216.14
	Native tree planting (5 trees per acre with at least 5 dbh)	1115.70
	Native shrub/grass planting (1 per acre) (includes grass cover per acre and 10 shrubs /ac)	650.00
	Insert nest/bird boxes (2 per acre)	544.00
		2525.84
Measures for 1 acre of Shrubland converted to Riparian Woodland		
	Invasive species control (mechanical)	216.14
	Native tree planting (10 per acre, plants with at least 5 dbh)	2230.00
	Native shrub/grass planting (10 per acre) (includes grass cover per acre and 10 shrubs /ac)	1300.00
	Insert nest/bird boxes (3 per acre)	816.00
	Excavation, soil prep, grading	780.00
		5342.14
Measures for 1 acre of Grassland / Savanna converted to Riparian Woodland		
	Native tree planting (10 per acre, plants with at least 5 dbh)	2230.00
	Native shrub/grass planting (10 per acre) (includes grass cover per acre and 10 shrubs /ac)	1300.00
	Insert nest/bird boxes (3 per acre)	816.00
	Excavation, soil prep, grading	780.00
		5126.00